Context Dependence in Modal Constructions

Von der Fakultät Philosophie der Universität Stuttgart
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genehmigte Abhandlung

Vorgelegt von Anette Frank aus Mosbach/Baden

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Betreuer: Prof. Dr. Dr. Hans Kamp, Universität Stuttgart
Mitberichter: Priv.–Doz. Dr. Thomas E. Zimmermann, Universität Stuttgart

Institut für Maschinelle Sprachverarbeitung der Universität Stuttgart

Hiermit erkläre ich, die vorliegende Arbeit selbständig verfaßt und nur die angegebenen Hilfsmittel und Quellen, sowie Hinweise namentlich genannter Personen verwendet zu haben.

Stuttgart, den 23.12.1996

Inside every large problem
is a small problem struggling to get out.

Danksagung

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Diese Dissertation ist meinen Eltern und meiner Schwester Claudia gewidmet.

Contents

Zusammenfassung

Gegenstand der vorliegenden Dissertation ist die Semantik und Kontextabhängigkeit modaler Konstruktionen. Zentrales Anliegen ist es hierbei, für eine breite Datenbasis im Phänomenbereich modaler Konstruktionen eine *uniforme* Analyse zu entwickeln.

Als theoretische Grundlage wählen wir die von Kamp(1981) entwickelte Diskursrepräsentationstheorie (DRT). Eine herausragende Eigenschaft dieser semantischen Theorie ist ihre repräsentationelle Komponente in Form einer Ebene der Diskursrepräsentation, einer Diskursrepräsentationsstruktur (DRS). Ein weitaus wichtigeres Charakteristikum dieser Theorie ist jedoch die grundlegende Einsicht, daß die Bedeutung natürlichsprachlicher Sätze nur unter Berücksichtigung ihrer Kontextabhängigkeit adäquat beschrieben werden kann. Eine besondere Form dieser Kontextabhängigkeit ist das Phänomen satzübergreifender anaphorischer Beziehungen zu sprachlichen Elementen, die im vorangehenden Diskurs eingeführt wurden. Gemeinsam mit der von Heim(1982) entwickelten File Change Semantics (FCS) ist die DRT eine der ersten semantischen Theorien, die für diese besondere Art der Kontextabhängigkeit eine formale Semantiktheorie bereitstellten. Einige der zentralen anaphorischen Phänomene, die im Rahmen der DRT und der FCS erfolgreich behandelt werden konnten, sind die Interpretation von Pronomina und definiten Kennzeichnungen, die Analyse von Tempus, die Semantik des Plurals, sowie Präsuppositionen.

Das Problem der modalen Subordination

Durch die DRT Analyse quantifizierender Konstruktionen lieferte Kamp(1981) eine Lösung für das klassische Problem der sogenannten Eselssätze (1). Quantifikation wird als intern dynamisch, jedoch als extern statisch analysiert. Ein Pronomen, das sich im Skopus eines Konditionals befindet, kann daher anaphorisch von einem indefiniten Antezedens gebunden werden, welches im Restriktor des Konditionals realisiert ist. Dagegen kann ein Pronomen, das im nachfolgenden Satz realisiert wird, nicht anaphorisch von einem indefinitien Antezedens gebunden werden, das im Restriktor oder Skopus eines Konditonals realisiert wird.

(1) If a farmer owns *a donkey*, he beats *it*. # He doesn't like *it*.

Roberts(1987,1989) diskutiert *Kontexte modaler Subordination*, die dieser Analyse widersprechen. Beispiele wie (2) zeigen, daß in speziellen Kontexten ein im nachfolgenden Satz realisiertes Pronomen als anaphorisch zu einem Antezedens interpretiert werden kann, welches sich in einem "opaquen" Kontext, z.B. im Restriktor eines Konditionals befindet. Auch in Roberts' DRT Analyse wird Quantifikation als extern statisch und intern dynamisch behandelt, wodurch Standardfälle wie (1) korrekt erfaßt werden. Ein spezieller *Akkommodationsmechanismus* erlaubt es jedoch, in Kontexten modaler Subordination wie (2) Material aus einem opaquen Kontext in eine zugängliche Position zu *akkommodieren*, sodaß Pronomina in "modal subordinierten" Sätzen anaphorisch gebunden werden können. Geurts(1995) entwickelt eine alternativen Analyse, in der Modaloperatoren als präsuppositionale Ausdrücke behandelt werden. Modale Subordination wie in (2) kann somit ohne Rekurs auf einen allzu mächtigen Akkommodationsmechanismus analysiert werden.

(2) If a farmer owns *a donkey*, he beats *it*. *It* might kick back.

Roberts' und Geurts' DRT Analysen der modalen Subordination basieren auf Kratzer's (1978,1991) Analyse *relativer* und *graduierter Modalität*. Auf der Ebene der Diskursrepräsentation findet jedoch keine Differenzierung zwischen beispielsweise deontischer und epistemischer Modalität (siehe (5)), oder indikativen und kontrafaktischen Konditionalen statt. Es ist daher auch nicht möglich, die anaphorische Dependenz eines deontischen Modaloperators relativ zu einem deontischen Kontext zu *repräsentieren*, der explizit durch den vorangehenden Diskurs eingeführt wurde, wie beispielsweise in (3) durch die Phrase *German tax law*. Schließlich erlaubt Geurts' Theorie keine Analyse modaler Subordination relativ zu einem negierten Kontext (6a), und auch die kontextuelle Dependenz eines Modaloperators relativ zum vorangehenden faktischen Kontext, wie in (6b), wird nicht korrekt erfaßt.

(3) According to *German tax law*, Max *must* pay taxes for his car.

Relative Modalität: Kontextuelle Dependenz in modalen Konstruktionen

Die Quintessenz von Kratzer's Analyse *relativer Modalität* ist es, daß modale Ausdrücke, wie z.B. *must* in (4) nicht semantisch ambig sind, gemäß der traditionellen Unterscheidung zwischen *epistemischer*, *deontischer* und "*circumstantial*" Modalität, sondern sich kontextuell auf unterschiedliche Arten von intensionalen "Hintergrundkontexten" – epistemisch (4a), deontisch (4b) oder "circumstantial" (4c) – beziehen, welche die *modale Basis* für die Interpretation eines *neutralen* (universalen) Modaloperators bilden.

(4) a. (*In view of* the available evidence,) Jockl *must* have been the murderer.

b. (*In view of* what the law provides,) Jockl *must* go to jail.

c. (*In view of* the present state of his nose etc.,) Jockl *must* sneeze.

Die Analyse relativer Modalität wird in Kratzer(1981) durch das Konzept der *graduierten Modalität* erweitert, insbesondere für die Analyse deontischer und kontrafaktischer Modalität: *Graduierte Modalität* involviert neben der modalen Basis einen zweiten Hintergrundskontext, die sogenannte *ordering source*, oder den *Ordnungskontext*. Dieser definiert eine partielle Ordung über der Menge von Welten, die durch die modale Basis bestimmt werden. Für das deontische Konditional (5a) wird der Modaloperator als relativ zu einer "circumstantial" modalen Basis und einem deontischen Ordnungskontext interpretiert, während das kontrafaktische Konditional in (5b) relativ zu einer leeren modalen Basis und einer "totally realistic ordering source" analysiert wird. Hierdurch induziert, für (5a), der deontische Ordnungskontext eine partielle Ordung über der Menge von Welten, die durch die modale Basis $f(w)$, vereinigt mit der durch das Antezedens denotierten Proposition p determiniert wird. Auf der Basis dieser partiellen Ordung wird die Domäne des universal quantifizierenden Modaloperators auf die Menge von Welten restringiert, die dem "Ideal" des deontischen Ordnungskontexts maximal "ähnlich" sind.

(5) a. If Max will buy a car, he must pay taxes.

b. If Max had bought a car, he would have paid taxes.

Kratzer's Analyse *relativer* und *graduierter Modalität* bietet eine ausgezeichnete Grundlage für die Behandlung anaphorischer Dependenz und Präsuppositionsprojektion in modalen Kontexten. Nicht zuletzt aus diesen Gründen wurde diese Theorie als Basis der von Roberts und Geurts entwickelten Analysen im Rahmen der DRT "rekonstruiert".

Eine Analyse modaler Operatoren als generalisierte Quantoren

In der Literatur herrscht weitgehende Einigkeit darüber, daß Modalverben, nach dem Vorbild von Frequenzadverbien, als generalisierte Quantoren zu behandeln sind (siehe Lewis(1975), Partee(1991), von Fintel(1994,1995). Dies erlaubt nicht nur eine natürliche Analyse graduierter Modalausdrücke, wie z.B. *probably, unlikely*, sondern ermöglicht insbesondere eine geeignete Modellierung der inhärenten Kontextabhängigkeit modaler Konstruktionen: von Fintel(1995) argumentiert, daß generalisierte Quantoren anaphorisch auf eine Variable des jeweils geeigneten Typs referieren, welche – zusammen mit dem Restriktor – die Quantifikationsdomäne des Quantors determiniert. Für Modaloperatoren wurde diese Einsicht durch Kratzer(1978) vorbereitet, die Modaloperatoren als *relativ zu*, oder kontextuell abhängig von unterschiedlichen Arten intensionaler Kontexte charakterisiert.

Wir ordnen daher Modalausdrücken eine Diskursrepräsentationsstruktur oder logische Form zu, die sie als *generalisierte Quantoren* auszeichnet, deren Restriktorargument durch einen *anaphorischen* Diskursreferenten eingeschränkt wird. Da Modaloperatoren als anaphorisch zu intensionalen Kontexten analysiert werden müssen, führen wir einen neuen Typ von Diskursreferenten ein, welche wir als *Kontextreferenten* bezeichnen. Kratzer's Begriff der *relativen Modalität* wird somit durch das Konzept eines anaphorischen Restriktorarguments eines generalisierten Modalquantors modelliert.

Dieser Ansatz liefert die Voraussetzung für eine *uniforme* Analyse von *relativer Modalität* und *modaler Subordination*, denn, wie wir zeigen ist modale Subordination als ein Spezialfall relativer Modalität zu betrachten. Jedoch stellen sich für diese Analyse – da konzeptuell der von Geurts entwickelten präsuppositionalen Analyse von Modaloperatoren sehr ähnlich – exakt dieselben Probleme, die wir für Geurts' Analyse nachweisen.

Wie oben erwähnt rekonstruieren Roberts und Geurts für die Analyse deontischer und kontrafaktischer Modalität das von Kratzer entwickelte Konzept der *graduierten Modalität.* Der Modaloperator wird relativ zu zwei intensionalen Kontexten interpretiert, der modalen Basis und dem Ordnungskontext: Für deontische Modalität, beispielsweise, induziert der deontische Antezedenskontext eine partielle Ordnung über der Menge von Welten die durch die modale Basis determiniert werden. Die Quantifikationsdomäne wird eingeschränkt auf diejenigen Welten, die bezüglich dieser partiellen Ordung maximal dem "Ideal", das durch den deontischen Ordnungskontext definiert wird, entsprechen.

Da jedoch in diesen Analysen der Ordnungskontext nicht auf der Ebene der DRS repräsentiert wird, werden den Konditionalen in (5a–b) identische Repräsentationsstrukturen zugeordnet (hier modulo temporaler Differenzierungen), und es ist prinzipiell ausgeschlossen, die anaphorische Dependenz des deontisch zu interpretierenden *must* in (3) relativ zu dem durch die Phrase *German tax law* eingeführten Kontexts zu repräsentieren, was der Behandlung anaphorischer Phänomene in der DRT zuwiderläuft.

Schließlich sind Beispiele wie in (6) problematisch für Geurts' Analyse: In (6a) befindet sich das Antezedens für das Pronomen *it* im Skopus der Negation, und ist daher für anaphorische Bindung unzugänglich. In Geurts' Theorie kann dieser Konstruktionstyp nicht als eine Instanz modaler Subordination analysiert werden. (6b) ist in anderer Hinsicht problematisch: Der Modaloperator des Konditionals kann nicht in gleicher Weise als kontextuell abhängig vom vorangehenden Kontext analysiert werden, wie dies in Fällen modaler Subordination möglich ist. Diese spezielle Analyse der kontextuellen Dependenz ist jedoch unerläßlich für eine korrekte Berechnung der Wahrheitsbedingungen für das Konditional.

(6) a. I don't have *a microwave oven*. I wouldn't know what to do with *it*.

b. There a three people in the room. If one of them leaves the room, there will still be one person in the room.

Doch auch die Repräsentation modaler Operatoren als anaphorische generalisierte Quantoren, die die Grundlage unserer Analyse bildet, ist mit diesen Problemen konfrontiert.

Repräsentation kontextueller Dynamik in DRT

Sowohl das Problem einer fehlenden Repräsentation des Ordnungskontexts für deontische Modalität, als auch die durch (6) illustrierten Probleme machen eine wesentliche Modifikation der Repräsentationssprache der DRT erforderlich.

Die Bedeutung eines Satzes wird in der DRT als essentiell *kontextabhängig* charakterisiert, indem jeder Satz relativ zum vorangehenden Kontext interpretiert wird, i.e. "as an addition to, or 'update' of, the context in which it is used" (Kamp&van Eijck(1996)). Dieser *dynamischen Perspektive* folgend ist die Bedeutung eines Satzes durch Bedingungen der Kontextveränderung zu beschreiben. Um diese Intuition formal zu erfassen, definieren Kamp&van Eijck(1996) eine *relationale* oder *dynamische* Semantik für DRSen: Die Bedeutung einer (partiellen) DRS D wird definiert als eine Relation zwischen "input" und "output" Funktionen s und s', die Individuen der DRS Sprache ins Modell abbilden: ${}_{s}[\![D]\!]^{M}_{s'}$ (siehe auch Kamp&Reyle(1996), Kamp(1996)). Durch diese relationale Semantik für DRSen wird nicht nur dem Aspekt der *dynamischen Bedeutung* von Sätzen im Diskurs Rechnung getragen. Durch die Einführung eines *Sequenzoperators ";"* wird überdies die kontextuelle Dynamik eines Diskurses explizit auf der Ebene der DRS *repräsentiert.*

Obwohl durch die relationale Bedeutungsdefinition der Aspekt kontextueller Dynamik sowohl in der Semantik, als auch in der Repräsentationssprache Eingang findet, führt dies noch nicht zur Lösung der oben skizzierten Probleme. Insbesondere kann die kontextuelle Abhängigkeit des Konditionals in (6b) nicht durch Bezugnahme auf eine Funktionen s' erfaßt werden, welche durch die relationale Semantik der DRS für den vorangehenden Satz definiert wird, da diese Funktion nicht Bestandteil der Objektsprache ist, und somit nicht als Antezedens für die anaphorische modale Basis des Modaloperators zur Verfügung steht.

Es wird gezeigt, daß die dynamische Semantik für DRSen durch eine Anreicherung der Repräsentationssprache zu einer *Repräsentation* der kontextabhängigen und dynamischen Interpretation von Sätzen erweitert werden kann. Wir stellen einen direkten Bezug her zwischen der relationalen Bedeutungsdefinition für DRSen und *update conditions* auf der Ebene der Diskursrepräsentation, bei gleichzeitiger Erweiterung zu einem intensionalen Modell.

In (7) definieren wir die Verifikation einer *update condition* $G :: F + K'$, wobei die Kontextreferenten F und G Mengen von Welt–Funktions–Paaren (oder "states") denotieren. Die Verifikationsbedingung (7) definiert die Denotation $e(G)$ des "Outputreferenten" G der *update condition* als diejenige Menge von "states" $\langle w', g \rangle$, für die es in der Denotation $e(F)$ von F einen "state" $\langle w', f \rangle$ gibt, sodaß $\langle w', f \rangle$ und $\langle w', g \rangle$ geeignete "input" und "output states" in der relationalen Bedeutung ${}_{\langle w',f \rangle}[\![K']\!]_{\langle w',g \rangle}$ von K' bilden.

(7) $\langle w, e \rangle \models_M G :: F + K' \quad \text{iff} \quad e(G) = \{\langle w', g \rangle : (\exists \langle w', f \rangle \in e(F))\ {}_{\langle w',f \rangle}[\![K']\!]_{\langle w',g \rangle}\}$.

Ausgehend von der grundlegenden Einsicht der DRT, daß jeder Satz eines Diskurses als kontextabhängig von, oder als "update" des vorangehenden Kontexts zu interpretieren ist, entwickeln wir ein neues Repräsentationsformat für DRSen, mit dem Ziel, die *Dynamik* des repräsentierten Diskurses *explizit* in der DRS zu repräsentieren. Der DRS Konstruktionsalgorithmus erzeugt nun für jeden Satz S_i innerhalb eines Diskurses eine neue *update condition* $C_i :: C_{i-1} + K_i$, wobei K_i die Repräsentation des Satzes S_i und C_{i-1} der "annotierende" Kontextreferent der für den vorangehenden Satz S_{i-1} konstruierten *update condition*. Auf der Basis dieses neuen Repräsentationsformats ist es nun möglich, in problematischen Fällen wie (6b) das anaphorische Restriktorargument X' eines Modalquantors als anaphorisch zu einem Kontextreferenten G zu repräsentieren, welcher – durch kontinuierliche "Updates" – den vorangehenden faktischen Kontext repräsentiert.

Diese Modifikation des DRS Formats zur Repräsentation kontextueller Dynamik erfordert eine sorgfältige Definition verifizierender Einbettungsfunktionen, um deren Wohlfundiertheit zu garantieren, sowie eine modifizierte Definition der Subordinationrelation als Basis für die Zugänglichkeitsrestriktionen für anaphorische Bindung. Die neu definierten Zugänglichkeitsrestriktionen erfassen nicht nur die Standardfälle (siehe (1)), sondern liefern auch adäquate Vorhersagen für *relative Modalität* (3)–(6), sowie Kontexte modaler Subordination (2). Neben den klassischen Fällen modaler Subordination, wie in (2), erfaßt unsere Analyse auch modale Subordination relativ zu negierten (8) und zu durch graduierte Modalquantoren (9) eingeführten Kontexten. Durch zusätzliche semantische Bedingungen in Abhängigkeit des Satzmodus modaler Konstruktionen werden weitere Einschränkungen für modale Subordination korrekt vorhergesagt (siehe (8a) vs. (8b) und (9a) vs. (9b)).

(8) Fred didn't buy a microwave oven.
  a. He wouldn't know what to do with it.
  b. # He might like/use it.
  c. # Clarissa is using it.

(9) a. If Max goes to China, *in no case/it's unlikely that* he will he buy books.
  He would/#will not read them.
  b. If Max goes to China, he *probably/might/necessarily* (will) buy books.
  He will not read them.

Die Verwendung unseres neuen DRS Formats zur Repräsentation kontextueller Dynamik erlaubt darüberhinaus eine Analyse *subordinierter disjunktiver Kontexte* (10) (sog. *modal splitting*). Im Gegensatz dazu argumentieren wir *gegen* eine Analyse der klassischen "bathroom" Sätze als Spezialfall der modalen Subordination (siehe Roberts(1989)).

(10) You will stay unmarried, or you will marry a tramp.
You'll become a nun, or the tramp will beat you regularly.
Either way you'll have a miserable life. Landman(1986:205)

(11) Either there is no bathroom in this house, or it is in a funny place. Roberts(1989:702)

Analyse (multipler) relativer Modalitaet

Durch die Verwendung des neuen DRS Repräsentationsformats kann nicht nur das Problem des anaphorischen Bezugs modaler Konstruktionen relativ zum faktischen Kontext (6b), sowie zu negierten Kontexten (6a) gelöst werden. Für das weitere Problem einer fehlenden Repräsentation des Ordnungskontexts in Fällen sogenannter *graduierter Modalität* (siehe (3), (5a–b)), entwickeln wir eine Analyse deontischer und kontrafaktischer Modalität, die vom Konzept der graduierten Modalität abweicht. Im Falle deontischer Modalität wird die modale Basis durch einen *komplexen* konsistenten Kontext instanziiert, der durch Konjunktion (*merge*) des faktischen Bezugskontexts mit einem maximalen oder relevanten Teilkontext des auf der Ebene der DRS repräsentierten (potentiell unterspezifizierten) deontischen Bezugskontexts gebildet wird. Zur Determination des reduzierten deontischen Teilkontexts machen wir Gebrauch von einer Relation der *context reduction*, ähnlich der Relation *contraction* in Gaerdenfors(1988). Auch für die Analyse kontrafaktischer Modalität wird die kontextuelle Dependenz zum faktischen Bezugskontext durch die Relation der *context reduction* vermittelt. Die semantische Differenzierung zwischen epistemischer und deontischer Modalität, sowie zwischen indikativen und kontrafaktischer Modalität wird durch unterschiedliche Repräsentationsstrukturen auf der Ebene der DRS reflektiert. Schließlich somit auch die anaphorische Dependenz eines deontischen Modaloperators relativ zu einem overt eingeführten deontischen Bezugskontext adäquat repräsentiert und analysiert werden.

Unsere Analyse deontischer Konditionale weicht deutlich von traditionellen Analysen, wie z.B. Lewis(1973) und Kratzer(1981,1991) ab, welche für deontische Konditionale eine "Ein–Operatoren" Analyse postulieren. Hierdurch können prinzipiell nur solche Lesarten deontischer Konditionale erfaßt werden, die als "conditional obligation" bezeichnet werden, wie z.B. (12a). Wir argumentieren dagegen für eine Analyse (indikativer und kontrafaktischer) deontischer Konditionale, die den deontischen Modaloperator im Skopus des "übergeordneten" (epistemisch modalisierten) Konditionals lokalisiert. In Fällen wie (12a), mit einer Lesart der "conditional obligation", ist der zugängliche deontische Kontext, die Gesetze, die in den epistemisch zugänglichen Welten gelten in denen Jesse Girgl ermordet, identisch mit dem in der aktualen Welt gültigen Gesetzeskontext, wohingegen in Fällen wie (12b) die "Gesetze", die in den epistemisch zugänglichen Welten gültig sind, in denen der Geschichtsverlauf von dem der aktualen Welt abweicht, deutlich von denjenigen abweichen können, die in der aktualen Welt gelten. Schließlich entwickeln wir eine Lösung für das Problem "trivialer wahrer" deontischer Sätze (13), die durch Lewis' und Kratzer's traditionelle Analyse deontischer Konditionale nicht ausgeschlossen werden.

(12) a. If Jesse murders Girgl, Jesse *must* go to jail.

b. If Luther hadn't engendered the Reformation, we'd still *have to* pay indulgence.

(13) If Jesse robs the bank and his mother gets notice of it, Jesse *must* have a mother.

Die von uns entwickelte Analyse "multipler" relativer Modalität erweist sich auch im Hinblick auf Kontexte modaler Subordination als adäquat, wie wir durch Untersuchung von Kontexten mit unterschiedlich kombinierten nicht restringierten und konditionalen epistemischen und deontischen modalen Sätzen zeigen.

Das Problem inkonsistenter Kontexte

Als wesentliche Motivation für ihre Analyse deontischer Modalität durch das Konzept der *graduierten Modalität* führt Kratzer Beispiele an, die inkonsistente, konfligierende faktische und deontische Bezugskontexte involvieren, wie z.B. das "Samariter Paradox", oder komplexere Beispiele wie "Practical Inference" (14). Die Analyse *graduierter Modalität* sagt vorher daß (14b–c) in einer *buletischen* (nicht–epistemischen) Lesart von *can/could* wahr sind. Dies widerspricht jedoch der sprachlichen Intuition: (14c) mit indikativem *can* kann nicht interpretiert werden als *angesichts der gegebenen Fakten und* **all** *meiner Wünsche kann ich berühmt werden.* Das Problem kommt in unserem rekonstruierten Beispiel (15), mit *deontischer* Modalität, noch stärker zum Ausdruck: die existentiell quantifizierten deontischen Sätze (15b–c) können im gegebenen Kontext und in der Lesart *in view of the facts and all of her parents' demands* nicht als wahr gelten.

(14) I become popular only if I go to the pub. I want to hike in the mountains, become popular, and not go to the pub. (In view of the facts and my desires)
  a. I should/must hike in the mountains.
  b. I *could/#can* not go to the pub.
  c. I *could/#can* become popular.

(15) You become popular only if you go to the pub. According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub. In view of the facts and in order to do justice to her parents' demands,
  a. Mary must go hiking.
  b. # Mary may (is allowed to) go to the pub.
  c. # Mary may (is allowed to) become popular.

Wir entwickeln eine Analyse "multipler" relativer Modalität mit inkonsistenten Bezugskontexten, die der sprachlichen Intuition für (15b–c), sowie (14b–c) mit indikativem vs. subjunktivem Satzmodus gerecht wird. Diese ergibt sich auf der Basis unserer alternativen Analyse deontischer (nicht–epistemischer) Modalität, in der der Modaloperator als *relativ* zu einem *konsistenten komplexen* Bezugskontext interpretiert wird, welcher durch Konjunktion (*merge*) aus dem faktischen Bezugskontext und dem durch *context reduction* minimal reduzierten, *relevanten* deontischen Bezugskontext gebildet wird. Die Analyse der wohlgeformten *subjunktiven* Sätze (14b–c) führt uns zur Analyse kontrafaktischer Modalität.

Auch unsere Analyse kontrafaktischer Modalität weicht von Kratzer's Analyse *graduierter Modalität* ab, und rekurriert statt dessen auf die Relation der *context reduction*, durch deren "Vermittlung" kontrafaktische Sätze oder Konditionale als kontextuell abhängig von einem (minimal) reduzierten Teilkontext des vorangehenden faktischen Kontexts interpretiert werden können.

Wiederum weisen wir die Adäquatheit der Analyse nicht restringierter und konditionaler Kontrafaktuale durch die Untersuchung von Kontexten modaler Subordination nach.

Schließlich ergibt sich aus unserer Analyse deontischer Konditionale durch einen *eingebetteten* deontischen Modaloperator eine neue Perspektive auf das Problem der sogenannten *backtracking counterfactuals.* Lewis(1973) untersucht das Phänomen der "asymmetrischen temporalen kontrafaktischen Dependenz" (*asymmetry of counterfactual dependence on time*), welche durch den Kontrast zwischen (16a) und (16b) illustriert wird. In Lewis' Analyse kontrafaktischer Konditionale wird dieser Kontrast durch spezielle Kriterien der "Similarität" epistemisch zugänglicher möglicher Welten erfaßt, wodurch die Selektion "maximal ähnlicher" Welten für die Evaluierung eines Kontrafaktuals auf diejenigen Welten beschränkt wird, deren Vergangenheit maximal mit der Vergangenheit der aktualen Welt übereinstimmt. Für Fälle wohlgeformter *backtracking counterfactuals* (16c), die sich durch die Präsenz eines eingebetteten Modalverbs *have to* auszeichnen, und die der Asymmetrie kontrafaktischer Dependenz zu widersprechen scheinen, postuliert Lewis, daß die "syntaktische Besonderheit" eines eingebetteten *have to* als Indiz dafür zu werten ist, daß die Selektion maximal "ähnlicher" Welten außer Kraft gesetzt wird, und daher eine Einschränkung der Menge zugänglicher Welten auf solche, deren Vergangenheit maximal mit derjenigen der aktualen Welt übereinstimmt, nicht gegeben ist.

(16) Jim and Jack had a quarrel yesterday.
a. If Jim had asked Jack for help today, Jack wouldn't help him.
Jim is a prideful guy.
b. # If he had asked Jack for help today, there would have been no quarrel yesterday.
c. If he had asked Jack for help today, there would *have to* have been no quarrel yesterday. Lewis(1979)

Wir argumentieren gegen eine solche Analyse für Fälle wie (16c), und entwickeln eine Analyse für Kontrafaktuale im allgemeinen und die Daten in (16) im Besonderen, die auf den von Kamp(1978) definierten Begriff der *Historischen Notwendigkeit* rekurriert: Die modale Basis kontrafaktischer Konditionale wird – im allgemeinen und in *allen* der durch (16a–c) illustrierten Fälle – durch eine verfeinerte, dem Begriff der *Historischen Notwendigkeit* angepaßte Definition der Relation der *context reduction* als ein reduzierter Kontext des faktischen Bezugskontext definiert, der mit der Vergangenheit, die durch den nichtreduzierten faktischen Bezugskontexts definiert ist, *maximal historisch identisch* ist, jedoch die konsistente Annahme des kontrafaktischen Antezedens zuläßt.

Durch die Maximalitätsbedingung wird der Kontrast zwischen Kontrafaktualen des Typs (16a–b), ähnlich wie bei Lewis, automatisch vorhergesagt. Für Beispiele des Typs (16c) postulieren wir einen implizit gegebenen oder als "Hintergrundskontext" akkommodierten zusätzlichen intensionalen deontischen Kontext, welcher im diskutierten Fallbeispiel (16c) zu paraphrasieren ist als *Bedingungen für (allzu) stolzes, einem bestimmten Ehrenkodex verpflichtetes Verhalten* (*how to act in accordance with one's sense of pride*), und welcher eine Bedingung folgender Art enthalten könnte: *Wer mit einem Freund Streit hatte, soll ihn danach nicht sofort wieder um Hilfe bitten (denn die Hilfe würde verweigert).*

In Konsequenz unserer Analyse deontischer (kontrafaktischer) Konditionale postulieren wir für (16c) einen eingebetteten deontischen Modaloperator, welcher sich sprachlich durch das Modalverb *have to* widerspiegelt, und welcher relativ zu dem akkommodierten deontischen Kontext interpretiert wird. Während der übergeordnete (epistemische) Modaloperator des kontrafaktischen Konditionals durch die Bedingung maximaler historischer Identität als relativ zu einem reduzierten faktischen Kontext interpretiert wird, in dem der gestrige Streit historisch determiniert ist, wird – in Konsequenz unserer Behandlung der zu vermeidenden "deontisch trivialen Wahrheit" (siehe (13)) – für die Bildung der komplexen modalen Basis des deontischen Operators der durch das konditionale Antezedens definierte hypothetische Kontext – in dem der gestrige Streit historisch determiniert ist – und welcher den epistemischen Bezugskontext für die Auswertung des eingebetteten deontischen Modaloperators bildet, weiter "reduziert" zu einem Kontext, in dem das Faktum des gestrigen Streits "aufgehoben" ist. In Konjunktion (*merge*) mit dem relevanten deontischen Hintergrundskontext (*how to act in accordance with one's sense of pride*) determiniert diese komplexe modale Basis des deontischen Modaloperators daher eine Menge von Welten (bzw. "states"), die das Konsequens des deontischen Quantors verifizieren.

Vagheit und "Variabilität" von Konditionalen

Jegliche Analyse (indikativer oder kontrafaktischer) Konditionale ist mit dem Problem der Vagheit und Nichtmonotonie von Konditionalen konfrontiert. Das Problem wurde von Lewis(1973) durch das Beispiel (17) illustriert: Wir betrachten (17) als wahr, ungeachtet der Tatsache, daß es epistemisch zugängliche Welten gibt, in denen Känguruhs in der Lage sind an Krücken zu gehen, und sich daher auch ohne ihre natürliche Balancehilfe aufrechthalten können. Um dieser Vagheit von (kontrafaktischen) Konditionalen Rechnung zu tragen, wird in Lewis'(1973) Analyse die Menge der epistemisch zugänglichen Welten für die Auswertung eines Kontrafaktuals auf diejenigen Welten eingeschränkt, die der aktualen Welt maximal ähnlich sind.

Wir argumentieren gegen das Kriterium der maximalen Ähnlichkeit zur Einschränkung der Quantifikationsdomäne, und folgen stattdessen der von Morreau(1992) vorgeschlagenen Analyse von Kontrafaktualen, in der die Quantifikationsdomäne auf eine Menge von Welten eingeschränkt wird, in denen "alles gilt, was, relativ zur aktualen Welt w, *normalerweise* der Fall ist in einer Situation in der das Antezedens wahr ist".

(17) If kangaroos had no tails, they would topple over. Lewis(1973:1)

Eng verwandt mit dem Phänomen der Vagheit von Konditionalen ist das Phänomen, das Lewis(1973) mit dem Begriff der *conditional variability* belegte. Sequenzen von Konditionalen wie in (18), mit zunehmend strikterem Antezedens und konfligierendem Konsequens, können in einem kohärenten Diskurs geäußert werden und, nach Lewis' Analyse, alle als nicht–trivial wahr interpretiert werden.

(18) If Otto had come, it would have been a lively party;
but if both Otto and Anna had come it would have been a dreary party;
but if Waldo had come as well, it would have been lively; ... Lewis(1973:10)

Wiederum erheben wir Einwände gegen diese Analyse. Nicht nur stellen wir die Adäquatheit des Kriteriums der Ähnlichkeit von Welten in Frage, welches nach Lewis die

Restriktion der Quantifikationsdomäne dieser Konditionale determiniert. Als ein weitaus schwerwiegenderes Problem der Lewis'schen Analyse weisen wir nach, daß diese Analyse der kontextuellen Dynamik, die sich als ein wesentliches Charakteristikum dieser spezifischen Art von Kontexten erweist, nicht Rechnung trägt. Ein Indiz für dieses Problem ist, daß es intuitiv nicht möglich ist, *relativ zu dem durch (18) etablierten Kontext* zu äußern, oder zu schließen, daß *If Otto had come, it would have been lively.* Dies wird jedoch von Lewis' Analyse vorhergesagt.

Der abschließende Teil der Dissertation ist daher dem Problem der konditionalen Vagheit und Variabilität gewidmet. Anstelle der fragwürdigen Eigenschaft der Ähnlichkeit von Welten verwenden wir den Begriff der *Normalität* zur Beschränkung der Quantifikationsdomäne, welcher auch in der Analyse generischer Sätze eine bedeutende Rolle spielt.

Wir diskutieren die wohlbekannte Verwandschaft generischer Sätze mit Konditionalen, wobei wir zeigen, daß die Analyse deontischer Konditionale als komplex strukturierte Quantifikationsstrukturen in der Domäne generischer Sätze eine natürliche Entsprechung findet. Wir zeigen, daß Theorien nichtmonotonen Schließens, die keine derartige Differenzierung zwischen deontisch und epistemisch zu interpretierenden generischen Sätzen treffen, inkorrekte Schlußfolgerungen vorhersagen. Dagegen können auf der Basis einer komplexen Struktur deontischer generischer Sätze korrekte Vorhersagen getroffen werden.

Wir untersuchen zwei Theorien nichtmonotonen Schließens für generische Sätze, die vom Begriff der Normalität und konditionaler Semantik Gebrauch machen, Conditional Default Reasoning (Delgrande(1987,1988)) und Commonsense Entailment (Asher&Morreau(1991, 1995)). Ausgehend von den Ergebnissen dieser Diskussion stellen wir eine alternative Analyse für Sequenzen variabel strikter Konditionale mit konfligierendem Konsequens (18) vor, die insbesondere dem dynamischen Aspekt der Interpretation Rechnung trägt, und welche in zweierlei Hinsicht von Lewis' Analyse abweicht. Zunächst weisen wir nach, daß – obwohl einen kohärenten Diskurs bildend – die einzelnen Konditionale innerhalb des gesamten Kontexts nicht alle gleichzeitig als wahr gelten können: durch einen Prozess der wiederholten *Revision* des zugrundeliegenden Evaluierungskontexts, reflektiert durch das Vorkommen von *"but"*, kann *relativ zum neuen Kontext*, der durch ein nachfolgendes konfligierendes Konditional etabliert wird, das vorangehende Konditional – welches relativ zum nichtrevidierten vorangehenden Evaluationskontext als wahr interpretiert wurde – nicht mehr als wahr gelten. Weiterhin werden infolge des Revisionsprozesses in (18) die Annahmen darüber, was in Situationen, in denen Otto kommt *normalerweise* der Fall ist, modifiziert. Dies erfassen wir durch eine *Variabilitätsrestriktion* der Normalitäts–Selektionsfunktion, die die Quantifikationsdomäne von Konditionalen restringiert. Hieraus folgt zunächst, daß die Interpretation eines Konditionals *If Otto had come, it would have been a lively party*, welches relativ zum Kontext (18) interpretiert wird, eine grundlegend verschiedene Interpretation erhält als das erste Vorkommen dieses identischen Konditionals in (18). Die Nicht–Adäquatheit einer solchen Äußerung wird auf der Basis einer *Spezifizitätrestriktion* der Normalitäts–Selektionsfunktion erklärt. Dieses Prinzip erklärt ebenfalls die Nicht–Adäquatheit von Sequenzen zunehmend nichtspezifischerer konfligierender Konditionale.

Im abschließenden Kapitel wird gezeigt, daß die Variabilitätsrestriktion der Selektionsfunktion, zusammen mit einer dynamischen Interpretation generischer Sätze nach dem Vorbild variabel strikter Konditionale, korrekte Vorhersagen für die von Delgrande und Morreau&Asher behandelten Prinzipien nichtmonontonen Schließens liefert.

1 Introduction

This dissertation is about context dependence in modal constructions. Our main objective is to devise a *uniform* analysis for a variety of phenomena to be observed in the realm of modal expressions. Our framework is discourse representaton theory (DRT), developped by Kamp(1981), and extended by later work[1] to a cover broad range of phenomena in natural language semantics.

One of the distinguishing features of DRT is its focus on representational aspects of meaning. Another, more important characteristic of the theory is the insight that the meaning of sentences cannot be determined by truth conditional semantics proper. A pervasive feature of natural language semantics is that it is essentially dependent on (material introduced within) the previous discourse context, and DRT and Heim's File Change Semantics (FCS) were the first semantic theories that made this specific kind of contextual dependence formally precise (Kamp(1981), Heim(1982)). Some of the many *anaphoric* phenomena that were recognized to call for a dynamic view of semantics were the interpretation of pronominals and definite descriptions, the analysis of tense, plurals, and presupposition.[2]

The problem of modal subordination

The DRT analysis of quantification is designed to capture the classical problem of donkey sentences (1): quantification is analyzed as internally dynamic, while externally static. Therefore, a pronoun that appears in the nuclear scope of a conditional can be bound to an antecedent that is introduced by an indefinite NP within the restrictor, but anaphoric reference to an indefinite that is introduced within the conditional's antecedent or scope is not possible for a pronominal that occurs in subsequent sentences.

(1) If a farmer owns *a donkey*, he beats *it*. # He doesn't like *it*.

Since Roberts(1987,1989) it is well–known that there are many exceptions to this rule.[3] Examples like (2) show that in specific contexts, so–called contexts of "modal subordination", a pronominal that occurs in a subsequent modal sentence can be anaphorically bound to an antecedent that is introduced within an "opaque context", e.g. a conditional's antecedent or scope. In Roberts' account the conditional is still analyzed as externally static to account for the "standard cases" exemplified in (1), while for modal subordination cases (2) a special *accommodation* device makes accessible material that is defined within "opaque" contexts, to allow for anaphoric binding of a pronominal in a subsequent, "modally subordinated" sentence.[4] Geurts(1995) offers a presuppositional/anaphoric account of modal subordination that is more restricted than Roberts' very powerful accommodation account.

(2) If a farmer owns *a donkey*, he beats *it*. *It* might kick back.

[1] See e.g. Asher(1986,1993), Geurts(1995), Kamp(1981b), Kamp(1990), Kamp&Reyle(1993,1996), Kamp&Roßdeutscher(1994a,1994b), Partee(1984), Reyle(1993,1996), van der Sandt(1992), etc.

[2] See references in the previous footnote, as well as Heim(1982,1983,1991,1992).

[3] But see already Karttunen(1976).

[4] Another way to account for (2) is to define quantification as externally dynamic (see Fernando(1993)).

Both Roberts' and Geurts' DRT analyses of modal subordination are built on Kratzer's(1978,1991) analysis of *relative* and *graded modality.* Yet, in both of these theories the DRSs do not distinguish between e.g. deontic and epistemic modality (cf. (5) below), nor between indicative and counterfactual conditionals. It is thus not possible to *represent* the contextual (anaphoric) dependence of a deontic modal relative to a deontic context that is explicitly introduced within the preceding discourse, as e.g. by the phrase *German tax law* in (3). Further, Geurts' analysis does not account for modal subordination relative to a negated context, nor for modal constructions that are contextually dependent on the preceding factual discourse (see below examples (6)).

(3) According to *German tax law*, Max *must* pay taxes for his car.

"Relative Modality": context dependence in modal constructions

The impact of Kratzer's analysis of *relative modality* is that modal expressions, e.g. *must* in (4), are not semantically ambiguous between different readings traditionally classified as *epistemic, deontic* or *circumstantial*, but are contextually dependent on different kinds of intensional *background contexts* – epistemic (4a), deontic (4b) and circumstantial (4c) – that provide the *modal base* of the (universal) modal operator (Kratzer(1991:639,640)).

(4) a. (*In view of* the available evidence,) Jockl *must* have been the murderer.

b. (*In view of* what the law provides,) Jockl *must* go to jail.

c. (*In view of* the present state of his nose etc.,) Jockl *must* sneeze.

Kratzer(1981) extends this analysis to the concept of *graded modality*, i.a. in order to account for deontic and counterfactual modality, where the modal operator is analyzed as *doubly relative*, as depending, as it does, on two conversational backgrounds.

Graded modality involves a second background context, the *ordering source*, which induces a partial order on the set of worlds determined by the modal base. For the deontic conditional (5a), the modal operator is relative to a *circumstantial* modal base and a *deontic* ordering source, while the counterfactual (5b) is analyzed relative to an empty modal base and a *totally realistic* ordering source. Roughly, for (5a), the worlds that make up the circumstantial modal base $f(w)$, "updated" with the proposition denoted by the antecedent clause ($f^+(w) = f(w) \cup \{p\}$) are partially ordered relative to the "ideal" provided by the deontic ordering source $g(w)$. Universal quantification then ranges over those worlds out of $\bigcap f^+(w)$ that are maximally close to the ideal defined by the ordering source.

(5) a. If Max will buy a car, he must pay taxes.

b. If Max had bought a car, he would have paid taxes.

Kratzer's analysis of *relative* and *graded modality* is well suited to account for anaphoric binding and presupposition projection out of modal contexts, and this is the main reason why it was "reconstructed" in various theories of modality in the framework of DRT, in particular Roberts(1987,1989) and Geurts(1995).

A generalized quantifier analysis of modal operators

There is a broad consensus nowadays that modal adverbs, much alike frequency adverbials, are best analyzed in terms of generalized quantification (see e.g. Lewis(1975), Partee(1991), von Fintel(1994,1995)). This not only leads to a natural analysis of graded modals (*probably*, *unlikely*), but more importantly allows us to render the inherent context dependent nature of modal constructions: As pointed out recently by von Fintel(1995), generalized quantifiers can be taken to refer to a contextually given or reconstructed variable of an appropriate type, which – in conjunction with the restrictor clause – constitutes the quantificational domain. For modal operators this view was anticipated by Kratzer(1978), who characterized modal operators as being *relative to*, or contextually dependent on different kinds of intensional contexts.

We therefore assign modal expressions a discourse representational or logical structure that characterizes them as *generalized quantifiers* that are *anaphoric* within their restrictor argument. Since modal operators are contextually dependent on different kinds of intensional background contexts (Kratzer's insight), the domain argument of the modal quantifier is characterized as anaphorically dependent upon a new type of discourse referents, *context referents*, that are defined to "stand proxy" for contexts, or DRSs of diverse intensional types. Kratzer's notion of *relative modality* is thus captured in terms of the notion of an *anaphoric* domain argument, or modal base of a generalized modal quantifier.

This analysis allows us to provide a *uniform* analysis of *relative modality* and *modal subordination* contexts, since, as we will argue, modal subordination constitutes just a special instance of the more general context dependent characteristic of modal expressions, to wit, *relative modality.* Yet, this analysis does not yet improve in any way over, e.g., Geurts'(1995) *presuppositional* analysis of modality and modal subordination.

As noted above, both Roberts' and Geurts' reconstructions of Kratzer's theory take over the analysis of deontic and counterfactual modality as involving *graded modality.* The modal operator is characterized as dependent on two conversational backgrounds, one of them functioning as the *ordering source.* For deontic modality, e.g., the deontic antecedent context is defined to induce a partial ordering over the set of worlds that constitute the modal base, and the quantification is defined to range over those worlds of the modal base that are "maximally close" to the "ideal" defined by the deontic context.

Yet, since the ordering source is not represented at the level of the DRS, the conditionals in (5a–b) are assigned the same representation (modulo temporal differences), and we cannot represent the anaphoric dependence, or relativization of deontic *must* in (3) to the deontic context introduced by the phrase *German tax law.*

Finally, Geurts' analysis does not account for examples like (6). In (6a) the antecedent of the pronoun *it* is defined within the scope of negation, and thus inaccessible according to DRT's constraints on anaphoric binding. (6b), on the other hand, is problematic since the modal operator cannot be represented as anaphorically dependent on the preceding factual context, which however is indispensible if we want to get at the correct truth conditions for the conditional. The analysis sketched above is of course pleaged by the same problems.

(6) a. I don't have *a microwave oven.* I wouldn't know what to do with *it.*

b. There a three people in the room. If one of them leaves the room, there will still be one person in the room.

Representing contextual dynamics in DRT

We will argue that both of these problems – the representation of the *ordering source* for deontic and counterfactual modality, as well as the problems illustrated by examples (6) – necessitate a radical reorganization of the standard DRT representation format.

The main insight of DRT is that the meaning of a sentence is essentially *context dependent*, that each sentence must be interpreted *relative to its preceding context*, or "as an addition to, or 'update' of, the context in which it is used" (van Eijck&Kamp(1996:1)). On this *dynamic perspective*, the meaning of a sentence is to be captured in terms of context change conditions rather than in terms of truth conditions proper. In order to make this view formally precise van Eijck&Kamp(1996) define a relational, or *dynamic* semantics for DRSs, where the meaning of a (partial) DRS D is stated as a relation between input and output assignments s and s' from individuals of U into M: ${}_s[\![D]\!]^M_{s'}$.[5]

But not only does this relational definition account for the *dynamic meaning* of sentences in discourse: by extension of the DRS language with a sequencing operator ; DRSs now explicitly *represent* the dynamics of discourse.

Yet the dynamic aspect of meaning that is thus built into the semantics and representation of DRT is still of no help for our problems above, in particular the one presented by example (6b): the assignments s, s' that record the assignments for referents used in the preceding ("input") context are not in the object language, and thus cannot serve as representational objects to provide an antecedent for the anaphoric modal base of a contextually dependent modal operator. But it is obvious how the dynamic view of the *semantics* of DRSs can be further strengthened to yield an explicit *representation* of this context dependent meaning of sentences at the DRS level: Modulo the intensional framework, there is a direct correspondence between the *relational* semantics of DRSs and *update conditions* on context referents, as in (7), where a context referent denotes a sets of world–function pairs. An update condition $G :: F + K'$ characterizes the "update" of an "input" context (referent) F by a DRS K' to yield the "output" context (referent) G, where $e(G)$ denotes the set of states $\langle w', g\rangle$ for which there is a state $\langle w', f\rangle \in e(F)$ s.th. $\langle w', f\rangle$ and $\langle w', g\rangle$ constitute correct input and output states in the relational meaning of K': ${}_{\langle w',f\rangle}[\![K']\!]_{\langle w',g\rangle}$.

$$(7)\;\; \langle w, e\rangle \models_M G :: F + K' \quad \text{iff} \quad e(G) = \{\langle w', g\rangle : (\exists \langle w', f\rangle \in e(F))\; {}_{\langle w',f\rangle}[\![K']\!]_{\langle w',g\rangle}\}.$$

Taking seriously the above observation that any sentence within a discourse is to be interpreted as contextually dependent upon, or as an 'update' of the context established by the preceding sentences, we develop a new representation format for dynamic discourse in DRT. We make use of update conditions like (7) to explicitly *represent* the dynamics of a discourse within the DRS that is to represent its *dynamic* meaning. To this end, DRS construction is designed to build a new update condition $C_i{::}C_{i-1}{+}K_i$ for each sentence S_i.

Due to this novel representation format it is possible – in problematic examples like (6b), and also for counterfactual and deontic modality (see below) – to represent the anaphoric domain argument X' of a modal operator as anaphoric to a context referent G that represents the (continuously updated) preceding factual context.

[5] See also Kamp&Reyle(1996). This relational semantics of DRSs follows the spirit of Heim(1982:Ch.4) and Groenendijk&Stokhof(1991), where context dependent meaning is defined in terms of updates.

For the correct working of this analysis we will have to guarantee the wellfoundedness of the verifying embedding functions. We also have to define an adjusted subordination relation for this new DRS format to constrain the accessibility of discourse referents for anaphoric binding. These binding constraints will prove appropriate not only for the standard non–subordination contexts (see (1) above), but also for relative modality (3)–(6) and modal subordination (2).

Besides the classical cases of modal subordination such as (2) our analysis will account for modal subordination relative to negated (8) and graded modal sentences (9), in conjunction with constraints on sentence mood, which additionally restrict the potential of modal sentences to engage in modal subordination.

(8) Fred didn't buy a microwave oven.
 a. He wouldn't know what to do with it.
 b. # He might like/use it.
 c. # Clarissa is using it.

(9) a. If Max goes to China, *in no case/it's unlikely that* he will he buy books.
 He would/#will not read them.
 b. If Max goes to China, he *probably/might/necessarily* (will) buy books.
 He will not read them.

Finally, on the basis of our new DRS representation format for *dynamic* discourse, our analysis of modal subordination extends to cases of "extended disjunctive discourses" such as (10), dubbed *modal splitting* by Landman(1986). For the famous bathroom sentences (11), however – which in Roberts(1989) are assigned an analysis in terms of modal subordination – we will argue that they must not be analyzed as *modally subordinated*, but rather by resorting to the semantics of *exclusive or*, which is essentially the analysis that Kamp&Reyle(1993) proposed for this type of sentences.

(10) You will stay unmarried, or you will marry a tramp.
 You'll become a nun, or the tramp will beat you regularly.
 Either way you'll have a miserable life. Landman(1986:205)

(11) Either there is no bathroom in this house, or it is in a funny place. Roberts(1989:702)

The analysis of (multiple) relative modality

The adoption of this new DRS representation format solves the problems of modal contexts that are to be interpreted as *relative to* the factual, or else a negated antecedent context.

For the second problem observed above, the missing *representation* of the ordering source (see (3) and (5a–b)), we will devise an alternative analysis of *deontic* and *counterfactual* modality that dispenses with the notion of *graded modality*. For deontic modality the deontic antecedent context will be represented at the level of the DRS, and the modal base, or domain argument of the deontic modal operator will be represented as anaphorically dependent upon a *consistent, complex* modal base, constituted by the *merge* of the factual antecedent context and a *maximal* or *relevent* subpart of the deontic antecedent context, where the latter is obtained by use of a relation of *context reduction* that is similar to the relation of *contraction* in Gaerdenfors(1988). For counterfactual modality we make use of the relation of *context reduction* to induce relativization to the factual antecedent context. The DRS representations therefore distinguish between epistemic and e.g. deontic modality, and also between indicative and subjunctive conditionals. Further, relativization to overtly introduced deontic, or else epistemic contexts (see (3)) is immediately accounted for.

Special attention is devoted to the analysis of deontic conditionals, where our analysis differs significantly from traditional analyses, as e.g. Lewis(1973) and Kratzer(1981/1991), which posit a "single–operator analysis" for deontic conditionals, and thus only allow for readings of "conditional obligation", as in (12a). Instead, we will argue for an analysis of (indicative and counterfactual) deontic conditionals that assigns the deontic operator narrow scope within the scope of the governing conditional. In cases of conditional obligation like (12a), the deontic context that is accessible from the epistemically accessible worlds where Jesse murders Girgl is identical to the "laws" that hold in actual world, while in cases like (12b) the laws that prevail in epistemically accessible worlds where history evolved differently may differ crucially from those of the actual world.

We will also offer a solution for the problem of "trivial deontic truth", as in (13), which is not accounted for by Lewis' and Kratzer's traditional analyses of deontic conditionals.

(12) a. If Jesse murders Girgl, Jesse *must* go to jail.

b. If Luther hadn't engendered the Reformation, we'd still *have to* pay indulgence.

(13) If Jesse robs the bank and his mother gets notice of it, Jesse *must* have a mother.

Finally, we will investigate this analysis of "multiple relative" modality in modal subordination contexts, with mixed occurrences of epistemic and deontic non–restricted and restricted, i.e. conditional modal sentences.

The problem of inconsistent contexts

As a major motivation for her analysis of deontic modals as involving *graded modality* Kratzer discusses cases of inconsistent, conflicting factual and deontic background contexts, as in the "Samaritan Paradox", or the more involved cases of "Practical Inference" (14).

The analysis in terms of *graded modality* predicts (14b–c) to be true on a *bouletic* (non–epistemic) interpretation of *can/could.* Yet, this does not correspond to our intuitions: in (14b–c) indicative *can* cannot be interpreted as *relative to the facts and all of my desires.*

This is more explicitly rendered by (15), where we cannot interpret the existentially quantified *deontic* modals in (15b–c) as *relative to the facts and all of her parents' demands.*

(14) I become popular only if I go to the pub. I want to hike in the mountains, become popular, and not go to the pub. (In view of the facts and my desires)
a. I should/must hike in the mountains.
b. I *could/#can* not go to the pub.
c. I *could/#can* become popular.

(15) You become popular only if you go to the pub. According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub. In view of the facts and in order to do justice to her parents' demands,
   a. Mary must go hiking.
   b. # Mary may (is allowed to) go to the pub.
   c. # Mary may (is allowed to) become popular.

We will offer a solution for these data which predicts the oddity of (15b–c) and of *indicative* (14b–c). It is grounded on our alternative analysis of deontic modality, where the modal operator is interpreted relative to a *consistent*, *complex* modal base, consisting of the merge of the factual antecedent context and a *relevant* (possibly reduced) deontic antecedent context. Our account for the wellformedness of *subjunctive could* in (14b–c), will then lead us to the analysis of counterfactual modality.

For the analysis of counterfactual modality we will again diverge from the analysis in terms of *graded modality*, and instead resort to the relation of *context reduction* to establish a *reduced* modal base by anaphoric reference to the factual antecedent context.

Our investigation of modal subordination contexts with non–restricted and restricted (conditional) counterfactuals, including deontic counterfactuals, will not only corroborate our constraints on modal subordination, but also support our analysis of deontic conditionals as involving *embedded* deontic quantification.

Interestingly, our analysis of deontic conditionals as involving an embedded deontic operator will shed some new light on the analysis of so–called *backtracking counterfactuals*. Lewis(1979) investigates the "asymmetry of counterfactual dependence on time", illustrated by the contrast between (8.a–b). This contrast is predicted, in Lewis' theory of counterfactuals, by constraining the relation of "overall similarity" to select a set of maximally similar worlds that "maximize spatio–temporal overlap" with the past of the actual world. For cases of wellformed "backtracking" counterfactuals like (8.c) with embedded *have to* Lewis claims that the "syntactic peculiarity" of the modal *have to* indicates that the "standard resolution of vagueness" in terms of "overall similarity" is not in force, such that the quantification ranges over worlds that do *not* exhibit maximal overlap with the actual past.

(16) Jim and Jack had a quarrel yesterday.
   a. If Jim had asked Jack for help today, Jack wouldn't help him.
   Jim is a prideful guy.
   b. # If he had asked Jack for help today, there would have been no quarrel yesterday.
   c. If he had asked Jack for help today, there would *have to* have been no quarrel yesterday. Lewis(1979)

We argue against this view of (16c), and instead come up with an analysis of the data in (16) that constrains the selection of accessible worlds to obey Kamp's(1978) notion of *historical necessity*, i.e. the set of accessible possible worlds is constrained to satisfy maximization of perfect correspondence with the actual past *in all of* (16a–c). Much as in Lewis' account this immediately predicts (16a–b). Yet for (16c) we assume an additional intensional background context *how-to-act-pridefully*, specifying that *if you had a quarrel with someone, you don't ask the person for help afterwards.* Following our analysis of deontic conditionals, this *deontic* context is taken into account for the evaluation of the embedded modal *have to* in (16c). While the governing conditional will quantify over a set of worlds where yesterday's quarrel is *historically determined*, in consequence of our treatment of trivial deontic truth (see (13)) this context is "reduced" to "undo" the fact of yesterday's quarrel when building the *complex* modal base for the embedded deontic modal. Together with the (accommodated) deontic context of *how-to-act-pridefully* the *complex* modal base will then verify the scope of (16c), that *there would not have been a quarrel yesterday.*

Vagueness and variablity of conditionals

Any analysis of (indicative and subjunctive) conditionals must address the problem of the *vagueness*, or *nonmonotonicity* of conditionals. In particular, (17) is considered true even though there are epistemically accessible worlds where kangaroos are able to walk around on crutches. In Lewis(1973) this was accounted for by restricting the set of accessible worlds to those that exhibit maximal *similarity* wrt. the actual world. We will argue against this view, and follow Morreau's(1992) analysis of counterfactuals where the quantificational domain is restricted to a set of worlds "where everything holds that is *normally* the case, relative to the evaluation world w, in a situation where the antecedent holds true".

(17) If kangaroos had no tails, they would topple over. Lewis(1973:1)

Yet, closely related to the *vagueness* of conditionals is the phenomenon that Lewis called *(conditional) variability*: We can have sequences of *increasingly strict* conditionals with *conflicting* consequents, as in (18), which can all be judged as non–vacuously true within a single context. Lewis'(1973) analysis of counterfactuals accounts for these cases by evaluation relative to a "system of spheres of comparative similarity", where for each one of the counterfactuals in (18) a distinct sphere of worlds is chosen, and which supports its truth.

(18) If Otto had come, it would have been a lively party;
but if both Otto and Anna had come it would have been a dreary party;
but if Waldo had come as well, it would have been lively; ... Lewis(1973:10)

Again we will object against this analysis. Not only do we question the appropriateness of the concept of *similarity* to restrict the quantificational domain, more importantly, we argue that the analysis in terms of a sphere system does not capture the contextual dynamics that is characteristic for such sequences of increasingly strict conditionals. In particular, we cannot conclude from the entire context conveyed by (18) that *if Otto had come, the party would have been lively*, which is, however, predicted by the theory.

So the final part of this dissertation is devoted to establish an analysis of conditionals that accounts for their *vagueness* and *nonmonotonicity* (or *variability*) in terms of a *context dependent* notion of *normalcy.* Given the close correspondence between conditionals and generic sentences we will investigate the notion of *normalcy* in theories of nonmonotonic reasoning with generic sentences (and conditionals). These investigations will lead us to postulate a specific constraint on our *context dependent* normalcy selection function for conditionals that accounts for wellformed increasingly (18) vs. *odd* decreasingly strict conditionals with conflicting consequents. This constraint on the selection of "normal worlds" within a dynamically evolving discourse context will finally prove adequate to capture the standard patterns of nonmonotonic inference with generic sentences.

2 Approaches to Modality, Conditionals and Modal Subordination

2.1 Possible worlds analyses of modality and conditionals

In the framework of possible worlds semantics modality is analyzed by existential or universal quantification over accessible possible worlds (1). Accessibility is defined in terms of binary relations R on the set of possible worlds W. Modal systems have been defined for epistemic, deontic, bouletic and other modalities (see e.g. Gamut(1991), Hughes&Cresswell(1968), Hilpinen(1971,1981), van Fraassen(1972), Kratzer(1991)).

(1) $[\![\Box\ \phi]\!] = \{\ \mathrm{w} \in \mathrm{W} : \text{for all } \mathrm{w}' \text{ s.th. } \mathrm{wRw}',\ \mathrm{w}' \in [\![\phi]\!]\ \}$

$[\![\Diamond\ \phi]\!] = \{\ \mathrm{w} \in \mathrm{W} : \text{for some } \mathrm{w}' \text{ s.th. } \mathrm{wRw}',\ \mathrm{w}' \in [\![\phi]\!]\ \}$

By contrast, in the possible worlds semantics of standard modal logic, conditionals are interpreted as material implication, i.e. no quantification over R–accessible possible worlds is involved:

(2) $[\![\phi \to \psi]\!] = \{\ \mathrm{w} \in \mathrm{W} : \mathrm{w} \notin [\![\phi]\!] \text{ or } \mathrm{w} \in [\![\psi]\!]\ \}$

The interpretation of conditional sentences in terms of material implication has been criticized in many places.[1] We will briefly review some of the arguments against the material interpretation put forward in Stalnaker(1968,1976), Lewis(1975) and Kratzer(1978,1991), who develop alternative analyses for conditional sentences.

Stalnaker(1968) argues that the meaning of the conditional, seen as a function of the meaning of two propositions, should not be analyzed as a *truth function* of these propositions, as defined by material implication in (2): Given you know (3a) and (3b) to hold true, this will not enable you to compute the truth value of the conditional (3c).

(3) a. Willie Mays didn't play in the American League.

b. Willie Mays didn't hit 400.

c. If Willie Mays had played in the American League, he would have hit 400.

Another argument runs as follows: The falsity of the antecedent is never a sufficient reason to affirm the truth of a conditional, not even of an indicative conditional: So (4) should not come out valid.

(4) The Chinese will stay out of the Vietnam conflict.
$\vdash$ If the Chinese enter into the Vietnam Conflict, the US will use nuclear weapons.

[1] See Kratzer(1978) for a beautiful overview of the "battle" on the "right" interpretation of conditionals from the ancients to modern logics and linguistics.

Finally, the intuition that two counterfactuals with the same antecedent but contradictory consequents, as in (5), are to be interpreted as negations of each other is not rendered by the material interpretation.

(5) a. If Kennedy had been alive, we wouldn't have been in this Vietnam mess.

b. If Kennedy had been alive, we (also) would have been in this Vietnam mess.

One way to cope with this and similar paradoxes (see e.g. Sainsbury(1991)) is to stick to material interpretation for semantic analysis, but explain the oddity of counterintuitive arguments, or "unintuitive meanings" as pragmatically determined. This has been done quite successfully by use of Gricean principles of conversational implicatures (Grice 1967) (see e.g. Veltman(1986)).

Yet, it has been convincingly argued by Lewis(1975) and Kratzer(1991) that a semantic analysis of *if*–sentences in terms of material implication, even if supplemented by a pragmatic analysis following Gricean conversational maximes, cannot save the material conditional for principled reasons going beyond the paradoxes illustrated above.

Based on his analysis of quantificational adverbs as generalized quantifiers over "cases", Lewis(1975) rejects the interpretation of conditional sentences, i.e. sentences introduced by an *if*–clause, by material implication: If the quantificational adverbs in (6) are taken to quantify over events, on a material interpretation of the conditional *if ... then ...* we do not get a correct interpretation for non–universal quantifiers like *for the most time*: Take a world with a million events, out of which 2000 involve a horse–buying man, and where all of these involve payment by check. Since on the material interpretation all the events that do not involve a horse–buying man do nevertheless satisfy the conditionals in (6), (6c) would – incorrectly – come out true (see Kratzer(1991:652)).

(6) a. Sometimes, if a man buys a horse, he pays cash for it.
There is an event e [if e involves a man buying a horse, then e is part of an event in which the man pays cash for it].

b. Always, if a man buys a horse, he pays cash for it.
For all events e [if ... then ...]

c. Most of the time, if a man buys a horse, he pays cash for it.
For most events e [if ... then ...]

Following the theory of nominal generalized quantifiers, Lewis treats quantificational adverbs as generalized unselective quantifiers, with the *if*–clause restricting the domain of quantification of the quantificational adverb.

Kratzer(1978,1991) generalizes Lewis' insights to a general theory of conditionals, with the *if*–clause acting as a restrictor for various modal operators. Bare conditional sentences constitute a special case on this analysis. They are analyzed as implicitly quantified by the necessity operator.

In the framework of Discourse Representation Theory (DRT), which is the theory we will build on in Chapter 3, in the extensional fragment covered in Kamp(1981), Kamp(1988) and Kamp&Reyle(1993), conditionals are given an analysis that reduces to material implication if no binding of variables occurs between (the representations for) antecedent and consequent. In our discussion of Section 2.3.1 we will argue that this problem can be avoided by quantification over an eventuality referent. Yet, the extensional analysis of conditionals is insufficient in that it does not cover counterfactuals, and does not allow for a distinction to be made between *would/will*– and *might*–conditionals.

Intensional analyses of modality, which improve on the extensional approach in the problematic aspects just mentioned, have been proposed, in the framework of DRT, by Roberts(1989), Kasper(1992), Geurts(1995) and Kamp&Reyle(1996). These analyses are basically reformulations, within the DRT framework, of the possible worlds analyses of conditionals and modality of Lewis(1973) and Kratzer(1978,1991). In the two main Section of the present Chapter we will first, in Section 2.2, review the most influential theories of modality and conditionals, especially by Stalnaker, Lewis and Kratzer, and point to some problems that we think have gone unnoticed. Given that the existing DRT analyses of modality build on these theories, our criticism of course carries over to these reformulations. Moreover, we will argue, in Section 2.3, that the reformulations of Kratzer's theory into the framework of DRT in Roberts(1989) and Geurts(1995) are deficient in important respects, especially in view of the context dependent meaning of these modal constructions.

Our main concern, in Chapter 3, will then be to develop an intensional analysis of modality and conditionals in DRT which covers a wide range of phenomena, including epistemic and non–epistemic (deontic, etc.) modality, graded modality, counterfactuality, and modal subordination. All of these phenomena will be investigated by putting emphasis on one of their unifying and most important characteristics, their inherent dependence upon context.

2.2 Conditionals and modals in context

2.2.1 Stalnaker: Conditionals as updates in accessible contexts

That possible worlds semantics is well suited for the analysis of natural language as inherently context dependent has been put forward quite early by the work of Stalnaker(1974/1976). The common ground of a discourse situation, the *context set*, is given as a set of possible worlds, which corresponds to the information that is taken for granted, or is presupposed in the conversation by the speaker of the utterance. The early analysis of conditionals in Stalnaker(1968) has been restated in these contextual terms in Stalnaker(1976).

Stalnaker rejects the analysis of conditionals by material implication. Instead, he considers the question: "How does one evaluate a conditional?", which leads him to a first approximation of a more context dependent analysis of conditionals: "Add the antecedent (hypothetically) to your stock of knowledge (or beliefs), and then consider whether or not the consequent is true. Your belief about the conditional should be the same as your hypothetical belief, under this condition, about the consequent" (Stalnaker(1968:43)). This is essentially the suggestion made by Frank Ramsey, known as the "Ramsey Rule".

Formally this is implemented in a possible worlds framework by use of a selection function f, which takes a proposition and a possible world into a possible world: $f(proposition, world)$

$\rightarrow$ *world*. "The s[election] function selects, for each antecedent A, a particular world in which A is true. The *assertion* which the conditional makes, then, is that the consequent is true in the world selected. A conditional is true in the actual world if its consequent is true in the selected world." (Stalnaker(1968:45)). The selected world $f(A, \alpha)$ may be the actual world or a non–actual possible world, depending on A, the facts that hold in α, and further conditions on the selection function.

(7) $A > B$ is true in α if B is true in $f(A, \alpha)$;
$A > B$ is false in α if B is false in $f(A, \alpha)$.

The selection function is constrained to choose the possible world which is most similar to the actual world (based on a partial ordering of the set of possible worlds). Thus, whenever the antecedent is true in the actual world α, the most similar alternative to α will be α itself. The conditional sentence *If A, then B* will then be true if B is true in α.

A further constraint on the selection function governs the distinction between 'indicative' hypothetical and subjunctive 'counterfactual' conditionals: "the world selected must, if possible, be within the context set as well (where C is the context set, if $i \in$ C, then $f(A,i) \in C$)." (Stalnaker(1976:199)). This constraint will only be fulfilled if A is compatible with the context set. Since, according to Stalnaker, this principle conforms to the "normal expectations", on the basis of the principles of communicative functions it is considered as the "unmarked" case of the indicative conditional. If the speaker wishes to defeat this pragmatic presumption, he has to indicate that the selection function reaches outside of the context set. Usually this is done by the use of subjunctive mood.[2]

On the basis of these pragmatic constraints, Stalnaker derives an appropriateness condition for indicative conditionals: "*It is appropriate to make an indicative conditional statement or supposition only in a context which is compatible with the antecedent.*" Since counterfactual conditionals cannot conform to this constraint, it follows that "*counterfactual* conditionals must be expressed in the subjunctive". (Stalnaker(1976:201))

Finally, a problem of the analysis has to be addressed: The selection function f is defined to choose a unique possible world which is maximally similar to the actual world. This maximality constraint is problematic in two important respects.

First, as argued in Lewis(1973), the assumption that for every world there will always be a single, maximally similar world, the so–called "Limit Assumption", is questionable.[3] The analysis of conditionals should therefore better not rest on this hypothesis.

One consequence of the selection of a unique (maximally similar) world for the analysis of conditionals is the validity of the law of the Conditional Excluded Middle (CEM) (8) (see Lewis(1973:79)). I.e. in the non–vacuous case – given that in both disjuncts the same world w is selected by f – only one of the disjuncts can be true, since by the ordinary law of the Excluded Middle either ϕ or $\neg\phi$ holds at any given world w.

[2]Stalnaker points out examples due to Watling and Anderson, which illustrate that subjunctive conditionals are not restricted to counterfactuals: Stalnaker(1976:200,201)

(i) If the butler had done it, we would have found just the clues which we in fact found.

Kratzer(1979) establishes slightly different pragmatic conditions for the use of subjunctive conditionals. See Section 4.3.2.

[3]For discussion see Lewis(1973:Ch. 1.9).

(8) $(\phi > \psi) \vee (\phi > \neg\psi)$

Yet, as Lewis argues, the principle of the CEM does not hold generally. There are cases such as (9a), where the selection function f cannot sensibly choose between (maximally similar) worlds w_1 and w_2, where Bizet and Verdi are Italian or French compatriots, respectively. Thus, though (9a) seems perfectly natural, it cannot be verified on Stalnaker's analysis, which – given a unique selected world $f(\phi, \alpha)$ to satisfy the conditional antecedent – by necessity observes the law of the CEM. By contrast, on Lewis' analysis of counterfactuals (to be discussed below), which can be (re)formulated in terms of a *set* selection function, (9b) is valid, i.e. the law of the Conditional Excluded Middle does not hold generally.

(9) a. It is not the case that if Bizet and Verdi were compatriots, Bizet would be Italian; and it is not the case that if Bizet and Verdi were compatriots, Bizet would not be Italian; nevertheless, if Bizet and Verdi were compatriots, Bizet either would or would not be Italian.

b. $\neg(\phi > \psi)$ & $\neg(\phi > \neg\psi)$ & $(\phi > (\psi \vee \neg\psi))$ Lewis(1973:80)

Second, and relatedly, the truth conditions for conditional sentences $A > B$ are not strong enough. Given that the selection function f returns a *single*, maximally similar world, the definition (7) does not convey the meaning of the consequence relation holding between A and B with *necessity*. Thus, in general, on Stalnaker's analysis the *would*–counterfactual (10a) is not distinguished truth–conditionally from the *might*–conditional (10b). (See also Lewis(1973:80) on this point.)

(10) a. If I had asked my boss for a raise yesterday, he would not have agreed.

b. If I had asked my boss for a raise yesterday, he might not have agreed.

Thus, instead of verifying the truth of the consequent in just *one* (maximally similar) world, the *would*–conditional should rather be analyzed by universal quantification over a *set* of selected worlds. So, from Stalnaker's analysis, which restricts the conditional antecedent to a single maximally similar world, the above criticism could be taken to lead us to the opposite extreme, namely a strict implication analysis of conditional sentences, where the quantification ranges over the set of *all* epistemically accessible worlds that verify the antecedent clause. Obviously, a strict implication analysis is too strong. Rather, the analysis of conditionals is to be located somewhere between these opposite extremes, such that "*If A then B*" holds true if in *all* the worlds out of some appropriately restricted set of epistemically accessible worlds in which A is true, B is also found to be true. An analysis along these lines, restricted to counterfactual conditionals, has been developed in Lewis(1973).

2.2.2 Lewis: Counterfactuals

(1) Alexander the Great was a great general.
(2) Great generals are forewarned.
(3) Forewarned is forearmed.
(4) Four is an even number.
(5) Four is certainly an odd number of arms for a man to have.
(6) The only number that is both even and odd is infinity.

Therefore, Alexander the Great had an infinite number of arms.

One of the major insights in Lewis(1973) is that strict implication, i.e. quantification over *all* epistemically (or deontically) accessible worlds is too strong for the analysis of counterfactuals, and – as we will argue later on – for the analysis of conditionals in general. While we consider (11) to be true, there are undoubtedly some worlds among all the epistemically accessible worlds where the antecedent of (11) holds true, while the consequent does not. We can imagine worlds where kangaroos have no tails, but are able to walk around on crutches.

(11) If kangaroos had no tails, they would topple over. Lewis(1973:1)

So, some kind of restriction is called for, which Lewis defines in terms of "overall similarity": The worlds taken into account are confined to those that "resemble [our actual world] as much as kangaroos having no tails permits." (Lewis(1973:1)). Counterfactuals are therefore analyzed as "strict conditionals corresponding to an accessibility assignment determined by similarity of worlds – overall similarity with respects of difference balanced off against respects of similarity" (Lewis(1973:9)).[4]

Based on a contextually determined relation (or sphere of accessibility) of similarity of worlds, a first analysis of counterfactuals – taking care of their inherent vagueness – is given as (12) (see Lewis(1973:7)):

(12) Let S_i, for every world i, be the set of all worlds that are similar to i to at least a certain fixed degree. Then
– $\phi \;\Box\!\!\rightarrow \psi$ is true iff ψ holds at every ϕ–world in S_i.
– $\phi \;\Diamond\!\!\rightarrow \psi$ is true iff ψ holds at some ϕ–world in S_i.

The relevant relation of similarity of worlds being highly dependent on contextually determined respects of comparison "[t]he truth conditions for counterfactuals are fixed only within rough limits; ... they are a highly volatile matter, varying with every shift of context and interest." (Lewis(1973:92)). Nevertheless, Lewis argues, the range of vagueness is restricted, since the standards of comparison vary within a certain range only.

Given that counterfactual conditionals are analyzed by quantification over a *set* of accessible worlds, this analysis allows for a distinction to be made between *would*– and *might*–counterfactuals, which was not accounted for in Stalnaker's analysis. It also predicts that the principle of the Conditional Excluded Middle does not hold in general (see p. 12).

[4]For an extensive discussion of the trade–off between aspects of similarity and dissimilarity of the worlds that are to be determined as more or less similar to the actual world see Lewis(1973:Ch.4.2) and Lewis(1979).

The second important aspect of Lewis' theory is the analysis of counterfactuals as "variably strict" conditionals. Lewis observes that (12) does not account correctly for examples involving a succession of counterfactuals, as e.g. in (13).

(13) a. If I (or you, or anyone else) walked on the lawn, no harm at all would come of it; but if everyone did *that*, the lawn would be ruined.

b. If the USA threw its weapons into the sea tomorrow, there would be war;
but if the USA and the other nuclear powers all threw their weapons into the sea tomorrow, there would be peace;
but if they did *so* without sufficient precautions against polluting the world's fisheries there would be war;
but if, after doing *so*, they immediately offered generous reparations for the pollution there would be peace; ...

c. If Otto had come, it would have been a lively party;
but if both Otto and Anna had come it would have been a dreary party;
but if Waldo had come *as well*, it would have been lively; Lewis(1973:10,italics added)

For these examples it holds that if the "first stage" counterfactual (14a) is true according to (12), the "next", or "higher stage" counterfactual (14b) is predicted to be false, given the Law of the Excluded Middle. Put in a different way, if both counterfactuals are true, the second is true vacuously: If ψ is true at every accessible ϕ_1–world, and $\neg\psi$ at every accessible ϕ_1 & ϕ_2–world, there cannot be any accessible ϕ_1 & ϕ_2–world.

(14) a. $\phi_1 \;\Box\!\!\rightarrow \psi$

b. $\phi_1 \;\&\; \phi_2 \;\Box\!\!\rightarrow \neg\psi$

Two approaches might be taken to account for this problem:

One might argue that for each of the counterfactuals in (13) a different sphere of accessibility is chosen, with varying degree of strictness:[5] "It may be that for every stage of the sequence, there is a choice of strictness that is right for that stage. But as we go down the sequence we need stricter and stricter conditionals." (Lewis(1973:12))

Yet, Lewis argues, if counterfactuals are analyzed in this way, as strict conditonals based on a contextually determined sphere of accessibility, "we have no hope of deciding, once and for all, how strict they are." (Lewis(1973:12)). Reference to a contextually dependent choice of different spheres of accessibility is argued to be problematic because the examples in (13) pertain to a single context.[6]

By contrast, Lewis develops an analysis of counterfactuals as "variably strict conditionals" by assignment to each world i not of a single sphere of accessibility, but of a nested

[5] Definition of strictness (Lewis(1973:8)):
If $\Box_1$ and $\Box_2$ correspond to an assignment to world i of spheres of accessibility S_i^1 and S_i^2, respectively, the strict conditional $\Box_2(\phi \rightarrow \psi)$ is *stricter at* world i than $\Box_1(\phi \rightarrow \psi)$ iff S_i^2 properly includes S_i^1.

[6] We will return to this issue below.

set, or "system of spheres" of accessibility (15), which reflects the overall comparative similarity of worlds. Each sphere around a world i contains the worlds that resemble i to a certain fixed degree. By the nesting condition (1) in (15) the worlds k contained within some sphere S_1 around i are more similar to i than any world j outside S_1 which pertains to some sphere S_2 that contains S_1.

(15) Let \$ be an assignment to each possible world i of a set $\$_i$ of sets of possible worlds. Then $\$_i$ is called a *(centered) system of spheres*, and the members of each $\$_i$ are called *spheres* around i, if and only if, for each world i, the following conditions hold.

(C) $\$_i$ is *centered on* i; that is, the set $\{i\}$ having i as its only member belongs to $\$_i$.

(1) $\$_i$ is *nested*; that is, whenever S and T belong to $\$_i$, either S is included in T or T is included in S.

(2) $\$_i$ is *closed under unions*; that is, whenever S is a subset of $\$_i$ and $\bigcup S$ is the set of all worlds j such that j belongs to some member of S, $\bigcup S$ belongs to $\$_i$.

(3) $\$_i$ is *closed under (nonempty) intersections*; that is, whenever S is a nonempty subset of $\$_i$ and $\bigcap S$ is the set of all worlds j such that j belongs to every member of S, $\bigcap S$ belongs to $\$_i$. Lewis(1973:13,14)

The truth conditions for counterfactual *would*– and *might*–conditionals are now stated relative to a system of spheres of comparative similarity of worlds:

(16) a. $\phi \;\Box\!\!\rightarrow \psi$ is true at a world i (according to a system of spheres \$) iff either

(1) no ϕ–world belongs to any sphere S in $\$_i$, or
(2) some sphere S in $\$_i$ does contain at least one ϕ–world, and $\phi \rightarrow \psi$ holds at every world in S. Lewis(1973:16)

b. $\phi \;\Diamond\!\!\rightarrow \psi$ is true at a world i (according to a system of spheres \$) iff both

(1) some ϕ–world belongs to some sphere S in $\$_i$, and
(2) every sphere S in $\$_i$ that contains at least one ϕ–world contains at least one world where ϕ & ψ holds. Lewis(1973:21)

For the variably strict conditionals in (13), instead of selecting an appropriate sphere of accessibility for each counterfactual in isolation, in a system of spheres (15) the respective spheres of accessibility are all together present in \$: "S_i^1 is there to make the first stage counterfactual non–vacuously true, S_i^2 is there to make the second stage counterfactual non–vacuously true, and so on. The stages can coexist in peace." (Lewis(1973:19))

According to clause (2) in (16a), for the truth of the first counterfactual in (13c) it is sufficient that there be *some* sphere S_i^x around i, containing some ϕ_1–worlds which all satisfy ψ. It does not matter whether there are other ϕ_1– worlds, less similar to i, which also do, or do not satisfy ψ. As Lewis puts it: "One such sphere is enough to make $[\phi_1 \;\Box\!\!\rightarrow \psi]$

true; it does no harm that there is also a larger $\phi[_1]$–permitting sphere – the outermost – that reaches $\phi[_1]$–worlds where ψ is false." (Lewis(1973:17,18))

What matters, however, is that there mustn't be any sphere S_i^y of worlds more similar to i than those of S_i^x and which contains some world where $\phi_1\&\neg\psi$ holds true.

Counterfactual and indicative conditionals

Lewis explicity restricts his analysis to counterfactual conditionals: "I cannot claim to be giving a theory of conditionals in general" (Lewis(1973:3)). This is surprising, given the definition of the counterfactual conditional in (16), which determines counterfactuals with true antecedents to be true in case the consequent holds true in the actual world.

Though counterfactuals with true antecedents violate presuppositions, or conversational implicatures to the effect that the antecedent is supposed to be false in the actual world, Lewis argues that this does not necessarily mean that such sentences are false. We perfectly agree with this view, yet we want to question his claim that "there really are two sorts of conditional" – indicative and counterfactual – which cannot be given a uniform analysis.

Lewis resorts to an argument given by Adams(1970): While the indicative conditional (17a) is certainly true, the counterfactual (17b) is false. It is conceivable that Kennedy would not have been killed, if Oswald had not killed him. From this Lewis concludes that "there really are two different sorts of conditional; not a single conditional that can appear as indicative or as counterfactual depending on the speaker's opinion about the truth of the antecedent." (Lewis(1973:3))

(17) a. If Oswald did not kill Kennedy, then someone else did.

b. If Oswald had not killed Kennedy, then someone else would have. Lewis(1973:3)

c. If Oswald did not kill Kennedy, then someone else will.

Yet, these differences in truth value are not to be captured in terms of distinct truth conditions for indicative vs. subjunctive conditionals, but rather – as argued later by Stalnaker(1976) – in terms of pragmatic constraints on the selection of accessible worlds from within or from outside the *context set*.

In the particular example considered the selection of accessible worlds from within or outside the context set is heavily dependent on the time of evaluation, or assertion of the conditionals: (17a–b) are asserted long time after the event that determined the fact that Kennedy has been killed, presumably by Oswald. In our actual world and time this fact is determined and unalterable. Therefore the indicative conditional (17a), which – according to Stalnaker(1976) – is tied to the set of worlds that according to our knowledge correctly describe the actual world – the *context set* in Stalnaker's terminology – is required to be true: given that Kennedy has been killed, if it was not Oswald who did it, someone else must have done it.

This differs for the subjunctive conditional (17b). Since Kennedy in fact has been killed in the actual world, presumably by Oswald, the subjunctive conditional must range over worlds outside the context set. In these worlds, two options are compatible with Oswald not killing Kennedy: someone else did it, which makes (17b) true, or else Kennedy has not been killed, which makes it false.

Now take the indicative conditional (17c) to be uttered at the very moment when Kennedy was shot at. As long as it is not determined whether Kennedy was in fact killed, the context set will contain worlds where Kennedy was killed by Oswald, others where someone else killed him, as well as, finally, others where he was not killed. Therefore the truth value of (17c) – although in indicative mood – is determined by there being an accessible world where Kennedy was not murdered by anyone in the same way as the subjunctive conditional (17b) is. The subjunctive (17b) and the indicative (17c) differ in that the quantification ranges over worlds from outside vs. from within the context set. But they must both be judged false, because in both cases the selected set of worlds does not (historically) determine that Kennedy was killed.

Thus, the difference in truth value between (17a) and (17b) cannot be argued to be determined by distinct truth conditions for indicative and counterfactual conditionals. (17c) shows that this cannot be considered as a relevant criterion. What the contrasting examples bring out is that the deterministic factor for the truth vs. falsity of these two kinds of conditionals is best captured by way of Stalnaker's pragmatic conditions for the choice of accessible worlds from within or outside the context set (see Section 2.2.1): The differing truth values of indicative and counterfactual conditionals in (17) are accounted for by pragmatic constraints on the selection of the set of accessible worlds to constitute the quantificational domain – worlds from within or outside the context set – determined by the use of indicative vs. subjunctive mood, respectively, while the two kinds of conditionals will be characterized by the *same truth conditions*.

Moreover, it is evident that indicative conditionals display the same kind of vagueness as counterfactual conditionals do. The "vagueness of strictness" observed in (11) for counterfactuals can be reconstructed for indicative conditionals, as in (18): It is conceivable that if kangaroos lose their tails, they learn to keep and walk upright, such that they will not topple over.

(18) If kangaroos lose their tails, they will topple over.

Or take the famous counterfactual: *If Nixon had pressed the button, there would have been a nuclear holocaust*, which can be turned into an indicative conditional *If Nixon presses the button, there will be a nuclear holocaust* – uttered at the time Nixon is still undecided – and which displays the same range of vagueness which in Lewis' analysis of counterfactual conditionals is captured by resorting to the notion of comparative similarity of worlds.

And in much the same way as counterfactuals are subject to "variable strictness", illustrated by (13), this holds for sequences of indicative conditionals (19).[7]

(19) If Otto comes, it will be a lively party;
but if both Otto and Anna come, it will be a dreary party;
but if Waldo comes *as well*, it will be lively.

[7]There have been further objections against Stalnaker's analysis of both indicative and counterfactual conditionals in terms of a "Ramsey test analysis". These will only be discussed in Section 4.3.1.

Variably strict counterfactuals and context dependence

As for the latter phenomenon we might ask ourselves whether it is correct – in a setting of contextual dynamics – to account for the variability of (counterfactual) conditionals exemplified by (13)/(19) by interpretation relative to a *set*, or *system* of spheres of accessibility.

To begin with, consider the argument in (20), which extends Lewis' example by a conclusion that takes up the "first–stage"–counterfactual.

(20) If Otto had come, it would have been a lively party;
but if both Otto and Anna had come, it would have been a dreary party;
but if Waldo had come as well, it would have been lively.
Thus, if Otto had come, it would have been a lively party.

Lewis' analysis predicts the conclusion to be correct whenever the first three counterfactuals hold true. On the assumption that the example constitutes a unique context – assumption which led Lewis to this very analysis – to be analyzed within a single system of spheres, whenever there is a sphere S_i^x that verifies the first counterfactual, it also verifies the conclusion. But intuitively, we do not want the conclusion to follow. Once we have learnt – by increasing strength, or specificity of the counterfactual premises – that *there are worlds taken into account* in this context where Otto comes to the party and the party is dreary, we cannot sensibly maintain the now rather unqualified statement that *if Otto had come, it would have been a lively party.* We have learnt too much already about this complicated social event.

Lewis' analysis of variably strict conditionals abstracts from, or disguises the contextual dynamics that is involved in this kind of examples: In a given system of spheres *all* the spheres pertaining to distinct "variably strict" counterfactuals are present together and, according to (16), *any* (appropriate) sphere may be chosen for evaluation of an individual counterfactual, irrespective from the fact that by increasing strength of a succession of counterfactuals as in (20) a very specific contextual setting has already been established dynamically, which should determine the contextual basis for the interpretation of the next counterfactual.[8]

[8]It is interesting to note that this aspect of contextual dynamics is discussed in Lewis(1979b), although no direct connection is drawn there to the phenomenon of variably strict conditionals. (This observation is due to Hans Kamp.)

Lewis(1979b) presents a "kinematic" view of the "language game" where the "conversational score", roughly equivalent to a context or information state, is updated according to the rules that specify the "kinematics of score": "If at time t the conversational score is $\underline{s}$, and if between time t and time t′ the course of conversation is c, then at time t′ the score is $\underline{s}'$, where $\underline{s}'$ is determined in a certain way by $\underline{s}$ and c." (Lewis(1979b:176)). In addition, the "language game" allows for special rules of accommodation: "the conversational score does tend to evolve in such a way as is required in order to make whatever occurs count as correct play." (Lewis(1979b:178)). Changes in the choice of standards of precision for the accessibility relation for modalities are argued to be governed by rules of accommodation, with further restrictions as regards the dynamics or "direction" of these shifts: "I take it that the rule of accommodation can go both ways. But for some reason raising of standards goes more smoothly than lowering." (Lewis(1979b:182)). "If the commonsensical epistemologist says: "I <u>know</u> the cat is in the carton – there he is before my eyes ...", [t]he sceptic replies: "You might be the victim of a deceiving demon." Thereby he brings into consideration possibilities hitherto ignored, else what he says would be false. Once the boundary is shifted, Further support for our suspicion that – instead of *variable* strictness of counterfactuals within a *single* context – this type of example involves a high degree of contextual dynamics comes from the observation that in (13) most of the conditional antecedents contain anaphoric expressions (propositional anaphors, VP–anaphors, etc.), which refer to antecedent expressions contained in the antecedent clause of the preceding, or "lower–stage" counterfactual. This particular kind of anaphoric dependency, reminiscent of "modal subordination" (Roberts(1987,1989)), reveals the true nature of "variably strict counterfactual conditionals" as *anaphorically dependent* or *modally subordinated* counterfactual conditionals. In a succession of increasingly strengthened counterfactuals such as (20) the antecedent of a "lower–stage" counterfactual is *additionally restricted* or *specified* by the antecedent of the subsequent "higher–stage" counterfactual. Once a higher degree of specificity is induced by a subsequent "higher–stage" counterfactual, only this more restrictive context is available for the evaluation of the anaphorically connected, and further specifying counterfactuals.

The process of dynamic interpretation that is involved in interpreting a sequence of increasingly strict conditionals such as (20) is tentatively illustrated in (21).

(21) a. $\phi_1 \;\Box\!\!\rightarrow \psi$

$$c_0: \begin{array}{l} \boxed{\begin{array}{llll} w_1: & \phi_1 \;\&\; \phi_2 \;\&\; \phi_3 & \&\; \psi & S_1 \\ w_2: & \phi_1 \;\&\; \phi_2 \;\&\; \neg\phi_3 & \&\; \psi & S_1 \end{array}} \\ \begin{array}{llll} w_3: & \phi_1 \;\&\; \neg\phi_2 \;\&\; \phi_3 & \&\; \psi & S_1 \\ w_4: & \phi_1 \;\&\; \neg\phi_2 \;\&\; \neg\phi_3 & \&\; \psi & S_1 \end{array} \end{array}$$

b. $\phi_1 \;\&\; \phi_2 \;\Box\!\!\rightarrow \neg\psi$

b′. $\phi_1 \;\&\; \underline{\neg\phi_2} \;\Box\!\!\rightarrow \psi$
$\phi_1 \;\&\; \phi_2 \;\Box\!\!\rightarrow \neg\psi$

$$c_1: \begin{array}{l} \boxed{\begin{array}{llll} w_{1'}: & \phi_1 \;\&\; \phi_2 \;\&\; \phi_3 & \&\; \neg\psi & S_2 \end{array}} \\ \begin{array}{llll} w_{2'}: & \phi_1 \;\&\; \phi_2 \;\&\; \neg\phi_3 & \&\; \neg\psi & S_2 \\ w_3: & \phi_1 \;\&\; \neg\phi_2 \;\&\; \phi_3 & \&\; \psi & S_1 \\ w_4: & \phi_1 \;\&\; \neg\phi_2 \;\&\; \neg\phi_3 & \&\; \psi & S_1 \end{array} \end{array}$$

c. $\phi_1 \;\&\; \phi_2 \;\&\; \phi_3 \;\Box\!\!\rightarrow \psi$

c′. $\phi_1 \;\&\; \neg\phi_2 \;\Box\!\!\rightarrow \psi$
$\phi_1 \;\&\; \phi_2 \;\&\; \underline{\neg\phi_3} \;\Box\!\!\rightarrow \neg\psi$
$\phi_1 \;\&\; \phi_2 \;\&\; \phi_3 \;\Box\!\!\rightarrow \psi$

$$c_2: \begin{array}{llll} w_1: & \phi_1 \;\&\; \phi_2 \;\&\; \phi_3 & \&\; \psi & S_3 \\ w_{2'}: & \phi_1 \;\&\; \phi_2 \;\&\; \neg\phi_3 & \&\; \neg\psi & S_2 \\ w_3: & \phi_1 \;\&\; \neg\phi_2 \;\&\; \phi_3 & \&\; \psi & S_1 \\ w_4: & \phi_1 \;\&\; \neg\phi_2 \;\&\; \neg\phi_3 & \&\; \psi & S_1 \end{array}$$

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the commonsensical epistemologist must concede defeat." (Lewis(1979b:183)).

It is not surprising then that counterfactual conditionals display the same peculiarity wrt. "shifts" in the choice of accessible worlds, as we observed for (20). Yet, while Lewis does not provide us with an explanation of why the rules of accommodation are governed by this tendency towards increasing specificity, he does give a hint towards an analysis of the phenomenon in a dynamic framework: The epistemologist must concede defeat, "yet he was not in any way wrong [...] What he said was true *with respect to the score as it then was*." (Lewis(1979b:183); italics added)

Thus, as we hinted at above, the interpretation of modalized sentences must be defined wrt. *a single context*, to be updated dynamically or adjusted by accommodation, in contrast to a *set* of contexts (i.e. a system of spheres of accessibility). Only on this view – and by taking into account the observed tendency of accommodation towards increasing specificity – the phenomenon of variably strict counterfactuals can be given a satisfactory analysis. In Section 5.3 we will come up with an analysis of conditional variability that not only accounts for this contextual dynamics, but also gives an explanation for the tendency towards increasing specificity – as opposed to decreasing specificity – which was observed by Lewis.

We take the context successively introduced by the increasingly strict conditionals (21a), (21b) and (21c) to form a dynamically extended discourse where the antecedents of the successive counterfactuals are contextually dependent on, or modally subordinated to the preceding ones. The selected set of accessible worlds that verifies the respective conditionals is represented in the figures to the right hand side.

The first counterfactual of the sequence, (21a), is verified by a set of worlds c_0 that contains worlds of the four types given in the right figure of (21a).

Now, the dynamic interpretation of (21b) relative to the context established by the first conditional leads to a contradiction, if evaluated relative to the same set of accessible worlds c_0. However, on the assumption that we are dealing with a coherent discourse, consistency can be obtained by "revision" of the first counterfactual in view of what is stated by the more specific, second conditional: This revision can be obtained in terms of accommodation of the further condition $\neg\phi_2$ into the antecedent of the first conditional, as indicated in (21b′). This of course must also lead to a "revision" of the set of worlds c_0 that verifies the revised counterfactual(s) in (21b′), as is indicated by the right figure of (21b′).[9]

The same principle applies to the third counterfactual, (21c), which is to be interpreted relative to this new, extended and revised context (21b′). Again we run into a contradiction, since the set of accessible worlds c_1 to verify (21b′) will not allow for verification of (21c). Again, consistency can be obtained by accommodating the condition $\neg\phi_3$ into the antecedent of the preceding counterfactual. This in turn must induce a revision of the set of worlds c_1 underlying the evaluation of the conditionals in (21b′), turning it into the set c_2 that verifies all of the three counterfactuals in the final extended context (21c′).

Thus, at the end of this succession of *contextually dependent* counterfactuals, we are not left with (21c) taken in isolation, or the conjunction of the three counterfactuals (21a–c), but, in essence, with the sequence of counterfactuals in (21c′), which are all verified by one and the same set of accessible worlds (here illustrated by c_2), and which displays the full complexity of the social event successively introduced in (13c).

And in fact, if (21c′) is taken to constitute the complex, dynamically constructed premise of the arguments in (20) and (22) respectively, (22) comes out valid, while (20) does not.

(22) If Otto had come, it would have been a lively party;
but if both Otto and Anna had come it would have been a dreary party;
but if Waldo had come as well, it would have been lively.
Thus, if Otto had come, but [not Anna or else both Anna and Waldo], it would have been a lively party.

Note that while the dynamic interpretation process illustrated in (21) explicitly reflects the dynamics of the interpretational process, involving successive specification by partial revision, in Lewis' analysis, in order to make the inference (22) valid, the system of spheres must *from the start* be structured in such a way that S_1 contains w_3 and w_4, S_2 additionally contains $w_{2'}$, and S_3 additionally contains w_1 (see (21c′)).

So the question is whether "conditional variability" should be analyzed by resorting to a system of spheres, to be given in full – and final – complexity by the *preceding* context, or whether the local context *itself*, consisting of the successive counterfactuals with

[9] The box indicates the set of worlds which are to be "revised" (relative to c_0) by taking into account the *further specifying* counterfactual (21b).

increasingly strengthened antecedents, dynamically specifies the contextually relevant (single) sphere of accessibility, thereby mirroring the dynamics of language which certainly is involved in this kind of example.

We take the present example to support our view, that it is counterintuitive, on principled grounds, to assume that an appropriately refined system of spheres – based on a contextual relation of comparative similarity of worlds – could be presupposed to constitute the "input" for examples as complex as the ones in (13). Such an assumption is especially questionable from the viewpoint of language understanding, but similar objections may be raised for the aspect of language production. Especially the use of *but* in these examples suggests an analysis in terms of continuous specification, involving (partial) revision, of the dynamically constructed sets of worlds underlying the evaluation of the increasingly strict conditionals.

At this point, the principles that underlie the process of (partial) revision for a dynamic interpretation of sequences of conflicting counterfactuals – which we just illustrated by going through a particular example – must still remain somewhat obscure. In Section 5.3 we will introduce constraints for the selection of a contextually determined set of "normal" worlds for the interpretation of conditionals that not only account for sequences of "variably strict conditionals" in a dynamic context, but also capture various patterns of nonmonotonic inference patterns.

Further support for a dynamic view of sequences of "variably strict counterfactuals" comes from their being intimately connected to the phenomenon of modal subordination.

In his discussion of "counterfactual fallacies" (Lewis(1973:Ch.1.8)) Lewis argues that the invalidity of certain logical inference patterns with counterfactuals is due to the fact that the strictness of counterfactual conditionals may vary. For transitivity (23a), this is exemplified by the argument in (23b), which is fallacious: "The fact is that Otto is Waldo's successful rival for Anna's affections. Waldo still tags around after Anna, but never runs the risk of meeting Otto. Otto was locked up at the time of the party, so that his going to it is a far–fetched supposition; but Anna almost did go. Then the premises are true and the conclusion false." (Lewis(1973:33))

(23) a.
$$\chi \;\Box\!\!\rightarrow\; \phi$$
$$\phi \;\Box\!\!\rightarrow\; \psi$$
$$\vdash \chi \;\Box\!\!\rightarrow\; \psi$$

b. If Otto had gone to the party, then Anna would have gone.
If Anna had gone, then Waldo would have gone. Lewis(1973:32,33)
$\vdash$ If Otto had gone, then Waldo would have gone.

c. If Anna goes out with Otto, Waldo avoids her.
If Otto had gone to the party, then Anna would have gone.
If Anna had gone, but not Otto, then Waldo would have gone.
$\nvdash$ If Otto had gone, then Waldo would have gone.

In the following I want to argue that for explanation of (23b) it is not only unnecessary, but in fact rather misleading to resort to a particular ranking of worlds in terms of their comparative similarity (or "far–fetchedness"). In the example discussed, it is the very contextual setting, the additional fact that "Waldo [...] tags around after Anna, but never runs the risk of meeting Otto", which makes the inference invalid. If we adopt this fact – which must be taken into account in order to make (23b) invalid also if we follow Lewis' explanation – as an additional conditional premise, as in (23c), we cannot unconditionally maintain the second counterfactual premis of (23b), that if Anna had gone, Waldo would have gone: This counterfactual cannot be true if we take into account the additional premise, adopted in (23c), which by assumption holds true in the actual world, and which must be assumed to hold true in the most similar counterfactual worlds we are considering in this context.[10] Thus, the third premise in (23c) must be modified by "taking into account" the first conditional, i.e. its interpretation is to be restricted to the context set up by the first premise.

Two conclusions are to be drawn from these observations: First, in the very contextual setting that Lewis introduces in order to show the failure of transitivity with counterfactuals, the argument in (23b) is inappropriate: the counterfactual premises cannot be verified in this particular contextual setting. So (23b) does not in fact prove the failure of transitivity.[11] Secondly, the crucial fact to note here is that by taking into account the first premise in the interpretation of the counterfactuals in (23c), such that the premises are true in the particular context considered, the supposedly fallacious inference is avoided: the conclusion that "If Otto had gone to the party, Waldo would have gone" does not follow. So the fallacious inference (23b), which Lewis argues to be caused by the variability of the counterfactuals, can be avoided by a context–dependent and dynamic account of counterfactual conditionals as illustrated in (23c).[12] [13]

It is interesting to note in this connection that, as Lewis observes, by adding a third premise, $\phi \,\Box\!\!\rightarrow \chi$, to the inference of transitivity in (24a), a special case of non–fallacious inference by transitivity ensues, reformulated in (24b–c), which in fact come down to a definition of modal subordination.

(24) a. $\begin{array}{l} \chi \,\Box\!\!\rightarrow \phi \\ \phi \,\Box\!\!\rightarrow \chi \\ \phi \,\Box\!\!\rightarrow \psi \\ \vdash \chi \,\Box\!\!\rightarrow \psi \end{array}$ b. $\begin{array}{l} \chi \,\Box\!\!\rightarrow \chi \,\&\, \phi \\ \chi \,\&\, \phi \,\Box\!\!\rightarrow \psi \\ \vdash \chi \,\Box\!\!\rightarrow \psi \end{array}$ c. $\begin{array}{l} \chi \,\Box\!\!\rightarrow \phi \\ \chi \,\&\, \phi \,\Box\!\!\rightarrow \psi \\ \vdash \chi \,\Box\!\!\rightarrow \psi \end{array}$ Lewis(1973:35)

Adding the premise $\phi \,\Box\!\!\rightarrow \chi$ to the argument in (23a) comes down to the statement that in all counterfactual worlds where Anna were to come, Otto and Anna would both come to the party. Therefore, if the premise $\phi \,\Box\!\!\rightarrow \psi$ is non–vacuously true, Waldo would come in those worlds where Otto and Anna both come to the party, which makes the inference valid. Note however, that this valid inference is incompatible with the additional assumption that "Waldo never runs the risk of meeting Otto". This *tacitly* assumed premise, which led to the fallacy of (23b), is now *explicitly* excluded in (24a).

[10]This has also been observed by Veltman(1986).

[11]For further examples of counterfactual fallacies which turn out to depend crucially on additional contextual assumptions not accounted for in the set of premises see Lewis(1973:32,35).

[12]In Section 5.3.2 we will investigate in more detail whether a context dependent analysis of (counterfactual) conditionals will be able to do away with the problematic "counterfactual fallacies", i.e. whether transitivity can be assumed as a valid inference with *context dependent* conditional reasoning.

[13]See also most recently von Fintel(1996).

More importantly, the premises of the valid inferences in (24), now relieved from the interference with tacit contextual assumptions, are equivalent to a succession of modally subordinated conditionals, which is most transparently represented in (24c): here the second premise is modally subordinated to the first one in that the antecedent and consequent of the first counterfactual jointly constitute the antecedent of the second counterfactual. It is thereby guaranteed that the second counterfacual is evaluated relative to the same sphere of accessibility as the first one, which makes the inference valid.

To sum up, next to the problem of invalid inferences in (20), both (23b–c) and (24) strongly support our suspicion that the interpretation of ("variably strict") counterfactual conditionals in a *system* of spheres abstracts away from contextual dynamics and context dependence, which are both aspects of meaning that are crucial for the validity of logical inferences in context. Instead of taking for granted a system of spheres which is pre–established so as to make true a succession of variably strict counterfactuals in *one* context, and thus has the effect of keeping the context constant, the cases considered call for a dynamic analysis where each counterfactual is interpreted relative to the local context established by its preceding (and in turn context dependent) counterfactual.

An alternative analysis which is in line with our objections arises – more or less directly – from the work of Lewis itself: One of his various reformulations of the theory of counterfactuals in Lewis(1973) is the definition of counterfactuals in terms of "multiple modalities", a family of (increasingly strict) modal operators, each one restricted to a specific sphere of accessibility S_i^m in a system of spheres $\$_i$.

(25) a. $\phi \ \Box\!\!\rightarrow\ \psi \ =^{df}\ (\Diamond_1\phi \ \&\ \Box_1(\phi \rightarrow \psi)) \vee \ldots \vee (\Diamond_n\phi \ \&\ \Box_n(\phi \rightarrow \psi)) \vee \neg\Diamond_n\phi$

b. $\phi \ \Diamond\!\!\rightarrow\ \psi \ =^{df}\ (\Diamond_1\phi \rightarrow \Diamond_1(\phi \ \&\ \psi)) \ \&\ \ldots \ \&\ (\Diamond_n\phi \rightarrow \Diamond_n(\phi \ \&\ \psi)) \ \&\ \Diamond_n\phi$

where $\Box_m\phi$ is true at a world i iff ϕ holds throughout S_i^m,
and $\Diamond_m\phi$ is true at a world i iff ϕ holds at some world in S_i^m. Lewis(1973:44)

As discussed above, the definition of the counterfactual conditionals in (25) abstracts from the way in which context determines the relevant sphere of accessibility (for evaluation of a given counterfactual). Instead, in light of the above discussion, we might proceed to a redefinition of (25), a definition of "multiple counterfactual conditionals" as given in (26). Here a counterfactual conditional is evaluated relative to *one single sphere of accessibility*, instead of a set of spheres. The definition allows to choose some specific sphere of accessibility S_i^m (possibly from a system of spheres $\$_i$), which is appropriate for the particular context the counterfactual appears in. Thus, the choice of the parameter m in (26), determining the selection of a particular sphere, or set of accessible worlds for evaluation of a particular counterfactual, is to be viewed as pragmatically, or contextually determined.

(26) a. $\phi \ \Box_m\!\!\rightarrow\ \psi$ is true at i iff $\Diamond_m\phi \ \&\ \Box_m(\phi \rightarrow \psi)$

b. $\phi \ \Diamond_m\!\!\rightarrow\ \psi$ is true at i iff $\Diamond_m\phi \rightarrow \Diamond_m(\phi \ \&\ \psi)$

where $\Box_m\phi$ is true at a world i iff ϕ holds throughout S_i^m,
and $\Diamond_m\phi$ is true at a world i iff ϕ holds at some world in S_i^m.

We have argued that the phenomenon of "variably strict (counterfactual) conditionals" calls for a dynamic analysis that restricts the evaluation of each of the individual conditionals to the (local) context set up by the preceding conditionals. We will propose an analysis along these lines the framework of DRT in Chapter 5. We will then investigate in more detail the aspect of nonmonotonic reasoning, which has not been addressed at this point.

Comparative similarity of worlds

Lewis' analysis accounts for the vagueness of counterfactuals in terms of the (context dependent) relation of "overall similarity" between worlds. He considers the concept of comparative similarity of worlds to be particularly suited to account for the vagueness of counterfactuals, given that the criteria for the underlying aspects of comparison do themselves vary "with every shift of context and interest" (Lewis(1973:92)). Yet, we may ask ourselves whether comparative similarity – besides being vague and context dependent – is in fact the right concept to choose here.

Of course, if we consider (11) it seems rather natural to exclude from consideration those far–fetched worlds, dissimilar from ours, where kangaroos are able to walk with crutches. But once we consider counterfactuals which must be tied to worlds that are quite similar to our actual world due to the amount of structure they involve, the concept of comparative similarity as the basis for choosing a set of accessible worlds gets more and more dubious.

Especially in light of our discussion of "variably strict counterfactuals" it should be evident that for the interpretation of a succession of increasingly strict counterfactuals the distribution of worlds over different spheres of accessibility cannot be based on matters of similarity. A non–dynamic analysis of variably strict counterfactuals must take for granted a system of spheres to be structured according to some very specific and rather unintuitive relation of comparative similarity of worlds for (13c) to come out true. Take it that Mary, Lisa and Sam came to the party. What kind of similarity criterion should determine an ordering of worlds that predicts the worlds where Otto came to the party to be more *similar* to this world than those where Otto and Anna came to the party, and these latter worlds to be more *similar* still to our world than those where Otto, Anna and Waldo came? In our view, such examples suggest that we do not quantify over more and more *dissimilar*, or *far–fetched* worlds, but *take into account* more and more specific, alternative worlds, or possibilities.

Another objection against the similarity account of counterfactuals is discussed in Lewis(1973) and more extensively in Lewis(1979).[14] For (27) the famous argument runs as follows: Take it that we are in world w_0, where Nixon does not press the button, and where there will never be a nuclear holocaust. Then any alternative world w_1 where Nixon presses the button and a nuclear holocaust ensues is – given the horrible consequences – more dissimilar to the actual world than some world w_3 where he presses the button, but where, due to some lucky circumstances resulting from some minor dissimilarities from the actual world, it is disconnected from the machinery that sets the holocaust in motion. Evaluation of the counterfactual conditional wrt. worlds that are most similar to the actual world should therefore falsify (27).

[14]For further criticism of the similarity approach to counterfactuals see e.g. Bowie(1979).

(27) If Nixon had pressed the button, there would have been a nuclear holocaust.
Fine(1975:452), Lewis(1979:467)

In Lewis(1979), Lewis defends his analysis of counterfactuals in terms of comparative similarity, although, he concedes, the relation of comparative similarity being extremely vague, "it does little to predict the truth values of particular counterfactuals in particular contexts." (Lewis(1979:465)).

In reviewing the objections raised in the literature,[15] Lewis establishes a system of "weights and priorities" to be imposed on the relation of overall similarity of worlds for the interpretation of counterfactuals (28). The criteria are defined so as to obey the "asymmetry of counterfactual dependence", i.e. the fact that the present and future are "asymmetrically dependent on the past": "The way the future is depends counterfactually on the way the present is. If the present were different, the future would be different. ...Likewise the present depends counterfactually on the past," but "[n]ot so in reverse." (Lewis(1979:455)).[16]

The similarity relation, next to "eliminating" worlds that involve great miracles (from the standpoint of the actual world) (see (28)(1)), characterizes as very similar those worlds which are exactly like the actual world in the past ((28)(2)). If some world "coincides" with the actual world in the past, in order to make true the counterfactual antecedent, some "small, localized miracle" violating the laws of the actual world is required, which induces a divergence of the two worlds. Given the high priority of perfect match in the past, such small miracles, although they may have important consequences, do not count much for the relation of similarity ((28)(3)). By contrast, worlds that are *quite*, but not exactly like the actual world up to some point of divergence are not in accordance with the asymmetry of counterfactual dependence, and therefore – though they may be very similar "in particular facts" – do not count as maximally similar worlds.

(28) (1) It is of the first importance to avoid big, widespread, diverse violations of law.

(2) It is of the second importance to maximize the spatio–temporal region throughout which perfect match of particular fact prevails.

(3) It is of the third importance to avoid even small, localized, simple violations of law.

(4) It is of little or no importance to secure approximate similarity of particular fact, even in matters that concern us greatly. Lewis(1979:472)

For Fine's example (27) these criteria for the relation of comparative similarity of worlds determine a similarity ranking $w_1 <_{w_0} w_3$, $w_3 <_{w_0} w_4$, $w_4 <_{w_0} w_2$ on the worlds w_1, w_2, w_3 and w_4, which are illustrated below.

The world w_1 is exactly like w_0 until shortly before t, where some "tiny, localized miracle" occurs that makes Nixon press the button at w_1, which causes a nuclear holocaust in w_1.

[15] See Lewis(1979:467) for references.

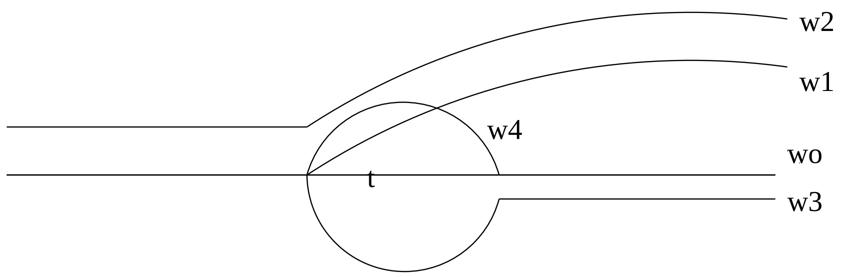
[16] We will discuss the aspect of asymmetric counterfactual dependence on time in more detail in Sections 5.1.3 and 5.1.4, where we refer to the concept of *historical necessity* discussed in Kamp(1978).

The two worlds diverge considerably, but given the maximal region of "perfect match" in the past, w_1 counts as maximally similar to w_0.

w_2 is a world that obeys the same laws as w_0, but differs from w_0 in that Nixon presses the button with the horrible consequences determined by the deterministic laws. Given the assumption of asymmetric dependence of counterfactuals on the past, this world does not count as sufficiently similar to w_0: being different in some spatiotemporal region around t, given that the same laws govern these worlds, they must also differ in the past. Since this contradicts the assumption of counterfactual dependence on the past, w_2 does not count as sufficiently similar to w_0.

w_3 is a world that is exactly like w_0 until shortly before t. A tiny miracle occurs in w_3 that makes Nixon press the button at t, but soon after t a second tiny miracle occurs in w_3 that prevents the signal from reaching the rockets. Apart from the facts that take place around t, w_3 is very similar to w_0. However, Lewis argues, there cannot be a perfect match after t: The finger on the button has left traces, Nixon could have been observed, etc., and "[s]ome of these little differences would give rise to bigger differences sooner or later." (Lewis(1979:470)). Therefore, w_3 is judged less similar to w_0 than w_1.

Finally, w_4 is like w_1 and w_3 in being exactly like w_0 before t, where a tiny miracle occurs that makes Nixon press the button. Unlike w_3, in w_4 a "widespread and complicated and diverse second miracle" occurs right after t that "not only prevents the holocaust but also removes all traces of Nixon's button pressing. ... in every detail of particular fact, however minute, it is just as if the button–pressing had never been. The worlds w_4 and w_0 reconverge." (Lewis(1979:471)). Given (28)(1), w_4 does not count as sufficiently similar to w_0, i.e. it does not falsify the counterfactual.



The example should make clear that the criteria for the relation of "overall" similarity are far away from any intuitive understanding of "respects of similarity". As Lewis puts it: "[...] we must use what we know about the truth and falsity of counterfactuals to see if we can find some sort of similarity relation – not necessarily the first one that springs to mind – that [...] yield[s] the proper truth conditions." (Lewis(1979:467))[17]

[17]For further discussion of the notion of similarity for the analysis of ordinary counterfactuals see also Bowie(1979). This is what he observes after having reviewed possible alternatives to specify an appropriate similarity relation to account for ordinary counterfactuals:

> "[s]ince there is a notion of similarity, namely similarity with respect to those truths which would remain truths if A were the case, which give us the right answer for the counterfactual A $\Box\!\!\rightarrow$ B, it is no surprise that the similarity approach seems to provide an acceptable logic for the counterfactual conditional. Unfortunately there is no non–circular way of explicating the required notion of similarity which does not itself involve counterfactual discourse. [...]

Note that the criteria in (28) fall into two classes: The importance of (2) and (3) is due to the assumption of asymmetric counterfactual dependence on the past, which requires the set of selected worlds to be "exactly like" the actual world as regards the past, while disregarding great dissimilarities pertaining to the future and small divergences required for the truth of the antecedent in the counterfactual worlds. This determined the ranking of w_1 as more similar to w_0 than w_2 in the present example. Condition (4) is in a way the counterpart of (2) and (3): it is more important to have "perfect match" of worlds in the past (with some little miracle at the point of divergence) than "overall approximate similarity" as regards particular facts.

By contrast, condition (1) seems to be tied to some rather intuitive notion of plausibility, or "expectation as to what is considered as the normal course of events", which is not necessarily to be understood in terms of similarity. From the standpoint of w_0 it is rather *implausible* – given what we know about its deterministic laws – that at some time in w_0 some fact or "miracle" causes alternative worlds to diverge from w_0, which are as miraculous as e.g. w_4 or w_3.

Our knowledge and imagination about non–factual worlds is restricted. This as well as pragmatic considerations drives us to take into account only those alternative worlds that involve no other divergences from w_0 than are required to make the counterfactual assumption true, and which otherwise obey the laws of the actual world as much as possible within these limits. Since events that completely undo the causes and effects of a nuclear holocaust do not correspond to what we expect to be the "normal course of events" in our actual world, w_4 is then judged as a rather *implausible* world. To a different degree also w_3 counts as rather implausible: We expect the machinery of nuclear weapons controlled by the button, given the horrible consequences of their use, to be checked carefully. But nothing prevents us from taking into account such more *implausible* worlds. Yet, these more "far–fetched" contexts must be marked appropriately, as in (29):

(29) The U.S. Army has been rather sloppy as regards the maintenance of the control systems of their nuclear weapons. If Nixon had pressed the button, (possibly) there would not have been a nuclear holocaust.

To summarize, the conditions (28) which Lewis imposes on the similarity relation for counterfactual conditionals turn out to result in a rather unintuitive notion of "similarity". We argued that the restrictions on the relation of accessibility are better analyzed in terms of two different underlying concepts: the asymmetric dependence of counterfactuals on time on the one hand and some notion of "plausibility" or "expectation as to what is considered the normal course of events" on the other (see e.g. Veltman(1990), Morreau(1992)). We will discuss these aspects in more detail in Sections 5.1 and 5.2.

Although for each counterfactual, there is trivially, a similarity relation which works for that counterfactual, there appears to be no similarity relation specifiable in non–counterfactual terms [...]" (Bowie(1979:496,497))

Deontic conditionals

As an extension to his theory of counterfactual conditionals, Lewis investigates the logic of deontic conditionals. "[T]here are variably strict conditionals to be found also in deontic logic, tense logic and egocentric logic." (Lewis(1973:96)). In our discussion we will restrict ourselves to counterfactuals in deontic logic.

For deontic modalities the system of spheres is based on a relation of "comparative goodness of worlds", and – given that the actual world is most likely not one of the best worlds – will not be centered; i.e. the actual world i does not belong to the innermost nonempty sphere determined by i. But the system of spheres of accessibility still obeys the conditions (1)–(3) in (15).[18] Given the truth conditions for the operators $\Box\!\!\rightarrow$ and $\Diamond\!\!\rightarrow$, relative to a system of comparative goodness of worlds, the deontic counterfactual $\phi \Box\!\!\rightarrow \psi$ (to be read as *Given that ϕ, it is obligatory* or *it ought to be that ψ*) is true at i if there are ϕ–worlds accessible from i iff ψ holds at all the best ϕ–worlds, according to the ordering from the standpoint of i.

Operators of conditional obligation and permission are needed to deal with cases where given that ϕ it ought to be that ψ, but where it (unconditionally) ought not to be that ϕ and it ought not to be that ψ. Lewis' example is (30).[19]

(30) a. Jesse should not rob the bank.
b. Jesse should not confess and give back the loot.
c. If Jesse robbed the bank, he ought to confess and give back the loot.

If the system of spheres is structured in such a way that the worlds where Jesse does neither rob the bank nor has to confess or to give back some loot are "better" from the standpoint of i than those where he robs the bank and confesses, and furthermore, those latter worlds are in turn "better" from the standpoint of i than those worlds where he robs the bank and does not confess or give back the loot, then all the deontically modalized sentences in (30) come out true.

Just like epistemically modalized counterfactuals, deontic conditionals can be analyzed as "variably strict" in a system of spheres, given alternating sequences such as (31).

(31) [If] Jesse robbed the bank, he ought to confess;
but [if] in addition [...] his confession would send his ailing mother to an early grave, he ought not to;
but [if] in addition [...] an innocent man is on trial for the crime, he ought to after all ... Lewis(1973:102,103)[20]

[18]We will not discuss the further conditions of "normality, universality, and absoluteness" which Lewis imposes upon a system of spheres of comparative goodness of worlds (see Lewis(1973:98,99)).

[19]Note that the example is in fact to be characterized as contextually dependent. The act of confessing in (30b) is understood to be anaphorically connected to the act of robbing the bank expressed in (30a), as made explicit in the paraphrase *Jesse should not confess having robbed the bank and give back the loot he took.* An example involving anaphorically independent premises would be something like the following:

(i) a. Max should not take the car.
b. Max should not put heavy things in his bag.
c. If Max takes the car, he should take heavy things in his bag.

It is explicit, by use of the phrase *in addition* and VP–ellipsis, that these variably strict deontic conditionals are to be analyzed as inherently context dependent. And, as we argued extensively for epistemically modalized conditionals above, an analysis of such sequences of variably strict (deontic) conditionals in a *system of spheres* will be inadequate: Again, we cannot conclude, from the entire context (31), that *If Jesse robbed the bank, he ought to confess*, while the analysis predicts so.

On Lewis' analysis deontically modalized conditionals – as opposed to epistemically based counterfactuals – are to be understood as some kind of *counter–obligational* conditionals. What this means is that in (30) the worlds where Jesse robs the bank are *contrary to the standards or laws* characterized by our ideal, or better worlds, where Jesse does not rob the bank. The "counter–deontic" conditional (30c) therefore is to be understood in the following way: In all the worlds – as good as possible within limits – where Jesse acts *against* what is true in our best possible worlds in that he robs the bank, it will also be the case that he confesses.

While this seems to be an appropriate analysis for (30c), the analysis also predicts other deontic counterfactuals to be true which we do *not* judge as intuitively adequate. For example, in all the – still best – worlds where Jesse robs the bank and his mother gets informed about this, Jesse has a mother. Therefore, (32a) will come out true.[21] In the same way, all deontic conditionals of the form $\phi \;\Box\!\!\rightarrow \phi$ as in (32b), and those that state a trivial truth in their consequent as in (32c) will come out true. But they are certainly not true in the context set up by (30) and (31).[22]

Example (32d) presents the problem from the opposite viewpoint. We certainly want (32d) to be true: Even if Jesse had acted against the law, his acts would still be prohibited by the law. Now, since Jesse robbed the bank in all the antecedent worlds, in all those that are "still best" according to the law, he will still have robbed the bank, and therefore we cannot derive that – according to the law – he shouldn't have done so.

(32) a. If Jesse robbed the bank and his mother got notice of it, Jesse ought to have a mother.

b. If Jesse robbed the bank, Jesse should rob the bank.

c. If Jesse robbed the bank, 1 plus 1 should equal 2.

d. Even if Jesse had robbed the bank, he shouldn't have done so.

Given that the deontic conditional quantifies over a set of worlds that all verify the conditional antecedent, this has the unwarranted consequence that the conditionals (32a–c), stating presuppositions or else logical truths in the consequent clause, come out true.

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[20] We have replaced *given that* by *if*.

[21] The modal *ought* is to be read non–epistemically in (32a).

[22] Note that the corresponding epistemic counterfactuals are not counterintuitive. They just express trivial truths, and are therefore more or less inappopriate, according to Gricean maxims.

(i) If Jesse had robbed the bank and his mother had got notice of it, Jesse would have a mother.

(ii) If Jesse had robbed the bank, he would have robbed the bank.

(iii) If Jesse had robbed the bank, 1 plus 1 would equal 2.

This first problem, in our view, is an immediate consequence of the analysis being tied to a possible worlds framework.[23]

There is, however, a more serious objection against Lewis' analysis, which in our view does not render the intuitive understanding of deontic conditionals:

While on Lewis' analysis the deontic conditional selects a set of worlds where the antecedent is true and which are maximally similar, according to the ranking of "comparative goodness of worlds", to the actual world, what e.g. the deontic conditional (30c) really expresses is that in those *maximally similar epistemically accessible worlds – relative to some notion of comparative similarity of worlds*, where Jesse robs the bank, *in the best of* these alternative accessible worlds, *according to a ranking of "goodness of worlds"*, he would confess. This paraphrase indicates that the selection of the worlds where the antecedent is true is not based on the relation of "comparative goodness of worlds", but rather on the relation of comparative similarity.[24] Once a particular sphere of epistemically accessible worlds is chosen, the worlds that verify the antecedent are then to be structured according to the relation of "comparative goodness of worlds".

An analysis along these lines will not only account for the typical examples of *conditional obligation*, exemplified by (30c), i.e. of deontic conditionals that are evaluated by resorting to (conditional) laws that are valid in the actual world, but will also account for cases like (33), where the antecedent clause takes us to worlds where the laws differ radically from those prevailing in the actual world.

(33) If Luther hadn't brought about the Reformation, we would still *have to* pay indulgence.

If we want the analysis to carry over to *counterfactual* deontic conditionals like (33), which explicitly state (epistemic) counterfactuality in the antecedent clause, while expressing deontic modality in the consequent, this will only be possible by evaluation of the *deontic* modal operator in the consequent clause as *embedded* within the *epistemically* modalized counterfactual conditional.[25] This distinction provides a way to use different ordering criteria, namely similarity vs. "goodness" of worlds for the evaluation of the individual modal operators – the counterfactual conditional and the embedded deontic modal.

In Lewis' framework this could be done by interpretation of deontic *if*-conditionals relative to *two* systems of spheres: one determining overall "comparative similarity of worlds" for evaluation of the higher, epistemically based operator, the other determining "comparative goodness of worlds" for evaluation of the embedded deontic operator.[26] The difference between the classical cases of conditional obligation (30a) and cases like (33) is then due to the fact that the selection of the antecedent in (30a) takes us to maximally similar worlds

[23]Similar problems arise in Kratzer's(1978,1991) analysis of deontic conditionals (see Section 2.2.3). In our DRT analysis of deontic modality in Section 4.1.4 we will come up with a solution to this problem.

[24]Recall the above observation that counterfactual and indicative conditionals display the very same kind of vagueness, which is captured in Lewis' framework by use of the notion of comparative similarity.

[25]The analysis of such sentences cannot be based on a *single* system of spheres, as defined in (16): Either the system of spheres must be structured by a relation that expresses both overall comparative similarity *and* comparative goodness of worlds at the same time – I do not see how this might be done –, or else either the aspect of counterfactuality or the deontic nature of the conditional gets lost.

[26]In contrast to Lewis(1973) and Kratzer(1978,1991) we will argue for an analysis along these lines in Sections 2.2.3 and 4.1.4.

where the laws are taken to be still the same as in our actual world, while in cases like (33) the antecedent takes us to (maximally similar, but) radically different worlds, where we must assume that the laws are different from our actual laws.

But note that for the analysis of (30c) such an analysis requires the embedded deontic operator to be *implicitly* restricted by an antecedent that restricts the deontic quantification to the very same set of worlds that constitute the quantificational domain of the "higher" operator, i.e. to (maximally similar) worlds where Jesse robs the bank. If this is not ensured, (30c) cannot be verified: In all (maximally similar worlds) where Jesse robs the bank it holds *unconditionally* that in all accessible worlds that are best according to the ranking of "goodness", he will not rob the bank. By contrast, for the *even–if* conditional in (32d) this is just what we want. Here the embedded deontic operator must be *unrestricted*, thus selecting the "best" accessible worlds, which define that there be no robbing of the bank. Nevertheless we consider the behaviour of sentences like (32d) as a special case, which is due to the particular semantics of *even–if* conditionals.[27] The "normal" case, exemplified by (30c), seems to require an implicit restriction of the embedded deontic operator.

A revised analysis of deontic conditionals along these lines does not by itself exclude the problematic cases in (32a–c). Once the embedded deontic operator is implicitly restricted to quantify over worlds where Jesse robs the bank (in order to ensure the truth of (30c)), it again holds that in all the "best" of these worlds he has a mother.

Yet, the analysis now offers a way to avoid the problem, by imposing an additional pragmatic constraint on the truth conditions for deontic conditionals.[28] We may require that in order for a deontic conditional $\phi \quad \Box\!\!\rightarrow \quad \psi$ to be pragmatically wellformed, it must hold that the consequent ψ is not determined to follow from the set of (maximally similar epistemically accessible) worlds that verify the antecedent clause. This constraint immediately rules out (32b–c), and – given some mechanism for presuppositon projection along the lines of Heim(1983) – also excludes (32a): if the presupposition that Jesse has a mother is satisfied or accommodated in the main context, it is determined that Jesse has a mother in all maximally similar worlds, hence the pragmatic constraint on deontic modal operators would rule out (32a).

In Section 4.1.4 we aim at an alternative analysis of deontic conditionals, based on a clear distinction between an epistemically based modal operator, restricted by the *if*–clause, and a contextually dependent deontic operator, embedded within the conditional's consequent clause. I.e. not only for counterfactual deontics like (33), but for deontic conditionals in general we will posit an *embedded* deontic modal quantification.

To sum up, Lewis' analysis of counterfactual conditionals overcomes the problems observed for Stalnaker's theory, by quantification over a *set* of accessible worlds. At the same time, it accounts for (i) the vagueness of counterfactuals, as well as (ii) their "variable strictness" by interpretation in a *system of spheres*, which is structured in terms of a relation of *comparative similarity.*

We have shown that the variability of counterfactuals cannot be explained by evaluation relative to a *system* of spheres: such an analysis licenses unwarranted inferences from sequences of increasingly strict conditionals with conflicting consequents (see (20)). Instead,

[27] This will be discussed in more detail in Sections 2.2.3 and 4.1.4.

[28] The observation is due to Hans Kamp.

we have argued that counterfactual variablity is best accounted for by a *context dependent* accessibility function, selecting, for each counterfactual in a particular local context, a particular sphere of (sufficiently similar, or else "normal") accessible worlds. As for the vagueness of counterfactuals, we argued that the criteria established in Lewis(1979) to constrain the relation of "overall comparative similarity" are better to be split off into an independent notion of "expectations as to what is considered as the normal course of events" and an analysis of asymmetric counterfactual dependence on time.[29]

An analysis of counterfactuals which is based on these notions in order to account for their vagueness and variablity should be extended to the analysis of conditionals in general. Counterfactual conditionals are then distinguished from indicative conditionals only by pragmatic restrictions on the selection of the set of accessible worlds. The analysis in Stalnaker(1976), which provides such pragmatic selection criteria based on sentence mood, prepared a unified analysis along these lines.

2.2.3 Kratzer: Relative and graded modality

ηνιδε κου κορακεf τεγεων επι κοια συνηπται
κρωζουσιν, και κωf αυθι γενησομεθα

Und siehe da krächzen es schon die Krähen von den Dächern,
welches die wahren Konditionale sind
und auch auf welche Weise wir wiedergeboren werden.
(Sextos Empeirikos, Adversus Mathematicos, I, 309)[30]

The analysis in Kratzer(1978,1991) "integrates" the positive features of Stalnaker's and Lewis' theories, and on these grounds develops a context dependent analysis of conditionals and modal operators.

Based on Lewis'(1975) insights about the restrictive character of *if*–clauses in adverbial quantification, Kratzer develops a comprehensive analysis of modal expressions in context, making explicit the concept of "relative modality": The analysis provides a "generalized" account of conditionals as implicitly or explicitly quantified by a modal operator, where the selected "background context" for the modal operator is additionally restricted by the *if*–clause. In Kratzer(1981,1991) the analysis is further extended to the notion of "graded modality", to account for modal expressions like *it is probable that, there is a good possibility that*, etc., as well as for (conditional) deontic modality.

Relative Modality

One of the main objectives in Kratzer(1978) and later work is to account for the "ambiguity" of modal expressions, exemplified in (34): The different "readings" of the modal verbs are traditionally classified as *epistemic, deontic*, and *circumstantial*, respectively.

[29] Both of these aspects, the vagueness and variability of conditonals, will be investigated in more detail in Chapter 5, where we will discuss further arguments against the notion of (maximal) similarity.

[30] Kratzer(1978:216). In the following, references to Kratzer's work will be abbreviated, for purposes of citation, as (K 1978:216), etc.

(34) a. Jockl must have been the murderer.
(*In view of* the available evidence, Jockl *must* have been the murderer.)

b. Jockl must go to jail.
(*In view of* what the law provides, Jockl *must* go to jail.)

c. Jockl must sneeze.
(*In view of* the present state of his nose etc., Jockl *must* sneeze.) (K 1991:639,640)

The impact of Kratzer's claim is that modal expressions are not semantically ambiguous, but context dependent. This is made explicit by the paraphrases in (34), involving the phrase *in view of*, which specify the kind of modality involved, followed by a "neutral" use of the modal expression.

> "The existence of neutral modals suggests that non–neutral modals are not truly ambiguous. They just need a piece of information to be provided by the context of use. The only difference between neutral and non–neutral modals, then, is that the kind of modality is linguistically specified in the former, but provided by the non–linguistic context in the latter. Modality is always **relative modality**." (K 1991:640)

Kratzer develops a formal semantics for "relative modality" in the framework of possible worlds semantics. Relative modality is accounted for by interpreting a modal operator relative to some *contextual background*, a concept corresponding to the phrases *what the law provides*, *what we know*, *what is morally commanded*, etc., and which is either determined by the context of use or by linguistic means.[31] A contextual background is represented as a function f from a world w to a set of propositions, i.e. a subset of the powerset of W. For each world w the epistemic conversational background $f(w)$ will be the set of propositions p which are known in w; the deontic conversational background $g(w)$ will be the set of propositions p which describe the laws in w.

The denotation of modal sentences is then given as (35):

(35) $[\![$ must $\alpha]\!]^{\mathrm{f}} = \{ \mathrm{w} \in \mathrm{W}$: $[\![\alpha]\!]^{\mathrm{f}}$ follows from f(w) $\}$
$[\![$ can $\alpha]\!]^{\mathrm{f}} = \{ \mathrm{w} \in \mathrm{W}$: $[\![\alpha]\!]^{\mathrm{f}}$ is compatible with f(w) $\}$ (K 1991:641)
(where $[\![\alpha]\!]^{\mathrm{f}} = [\![\alpha]\!]$ if α does not contain a modal operator)

The analysis of relative modality in terms of different "conversational backgrounds" is illustrated in Kratzer(1981) by the subtle differences in the interpretation of (36a) and (36b): (36a) has an epistemic and a circumstantial reading, while in (36b) the epistemic reading

[31] Further types of conversational backgrounds are listed in Kratzer(1981):

Realistic Conversational Backgrounds:	*In view of facts of such and such kind ...*
Totally Realistic Conversational Backgrounds:	*In view of what is the case ...*
Epistemic Conversational Background:	*In view of what is known ...*
Stereotypical Conversational Background:	*In view of the normal course of events*
Deontic Conversational Background:	*In view of what is commanded ...*
Teleological Conversational Background:	*In view of what is aimed at ...*
Bouletic Conversational Background:	*In view of what is desired ...*
The Empty Conversational Background	(K 1981:45)

is prominent. In a situation where one is travelling in an exotic country and discovers that the climat is appropriate for planting plum trees, (36a) can be true on the circumstantial reading – here: *in view of the given facts about the climat*, while (36b), forcing the epistemic reading, would be false, in case it is known that the exotic country has had no contact with plum–culturing countries yet. So while in the epistemic reading the conversational background specifying our knowledge about facts in the world is taken into account as a whole, the circumstantial conversational background neglects some of these facts. By making the interpretation of modal sentences dependent on a conversational background, restrictions on the set of propositions which serve as the "modal base" can result in differences of truth.

(36) a. In dieser Gegend können Zwetschgenbäume wachsen.
'Plumtrees can grow in this area.'

b. Es kann sein, daß in dieser Gegend Zwetschgenbäume wachsen.
'It is possible that plumtrees grow in this area.' (K 1981:53)

The interpretation of modals relative to some contextually specified conversational background is shown to be equivalent to the traditional analysis of modality in possible worlds semantics in terms of accessibility relations (see Kratzer(1978,1991)): Since the relation of epistemic accessibility specifies in w the set of worlds w' compatible with everything we know in w, and since the relation of deontic accessibility specifies in w the set of worlds w' compatible with what is prescribed by the laws in w, the meaning of the modal operators *must* and *can* in their respective context dependent reading (epistemic, deontic, etc.), can be defined in traditional terms as in (37):

(37) $[\![\text{ must } \alpha]\!]^{\mathrm{R}} = \{ \text{ w} \in \text{W: for all w}' \text{ s.th. wRw}', \text{ w}' \in [\![\alpha]\!]^{\mathrm{R}} \}$
$[\![\text{ can } \alpha]\!]^{\mathrm{R}} = \{ \text{ w} \in \text{W: for some w}' \text{ s.th. wRw}', \text{ w}' \in [\![\alpha]\!]^{\mathrm{R}} \}$
(where $[\![\alpha]\!]^{\mathrm{R}} = [\![\alpha]\!]$ if α does not contain a modal operator
and R an epistemic, deontic, etc. accessibility relation) (K 1991:642)

With (38a), stating that every conversational background f uniquely determines an accessibility relation R_f, Kratzer's definition of modal operators in (35) can be given in terms of accessibility relations as in (38b):

(38) a. For all $\text{w,w}' \in \text{W: wR}_{\text{f}}\text{w}' \text{ iff w}' \in \bigcap \text{f(w)}$

b. $[\![\text{ must } \alpha]\!]^{\mathrm{f}} = \{ \text{ w} \in \text{W: for all w}' \text{ s.th. wR}_{\text{f}}\text{w}', \text{ w}' \in [\![\alpha]\!]^{\mathrm{f}} \}$
$[\![\text{ can } \alpha]\!]^{\mathrm{f}} = \{ \text{ w} \in \text{W: for some w}' \text{ s.th. wR}_{\text{f}}\text{w}', \text{ w}' \in [\![\alpha]\!]^{\mathrm{f}} \}$
(where $[\![\alpha]\!]^{\mathrm{f}} = [\![\alpha]\!]$ if α does not contain a modal operator) (K 1991:642)

Given this equivalence the real challenge of the analysis is that the choice of the conversational background – or kind of accessibility relation – for the interpretation of a modal expression is determined contextually.

Graded Modality

In Kratzer(1981) the analysis of "relative modality" is extended to the concept of "graded modality". For one, this concept is needed to account for graded modal expressions like *there is a good possibility that ..., there is a slight possibility that ..., it is probable that ...,* as well as for comparatives like *it is more likely that ... than ....* Moreover, the concept of graded modality is applied to the analysis of non–epistemic (e.g. deontic) modality, where it proves successful in avoiding some logical paradoxes, like e.g. the Samaritan Paradox (see below).[32] To account for "graded modality", in addition to the "modal base" and the "modal force" of the operator the concept of an "ordering source" is defined, which induces a partial ordering on the set of accessible worlds that make up the modal base.

In support of her analysis of graded modality Kratzer argues as follows: In (39), among the epistemically accessible worlds, the one where Michl is Girgl's murderer is judged (by the inspector) to be more or less "far–fetched" than others. Now, which are the criteria that determine which worlds are more "far–fetched" than others?

(39) a. Michl must be the murderer.

b. Michl is probably the murderer.

c. Michl might be the murderer.

d. There is a slight possibility that Michl is the murderer.

e. Michl is more likely to be the murderer than Jakl. (K 1991:643,644)

Kratzer suggests that besides the "modal base" – here the epistemic conversational background – there is a second conversational background involved: a stereotypical conversational background ("in view of the normal course of events"). This additional conversational background is defined to induce a partial order on the set of worlds in the modal base with respect to the degree of similarity to the "ideal" defined by that background: "For each world, the second conversational background induces an *ordering* on the set of worlds accessible from that world. It functions as the **ordering source**." (K 1991:644).[33] The ordering source is formally given as a function g from worlds into a set of propositions, the "ordering" conversational background.

Based on Lewis(1981) a partial order $\leq_A$ on the set of worlds W, induced by the ordering source A, is defined in (40): a world w is closer to the "ideal represented by A" than a world w' ($w \leq_A w'$) if – roughly – *at least* those facts which hold in w' and which are defined by the ordering source A are true in w:

(40) For all w,w′ $\in$ W, for any A $\subseteq \wp$(W):
w $\leq_A$ w′ iff $\{$ p: p $\in$ A and w′ $\in$ p $\} \subseteq \{$ p: p $\in$ A and w $\in$ p $\}$
"A world w is at least as close to the ideal represented by A as a world w′ iff all propositions of A which are true in w′ are true in w as well." (K 1991:644)

[32] The analysis of the Samaritan Paradox is accounted for in Kratzer(1978) by an alternative mechanism.

[33] Further kinds of conversational backgrounds that may play the role of an ordering source are proposed: *The Law, What my father provided in his last will, What is good, What you think is good, Our plans, Our aims, Our hopes, Our wishes, Our conception of a good life*, etc. (K 1981:59).

With (40) it is possible to define the basic (graded) modal operators: *necessity* and *at least as good a possibility* in (41a–b),[34] as well as derived notions of graded modality in (41c–f), stated in an abbreviated manner here. As Kratzer puts it: "These modal notions are **doubly relative**. They depend on two conversational backgrounds." (K 1991:644)

(41) a. A proposition p is *a necessity* in a world w wrt. a modal base f and an ordering source g iff the following condition is satisfied:
For all u $\in \bigcap$f(w) there is a v $\in \bigcap$f(w) such that v $\leq_{g(w)}$ u and
for all z $\in \bigcap$f(w): if z $\leq_{g(w)}$ v, then z $\in$ p.

b. A proposition p is *at least as good a possibility as* a proposition q in a world w wrt. a modal base f and an ordering source g iff for all u such that u $\in \bigcap$f(w) and u $\in$ q, there is a v $\in \bigcap$f(w) such that v $\leq_{g(w)}$ u and v $\in$ p.

c. p is *a possibility*^{f,g,w} iff $\neg$p is not *a necessity*^{f,g,w}.

d. p is *a better possibility*^{f,g,w} *than* q iff
p is *at least as good a possibility*^{f,g,w} *as* q
but q is not *at least as good a possibility*^{f,g,w} *as* p.

e. p is *a weak necessity*^{f,g,w} iff p is *a better possibility*^{f,g,w} *than* $\neg$p.

f. p is *a slight possibility*^{f,g,w} iff p is *a possibility*^{f,g,w} and $\neg$p is *a weak necessity*^{f,g,w}.

Note that by using a "stereotypical" conversational background as an ordering source for "graded modals" two distinct aspects are introduced into the analysis.

Given the definitions in (40) and (41), the worlds taken into account for the evaluation of the modal operators are all subsets of the ordering source $g(w)$, i.e. they all correspond – as much as possible – to "what is considered to be the normal course of events". Note that this is the concept we argued to provide a more intuitive basis for the *vagueness* of conditionals than does Lewis' notion of "overall similarity", and of course the argument carries over to non–restricted modal operators. But this *vagueness* of the clear–cut modal operators of *necessity* and *possibility* in (41a) an (41c) – in terms of a set of *normal* worlds taken into account – is to be clearly distinguished from truly *graded*, or *comparative* modal operators, such as *at least as good a possibility as* and the derived notions in (41d–f).

This is most obvious if we consider again the examples in (39). If we make use of a stereotypical ordering source, (39a) asserts that in *all* worlds that come closest to "what is considered the normal course of events", it is the case that Michl is the murderer. And this corresponds more or less directly to the use that Lewis makes of the notion of "overall similarity" to account for the vagueness of counterfactuals.

Thus, in Kratzer's analysis of "graded modality" the "clear–cut" notions of necessity and possibility get relativized to some stereotypical context by use of an ordering source to account for their inherent vagueness, while they do not involve any notion of "gradedness",

[34]We omit the definition of *good possibility*. The distinction between *possibility* and *a good possibility* is not clear to us. Since the concept is not used to define derived notions, this should do no harm.

A proposition p is *a good possibility* in a world w with respect to a modal base f and an ordering source g iff there is a world u $\in \bigcap$f(w) such that for all v $\in \bigcap$f(w): if v $\leq_{g(w)}$ u, then v $\in$ p. Kratzer(1991:644) as opposed to the truly *comparative* or *graded* modal operators (41b) and (41d–f).

Another use that Kratzer makes of the concept of an ordering source is the analysis of non–epistemically modalized sentences. Yet, taking a deontic conversational background to constitute the ordering source for the examples in (42), given that it does not provide aspects of probability by its very nature, does not give us a "graded" meaning for the clear–cut modal operators in (42a–c), as opposed to the truly graded operators in (43).

This is of course not to say that an analysis of (42) in terms of the concept of graded modality, as defined by (40) and (41), is inadequate. Yet the term "graded" – motivated by examples involving truly graded modal operators as in (39) – is misleading in these cases: what is at stake here is relativization of the modal operator to a double, or complex conversational background, consisting of modal base and (deontic) ordering source.

(42) a. Jetzt dürfen wir keinen Lärm machen.
In view of the circumstances (a burglary) *and in view of* our aims/desires (not to be caught), it is *necessary* for us to act quietly.

b. Ich darf nicht laufen.
In view of the circumstances (I got my leg injured) *and* in *view of* the doctor's instructions (not to walk), it is *necessary* for me not to walk.

c. Du kannst doch nicht nur Häuser bauen oder Semmeln backen und wenn du dann gestorben bist, ist alles aus, alles weggewischt. (K 1981:59)
In view of the circumstances (life is short) *and in view of* some conception of an ideal life, it is *necessary* that you do more than just work.

(43) a. Ich kann eher Bäcker als Stellmacher werden. (K 1981:64)
Given the circumstances (I'm handicapped) *and* in view of some ideal (everyone is good in his craft), the *possibility* of becoming a baker *is better than* becoming a cartwright.

b. Given your state of health, you'd be better off going to Davos than to Amsterdam. (K 1991:646)

Further arguments for the analysis of modality in terms of a modal base and an ordering source are put forward in Kratzer(1981,1991) by considering examples like (44):

In terms of "graded modality" the contrast illustrated in (44) is explained as follows: "In uttering (b) instead of (a), I signalize that I don't reason from established facts alone. I use other sources of information which may be more or less reliable." (K 1981:57;K 1991:645) Thus, while (44a) is analyzed relative to an epistemic modal base and an empty ordering source, (44b) additionally makes use of a stereotypical ordering source. The analysis thereby ensures that (44b) does not imply (44a).

(44) a. Das ist die Bürgermeister–Weiß–Straße.
'This is the Bürgermeister–Weiß street.'

b. Das muß die Bürgermeister–Weiß–Straße sein.
'This must be the Bürgermeister–Weiß street.'

The most prominent arguments Kratzer provides for an analysis of "graded modality" in terms of an "ordering source" are concerned with examples that involve inconsistent conversational backgrounds. It is argued in Kratzer(1981,1991) that the concept of "graded modality" provides a solution to the "Samaritan Paradox", as well as to the problem of "Practical Inference", both types of examples involving inconsistent sets of premises. Whereas in traditional modal logic, *any conclusion* follows from, and *no conclusion* is possible, given a set of inconsistent premises, the concept of an ordering source is shown to avoid these problems. We will argue that for "Practical Inference" the conclusions derived by Kratzer's analysis do not correspond to our intuitions. Instead, we will propose an alternative solution to these problems in terms of a notion of "multiple relative modality", which does not make use of an ordering source. We will argue that our notion of "multiple relative modality" carries over to all the other phenomena that Kratzer captures in terms of "graded modality".

The Samaritan Paradox

In classical modal logic, the analysis of sentences like (45a–b) constitutes a problem. If (45a) is true in every world that is *morally accessible* from the actual world w, then (45b) can be true in every such *morally accessible* world only vacuously, and so is (45c).

(45) a. No murder occurs.

b. If a murder occurs, the murderer will go to jail. (K 1991:643)

c. If a murder occurs, the murderer will be invited for dinner.

On Kratzer's analysis, by taking a circumstantial background as the modal base f, and the juridical background as ordering source g, (45b) is non–vacuously true. In (45b) the worlds that make up the modal base f are such that a murder occurred. The worlds $\bigcap f(w)$ are ordered by the modal base $g(w)$ in such a way that w_1, where a murder occurs and the murderer goes to jail is considered as "closer to the ideal represented by $g(w)$" than is w_2 ($w_1 \leq_{g(w)} w_2$), where a murder occurs, but the murderer is invited for dinner. Since the worlds where no murder occurred are not contained in $\bigcap f(w)$ – though being even closer to the ideal represented by $g(w)$ – these worlds are not taken into account for the evaluation of the necessity operator relative to the modal base f and ordering source g. (45c), on the other hand, is false: the worlds that make up the modal base $f(w)$, where a murder occurs, are ordered wrt. the juridical background context $g(w)$, such that those that come closest to the "ideal" defined by $g(w)$ will not support that the murderer will be invited for dinner.

But in our view the paradox can be resolved without resorting to the concept of "graded modality". This is even suggested by Kratzer: "We have just seen that the proposition [*If a murder occurs, the murderer will go to jail*] is true in w just in case the murderer goes to jail in all those worlds in which a murder occurs and which come closest to what the law provides in w. We are only allowed to consider worlds in which a murder occurs. *Hence we have to drop the part of the law requiring that no murder occurs.*" (K 1991:649, italics added). No "graded" modal operators are involved here, such as *it is likely*, or *probably.*

Instead, as Kratzer correctly puts it, what is relevant here is the notion of *relative modality* together with a proviso for dealing with inconsistent propositions. Shortly below we will sketch an alternative analysis of "graded modality", in terms of a notion of compatibility restricted, multiple relative modality, which correctly accounts for the "Samaritan Paradox", as well as for cases of "Practical Inference".

Practical Inference

The second type of example involving an inconsistent set of propositions is "Practical Inference". Again, this is analyzed in Kratzer(1981,1991) by use of the concept of an ordering source. In (46) the first premises characterize a bouletic context $g(w)$, while the last premise characterizes the factual context $f(w)$. If we took the modal base to consist of the *union* of the bouletic and factual context, in (46) the modal base $f(w) \cup g(w)$ would be inconsistent, and any conclusion could be drawn from the premises, as indicated.

	$g(w)$:	I want to hike in the mountains.
		I want to become popular.
		I want not to go to the pub.
(46)	$f(w)$:	I will become popular if and only if I go to the pub.
	$\vdash_{f(w)\,\cup\,g(w)}$	You should go to the pub.
		You should not go to the pub.
		You should not go hiking in the mountains. (K 1991:647,648)

If instead the modal base f consists of the factual context, while the bouletic context forms the ordering source g, the modal base is consistent and the set of accessible worlds gets partially ordered by *what I want in w*, as indicated in (47) (with ϕ = *I go hiking*, ψ = *I will become popular*, and ω = *I will go to the pub*). The worlds w_3 and w_4 come closest to *what I want in w*, so according to Kratzer's analysis of graded modality the conclusions in (48) are valid: It *follows* from the factual context f and bouletic ordering source g that ϕ: *I go hiking*, while it is *compatible* with the circumstances f, ordered wrt. my desires g that $\neg\omega$: *I will not go to the pub*, or ω: *I will go to the pub*, as well as ψ: *I will become popular.*

(47) a.

w_1:	$\neg\phi$	$\neg\psi$	$\neg\omega$	1 wish fulfilled
w_2:	$\neg\phi$	ψ	ω	1 wish fulfilled
w_3:	ϕ	$\neg\psi$	$\neg\omega$	2 wishes fulfilled
w_4:	ϕ	ψ	ω	2 wishes fulfilled

b. $w_3 \leq w_1$, $w_3 \leq w_2$, $w_4 \leq w_1$, $w_4 \leq w_2$

	$g(w)$:	I want to hike in the mountains.	
		I want to become popular.	
		I want not to go to the pub.	
(48)	$f(w)$:	I will become popular if and only if I go to the pub.	(K 1991:648)
	$\vdash^{g(w)}_{f(w)}$	You could go to the pub.	
		You could also not go to the pub.	
		You should hike in the mountains.	

Does this correspond to our intuitions? In one way it does, but in another it doesn't.
Since in Kratzer's analysis the bouletic context is taken into account as an "ordering source", inducing a partial order on the worlds that make up the modal base f, the worlds quantified over are "as ideal as possible" – given the circumstances. While in *all* these ideal worlds *I go hiking*, in some of them *I don't go to the pub* and in some of them *I go to the pub* and *I become popular*. Now note that in the very same way it is *compatible* relative to the factual modal base f and the ordering source g that χ (*I will go dancing*) and that $\neg\chi$ (*I will not go dancing*), simply because in my set of desires I do not take a stand on this question: In some of the most ideal worlds (where I will go hiking, and where I either go or don't go to the pub) I will go dancing, while in others I won't.

It should now become more transparent what it intuitively means that ϕ is *necessary* wrt. a factual modal base f and bouletic ordering source g ($\Box_f^g\ \phi$), in contrast to ϕ being *possible* or *compatible* wrt. f and g ($\Diamond_f^g\ \phi$).
If we took our modal base f, structured according to our set of desires g, as a foundation for a theory of action which is directed towards the realization, or maximal satisfaction of our set of desires, we can understand the necessity operator *should* or *ought to* represented by $\Box_f^g\ \phi$ as an imperative to realize an action γ that brings about that ϕ holds in the actual world and future. By contrast, the corresponding possibility operator *it is possible that* ϕ, $\Diamond_f^g\ \phi$, can only be understood – in these terms – as not directing us (with necessity) towards an action γ which brings it about that ϕ holds in the actual world.
So if e.g. we do not take a stand as to whether we want to go dancing, the analysis correctly predicts that we will not be driven by our wishes to realize ϕ in the actual world. Yet, the same characterization is derived for our *conflicting desires* ψ and $\neg\omega$ in (46): it is derived that we will neither be driven to become popular, nor not to go to the pub, *as if we never had taken a stand on these issues.*
So on the one hand the theory captures correctly that – given the conflicing desires – we are caught in a "deadlock": we are not driven to realize (with necessity) one or the other of our conflicting desires. But on the other hand, the inferences do not distinguish between the source of our "non–action" wrt. ψ and ω (stemming from their incompatibility) as opposed to χ (on which we do not take a stand at all).

As we briefly mentioned above, there is an alternative way to conceive of such cases of conflicting, or inconsistent desires (or demands), which does not resort to the notion of "graded modality" in terms of an ordering source, but instead focusses on the notion of "(multiple) relative modality".
If we reconsider the case of "Practical Inference" – given a set of inconsistent desires – under the heading of "(multiple) relative modality", the picture is slightly different: As our set of desires, *taken as a whole*, is conflicting with reality, i.e. the factual modal base, we cannot say rightaway that it is *compatible* with the facts and all of our desires *not to go to the pub* – we still have this desire of *becoming popular*, which contradicts this possibility! In the same way we cannot truly state that it is compatible with the facts and *all* of our desires *to become popular*, since this requires a violation of our desire of not going to the pub. The only rational move then is to "give up" one or the other of our (conflicting) desires. But then our bouletic context has changed! Having decided that we can do without becoming popular, as indicated in (49a), we can build a new *complex* modal base, consisting of the union of the revised set of desires $g_1(w)$ and the circumstances $f(w)$, from which it now

follows that – according to the facts and our (revised) desires – we *should* not go to the pub. After all, we already abstain from popularity. The same holds, vica versa, if, after all, we resign to spend our evenings in a smoky pub (49b): it is then imperative that we *should* become popular, and – given the circumstances – that we *should* go to the pub.[35]

$$
\begin{array}{lll}
 & f(w): & \psi \leftrightarrow \omega \\
\text{(49) a.} & g_1(w): & \phi, \neg\omega \\
 & \vdash & \Box_{f(w)\,\cup\, g_1(w)}\ \phi,\ \Box_{f(w)\,\cup\, g_1(w)}\ \neg\omega
\end{array}
$$

$$
\begin{array}{lll}
 & f(w): & \psi \leftrightarrow \omega \\
\text{b.} & g_2(w): & \phi, \psi \\
 & \vdash & \Box_{f(w)\,\cup\, g_2(w)}\ \phi\ ,\ \Box_{f(w)\,\cup\, g_2(w)}\ \psi,\ \Box_{f(w)\,\cup\, g_2(w)}\ \omega
\end{array}
$$

One argument to support our view that in cases of conflicting desires such as (48) some *revision* of the original set of conflicting desires is called for, is that – if the modal adverb is to be interpreted as dependent upon the unchanged and *complete* desire context, and respecting the factual circumstances – it is not possible to turn the subjunctive *could* in (48) to indicative *can.* The use of the subjunctive strongly supports a "counterfactual" analysis along the lines of the following paraphrase: *(If I did without becoming popular) I could not go to the pub*, or else *I could not go to the pub (if I did without becoming popular).* According to our intuition, this is the only way we can understand (48) if *could* is to be interpreted as *fully* dependent upon our set of desires, while respecting the factual circumstances.[36]

How can we achieve these results through an appropriate definition of "multiple relative modality" based on a (consistent) complex modal base? In (50) we define the "compatibility restricted union"[37] $f(w)\cup! g(w)$, which gives us, for (possibly conflicting) modal bases $f(w)$ and $g(w)$, a set of consistent complex modal bases $h_i(w)$, each consisting of $f(w)$ together with a subset $g'(w)$ of $g(w)$ that is maximally consistent within $f(w) \cup g(w)$.[38]

$$
\begin{aligned}
\text{(50)}\ \ f(w) \cup!\ g(w) = \{f(w) \cup g'(w) : g'(w) \subseteq g(w)\ \&\ \text{consistent}(f(w) \cup g'(w))\ \&\\
\forall g''(w) : g''(w) \subseteq g(w) \text{ if } g'(w) \subsetneq g''(w), \text{ then inconsistent}(f(w) \cup g''(w))\}
\end{aligned}
$$

[35]Here it turns out that the interpretation of *should* is not really dependent on the set of desires g, but builds upon a theory of action, specifying which actions are to be carried out in order to obtain maximal satisfaction of our desires (given the circumstances): *Given that you want to be popular, and given the circumstances, it is demanded, according to a theory of action, that you go to the pub.* So, in a way there is a third, deontic context d, determined by f and g, that provides the modal base of *should* in the example.

So both the analysis of Kratzer and our alternative proposal do not correctly account for cases like (49b), where ω is not defined within the bouletic ordering source $g_2(w)$, but follows from $f(w) \cup g_2(w)$ in just the same way as ϕ and ψ, which are contained within the set of desires $g_2(w)$.

This is again a consequence of the possible worlds analysis of attitudinal states, such as *desire.*

[36]There is of course also a purely epistemic reading of *could* in (48), but this is certainly not the reading to be considered here.

[37]The term is borrowed from Kasper(1992:322).

[38]It is equivalent to define the compatibility restricted union $f(w) \cup!\ g(w)$ as the set of all maximally consistent subsets of $f(w)\ \cup\ g(w)$ which contain $f(w)$ as a subset:

(i) $f(w) \cup!\ g(w) = \{X \subseteq (f(w) \cup g(w)) : \text{consistent}(X)\ \&\ (\forall Y)\ X \subset Y\text{: inconsistent}(Y)\ \&\ f(w) \subseteq X\}$

In our present example, for $f(w)$ and $g(w)$ as given in (48) $f(w) \cup! \; g(w)$ contains two sets of propositions, (51a) and (51b). Note that these are exactly the complex modal bases $f(w) \cup g_1(w)$ and $f(w) \cup g_2(w)$ of (49) above, which arose from different ways of resolving the incompatibility of the bouletic context $g(w)$ in light of the facts represented by $f(w)$.

(51) a. $h_1(w) = \{ \; \psi \leftrightarrow \omega, \;\; \phi, \;\; \neg\omega \; \}$

b. $h_2(w) = \{ \; \psi \leftrightarrow \omega, \;\; \phi, \;\; \psi \; \}$

We can now state an alternative analysis of "graded modality" in terms of "multiple relative modality" and the notion of "compatibility restricted union" (52). The modal operator is interpreted relative to some complex modal base $h_i(w)$, an element of the compatibility restricted union $f(w) \cup! g(w)$ of two conversational background contexts f and g. Instead of resorting to a partial order of worlds for evaluation of the "clear–cut" modal operators *necessary* and *possible*, these are now defined, just as in (35), such that the proposition p follows from, or is compatible with the modal base, which is here defined as one outcome of the compatibility restricted union $f(w) \cup! g(w)$ of the (possibly conflicting) relevant background contexts $f(w)$ and $g(w)$.

Also, instead of resorting to a partial order of worlds induced by an ordering source $g(w)$, graded and comparative modal operators such as *probable*, or *at least as good a possibility as* are now defined in terms of a probability operator P, which computes the probability of p and q relative to one outcome $h_i(w)$ of the compatibility restricted union of $f(w) \cup! g(w)$. I.e. also for the truly graded and comparative modal operators we require them to be interpreted relative to a consistent (complex) modal base.[39]

(52) Let f, g be conversational backgrounds, w the actual world and p, q propositions. A complex modal base h_i is defined from f and g by compatibility restricted union: $h_i(w) \in f(w) \cup! \; g(w)$

a. $[\![\text{necessary p}]\!]^{h_i} = \{ \text{ w} \in \text{W} : [\![p]\!] \text{ follows from } h_i(\text{w}) \; \}$

b. $[\![\text{possible p}]\!]^{h_i} = \{ \text{ w} \in \text{W} : [\![p]\!] \text{ is compatible with } h_i(\text{w}) \; \}$

c. $[\![\text{p is at least as good a possibility as q}]\!]^{h_i} = \{ \text{ w} \in \text{W} : P([\![p]\!]^{h_i}) \geq P([\![q]\!]^{h_i}) \; \}$

d. $[\![\text{p is a better possibility than q}]\!]^{h_i} = \{ \text{ w} \in \text{W} : P([\![p]\!]^{h_i}) > P([\![q]\!]^{h_i}) \; \}$

e. $[\![\text{weak necessity p}]\!]^{h_i} = [\![\text{p is a better possibility than } \neg\text{p}]\!]^{h_i}$

f. $[\![\text{slightly possible p}]\!]^{h_i} = [\![\text{possible p}]\!]^{h_i} \cap [\![\text{weak necessity } \neg\text{p}]\!]^{h_i}$

Notice that for the non–graded operators *necessary* and *possible* the definition given in (52) should turn out to be equivalent to Kratzer's original definition in (41). In (40) the partial order $\leq_{g(w)}$ is defined between worlds that all satisfy some subset of the propositions in $g(w)$. So by (41) the worlds in the quantificational domain of the modal operator do *all* satisfy the conversational background $f(w)$, and they satisfy $g(w)$ to the highest

[39] We will not go any further into the semantic analysis of such graded or comparative operators.

possible degree, depending on the "degree of compatibility" with $g(w)$. This is equivalent to our definition of "multiple relative" modality in (52) with compatibility restricted union (50) of e.g. a circumstantial or epistemic conversational background $f(w)$ and a deontic, or stereotypical background $g(w)$ to provide the complex modal base in (52): The more the circumstantial/epistemic context diverges from *what is considered normal*, or *what is demanded*, the more propositions pertaining to $g(w)$ will be incompatible with $f(w)$, and therefore be excluded from the complex modal base by compatibility restricted union.

What differs, however, from Kratzer's analysis of graded and relative modality in (41), is the fact that the modal operators in (52) are relativized to *individuated* outcomes $h_i(w)$ of the compatibility restricted union $f(w) \cup! g(w)$.

Based on this individuated notion of modality "in light of inconsistent sets of premises" in (52), for the example considered in (48) above, either way of resolving the inconsistency by compatibility restricted union of $f(w) \cup! \, g(w)$ – $h_1(w)$ and $h_2(w)$ as displayed in (51) – supports the conclusion that in light of the facts and according to my (revised) desires *I should go hiking*, and – depending on which of my desires I took the decision to revise – that *either* it is *compatible* with my (revised) desires not to go to the pub (if I think I can do without being popular), or *else* it is compatible with my (differently revised) desires that I become popular (if I resign to go to the pub). Thus, *either* I *can* (in fact, *should*) go to the pub, or *else* I *can* (in fact, *should*) become popular.

Note that on this analysis it is not *compatible* with $h_1(w) \in f(w) \cup! \, g(w)$ that *I become popular*, nor is it compatible with $h_2(w) \in f(w) \cup! \, g(w)$ that *I do not go to the pub*, which was derived by Kratzer's analysis in terms of "graded modality". By contrast, for any proposition χ which is not contained in the set of my desires $g(w)$, it is supported that both χ and $\neg\chi$ are compatible – i.e. are not conflicting – with any consistent complex modal base $h_i(w)$, consisting of my desires in light of the circumstances.

(53) a.
$$\begin{array}{ll} f(w): & \psi \leftrightarrow \omega \\ g(w): & \phi,\ \psi,\ \neg\omega \\ \vdash & \Box_{h_1(w)}\ \phi,\ \ \neg\Diamond_{h_1(w)}\ \psi,\ \ \Box_{h_1(w)}\ \omega,\ \ \Diamond_{h_1(w)}\ \chi \end{array}$$

b.
$$\begin{array}{ll} f(w): & \psi \leftrightarrow \omega \\ g(w): & \phi,\ \psi,\ \neg\omega \\ \vdash & \Box_{h_2(w)}\ \phi,\ \ \Box_{h_2(w)}\ \psi,\ \ \neg\Diamond_{h_2(w)}\ \omega,\ \ \Diamond_{h_2(w)}\ \chi \end{array}$$

In sum, for cases of Practical Inference our definition of "(multiple) relative modality" in (52), focussing on *individual ways* of resolving the inconsistency arising from contradictory background contexts, derives different conclusions – as compared to Kratzer's analysis in terms of "graded modality".[40]

It should be noted that it is, though, possible to give an analysis in terms of "compatibility restricted" relative modality which derives the same conclusions as does Kratzer's analysis. It works essentially by quantification over the different ways h_i of resolving the inconsistency

[40] Nothing will be said here about the factors that determine the choice among the different elements of $f(w) \cup! \, g(w)$. This is a complex matter of commonsense reasoning, intentions and preferences, which does not pertain to the domain of semantics (and even pragmatics) proper, but rather to a theory of action and planning.

by compatibility restricted union of $f(w) \cup! \; g(w)$. This is illustrated in (54a–b). Here, for (48) we derive the conclusion that it is possible relative to the complex modal base $h(w) = f(w) \cup! \; g(w)$ that ψ (*I will become popular*) and that it is possible relative to $h(w)$ that $\neg\omega$ (*I will not go to the pub*).

(54) Let f, g be conversational backgrounds, w the actual world and p, q propositions. h is the compatibility restricted union $h(w) = f(w) \cup! \; g(w)$.

a. $[\![\text{necessary p}]\!]^h = \{ \text{ w} \in \text{W} : [\![p]\!] \text{ follows from every } h_i(\text{w}) \in \; h(w) \; \}$

b. $[\![\text{possible p}]\!]^h = \{ \text{ w} \in \text{W} : [\![p]\!] \text{ is compatible with some } h_i(\text{w}) \in \; h(w) \; \}$

The definition in (54) is roughly equivalent to the original analysis in Kratzer(1978), where an inconsistent set of propositions A implies a proposition p if p follows from *all* maximally *consistent* subsets of A, while p is possible wrt. A if p is compatible with at least one of these subsets. Yet, this analysis did not account for cases of "Practical Inference" (see (Kratzer(1981:67)). Trivially, in (48), $g(w)$ constitutes a maximally consistent subset of $f(w) \cup g(w)$, and thus it holds that any proposition contained in $g(w)$ is necessary relative to the (inconsistent) background contexts provided by $f(w)$ and $g(w)$. The analyses in both (52) and (54) avoid this unwarranted effect by use of asymmetric compatibility restricted union (50), which requires one of the modal bases involved to be taken into account *in toto*, depending on which kind of conversational background is considered to contribute "hard facts".[41]

Where do we stand now? We have argued that for cases of Practical Inference we do not share Kratzer's intuitions about valid inferences from a set of inconsistent propositions if we take seriously the notion of "relative modality". It was shown that by use of an "individuated", context–dependent notion of (multiple) relative modality – sensitive towards different ways of resolving inconsistencies – we are able to derive conclusions that are more in line with the notion of "relative modality".

Once a mechanism is provided for dealing with inconsistencies in contexts of "multiple relative modality", we are able to dispense with the notion of an ordering source altogether. As Kratzer puts it herself, the graded modal operators "are analyzed as being **doubly relative**. They depend on two conversational backgrounds". Just as the paraphrases for the examples in (39) and (42) suggest, they are to be interpreted relative to some consistent, complex modal base, to be obtained from two (possibly conflicting) conversational contexts. This is particularly obvious for examples involving the "clear–cut" necessity and possibility operators, as in (39) and (42), where no truly graded meaning is involved. So it seems that it is essentially equivalent to Kratzer's concept of an ordering source to define their meaning by universal and existential quantification relative to a complex modal base, to be

[41] In general we assume the factual, circumstantial and also epistemic backgrounds to constitute "harder facts" than the non–factual bouletic, or deontic backgrounds. Is there any evidence for this assumption? Now everything that is determined to be factual in our world will always be so. Even if the facts are conflicting with our desires, nothing will ever change them (see Kamp(1978), Lewis(1979)). So it is impossible – if we act rationally – to drop part of our factual context information and instead adopt a conflicting nonfactual assumption – at least for the interpretation of indicative conditionals. Sometimes we might neglect factive information of the relevant context, if we do not want to face the facts and give up our desires. But sooner or later, if we try to realize our conflicting desires, we will be confronted with reality.

obtained by compatibility restricted union, as in (52). By contrast, truly graded or comparative modal operators are accounted for, in (52), in terms of a probability operator P, again relative to a consistent complex modal base, resulting from compatibility restricted union.

The analysis of "multiple relative modality" in (52) carries over straightforwardly to cases of "stereoptypical", or other types of non–epistemic modality, by additionally restricting the modal base $f(w)$ by some non–epistemic or stereotypical conversational background $g(w)$. This is strongly reminiscent of what we know as "domain restriction" (see also von Fintel(1994)). Instead of resorting to the concept of an ordering source, the problem of inconsistent sets of propositions for multiple relative modality, arising in the "Samaritan Paradox" or cases of "Practical Inference" is accounted for by the definition of – asymmetric – "compatibility restricted union".

In light of our discussion we finally want to object to Kratzer's claim that on principled grounds it would not be possible to give an analysis of graded modality in standard possible worlds semantics. Kratzers definition of relative modality in (35) in fact does not allow for graded notions – a proposition *is* or *is not* compatible with the modal base –, and this may have been the reason for her to introduce the concept of graded modality in terms of a partial ordering over possible worlds. Yet, as we have argued, no such partial order seems to be called for to account for the analysis of essentially non–graded modal operators relative to inconsistent (complex) modal bases. What we really need is an account of "multiple relative modality" – dealing with inconsistent sets of propositions – which contextually restricts the domain of quantification for these non–graded modal operators.

Based on these assumptions the traditional analysis in terms of quantification over possible worlds (37) *can* be straightforwardly extended to a notion of (truly) graded modality: We have to define a complex and consistent modal base by compatibility restricted union of the outcomes of (contextually determined) accessibility functions: $\mathrm{R(w)} = \mathrm{R}_1\mathrm{(w)} \cup! \ \mathrm{R}_2\mathrm{(w)}$. Then, besides the universal and existential quantifiers *all* and *some* for *necessary* and *possible* one has to introduce generalized quantifiers over (accessible) possible worlds which correspond to the meaning of truly graded modal operators, such as *probably*, etc.

Conditionals as implicitly or explicitly modalized sentences

When we discussed the traditional analysis of conditionals in terms of material implication in Section 2.1, we already presented the compelling argument that arose from Lewis' work on adverbial quantification, where the *if*–clause acts as a restrictive argument for the adverb analyzed as an unselective generalized quantifier. With non–universally and non–existentially quantifying adverbials a material implication analysis of the conditional would not give us the intuitively adequate meaning: (55) would be compatible with a world where my roof unconditionally *often* leaks, while what (55) really means is that *in many situations where rain pours down* it is the case that my roof leaks.

(55) Often if it is raining my roof leaks. Lewis(1975:10)

This insight has been generalized in Kratzer(1978) to the analysis of bare conditionals. Based on the analysis of "relative modality" conditional sentences are analyzed as (implicitly or explicitly) modally quantified sentences: the *if*–clause acts as an additional restriction on the modal base, i.e. together with the modal base it constitutes the restrictor argument of an overt or implicit modal operator which takes the consequent in its scope.

As exemplified in (56), the bare conditional must be analyzed as implicitly quantified by the necessity operator: (56a) is synonymous with the overtly universally quantified (56b), but not with (56c), which expresses possibility.

(56) a. If Max went to London, he has seen Big Ben.

b. If Max went to London, he surely/necessarily has seen Big Ben.

c. If Max went to London, he might have seen Big Ben.

Kratzer's definition of the conditional *if p, then modal q* is given in (57):

(57) i. The first part of the utterance requires one, and only one, modal base and one, and only one, ordering source to be correct.

ii. If f is the modal base and g the ordering source for the first part of the utterance, then f^+ is the modal base and g the ordering source for the second part of the utterance. f^+ is that function from possible worlds to sets of propositions, such that for any world w, $f^+(w) = f(w) \cup \{ p \}$. (K 1981:68)

If (58) is interpreted relative to an epistemic modal base f and an empty, or "stereotypical" ordering source g in w, the conditional will be true – according to (57) and (41) – if it is *necessary* relative to the "updated" modal base $f^+(w) = f(w) \cup \{p\}$ and the ordering source $g(w)$ that q (Max has seen Big Ben).

(58) If Max went to London, has seen Big Ben.

Counterfactual conditionals are characterized in Kratzer(1981:69) by the following conditions on the modal base f and the ordering source g:

(59) A counterfactual is characterized by an empty modal base f and a totally realistic ordering source g ("what is actually the case").

As Kratzer puts it: "All possible worlds in which the antecedent p is true are ordered with respect to their being more or less near to what is actually the case in the world under consideration." (Kratzer(1981:69)). A counterfactual conditional will therefore come out true if the consequent holds in *all* those worlds where the antecedent is true and which are closest to "what is actually the case".[42]

[42]Thus Kratzer essentially follows the analysis of (counterfactual) conditionals in Lewis(1973) by definition of a partial order on the set of possible worlds centered around the actual world depending on their comparative similarity to the actual world. It is evident that the objections against Lewis' analysis of conditionals in terms of comparative similarity of worlds carry over to Kratzer's account.

In line with the context dependent analysis of conditionals in Stalnaker(1976), Kratzer(1978) states pragmatic constraints for indicative and subjunctive conditionals: The condition for *indicative conditionals* is taken over from Stalnaker: "it is appropriate to make an indicative conditional statement or supposition only in a context which is *compatible* with the antecedent." A *subjunctive conditional* is defined to be pragmatically wellformed only if the conversational background that makes up the modal base is *incompatible* with the antecedent of the subjunctive conditional (K 1978:267).[43]

In Kratzer(1981) non–epistemically modalized conditionals (deontic or bouletic) as in (60) are analyzed in terms of an empty or circumstantial modal base and a deontic or bouletic ordering source.[44] Following (57), (60a) can be evaluated relative to a circumstantial modal base f (*given the circumstances*) and a deontic ordering source g (*what is commanded by law*):[45] The conditional is true in w iff in all circumstantially accessible worlds where Max will buy a car, and which come closest to what is commanded by law in w, Max pays taxes for it.

(60) a. If Max will buy this car, he must pay taxes for it.

b. If Max had bought a car, he would have to pay taxes for it.

c. If Max really loved his dog, he should take it for a walk.

But things are different for *counterfactual* deontic conditionals like (60b) and (60c). In order to select the relevant counterfactual worlds in which the consequent must hold with necessity, (59) requires the ordering source to be "a totally realistic ordering source g", which induces a partial order on the set of accessible worlds as to their comparative similarity to the actual world. Given (57) the conditional must be interpreted wrt. a *single* modal base and ordering source. This has the unwarranted consequence that the deontic meaning component of the counterfactual conditionals (60b–c) gets lost: they are predicted to be equivalent in meaning to the epistemically modalized counterfactuals in (61b–c).

(61) b. If Max had bought a car, he would pay taxes for it.

c. If Max really loved his dog, he would take it for a walk.

It is not possible – as far as I can see – to weaken the constraint in (57i) by allowing multiple conversational backgrounds to serve as ordering sources as roughly indicated in (62), by sub– and superscripting the modal operator by the modal base and ordering source(s), respectively.

[43]This condition does not account for non–counterfactual subjunctive conditionals, which were discussed in Stalnaker(1976) (see footnote 2):

(i) If the butler had done it, we would have found just the clues which we in fact found.

But see also the more refined conditions in Kratzer(1979), to be discussed in Section 4.3.2.

[44]Here the analysis departs from Lewis' analysis of deontic counterfactuals, in particular by the distinction between circumstantially and deontically accessible worlds in terms of modal base and ordering source.

[45]Kratzer often assumes an empty modal base for conditionals. As soon as we try to verify this assumption by considering presuppositional or anaphoric data, it is evident that this cannot be right. By contrast, these aspects of the meaning of conditionals are correctly accounted for by Stalnaker's(1976) analysis in terms of the selection of epistemically accessible worlds from within or outside the given contextual background.

(62) a. *if p , then* $necessary^{realistic,deontic}_{circumstantial}$ q

b. $necessary^{g,g'}_{f+}$ q

f a circumstantial modal base, g a totally realistic and g' a deontic ordering source and $f^+(w) = f(w) \cup \{p\}$

If we allow for multiple ordering sources, we run into some kind of proportion problem. This is illustrated by (63). Take (63a) to be true: in all counterfactual, but maximally similar worlds where Max buys a car, he will not pay taxes for it – that's Max. In such a context, still (63b) should be valid: In all such maximally similar worlds where he buys a car and refuses to pay, Max is after all *obliged* to do so. Yet, if the modal base is to be ordered wrt. *both* a realistic and a deontic ordering source, what would it come down to, and would it license the conclusion that q (*Max pays taxes*) holds with necessity?

(63) a. If Max had bought a car, he would not pay taxes for it.

b. If Max had bought a car, he would have to pay taxes for it.

Taken in isolation, the different ordering sources induce different orderings onto the modal base: according to the overall similarity of worlds, $\neg$ q holds with necessity, while according to what is "most ideally" demanded by law, q does. Mixing up these different ordering critieria would lead us into serious problems. If a partial order were defined according to some "combined" ordering source, it would not be clear anymore – especially for graded modals – which kinds of ordering criteria are prevalent in judging some world w' as more or less similar to the actual world than some other world w''. But more importantly, we could never verify (63b) in the context of (63a) on the basis of a single (combined) ordering source. In the same way, it would not be possible to account for the contrast in (64) in terms of truth conditions.

(64) a. If Max had bought a car, he would be allowed to pay taxes for it – and he would do so.

b. If Max had bought a car, he would have to pay taxes for it –and he might do so.

Similar problems arise once we have a closer look at the analysis of indicative deontic conditionals. Besides (65a) and (65b), which Kratzer gives an analysis in terms of a circumstantial modal base f and a deontic ordering source g, as indicated in (66a–b), there are further types of deontic conditionals, such as (65c–d), which are overtly quantified by an (epistemic) possibility operator, but differ with respect to deontic modal force.

(65) a. If Max stays with his Grandma, he is allowed to take the dog for a walk.

b. If Max stays with his Grandma, he must take the dog for a walk.

c. If Max stays with his Grandma, he might be allowed to take the dog for a walk.

d. If Max stays with his Grandma, he might have to take the dog for a walk.

There is no possible analysis of (65c–d) by use of a single (epistemically based)[46] modal operator and a deontic ordering source. It seems more adequate to follow the surface linguistic form and take these conditionals as epistemically modalized, with an embedded deontic modal operator in the consequent clause. (65c–d) could then be analyzed as in (66c–d), respectively. Here, the conditional antecedent restricts the epistemic modal base f of the overt possibility operator. The embedded possibility or necessity operator is evaluated relative to the updated modal base f^+ – thereby constraining the quantification to range over worlds where Max stays with Grandma –, but now restricted by some deontic ordering source g.[47]

(66) a. $possible^{g}_{f+}\ q$
b. $necessary^{g}_{f+}\ q$
c. $possible^{\emptyset}_{f+}\ (\ possible^{g}_{f+}\ q)$
d. $possible^{\emptyset}_{f+}\ (\ necessary^{g}_{f+}\ q)$
f an epistemic modal base, g a deontic ordering source and $f^+(w) = f(w) \cup \{p\}$

But if we accept (66c–d) as an appropriate analysis of (65c–d), it is straightforward to question the analysis of (65a–b) by (66a–b). Since bare conditionals are to be analyzed as implicitly quantified by a universal frequency or modal operator, by analogy it is plausible to assume an implicit (epistemic) necessity operator to take scope over the overt deontic modal in the consequent clause as indicated in (67a–b).

(67) a. $necessary_{f+}\ (\ possible^{g}_{f+}\ q\ )$
b. $necessary_{f+}\ (\ necessary^{g}_{f+}\ q\ )$
c. $possible_{f+}\ (\ possible^{g}_{f+}\ q\ )$
d. $possible_{f+}\ (\ necessary^{g}_{f+}\ q\ )$
f an epistemic modal base, g a deontic ordering source and $f^+(w) = f(w) \cup \{p\}$

In fact, we can add the universally quantifying adverb *necessarily* (or *always*) to (65a–b) without changing their meaning (68).

(68) a. If Max stays with his Grandma, he is (necessarily) allowed to walk the dog.

b. If Max stays with his Grandma, he (necessarily) must walk the dog.

These observations lead us to the conclusion that there are in fact no truly *deontically modalized if*–conditionals.[48] Instead we assume conditionals with a deontic modal operator

[46] We will often use the term *epistemic*, intended to cover also factual and circumstantial modality, in contrast with *non–epistemic* (deontic, bouletic etc.) modality.

[47] There is an open question regarding the relativization of the embedded modal operator to the modal base f^+. We will come to discuss this aspect momentarily.

[48] Note that what corresponds to a truly deontically based conditional can only be expressed by use of an adjunct – instead of an *if*–clause –, which specifies the relevant deontic background context:

(i) a. Im Buddismus darf man kein Rindfleisch essen.
'Buddhists may not eat beef.'
b. Im Islam darf man kein Schweinefleisch essen.
'Moslems may not eat porc.'
c. Im Christentum darf man freitags kein Fleisch essen.
'Christians may not eat meat on friday.'

in the consequent clause to be analyzed throughout in terms of an implicit or explicit epistemically (or circumstantially) based modal operator. The deontic modal adverb is then to be analyzed within the scope of the "higher" epistemic modal operator.[49]

Let us now reconsider in more depth the analysis of deontic conditionals according to the revised logical forms in (67).[50]

To this end we will use example (69), where we assume the juridical context to be given by *German tax law*, which prescribes that *any person who owns a car and is not handicapped will have to pay taxes*, while *people who own a car but are handicapped must not.*

(69) a. If Max had bought a car, he would have to pay taxes.

b. $necessary^{g(w)}_{f+(w)}$ ($necessary^{g'(w')}_{f'(w')}$ q)
$f(w)$ the empty modal base, $g(w)$ a realistic and $g'(w')$ a deontic ordering source and $f^{+}(w) = f(w) \cup \{p\}$

According to the logical form in (69b) the necessity operator of the counterfactual conditional quantifies over worlds w' where p holds true, and which are most similar to the actual world w, according to the partial order induced by the "totally realistic ordering source $g(w)$". If the context does not state otherwise, we assume that those "maximally similar" worlds w' are worlds where Max is not a handicapped person. All of these worlds w' must verify the embedded formula $necessary^{g'(w')}_{f'(w')}q$, where we take $g'(w')$ to constitute the deontic ordering source.[51]

As a first option, we could choose the modal base $f'(w')$ of the embedded deontic operator to be the *empty modal base*. An empty conversational background is, according to Kratzer, "the function which assigns to every world the empty set" [of propositions] (Kratzer(1991:645)). But then the embedded necessity operator will range over the set $\bigcap f'(w')$, the entire set of worlds. Among these worlds there are certainly worlds where Max owns a car, but also others where he doesn't, such that an ordering induced by $g'(w')$ will not restrict the quantification to range over worlds where Max will pay taxes.

On the other hand, if we choose $f'(w')$ to correspond to a *factual* or *totally realistic modal base*, which provides every proposition that holds true in w', the modal base will be restricted to worlds where Max owns a car (since this is true by virtue of the higher conditional). But since $f'(w')$ encodes every proposition that holds in w', the intersection $\bigcap f'(w')$ will result in the singleton set $\{w'\}$. I.e. q will be verified by $\Box^{g'(w')}_{f'(w')}$ irrespective of the ordering source, if q holds in w'. Now, if w' is a (maximally similar) world where Max owns a car but doesn't pay taxes (i.e. where Max disobeys the laws), the embedded quantification will not succeed.

We are then left with two further options: (i) We could choose $f'(w')$ as *a circumstantial modal base*, which should comprise those facts that are in some way or other *relevant* for the deontic consequent, i.e the question to decide whether Max has to pay taxes. For (69) this *circumstantial* background context should comprise worlds where Max owns a car *and*

[49]Recall also our discussion of deontic counterfactuals in Section 2.2.2.

[50]Here I benefitted from help by Ede Zimmermann.

[51]We follow our convention of subscribing the modal base and superscribing the ordering source.

is not handicapped. Evaluation relative to the deontic ordering source $g'(w')$ will then verify that in all the most "ideal" of these worlds, Max has to pay taxes.

While at first sight this solution seems promising, it remains somewhat mysterious how to get at the appropriate *circumstantial* modal base. In particular the restriction to worlds where *Max is not handicapped* is in the general case to be captured in terms of a "stereotypical" or "realistic" ordering source. Nevertheless the analysis stays in the spirit of Kratzer's general account, which holds that the contextual backgrounds that enter into the analysis of modal operators are contextually determined, and thus to a certain extent unrestricted, or vague.

(ii) As an alternative, we could choose the embedded modal base $f'(w')$ to be "anaphoric" to the updated modal base $f^+(w)$ of the conditional's operator, as we did in (67): $f'(w') = f^+(w)$. This will give us worlds where Max owns a car, to be ordered by what is the relevant tax law in these worlds, $g'(w')$ (which in this example should be identical to the deontic background context of the actual world w). Yet, what is missing here is the additional relativization to "maximally similar", or *normal* worlds, which for the evaluation of the conditional is induced by the "realistic ordering source". Thus, it will not be verified, with necessity, that Max will have to pay taxes. He might after all be a handicapped person.[52]

Note however that this missing restriction to maximally similar worlds could be ensured by a slightly different analysis of (counterfactual and indicative) conditionals – not in terms of "graded modality", but in terms of compatibility restricted union (see p. 42): In this setting a conditional would be interpreted relative to a factual or circumstantial modal base that is maximally consistent with the (possibly counterfactual) antecedent p, and which in addition contains as many assumptions as possible – maintaining consistency – of *what is considered to be the normal course of events.* In such an analysis the higher operator's modal base is appropriate to establish the modal base of the embedded deontic quantification.[53]

Now note that on this latter analysis we get into difficulties with examples like (70). Here we cannot assume the modal base of the embedded deontic operator to be identical to the conditional's (updated) modal base. The updated modal base of the conditional determines worlds where Max does not pay taxes for his car. Taking this modal base to constitute the modal base of the deontic *have to* – with additional restriction to what the law demands – will therefore not verify that he is obliged to pay taxes. At best it comes out that the bailiff will have to pass.

(70) If Max had refused to pay taxes, he *nevertheless* would have had to pay taxes.

But we already noted, in Section 2.2.2, that such examples are somewhat peculiar in that they depend on additional material, such as *nevertheless* in (70), or the use of an *even–if* conditional, as in (71b). The respective sentences are extremely odd once these expressions are omitted (71c). At least for the *even–if* conditional one can argue that it requires a somewhat different analysis of the embedded deontic modal. While for normal conditionals the default assumption is that the consequent is causally dependent on the antecedent, for the *even–if* conditional this is not the case: its semantics in fact states that the consequent

[52]The argument carries over to indicative deontic counterfactuals, which on our contention must also be restricted to quantify over *normal*, or "similar" worlds by use of an ordering source in Kratzer's framework.

[53]We will argue for an analysis along these lines in Section 4.1.4.

is causally *independent* of the antecedent.[54]

This we could use as a motivation to stick with the analysis proposed above for the "usual" deontic conditionals such as (71a), i.e. to constrain the embedded modal base to be identical to, or "anaphorically dependent" on the higher operator's updated modal base ($f'(w') = f^+(w)$), while for the special case of the deontic *even–if* conditional in (71b) we can choose the non–updated modal base ($f'(w') = f(w)$) to restrict the embedded modal.

(71) a. If Jesse had robbed the bank, he would have to go to jail.
Wenn Jesse die Bank ausgeraubt hätte, *müßte* er ins Gefängnis gehen.

b. *Even if* Jesse had robbed the bank, he shouldn't have done so.
Selbst wenn Jesse die Bank ausgeraubt hätte, hätte er es nicht tun *dürfen*.

c. # If Jesse had robbed the bank, he would have been obliged not to rob the bank.
Wenn Jesse die Bank ausgeraubt hätte, hätte er es nicht tun *dürfen*.

As can be seen by way of (72a), an empty modal base will not do, since the deontic operator is to be restricted to worlds where Max owns a car and is not handicapped in order to derive that he is (nevertheless) obliged to pay taxes.

We will investigate these examples again in Section 4.1.4, where we will argue that – given the special semantics of the *even–if* conditional – the embedded modal base is anaphoric not to the *updated* modal base of the conditional, but to the *non–updated* modal base, which in the special case of (72a) will consist of worlds where Max owns a car (and which will be additionally restricted by the embedded quantifier to "normal" worlds where he is not handicapped). The analysis will then not only account for (72a), but also for the oddity of (72b).

(72) a. Max has bought a car.
Even if he refused to pay taxes, he would *have to* do so.

b. Max has bought a car.
If he refused to pay taxes, he would *have to* do so.

Before concluding this discussion of deontic conditionals we want to raise one final issue, which is of some importance in light of the DRT analysis we will propose for (multiple) relative modality and deontic conditionals.

Both of the alternative analyses we arrived at, (i) and (ii), still suffer from the problem we already mentioned in Section 2.2.2: any deontic conditonal *if* ϕ *then* ψ where ϕ implies ψ will come out true, even if ψ is not "prescribed" by the deontic ordering source g' involved.

As a possible solution to this general problem one could conceive of interpreting the embedded modal operator as relative to a *deontic modal base*, instead of using the deontic context as the ordering source. This move would not only avoid these counterintuitive results, but also smoothly account for examples like (70) and (72): If in (70) the embedded modal base $f'(w')$ determines what in w' (where Max is not handicapped and owns a car)

[54]See e.g. von Fintel(1994).

is demanded by German tax law, it follows necessarily that he has to pay taxes, while it doesn't follow that he has a car – this will not be prescribed by the tax laws in w'. Similarly for (72), where the higher operator quantifies over worlds w' where Max owns a car but doesn't pay taxes. Again the deontic modal base $f'(w')$ accessible from these worlds will necessarily prescibe that Max – nevertheless – has to pay taxes.

The reasons why we reject an analysis along these lines are twofold:

First, given that contextual backgrounds are defined as sets of propositions, the deontic context $f'(w')$ in the examples just considered must consist (at least) of the proposition q corresponding to *Max pays taxes*: this is what is demanded in worlds like w'. But it remains somewhat mysterious how one should get at such a deontic background context. In introducing examples (69)/(70) we have defined the relevant deontic background context corresponding to *German tax law* in terms of conditional assertions: *If someone owns a car and is not handicapped, he must pay taxes; If someone owns a car and is handicapped, he must not.*

Since Kratzer's theory explicitly allows for the linguistic context to establish conversational background contexts, one should take the propositions that make up the relevant deontic background context $l(w)$ to consist just of such *conditional* propositions. In fact, it is inconceivable that juridical texts give lists of particular individuals that have to pay such and such an amount of taxes. Further, as noted in Section 2.2.2, in cases of conditional obligation, such as (69)–(72), the antecedents of deontic conditionals take us to worlds w' where the "laws" prevailing in w are still in force. Thus, we very much prefer an analysis of the deontic conditionals (70) and (72) where the deontic background context $g'(w')$ is identical to the *conditional* laws $l(w)$ prevailing in w. But then, restricting the embedded operator to this deontic modal base *alone* does of course not give us the desired results.

Finally – conceding the possibility that the deontic context consist of non–conditional propositions – this account would confront difficulties with all sorts of anaphoric phenomena: anaphoric binding of pronominals, and presuppositional binding, as in *If Max buys a car, he must pay taxes for* **his car**: Since the deontic modal base will not specify that there exist(s) a person Max and a car owned by him, there will be no antecedents for the anaphoric or presuppositional expressions.

We therefore prefer a solution along the lines discussed above, where the embedded modal base of the deontic operator is constituted either (ii) by anaphoric reference to the modal base of the higher operator, or (i) by assuming a circumstantial modal base, to comprise *relevant* facts for the deontic "issue" to decide, while the deontic force of the quantification is imported by use of a deontic ordering source.

The problem of counterintuitive examples verifying "trivial" truths in the scope of the deontic operators can then only be captured by resorting to pragmatic conditions which require that for deontic quantification the modal base does not by itself license the verification of the proposition in the scope of the deontic operator (see Sections 2.2.2 and 4.1.4).

To conclude, we will opt for an analysis of deontic conditionals where the deontic quantifier is embedded within the scope of the quantificational structure induced by the conditional, and where – in the general case – the embedded modal base $f'(w')$ is anaphoric to the modal base $f^+(w)$ of the governing conditional.

But an analysis along these lines not only requires a slightly different analysis of the *vagueness* of conditionals, i.e. their restriction to maximally similar worlds, but is also dependent on a framework that offers a device to (anaphorically) refer to the modal base of an embedding modal operator. It is unclear to me whether the latter constraint can be fulfilled in Kratzer's framework, at least if the analysis is intended to be compositional.[55]

We conclude by stating that the impact of Kratzer's analysis of modality and conditionals consists mainly in the focus on the contextual dependence of modal operators which is captured by the notion of *relative modality*, and the generalization of Lewis' insights about *if*–sentences as involving (restricted) adverbial quantification to an analysis of conditionals as involving (restricted) implicit or explicit modal quantification. The main objections raised against the analysis were concerned with the notion of *graded modality*. The concept has been applied to various phenomena, including graded modals, non–epistemic modality and counterfactuality as well as inferences based on inconsistent sets of propositions. We have proposed an alternative analysis in terms of *(multiple) relative modality* and *compatibility restricted union*, which provides more intuitive results for cases of Practical Inference. Our discussion of deontic conditionals has driven us to analyze *if*–conditionals as epistemically based throughout, while the deontic modal operator can only be interpreted within the scope of the conditional's modal operator. The revised logical form for deontic conditionals led us to a possible weakness of the non–representational framework, which does not straightforwardly allow for anaphoric reference to the higher operator's updated modal base, to define the modal base of the embedded deontic modal.

2.3 DRT analyses of modality, conditionals and modal subordination

2.3.1 The standard DRT analysis of conditionals

In the "standard" extensional fragment of DRT (Kamp(1981), Kamp&Reyle(1993)[56]) conditional sentences are represented by complex DRS–conditions (73a), consisting of subDRSs K_1 and K_2 and the conditional arrow. The universal quantificational force of the conditional is induced by the verification condition (73b), which requires that there be an extension g of the function f that verifies the complex condition, such that for every g that verifies K_1 in **M** there is an extension h of g that verifies K_2 in **M**.

(73) a. $\mathrm{K}_1 \Rightarrow \mathrm{K}_2$

b. f *verifies* $\mathrm{K}_1 \Rightarrow \mathrm{K}_2$ *in* **M** iff
for every extension g of f s.th. $\mathrm{Dom(g)} = \mathrm{Dom(f)} \cup \mathrm{U}_{K_1}$ which verifies K_1 in **M** there is an extension h of g s.th. $\mathrm{Dom(h)} = \mathrm{Dom(g)} \cup \mathrm{U}_{K_2}$ and h verifies K_2 in **M**. (K&R 1993:157)

This analysis of conditional sentences was primarily concerned with the famous "donkey sentences", i.e. the puzzle involved in the interpretation of conditionals involving an

[55] Mats Rooth (p.c.) raised the idea that a mechanism of quantifying–in could avoid the problem of compositionality. Hans Kamp (p.c.) indicated a problem of metalanguage vs. object language. We leave this matter undecided.

[56] In the following we abbreviate reference to Kamp&Reyle's work by (K&R 1993).

indefinite NP in the antecedent clause with an anaphorically dependent pronoun in the consequent.[57] The verification condition (73b) ensures that the indefinite *a donkey* in (74) gets universally quantified while in general indefinite NPs are not analyzed as inherently quantificational. The dependent pronoun in the consequent DRS is treated as a bound variable: the accessibility restrictions for anaphoric binding ensure that the pronoun can be anaphorically bound to the indefinite NP in the conditional's antecedent. The implicit universal operator in conditional sentences is analyzed as an unselective binder: more than one variable can be bound, as illustrated in (74b) (see (K&R 1993:177)).

(74) a. If a farmer owns a donkey, he beats it.
b. $\forall$ xy ((farmer(x) & donkey(y) & owns(x,y)) $\rightarrow \exists$ uv (u = x & v = y & beats(u,v)))

As observed by Kamp(1988) and Kamp&Reyle(1993), the verification condition (73b) for conditional DRSs comes down to material implication in case no anaphoric relations hold between the antecedent and consequent DRS, as in (75).

(75) If Jones owns a Porsche, then Smith owns a Ferrari. (K&R 1993:158)

x z Jones(x) Smith(z)		
y Porsche(y) x owns y	$\Rightarrow$	u Ferrari(u) z owns u

Since in such cases it is immaterial, for the verification of K_2 by an assignment h, which value is assigned to y by g, the function h, which is to verify K_2 by assigning appropriate elements of $\mathbf{U}_{\mathrm{M}}$ to x, z, y and u, might be replaced by a function h', which assigns elements only to x, z and u and still verifies K_2. For such examples the verification condition in (73b) is equivalent to (76a) and therefore to (76b), which expresses material implication.

(76) a. for every extension g of f which assigns an element of **M** to y and verifies K_1 there is an extension h' of f which assigns an element of **M** to u and verifies K_2.
b. either there is no extension g of f which verifies K_1 in **M** or there is an extension h' of f which verifies K_2 in **M**. (K&R 1993:159)

As it stands, this analysis of conditionals does not account for non–universally quantified conditionals (77b–c). This can only be accounted for in an analysis that follows Lewis(1975) in taking conditional sentences to introduce a tripartite quantificational structure, where the adverb of quantification is overtly restricted by the *if*–clause.

(77) a. If a farmer owns a donkey, he [always/surely] beats it.

b. If a farmer owns a donkey, he sometimes/might beat(s) it.

c. If a farmer owns a donkey, he usually/probably beats it.

[57]For recent discussion see Chierchia(1995).

Moreover, the distinction between temporal and modal readings of conditionals, indicated by use of temporal vs. modal adverbs of quantification in (77), is not accounted for by the DRT analysis of conditionals sketched above. Finally, this analysis of conditionals does not capture the distinction between indicative and subjunctive conditionals in (78). The verification condition (73b) defines the embedding function g that is to verify the antecedent DRS as an extension of f. But in the case of a counterfactual subjunctive conditional there will be no extension g of f that verifies the antecedent DRS K_1 in $\mathbf{M}$. The analysis in (73) therefore does not account for counterfactual conditionals such as (78b).

(78) a. If Max went to London, he will eat lots of Chinese food.

b. If Max had gone to London, he would have eaten lots of Chinese food.

This has, of course, not gone unnoticed. Kamp(1988) is well aware of the fact that for "hypothetically connected sentences" such as (75) an intensional analysis is called for, to be defined in terms of possible worlds semantics:

> For instance we could stipulate that [(75)] is true in a model structure M at a world w iff for every w′ ∈ W such that wRw′ and every assignment f of elements of $U_{w'}$ to the reference markers of K1 and that these elements satisfy the conditions of K1 and [sic] M at w′ there is an extension of f to the markers of K2, again involving elements involving $U_{w[']}$, so that the conditions of K2 are satisfied in M at w′ also.
> Any other definition of a conditional connection in terms of possible worlds, as one finds these e.g. in the work of Lewis 1975, Stalnaker 1968 or any of the works ... [Pollock, Kratzer, Veltman] could be adapted in a similar way. Kamp(1988:93)

In fact, there are various "reconstructions" of possible worlds analyses of conditionals in the framework of DRT, namely of Lewis' analysis by Kasper(1992), and of Kratzer's analysis by Roberts(1989) and Geurts(1995) as a follow–up. We will turn to these analyses shortly, in Section 2.3.2.

Generalized adverbial quantification for conditional sentences

But first we want to address the problem of non–universally quantified conditionals mentioned above, which can be given a straightforward solution by carrying over to the analysis of conditionals the DRT account of generalized quantification, which was originally designed for NP–quantification and the proportion problem (79).

(79) a. Every farmer who owns a donkey beats it.

b. Most farmers who own a donkey beat it.

Much like the implicative condition for conditionals, the DRS–conditions for generalized quantifiers consist of two subDRSs K_1 and K_2, representing the restrictor and the nuclear scope of the quantifier, and the "diamond", which indicates (i) the relation Q the quantifier expresses (see (80c)), and (ii) the variable(s), or discourse referent(s) the quantifier binds.

As is made explicit by the verification conditions in (80b), the quantification only ranges over the elements associated with the discourse referent specified in the diamond. I.e. the quantification does not range over tuples of *all* discourse referents introduced into the restrictor by indefinite NPs, as does the analysis by unselective binding. This accounts for the proportion problem,[58] while still capturing the analysis of indefinite NPs and "donkey anaphora".

(80) a. $\boxed{K_1} \diamond^{Q}_{x} \boxed{K_2}$

b. $M \models_f \boxed{K_1} \diamond^{Q}_{x} \boxed{K_2}$

iff $\langle A, B\rangle \in \mathrm{Quant}_M(\mathrm{Q})$, where

$A = \{b : b \in U_M \;\&\; (\exists g)\ (f \cup \{\langle x, b\rangle\} \subseteq_{U_{K_1}-\{x\}} g \;\&\; M \models_g K_1)\}$ and

$B = \{b : b \in U_M \;\&\; (\exists g)\ (f \cup \{\langle x, b\rangle\} \subseteq_{U_{K_1}-\{x\}} g \;\&\; M \models_g K_1) \;\&$

$\quad \forall g(f \cup \{\langle x, b\rangle\} \subseteq_{U_{K_1}-\{x\}} g \;\&\; M \models_g K_1) \rightarrow (\exists h)(g \subseteq_{U_{K_2}} h \;\&\; M \models_h K_2))\}$

c. $\mathrm{Quant}_M(\text{every}) = \{\ \langle A, B\rangle : A \subseteq A \cap B\ \}$

$\mathrm{Quant}_M(\text{some}) = \{\ \langle A, B\rangle : A \cap B \neq \emptyset\ \}$

$\mathrm{Quant}_M(\text{most}) = \{\ \langle A, B\rangle : \mid A \cap B \mid > \mid A \backslash B \mid\ \}$ (K&R 1993:427)

In the sense of Lewis(1975) conditionals such as (81) can then be analyzed in terms of generalized quantification over "cases", which may be interpreted as quantifications over times, events, individuals, or tuples of them.

(81) a. The fog usually lifts before noon here.

b. Riders on the Thirteenth Avenue line seldom find seats.

c. A quadratic equation usually has two different solutions. (Lewis 1975:3–5)

Kamp&Reyle(1993:644–646) give an analysis along these lines for temporal adverbs of quantification, and more recent work of Kamp(1994) deals with the analysis of (frequency) adverbial quantification in much more detail and sophistication. Evidently, the semantics of generalized quantification in (80) captures the "graded" meaning of conditionals like (82).

(82) Mostly a farmer who owns a donkey beats it.

Mostly, if a farmer owns a donkey, he beats it.

$$\boxed{\begin{array}{l} \text{n t} \\ \text{n} \subseteq \text{t} \\ \boxed{\begin{array}{l} \text{x y s} \\ \text{s} \subseteq \text{t} \\ \text{farmer(x)} \\ \text{donkey(y)} \\ \text{s: x own y} \end{array}} \;\diamond^{\text{most}}_{?}\; \boxed{\begin{array}{l} \text{s}' \\ \text{s}' \subseteq \text{t} \\ \text{s}' \bigcirc \text{s} \\ \text{s}' : \text{x beat y} \end{array}} \end{array}}$$

where ? = x,y or s or s,x,y (K&R 1993:645)'

[58]There are still many open problems in that (i) the judgements are not so clear and (ii) there are no conditions yet that "trigger" the selection of the appropriate referent(s) to quantify over. See (K&R 1993:425).

And further, if the quantification in (83) ranges over situations *s* where Jones owns a Porsche, the consequent clause being anaphorically dependent on *s*, the conditional does not reduce to material interpretation.

(83) If Jones owns a Porsche, then Smith owns a Ferrari.

<table>
<tr><td colspan="3">n t x z
n ⊆ t
Jones(x) Smith(z)</td></tr>
<tr><td>s y
s ⊆ t
Porsche(y)
s: x owns y</td><td>every
s</td><td>s′ u
s′ $\bigcirc$ s
Ferrari(u)
s′ : z owns u</td></tr>
</table>

Frequency vs. modal quantification

But is it in fact appropriate for (83) to induce quantification over situations? At least there is no prominent reading such that there are several *subsequent* situations where Jones owns a Porsche and where it additionally holds that Smith owns a Ferrari. So, if the generalized quantification ranges over a discourse referent for an eventuality, in order to distinguish between frequency and modal readings, the eventualities quantified over must be constrained to be either temporally related for a frequency reading, or in a way such that no temporal relation is defined between the situations or events quantified over, which characterizes a modal interpretation.[59] But if for a modal interpretation the quantification is taken to range over situations that are not temporally related, we might ask ourselves whether situations are in fact the right kind of things to quantify over in such cases.

Before we try to answer this question, let us discuss some data, now confined to German, to establish the distinction between frequency and modal quantification. Bare conditionals such as (84a) are commonly assumed to be universally quantified by an implicit adverbial quantifier. The overt *graded* adverbs of quantification in (84b–c), by their lexical meaning, clearly indicate frequency and modal quantification, respectively. Given this contrast it is not obvious which kind of implicit universal quantification – frequency (*immer/always*) or modal (*sicherlich/certainly*)– we have to posit for the bare conditional (84a).

(84) a. Wenn Max in die Oper geht, sitzt er in der ersten Reihe.
'If Max goes to to opera, he is sitting in the first row.'

b. Wenn Max in die Oper geht, sitzt er *meistens* in der ersten Reihe.
'If Max goes to to opera, he usually is sitting in the first row.'

c. Wenn Max in die Oper geht, sitzt er *wahrscheinlich* in der ersten Reihe.
'If Max goes to to opera, he is probably sitting in the first row.'

But at closer inspection the overt *graded* frequency vs. modal quantifiers are not the only quantificational elements in (84b–c). We may freely assume or add an (implicit) universally quantified modal or frequency adverb, respectively, as indicated in (85).

[59] We do not consider generic readings for the moment.

(85) a. Wenn Max in die Oper geht, sitzt er [sicher] [immer] in der 1. Reihe.
'If Max goes to to opera, he is [surely] [always] sitting in the first row.'

b. Wenn Max in die Oper geht, sitzt er [sicher] *meistens* in der 1. Reihe.
'If Max goes to to opera, he is [surely] usually sitting in the first row.'

c. Wenn Max in die Oper geht, sitzt er *wahrscheinlich* [immer] in der 1. Reihe.
'If Max goes to to opera, he is probably [always] sitting in the first row.'

If for (85b–c) we do not want to run into a proportion problem, we'd better clearly distinguish between universal modal but graded frequency quantification for (85b), and graded modal but universal frequency quantification in (85c). This can only be achieved by positing *two* adverbs of quantification, modal and frequency, to be present in conditionals that allow for both kinds of quantification. On this assumption the bare conditional (84a) must be assumed to host two implicit universal operators, one for modal and one for frequency quantification.

If conditionals involve two kinds of quantification, it must be possible to isolate either one. For a "pure" modal reading, this is easily done: Restricting the antecedent clause to a temporal domain that prohibits subsequent realizations of the event or situation to be quantified over results in a plain modal reading. For example, since it is highly implausible that someone goes to the opera more than once a day, a pure modal reading is forced for (86). This is corroborated by the impossibility to construe these examples with a frequency adverb such as *immer* or *meistens*.[60]

(86) a. Wenn Max gestern in die Oper ging, saß er [sicher/#immer] in der 1. Reihe.
'If Max went to the opera yesterday, he was [surely/#always] sitting in the 1st row.'

b. Wenn Max gestern in die Oper ging, saß er *wahrscheinlich*/#meistens in der 1. Reihe.
'If Max went to the opera yesterday, he was probably/#mostly sitting in the 1st row.'

Isolating a non–modal frequency reading is more difficult. It does not help, e.g., to make use of a factive past time antecedent, which in German is indicated by the switch from *wenn* to *als*. (87a) can still be completed by modal adverbs of quantification: even if the antecedent is known to be true, this does not predict the consequent to hold with necessity. But we observe that if, in German, the temporal adverb *immer* is fronted, as in (87b), a plain frequency reading is forced: adding a modal adverb such as *sicher* or *wahrscheinlich* results in a semantically illformed sentence.

(87) a. Als Max noch in die Oper ging, saß er (sicher/wahrscheinlich) *immer* in der 1. Reihe.
'When Max still went to the opera, he was (surely/probably) sitting in the 1st row.'

[60]This example parallels (83), where the most prominent reading is a non–frequency reading.

b. *Immer* wenn Max in die Oper ging, saß er (??*sicher*/#*wahrscheinlich*) in der 1. Reihe.
'Always, if Max went to the opera, he was ??surely/#probably sitting in the 1st row.'

One might object that the oddity of (87b) could be due to some syntactic peculiarity, rather than to some semantic incompatibility. Yet, the contrast between (88a) and (88b) clearly shows that there is more to it. While (88a) is wellformed, the corresponding counterfactual construction in (88b) is odd. By contrast, if the frequency adverb rests in place, as in (88c), the subjunctive conditional is perfect. Thus, although I cannot tell why, fronting of the frequency adverb *immer* forces a plain frequency reading, which is not compatible with (graded) modal quantification or subjunctive mood.

(88) a. *Immer* wenn Max zur Schule ging, lief er den Fluß entlang.
'Always, if Max went to school, he walked along the river.'

b. # *Immer* wenn Max zur Schule gegangen wäre, wäre er den Fluß entlanggelaufen.
'# Always, if Max had gone to school, he would have walked along the river.'

c. Wenn Max zur Schule gegangen wäre, wäre er (sicher/wahrscheinlich) *immer* den Fluß entlanggelaufen.
'If Max had gone to school, he (surely/probably) always would have walked along the river.'

To sum up, the existence of "mixed" cases of implicit universal and explicit graded quantification of different kinds in (85), as well as the existence of "pure" readings of either modal or frequency quantification as in (86) and (87b)/(88a) call for an analysis of conditionals that provides a clear distinction between modal and frequency quantification. For bare conditionals which in principle allow for both kinds of quantification this involves the assumption of two implicit quantificational operators. Since both modal and frequency adverbs must be analyzed in terms of generalized quantification to account for non–universal quantification (*mostly, probably*, etc.), the relevant distinction must be tied to the kind of variable quantified over. One might be tempted to tie the relevant distinction to the temporal (non–)connectedness of the eventualities quantified over. Given the definition of generalized quantification in (80) above, this could be obtained by imposing additional constraints on frequency quantification (exemplified by the frequency adverb *always* in (89a)), and restrictions for modal quantification, as e.g. for *necessarily* in (89b).

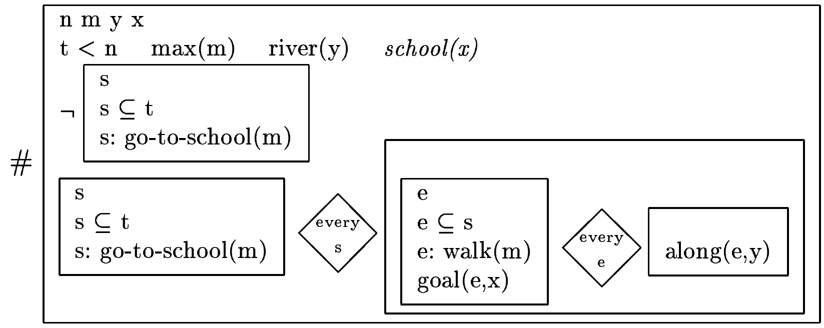
(89) a. $\text{Quant}_M(\text{always}) = \{ \langle A, B \rangle : A \subseteq A \cap B \}$ &
$\forall b_i, b_j \in A : b_i \leq b_j$ or $b_j \leq b_i$ (frequency reading)

b. $\text{Quant}_M(\text{necessarily}) = \{ \langle A, B \rangle : A \subseteq A \cap B \}$ &
$\forall b_i, b_j \in A :$ neither $\text{b}_i \leq b_j$ nor $b_j \leq b_i$ (modal reading)

But this would be somewhat shortsighted. First note that in the underlying model theory the distinction between temporally related and non–related eventualities cannot be captured within a *single* eventuality structure $\mathcal{EV}$ (see (K&R 1993:677)). Thus, quantification over temporally non–connected eventualities in fact involves quantification over elements pertaining to different eventuality structures $\mathcal{EV}_i$.

Yet, if the reference to eventualities pertaining to different structures is not made explicit, this does not provide a satisfactory solution for subjunctive conditionals, which are undoubtedly to be analyzed in terms of modal quantification. Subjunctive conditionals come with a strong pragmatic implicature that the antecedent is counterfactual, i.e. does not hold in the actual context. Note that this is exactly what licenses the negative subDRS $\neg K_1$ in (90): there is no extension g of f that verifies the negated subDRS K_1 in the model. Yet, at the same time evaluation of the conditional DRS does require there to be an extension g' of f that *does* verify the very same (or an alphabetic variant of this) subDRS K_1 in the same model. The conditional can then be true only vacuously.

(90) If Max had gone to school, he always would have walked along the river.



In order to capture the distinction between indicative and counterfactual conditionals, quantification over eventualities pertaining to different eventuality structures must be made explicit in both the representation language and the verification conditions. Commonly this is done by use of indices, or "possible worlds". In sum then, for a general account of modal quantification, both indicative and counterfactual, it seems more promising to distinguish between quantification over eventualities for frequency quantification on the one hand, and quantification over worlds (or world–function–pairs) for modal quantification on the other. In the following we will only consider modal quantification.

2.3.2 Possible worlds analyses of modality in DRT

Formal treatments of modality in the framework of DRT have been presented by Roberts(1989), Kasper(1992) and most recently by Geurts(1995) and Kamp&Reyle(1996). All these analyses of modality make use of the concept of possible worlds.

Kasper: A reconstruction of Lewis' analysis of counterfactuals

The analysis of modality in Kasper is a straightforward reconstruction of Lewis' analysis of counterfactuals in the framework of DRT. The model contains a set W of possible worlds w, and a function \$ which assigns to each world w a *sphere system* in the sense of Lewis(1973). The system of spheres is strongly centered, nested, closed under union and (non–empty)

intersection. The function \$ assigns to each world w a set of sets of possible worlds that represents a partial ordering of the possible worlds according to their similarity to w.
A conditional $K_1 \Rightarrow K_2$ is verified in such a model if there is some sphere $S \in \$(w)$ such that for every world $w' \in S$ and for every extension g of f that verifies K_1 relative to w' there is an extension g' of g that verifies K_2 relative to w'.

Given that Kasper's analysis is a reconstruction of Lewis' analysis of (counterfactual) conditionals, the same objections apply as to the failure to account for a context dependent interpretation of sequences of variably strict counterfactuals such as (91).

Since each conditional is evaluated in some distinct sphere $S \in \$(w)$, in a context set up by the first three conditionals, it is valid to draw the conclusion that *if Otto comes, it will be a lively party.* As we have argued in Section 2.2.2, given that *there are worlds taken into account* in this context where Otto comes to the party and the party is dreary, we cannot sensibly maintain the now rather unqualified statement that *if Otto comes to the party, it will be lively.*

(91) If Otto comes, it will be a lively party;
but if both Otto and Anna come, it will be a dreary party;
but if Waldo comes as well, it will be lively.
$\vdash$ If Otto comes, it will be a lively party.

The most serious objection against Lewis' analysis – which carries over to Kasper's reconstruction in DRT – is that the analysis of "variably strict" conditionals in a *system* of spheres abstracts away from contextual dependence which is, however, crucial for the dynamic aspects of language in context, as well as the validity of logical inferences in context. Instead of taking for granted a system of spheres which is pre–established as to make true a succession of stricter and stricter conditionals in one context, such cases call for a dynamic analysis where each conditional is interpreted relative to the local context established by the preceding (and in turn contextually dependent) conditional.

Roberts: A reconstruction of Kratzer's analysis of relative and graded modality

An analysis that captures important aspects of the context dependent nature of conditionals is Roberts(1987,1989). The underlying semantics of modality is based on Kratzer(1981). Again, the model is enriched by a set W of possible worlds w, and a DRS K is verified in the model relative to a world–function–pair $\langle w, f\rangle$.

Following Kratzer's analysis of relative and graded modality, a modal operator is interpreted relative to a modal base m and an ordering source o, both defined in the model as sets of propositions, i.e. sets of sets of possible worlds. The verification conditions for necessity and possibility wrt. to a modal base m and ordering source o are stated in (92).

As in Kratzer's theory, the modal base provides the implicit restriction argument of the modal operator, which is further restricted by the antecedent DRS K_i. The ordering source $o(w)$ defines a partial order on the worlds $\bigcap m(w)$ that make up the modal base: w' is judged *closer* to the ideal constituted by $o(w)$ than w'' ($w' \leq_{o(w)} w''$) iff more of the propositions in $o(w)$ are true in w' than in w''. The universal modal operator then quantifies over those worlds that come closest to the 'ideal' constituted by the ordering source.

(92) For all worlds w, u, v, w', u', assignment functions f, g, h, modal bases m, ordering sources o, models M, DRSes K, K_i, K_j, sets of conditions C, n-place predicates P, and variables x:

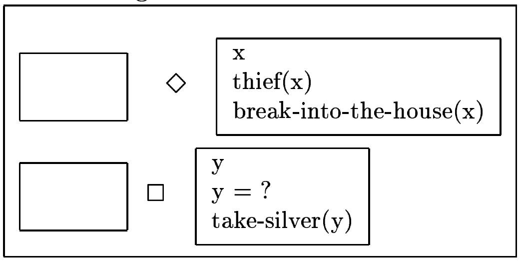
2.a.–d. ...

e. $\langle w, f\rangle \models_M \ (K_i \Box_{m,o} K_j)$ iff
$\forall u, g[g\langle X_{K_i}\rangle f \ \& \ u \in \bigcap[m(w) \cup \{\{v : \langle v, g\rangle \models_M K_i\}\}] \rightarrow$
$\exists w'(w' \in \bigcap[m(w) \ \cup \ \{\{v : \langle v, g\rangle \models_M K_i\}\}] \ \& \ w' \leq_{o(w)} u \ \&$
$[\forall u'[u' \in \bigcap[m(w) \ \cup \ \{\{v : \langle v, g\rangle \models_M K_i\}\}] \ \& \ u' \leq_{o(w)} w' \rightarrow$
$\exists h(h\langle X_{K_j}\rangle g \ \& \ \langle u', h\rangle \models_M K_j)])]$

f. $\langle w, f\rangle \models_M \ (K_i \Diamond_{m,o} K_j)$ iff
it is not the case that $\langle w, f\rangle \models_M \ (K_i \Box_{m,o} \neg K_j)$ Roberts(1989:714)

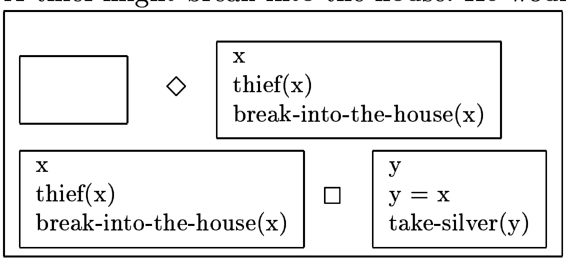
Although Kratzer's analysis of relative and graded modality is designed to capture the inherent context dependent nature of modal operators, this definition does not yet account for modal subordination contexts, such as Roberts' famous example (93). Even if – following Kratzer – modal operators are analyzed as implicitly restricted in terms of a contextually supplied modal base, the modal base of the necessity operator in (93) is not marked as contextually dependent on the scope of the possibility–operator. Thus, according to the DRT accessibility restrictions for anaphoric binding the referent x for the indefinite antecedent *a thief* is inaccessible for the pronoun *he* in the subordinate sentence.

(93) A thief might break into the house. He would take the silver.



In order to allow for anaphoric binding of the pronoun *he* to the indefinite NP *a thief*, Roberts develops the "accommodation of the missing antecedent approach to modal subordination", which makes material defined in "opaque" contexts acessible for anaphoric binding in subsequent (modally subordinated) sentences. In (94) the second sentence is treated as modally subordinated to the first one by accommodating the scope DRS of the possibility operator into the empty antecedent DRS of the modally subordinated necessity operator, to fill its implicit restriction argument. Once accommodation has taken place, the anaphoric referent y can be bound to the accommodated referent x in the antecedent DRS.

(94) A thief might break into the house. He would take the silver.



Although we think that Roberts' analysis of modal subordination is basically correct, it is arguable whether the device of accommodation is the right way, or the only way to go.

One problem is that accommodation is a very powerful device, and Roberts' theory does not provide any way to constrain it.

Roberts suggests possible restrictions to accommodation, which, however, are not given as a formal constraint on accommodation. E.g. she holds that "modal subordination, and thus the accommodation which it triggers, requires non–factual mood" (Roberts 1989:701). If the future tense *will* is interpreted as a non–factual modal operator, accommodation in (95a) and (96a) is in fact licensed, as opposed to the (b) examples.

(95) If John bought a book, he'*ll* be home reading it by now.
  a. It'*ll* be a murder history.
  b. # It is/was a murder history.

(96) A thief *might* break into the house.
  a. He *would/will* take the silver.
  b. # He takes the silver.

Yet, there is more to it: in the context of a subjunctive modal sentence, such as (97) and (98), modal subordination of a future tense subsequent, although in non–factual mood, is not correct (97b)/(98b). The constraints on accommodation must therefore be much more restrictive. In the same way, the modal *can* in (98b), although inherently non–factual, does not license accommodation of the counterfactual's antecedent and/or scope.

(97) John *should have* bought a bike for his daughter.
  a. She *would have* liked it.
  b. # She will like it.

(98) If I had a bike with a basket, I *could/would* take water with me.
  a. I *could/would* ride the whole day long.
  b. # I can/will ride the whole day long.[61]

Thus, different kinds of modality – futurate, hypothetical or counterfactual – are to be distinguished in such a way that in order for a modal expression to be analyzed as subordinate to some other modal context, the respective kinds, or types of modality are constrained to be *compatible* – in a sense to be explained in semantic terms. It should be obvious that the device of accommodation is far from providing such an account.

A more principled objection against Roberts' analysis of context dependence in modal constructions is that it is a hybrid theory.

The analysis is based on Kratzer's theory, which characterizes modal adverbs as *context dependent* expressions, dependent upon conversational background contexts: *modal base* and *ordering source*. These are most often to be reconstructed pragmatically, but can also

[61] Odd in a modal subordination reading.

be explicitly introduced by the preceding linguistic context.

In Roberts' analysis modal base and ordering source are not represented at the level of the DRS, but denote *sets of propositions* that are defined in the *model* for the verification of modal (or conditional) DRSes in (92). In fact, the reference to the modal base m and ordering source o in $K_i \Box_{m,o} K_j$ (see (92e–f)) is not even provided by the DRS language:[62] According to Roberts the selection of both modal base and ordering source "involves pragmatic questions, which go beyond the purview of semantic theory." (Roberts 1989:712).

This is of course not a tenable position. Although modals are often rather unspecified as to the range of modal bases they allow for, as Kratzer has shown, there are many modal operators that by their very lexical meaning select specific kinds of modal bases or ordering sources. In order to capture their meaning appropriately, it must be possible to specify at least the *kind of* intensional context they are to be interpreted as dependent on. Also, modal operators are often dependent upon *contextually given (i.e. linguistically introduced)* "conversational backgrounds".

Now, in Roberts' analysis – while the most pervasive phenomenon of context dependence, the interpretation of modal operators relative to a modal base and an ordering source, is treated at the level of the *verification conditions* – one *special* aspect of context dependence in modal contexts, modal subordination, is accounted for by use of an accommodation mechanism *at the level of the DRS.*

In our view, given that conversational background contexts for modal operators may be introduced by the linguistic context or constrained by the lexical meaning of modal (ad)verbs, the more fundamental notion of context dependence, *relative* modality, should be treated at the level of discourse representation structure.

If this is not ensured, no appropriate semantic representation is provided to account for the context dependent meaning of *have to* in (99). Given that the ordering source is not represented in the DRS, the contextual relativization of the deontic modal to the juridical context referred to by the phrase *a new tax system* cannot be accounted for.

(99) The government has just passed a new tax law for cars. If Max had bought a Ferrari last year, he would have to pay much higher taxes for it by now.

Note that this deficiency can not be overcome simply by introduction of a (sub)DRS or a context referent to represent the intensional deontic context denoted by the phrase *a new tax system.* For one, such an approach necessitates a redefinition of both the relation $\leq$ and of the verification conditions (92) to account for this new type of the ordering source. Furthermore, recall that we objected against the particular definition of "graded modality" to account for various phenomena involving non–graded modal constructions (such as counterfactual and deontic conditionals, and cases of "Practical Inference"), which led us to a slightly revised analysis of "multiply relative modality" in terms of "compatibility restricted union" to form a maximally consistent complex modal base. It is evident that if the ordering source is to be represented at the DRS level to render the relativization of the modal operator to some complex modal base, both the verification conditions and the accommodation device for modal subordination have to be refined accordingly, to account for

[62]The relevant clause of the syntax of DRL is:

(5) If K_i and K_j are DRSes, then $K_i \Box K_j$ is a condition. Roberts(1989:713)

inconsistent contexts. Although it is possible to deal with these problems in DR–theoretic terms (this will be our objective in the following Chapters) it should be obvious that the problem is too complex to be covered by a simple accommodation device.

Representation of both modal base and ordering source at the level of the DRS is, however, not only a promising perspective to represent the context dependent meaning of modal expressions, but is indispensible for general semantic reasons.

Since modal base and ordering source are not represented at the level of the DRS, the DRS in (100a) does not fully capture the meaning of the deontically modalized sentence (i). (100a.i) and (100a.ii) get assigned the same semantic representation.

Similarly, the relativization of a subjunctive modal to some "totally realistic ordering source" is not rendered by the DRS representation. (100b.i) is therefore not distinguished in DR–theoetic terms from the indicative (100b.ii). Note that if we were to stick with an analysis of deontic conditionals as originally proposed by Kratzer, this would carry over to (100b.iii), for which the DRS does not display the restriction to a deontic ordering source.

(100) a. i. Harry may$_{deontic}$ buy a car.
ii. Harry might buy a car.

x harry(x) [ ] ◇ [e y car(y) e: buy(x,y)]

b. i. If Max had bought a car, he would be happy.
ii. If Max has bought a car, he will be happy.
iii. If Max has bought a car, he must be happy.

m max(m) [x car(x) buy(m,x)] □ [happy(m)]

Finally, this observation leads us to another respect in which Roberts' analysis can be judged as a hybrid theory: Modal subordination, which is analyzed in terms of DRS–accommodation, is sensitive to different kinds of modal base and ordering sources. These concepts, however, are not represented in the DRS to constrain the accommodation device.

Recall our criticism as regards missing constraints on accommodation. Now, the very same kinds of distinctions that we argued were missing to account for restrictions on modal subordination – futurate, hypothetical and counterfactual modality as well as different "kinds" of non–epistemic modality – are exactly what is captured by Kratzer's analysis in terms of relative and graded modality in terms of modal base and ordering source. Consider (101) and (102). The (a) examples can be analyzed without making use of the mechanism of modal subordination, while in the (b) examples the constructions are modified such that modal subordination must apply. The logical forms state the modal operators, together with their (subscripted) modal base and (superscripted) ordering source, if any.

In (101a) the necessity operator is interpreted wrt. an epistemic modal base (further restricted by the antecedent p) and an empty ordering source. The modal subordination case (101b) first evaluates *possible*$_{epistemic}$ p, and then evaluates *necessary* q wrt. *the same* **epistemic** *modal base*, which – by accommodation – is further restricted to satisfy p, the scope of the first modal operator. The point in question is that besides the restriction of the modal base of the dependent modal operator to satisfy p – which is accounted for by the accommodation mechanism – this modal base must furthermore be constrained to "take up" the epistemic modal base of the higher operator, to which it is modally subordinated. Yet, this dependence upon the modal base of the "antecedent" modal construction is not captured by the accommodation approach to modal subordination.

Note that this missing dependency can result in differences of truth: If in (101) the preceding context had introduced the additional information that a frightfully dangerous dog is in the house, we would not want to deduce with necessity that *If a thief breaks in, he will take the silver* (even if we take into account the vagueness of conditionals). We will come back to this problem below.

(101) a. If a thief breaks in, he will take the silver.
$necessary_{epistemic\ \cup\ \{p\}}\ q$

x thief(x) break-into-the-house(x)	□	y y = x take-silver(y)

b. A thief might break in. He will take the silver.
$possible_{epistemic}\ p\ ;\ necessary_{\mathbf{epistemic}\ \cup\ \{p\}}\ q$

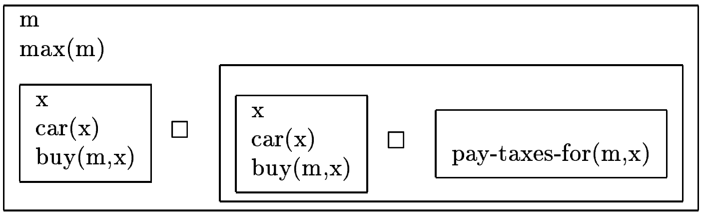
	◇	x thief(x) break-into-the-house(x)
x thief(x) break-into-the-house(x)	□	y y = x take-silver(y)

The next example, involving counterfactuality, is intended to illustrate that modally subordinated sentences are "anaphoric" not only to the modal base, but also to the ordering source of the antecedent modal construction. The counterfactual in (102a) is analyzed wrt. an empty modal base, updated with the antecedent p, and a "totally realistic" ordering source to select the counterfactual p–worlds that are most similar to the actual world. The embedded necessity operator takes up the modal base p, which now is "ordered" by a deontic ordering source, such that q holds with necessity in those p–worlds that are most similar to what the "law" demands in those maximally similar p–worlds.[63] Again, a correct analysis of the parallel modal subordination case (102b) requires more than accommodation of the scope of the antecedent modal construction into the restrictor argument of the modally

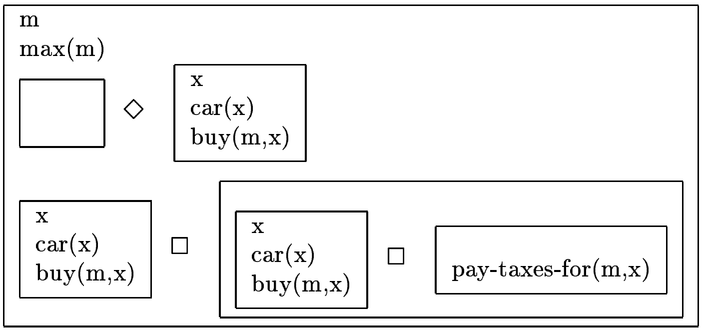
[63]Recall our discussion of deontic *if*–conditionals in Section 2.2.3, where we argued that in Kratzer's (revised) analysis the modal base of the embedded deontic modal operator must be anaphoric to, or "take up" the (updated) modal base f^+ of the conditional's higher modal operator. The adequacy of accommodating the antecedent DRS of the higher modal operator into the restriction argument of the embedded modal operator, as displayed in (102a–b), will be discussed – and questioned – below.

subordinated operator: This modally subordinated operator must be evaluated wrt. the same kind of ordering source, in order to cope with the aspect of counterfactuality.

(102) a. If Max had bought a car last year, he would have had to pay high taxes for it.
$necessary_p^{realistic}$ [$necessary_p^{deontic} q$]



b. Suppose Max had bought a car last year. He would have had to pay high taxes for it.
$possible^{realistic}\ p$; $necessary_p^{\mathbf{realistic}}$ [$necessary_p^{deontic} q$]



It should be obvious from these examples that if both modal base and ordering source were represented at the DRS level, relative modality could be represented by anaphoric reference to (possibly underspecified) contextual backgrounds. In the examples we just considered, modal subordination could then be constrained in terms of anaphoric reference to the modal base and/or ordering source of the antecedent modal construction. An analysis along these lines would provide the necessary restrictions on modal subordination exemplified by (97) and (98), given appropriate semantic characterizations of the different kinds of intensional contexts.[64] Since, e.g. a realistic ordering source is only licensed for subjunctive modals (*would, could*, etc.), but not for indicative auxiliaries like *will* or *can*, no anaphoric reference could be established to the modal base and ordering source of the counterfactual antecedents in (97b) and (98b).

The previous example, involving deontic *if*–conditionals, leads us again to the problem of implicitly restricted modal operators in embedded position, discussed in Section 2.2.3. We have argued that in Kratzer's framework the embedded deontic operator in e.g. (102a) must be interpreted relative to either (i) a circumstantial modal base, or (ii) a modal base that is identical to the modal base of the embedding conditional. On our view the second option is to be preferred, but can only be realized in a framework that allows for anaphoric reference to, or accommodation of the higher operator's modal base.

[64] We will only state such restrictions in Section 3.4, on the basis of our alternative analysis of generalized contextual dependence in modal contexts, to be developed in Chapters 3 to 5.

Since Roberts' analysis is a reconstruction of Kratzer's, the objections raised against an analysis along the lines of (i) carry over to Roberts' account. As for the second option, one could conjecture that – since the *if*–clause is represented in the DRS – the accommodation device could be used to provide an appropriate restriction argument for the embedded operator by accommodation of the higher operator's antecedent DRS, as displayed in (102). The embedded modal is then in fact constrained to quantify over worlds where Max buys a car, and which correspond as much as possible to what the law demands.

But accommodation of the higher operator's antecedent DRS to fill the restrictor of the embedded deontic operator does not work in the general case.

Imagine first an indicative variant of (102a), uttered in a context where we first get to know that *Max is a disabled person.* In this context, the conditional *If Max buys a car, he must pay taxes* is not true. Assuming that for the indicative conditional we can take the (factual) antecedent context to provide the modal base $f(w)$ of the higher operator, restricting the embedded operator to anaphorically refer to the updated modal base $f^+(w) = f(w) \cup \{p\}$, as we proposed for Kratzer's account, will give the correct result: the updated modal base contains only worlds where Max is a disabled person, thus in those worlds out of these, that are maximally similar to what the law provides, Max will not be demanded to pay taxes for his new car.

Now, with an analysis along the lines of (102a), where the restrictor of the embedded operator is filled by *accommodation* of the higher operator's *antecedent DRS* only, the contextual information that Max is a disabled person is lost. Therefore, we cannot derive that it is false that *If Max will buy a car, he must pay taxes.* Thus, in this case anaphoric reference to (or accommodation of) the entire, updated modal base of the higher operator is needed to get the correct truth conditions. This is – in principle – possible in Kratzer's account, but not so in Roberts', where the accommodation and anaphoric devices operate on the DRS level, while the modal base is not represented in the DRS.

The problem is even more involved for the counterfactual (102a), if settled into this specific context. Also in Kratzer's analysis this case cannot not be accounted for by anaphoric reference to the conditional's modal base.[65] The modal base of the counterfactual conditional cannot be chosen to be provided by the factual antecedent context, since there will be no consistent update with the antecedent p. The conditional's operator is therefore to be restricted by an "empty" modal base and a "totally realistic" ordering source. While the higher modal quantification is thereby restricted to "maximally similar" worlds where Max is a disabled person, this restriction is lost for the embedded quantification, if it only refers to the conditional's (updated) modal base f^+, consisting of the proposition p alone.

So it turns out that for deontic *if*–conditionals (i) *accommodation of the antecedent DRS* to fill the restrictor of the embedded deontic operator is insufficient, that (ii) anaphoric reference to the higher operator's *(updated) modal base* works fine for the indicative case, while (iii) for counterfactuals this analysis is only appropriate if the modal base can be defined in such a way that it satisfies *as much information as possible* of what is provided by the factual antecedent context *as is consistent with the counterfactual's antecedent.* Not surprisingly, this informal rendering corresponds closely to the notion of *compatibility restricted union* in building up a maximally consistent *(complex) modal base*, which we introduced and defended in Section 2.2.3.

[65] Though the analysis works correctly if the embedded quantification is analyzed by use of a circumstantial modal base and a deontic ordering source.

We conclude that Roberts' analysis of modal subordination is insufficient in important respects. First, it does *not* capture the appeal of Kratzer's analysis of "relative modality", in that the contextual backgrounds that constitute the "modal base" and "ordering source" of a modal operator are not represented at the level of discourse representation structure, but are simply defined in the model, for verification of the modal quantification condition (see (92)). It is therefore not possible to anaphorically refer to contexts set up by the preceding discourse, to account for the contextual relativization of a modal operator, as e.g. in (99). Also, the discussion of deontic *if*–conditionals brought out that a representational account of *relative modality* is required also for these non–modal–subordination cases, if the modal base of the embedded deontic modal operator is to be instantiated by way of anaphoric reference to the higher operator's modal base.

So the weakness of Roberts' theory is that it is a hybrid theory: the accommodation device for modal subordination operates at the level of the DRS, while the more fundamental notions of context dependence in terms of "modal base" and "ordering source" are not displayed in the semantic representation – they just figure in the verification conditions.

Finally, given that the accommodation mechanism – besides being a much too powerful device – does not have access to this level of the semantic analysis, there is no way to state appropriate constraints on modal subordination – which were shown above to be tied to the concepts of modal base and ordering source.

In sum, we have seen that the general, more fundamental phenomenon of contextual dependence in modal constructions – captured by the notions of modal base and ordering source – and the "special case" of modal subordination are better to be covered by a *unified* analysis of context dependence in modal contexts.

In Chapters 3 to 5 we try develop an analysis of "generalized" contextual dependence in modal constructions that accounts for many of the open problems we discussed, up to now, by reviewing existing theories.

Geurts: Another reconstruction of relative and graded modality in DRT

A very recent DRT analysis of modality and modal subordination is Geurts(1995). It is built upon both Kratzer's and Roberts' analyses, focussing on the phenomenon of presupposition projection in modal and attitudinal contexts. Geurts' analysis diverges from Roberts' account in that a modal expression is taken to presuppose its domain, thereby making superfluous the device of accommodation, which Geurts also criticizes for being heavily unrestricted.

Driven by – very convincing – arguments as to the analogy between generalized quantifiers like *most* and modal expressions, which can both be claimed to presuppose their quantificational domain, Geurts takes modal expressions to *presuppose* their domain argument. Given that his account of presupposition is based on van der Sandt's theory of presupposition as anaphora (van der Sandt(1992)), the presupposed domain argument of a (subordinated) modal operator can be bound to an accessible propositional reference marker – standing proxy for a preceding modal context – to make accessible discourse referents that are defined within this modal antecedent context for anaphoric binding: "If a modal expression ψ presupposes its domain, it makes sense to say that it can link up to another modal φ via this presupposed domain, in the process of which entities that were introduced in φ become accessible from within ψ." (Geurts(1995:79))

The DRS language is extended to include propositional reference markers p, q, etc., which are defined to denote sets of "states", i.e. pairs of worlds and embedding functions, where such a set is called an "indexed proposition". Propositional discourse referents can be used to build terms $p + K$, denoting "the indexed proposition denoted by p incremented with the information in K" (Geurts(1995:81)).

DRSs are interpreted in an intensional model $M = \langle D, W, I\rangle$, D a domain, W a set of possible worlds, I an interpretation function. A DRS K is given an interpretation $[\![K]\!]_s$ in terms of the set of states that verify K in the model relative to some state $s = \langle w, f\rangle$.[66]

Modal operators are represented as two–place relations between propositional terms: $p \Diamond q$, $p \Box q$. On a first approximation, they are given a standard interpretation, as relations between indexed propositions σ, σ', as defined in (103).

(103) a. $I_w(\Box) = \{\langle\sigma, \sigma'\rangle : \forall\langle w, f\rangle \in \sigma,\ \exists\langle w, g\rangle \in \sigma',\ f \subseteq g\ \}$

b. $I_w(\Diamond) = \{\langle\sigma, \sigma'\rangle : \exists\langle w, f\rangle \in \sigma,\ \exists\langle w, g\rangle \in \sigma',\ f \subseteq g\ \}$ Geurts(1995:86)

Modal subordination is then represented as in (104). The modals *might* and *would* induce presuppositional domain arguments, propositional referents $\underline{p}$ and $\underline{p'}$ (see (104a)), which – according to the "AB theory of presuppositions" (Geurts(1995:22ff)) are accommodated in the main DRS (p), or bound to the scope argument of the first modal construction ($p' = q$), respectively, as indicated in (104b).[67]

To see the impact of the semantic definition of propositional terms $p + K$, the semantics of the DRS (104b) is given in (104c). The set of states denoted by (104b) is constrained by the DRS conditions to be such that the indexed proposition denoted by p can be extended to some indexed proposition q satisfying the first subDRS, and in addition, every state in the denotation of q can be extended to some state in the denotation of the indexed proposition q' obtained by extending q to satisfy the second subDRS. Given the definitions for accessibility of discourse referents – which I will not state here – the anaphoric referent z can be bound to the antecedent x in (104b).

By taking modal operators to *presuppose* their quantificational domain, and given that presuppositions are conceived of as anaphors in the sense of van der Sandt(1992), Geurts' analysis of modal subordination avoids the powerful accommodation device underlying Roberts' analysis. Anaphoric reference to (or modal subordination relative to) a modal

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[66] (i) DRS semantics [...] Let s = $< w, f >$ be a state Geurts(1995:85)

a. $[\![\alpha]\!]_s = f(\alpha)$, if α is a reference marker

b. $[\![p + K]\!]_s = \{\ s'' : \exists s' \in [\![p]\!]_s : s'' \in [\![K]\!]_{s'}\}$

c. $[\![K]\!]_s = \{\ < w, g >: f \subseteq g\ \&\ \mathrm{dom}(g) = U^*(K)\ \&\ \forall\varphi \in \mathrm{Con}(K),\ [\![\varphi]\!]_{<w,g>} = 1\}$

d. $[\![P(\alpha_1, ..., \alpha_n)]\!]_s = 1$ iff $< [\![\alpha_1]\!]_s, ..., [\![\alpha_n]\!]_s > \in I_w(P)$

e. $[\![\alpha = \beta]\!]_s = 1$ iff $[\![\alpha]\!]_s = [\![\beta]\!]_s$

f. $[\![\neg K]\!]_s = 1$ iff $[\![K]\!]_s = \emptyset$

g. $[\![K \vee K']\!]_s = 1$ iff $[\![K]\!]_s \cup [\![K']\!]_s \neq \emptyset$

h. $[\![K \Rightarrow K']\!]_s = 1$ iff $\forall s' \in [\![K]\!]_s : [\![K']\!]_{s'} \neq \emptyset$

[67] I will not go into the details of the AB theory of presupposition (see Geurts(1995:22ff)).

context can only be established by way of a presuppositional domain argument of a modal expression. Moreover, since propositional referents are subject to the accessibility restrictions for anaphoric reference, modal subordination is much more restricted in this theory.

(104) A thief might break in. He would take the silver.

a. $\boxed{\begin{array}{l} \underline{\mathrm{p}}\ \mathrm{q}\ \underline{\mathrm{p}'}\ \mathrm{q}' \\ \mathrm{q} = \mathrm{p} + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{thief(x)} \\ \mathrm{break\text{-}in(x)} \end{array}} \\ \mathrm{p} \diamond \mathrm{q} \\ \mathrm{q}' = \mathrm{p}' + \boxed{\begin{array}{l} \underline{\mathrm{z}} \\ \mathrm{take\text{-}silver(z)} \end{array}} \\ \mathrm{p}' \Box \mathrm{q}' \end{array}}$ b. $\boxed{\begin{array}{l} \mathrm{p}\ \mathrm{q}\ \mathrm{q}' \\ \mathrm{q} = \mathrm{p} + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{thief(x)} \\ \mathrm{break\text{-}in(x)} \end{array}} \\ \mathrm{p} \diamond \mathrm{q} \\ \mathrm{q}' = \mathrm{q} + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{take\text{-}silver(x)} \end{array}} \\ \mathrm{q} \Box \mathrm{q}' \end{array}}$

c. $[\![(104\mathrm{b})]\!]_{\langle w,f\rangle}$

$= \{\ \langle w,g\rangle : f \subseteq g\ \&\ \mathrm{dom}(g) = \{\mathrm{p, q, q'}\}\ \&$
$\quad [\![\ \mathrm{q = p + [\ x: thief(x); break\text{-}in(x)]}]\!]_{\langle w,g\rangle} = 1\ \&$
$\quad [\![\ \mathrm{p} \diamond \mathrm{q}]\!]_{\langle w,g\rangle} = 1\ \&$
$\quad [\![\ \mathrm{q' = q + [\ : take\text{-}silver(x)]}\ ]\!]_{\langle w,g\rangle} = 1\ \&$
$\quad [\![\ \mathrm{q} \Box \mathrm{q'}\ ]\!]_{\langle w,g\rangle} = 1\ \}$

$= \{\ \langle w,g\rangle : f \subseteq g\ \&\ \mathrm{dom}(g) = \{\mathrm{p, q, q'}\}\ \&$
$\quad g(q) = \{\langle v,j\rangle : \langle v,h\rangle \in g(p)\ \&\ h \subseteq j\ \&$
$\qquad \mathrm{dom}(j) = \{\mathrm{x}\}\ \&\ j(x) \in I_v(\mathrm{thief}) \cup I_v(\mathrm{break\text{-}in})\}\ \&$
$\quad \exists\langle v,h\rangle \in g(p), \exists\langle v,j\rangle \in g(q), h \subseteq j\ \&$
$\quad g(q') = \{\langle v,j\rangle \in g(p) : j(x) \in I_v(\mathrm{take\text{-}silver})\}\ \&$
$\quad \forall\langle v,h\rangle \in g(q), \exists\langle v,j\rangle \in g(q'), h \subseteq j\ \}$ Geurts(1995:86,87)

Geurts finally replaces the classical analysis of modals in (103) by Kratzer's semantics of relative and graded modality. Given a partial order (105) wrt. a (context determined) ordering source S, a set of propositions $S \subseteq \wp(W)$, the semantics of modal operators is defined in (106) in terms of a (presupposed) modal base σ and an ordering source $o(w)$.[68]

(105) $\forall w, v \in \mathrm{W},\ w \leq_S v$ iff $\forall p \in S$, if $v \in p$, then $w \in p$ Geurts(1995:89)

(106) Let o be some given ordering source. Then:

a. $I_w(\Box) = \{\langle\sigma,\sigma'\rangle : \forall s \in \sigma, \exists t \in \sigma,\ t \leq_{o(w)} s\ \&\ \forall t' \in \sigma,$ if $t' \leq_{o(w)} t$ then $t' \in \sigma'\ \}$

b. $I_w(\diamond) = \{\langle\sigma,\sigma'\rangle : \exists s \in \sigma, \forall s' \in \sigma,$ if $s' \leq_{o(w)} s$ then $s' \in \sigma'\ \}$ Geurts(1995:90)

[68] As it stands, the definition in (106) is not correct. Either (105) must be redefined as a relation holding between states (as is suggested by Geurts), or else the quantification in (106) must range over the worlds pertaining to states s, t and t'. The first option will not only require a more involved definition of the relation $<_{o(w)}$, but will also have to characterize the embedding functions g' in states $t' \in \sigma'$ as *extensions* of functions g in states $t \in \sigma$ in (106).

In light of our above discussion of Roberts' theory it is evident that the present proposal runs equally short of capturing the inherent contexual dependency of modal operators upon the *complex modal base*, determined by the modal domain *and* the ordering source:[69] While in Geurts' analysis modals presuppose their domain, or modal base, represented in terms of a propositional discourse referent, the contextually determined ordering source is *not* represented at the level of the DRS, but must again be assumed to be given in the model. As we argued at length, this runs short of an adequate semantic representation of the context dependent meaning of modal expressions.

It is true, as argued by Geurts, that contextual dependence upon the modal domain is sufficient for the aspects of presupposition projection and anaphoric binding in modally subordinated constructions. E.g. (107) is intended to prove that neither different ordering sources nor different quantificational forces affect the possibility of modal operators to engage in modal subordination. The first modal in (107b) can be interpreted epistemically, which does not preclude the possibility of modally subordinating the second (deontic) modal construction.

(107) a. You *must* carry an umbrella but you *may* leave it at the reception.

b. Harry *may* carry an umbrella but he *must* leave it at the reception.

Geurts(1995:90)

Yet, it must be kept in mind that the validity of the semantic analysis cannot be determined exhaustively in terms of presuppositional properties. We must also make sure that the semantic representations built up in context finally turn out to yield the correct truth conditions. This, however, cannot be ensured by the analysis.

As we already observed in connection with Roberts' theory, since the ordering source is not represented at the level of the DRS, the semantic representations obtained for (108a) and (108b) do not render their crucial difference in meaning:[70]

(108) a. Harry may (is allowed to) carry an umbrella.

b. Harry might carry an umbrella.

$$\boxed{\begin{array}{l} \mathrm{x\ p\ q} \\ \mathrm{harry(x)} \\ \mathrm{p} \Diamond \mathrm{q} \\ \mathrm{q = p +} \boxed{\begin{array}{l} \mathrm{e\ y} \\ \mathrm{umbrella(y)} \\ \mathrm{e{:}\ carry(x,y)} \end{array}} \end{array}}$$

[69]Recall also our extensive discussion of 'Practical Inference' and of deontic *if*-conditionals, which put some doubt on the particular analysis of "graded modality" in Kratzer's theory – and which carries over to the reconstructions of this notion in the DRT analyses of Roberts and Geurts.

[70]Note that the deontic ordering source $o(w)$ which must enter the interpretation of (108a) cannot be represented in terms of a propositional discourse referent without further ado: according to (105) ordering sources denote sets of propositions $S \subseteq \wp(W)$. So if the verification condition for graded modality were to be adapted to account for ordering sources in terms of propositional discourse referents, both (105) and (106) would need redefinition (see also footnote 68).

For the same reason, the representation constructed for the deontic conditional in (109) does not reflect the counterfactual and deontic interpretation of the two modal operators.

And, as we already noted above, when discussing Roberts' account, there is no way to *represent* the contextual dependence of a sentence like (109) upon a deontic background context that is *linguistically introduced* by the preceding context, as e.g. by the phrase *according to German tax law* (see (99)).

(109) If Max had bought a car, he would have had to pay high taxes for it.

$$\begin{array}{|l|}\hline \text{m p q q}' \\ \text{max(m)} \\ \text{q} = \text{p} + \begin{array}{|l|}\hline \text{x} \\ \text{car(x)} \\ \text{buy(m,x)} \\ \hline\end{array} \\ \text{q} \;\Box\; \text{q}' \\ \text{q}' = \text{q} + \begin{array}{|l|}\hline \text{r s} \\ \text{r} = \text{q} \\ \text{r} \;\Box\; \text{s} \\ \text{s} = \text{r} + \boxed{\text{pay-taxes(m,x)}} \\ \hline\end{array} \\ \hline\end{array}$$

Also, even though the modal base is now represented as a propositional referent, it will still not be possible, on Geurts analysis, to represent the embedded deontic quantifier as *anaphoric* to the updated modal base of the embedding conditional structure (see p. 70).

E.g. if for (109) the preceding context introduces the information that *Max is a handicapped person*, the modal base of the conditional (and with it the anaphorically dependent modal base of the embedded deontic modal) cannot be bound to a propositional referent that represents this piece of information: the propositional referent p in (109) is accommodated into the universe of the main DRS, but cannot be represented as an extension, or update of the informational content that is introduced, by the preceding context, within the main DRS. The anaphoric domain of the deontic modal will therefore not be restricted to worlds where Max is handicapped, and the deontic conditional cannot be falsified.

This problem also shows up in constructions where a simple indicative conditional is contextually dependent upon the factual antecedent context, as e.g. in (110).

(110) Harry doesn't carry an umbrella. If it starts raining, he'll get wet.

$$\begin{array}{|l|}\hline \text{h n p q r} \\ \text{harry(h)} \\ \neg \begin{array}{|l|}\hline \text{x} \\ \text{umbrella(x)} \\ \text{s: carry(h,x)} \\ \text{n} \subseteq \text{s} \\ \hline\end{array} \\ \text{q} = \text{p} + \begin{array}{|l|}\hline \text{e} \\ \text{e: begin\_raining} \\ \text{n} \;)(\; \text{e} \\ \hline\end{array} \\ \text{r} = \text{q} + \begin{array}{|l|}\hline \text{e} \\ \text{s}'\text{: wet(h)} \\ \text{e} \;)(\; \text{s}' \\ \hline\end{array} \\ \text{q} \;\Box\; \text{r} \\ \hline\end{array}$$

Even though the discourse referents that are introduced within the main DRS are made accessible for interpretation of the subDRSs that correspond to the conditional's antecedent and scope (see the semantic definitions in footnote 66), since the "input" referent p in (110) is not defined as an *extension*, or update of the preceding factual discourse, the denotation of p will *not* be defined to denote a set of states that determine that Harry doesn't carry an umbrella. The quantificational domain of the conditional is therefore not appropriately restricted to license the necessary conclusion that Harry will get wet if it starts raining.

Note that it is not possible to induce the proper restriction by use of a *totally realistic ordering source*, thereby restricting the quantificational domain to those worlds that are maximally similar to the world of evaluation, and thus to worlds where Harry doesn't carry an umbrella. The use of a totally realistic ordering source is restricted, in Kratzer's analysis of graded modalitiy, to counterfactual conditionals (see Kratzer(1981)). We are not sure whether the use of a *stereotypical* ordering source is appropriate to induce an appropriate restriction of the quantificational domain in the general case. See also examples in Sections 3.2 and 3.3.

Geurts concludes his discussion of modal subordination by giving some hints as to how to constrain modal subordination in terms of restrictions to be imposed upon the modal domain. E.g. the wellformedness of modally subordinating a deontic context to some epistemically modalized context, as in (107b), could be captured by constraints that require the modal base of a deontic modal adverb to be "a subset of the set of possible futures". It is not particularly clear to us how the first conjunct of (107b) is to be construed as "a subset of the set of possible futures". In any case, there are immediate counterexamples to this generalization. E.g. the first sentence in (111) is undoubtedly tied to the past, yet the deontic modal does engage easily in modal subordination.

(111) Harry might have brought an umbrella. He must/should leave it at the reception.

Irrespective of the strength of these possible restrictions on modal subordination, given that the representations constructed for (107) do not distinguish between an epistemic and a deontic reading of the modal operator, it is not clear *in what terms* such restrictions on the modal base are to be stated – and checked.

Also, recall our observations when discussing Roberts' account of modal subordination, where it turned out that constraints on modal subordination must be stated not only wrt. the modal base, but also the ordering source (see in particular (97) and (98)).

Finally, Geurts concedes an open problem in his account of modal subordination, which is tied to counterfactual modality. If – like other modal operators – the modal *would* in (112) presupposes its modal domain, no antecedent context (or propositional discourse referent) is accessible to allow for anaphoric binding of the pronominal *it*.

(112) a. I don't have a microwave oven. I wouldn't know what to do with it.

b. I have considered buying a microwave oven, but frankly I wouldn't know what to do with it.

c. My wife wants us to buy a microwave oven, but I wouldn't know what to do with it. Geurts(1995:95)

Geurts hints at two possible solutions to this problem, which, however don't seem too attractive. Negated sentences such as (112a) could be assumed to evoke a corresponding positive context. Yet, irrespective of the overall justification of such an assumption, it does not account for (112b–c), which, however, seem to be related.

On the other hand, Geurts hypothesizes, one could take the modal *would* to presuppose its domain, just as any other modal adverb. But as no antecedent is available to bind the presupposition, "there is some pressure to find a suitable antecedent, after all. Therefore, the hearer decides (and is expected) to 'fill in' the content of the presupposition on the basis of contextually given information." (Geurts(1995:96)). As Geurts concedes, "this would amount to conceding that Roberts' is the correct account of the examples in ..." (Geurts(1995:96)). So this second solution undermines the *presuppositional* – as opposed to the accommodation – *account* to modal subordination and therefore is judged as not very attractive either.

In Sections 3.4 and 4.3.4 we will come back to these and related examples of modal subordination in opaque contexts, where we will show how they fit into the general theory of relative modality and modal subordination, which we will now turn to develop in Chapters 3 to 5.

3 A DRT Framework for the Analysis of Relative Modality

In the previous Chapter, by reviewing diverse approaches to modality, conditionals and modal subordination, both within traditional possible worlds semantics and the DRT–framework, we have outlined basic requirements to be met by a *unified* analysis of these phenomena. These are briefly stated in (1).

(1) a. *If*–conditionals (in case they get a modal interpretation) are to be analyzed as explicitly restricted modal operators (Kratzer's insight, based on Lewis(1975)).

b. Implicitly or explicitly restricted modal operators are contextually dependent upon a *modal base* (Kratzer's term) or a presupposed *modal domain* (Geurts).

c. Implicitly or explicitly restricted modal operators can have a *graded* meaning (*probably*, etc.).

d. Both indicative and counterfactual conditionals (and modals) are *vague* (Stalnaker, Lewis). The quantificational domain is therefore to be restricted to some appropriate subset of worlds, which correspond as much as possible to *what is considered normal* or *relevant* in the particular context of use. We questioned the usefulness of the notion of *similarity* to account for the vagueness of conditionals.

e. Both indicative and counterfactual conditionals are *variably strict* (Lewis). We have argued that Lewis' analysis in terms of a *system of spheres* does not appropriately render the contextual dynamics which is characteristic for sequences of variably strict conditionals, and moreover allows for counterintuitive inferences to be drawn from such sequences. The analysis of "counterfactual fallacies" that ensues from this theory is mistaken in that it weakens the strength of (counterfactual) inference schemes, instead of focussing on the contextual relativization of conditional sentences in a dynamically evolving discourse.

f. *If*–conditionals cannot be analyzed by use of a non–epistemic (deontic, etc.) modal operator. For non–epistemically modalized conditionals we therefore postulate an embedded modal operator, which is to be interpreted relative to some non–epistemic (deontic, etc.) background context. An analysis along these lines is necessary to account for deontic conditionals where the antecedent takes us to worlds where the relevant laws differ from those provailing in the actual world.

g. While in the DRT–approaches to modality we reviewed above the *modal base* and/or *ordering source* were not represented at the DRS level, we have shown that this falls short of the full contextual meaning of modal constructions. Moreover, accessibility of the ordering source is indispensible if we want to define restrictions on modal subordination.

h. Kratzer's theory (which underlies Roberts' and Geurts' DRT–aproaches) makes use of an ordering source to deal with inconsistent contexts for non–epistemic or counterfactual modality. We argued that this leads to unintuitive results in cases of "Practical Inference". We aim at an alternative analysis for the problem of inconsistent modal bases with non–epistemic and counterfactual modality.

i. Modal subordination is a special instance of the more general context dependent characteristic of modal constructions, which in Kratzer's theory is analyzed in terms of *relative modality.* The analysis to be developed below therefore intends to give both phenomena a *unified* analysis.

j. Given the close analogy we find between the context dependent nature of modal operators on the one hand and the context dependent characteristic of adverbial and nominal quantification on the other, we will conceive of modal operators as generalized quantifiers, which various authors take to be *anaphoric* in their restrictor argument (see von Fintel(1994,1995)).[1]

k. For modal subordination, modal operators must be allowed to anaphorically refer to (apparently) non–accessible contexts, created by modal constructions, attitudinal contexts, negation or disjunction. We aim at capturing these phenomena without making use of an unrestricted accommodation device, in terms of anaphoric reference to context referents, such that semantic restrictions on modal subordination can be stated in terms of constraints on anaphoric binding.

The present Chapter is devoted to develop the fundamentals for an analysis of modality, conditionals and modal subordination that in many respects relies on the work reviewed above, but tries to capture the aspects summarized in (1d–k), which arose from criticism of the previous approaches.

3.1 Contextual dependence of modal operators

There is a broad consensus nowadays that modal (ad)verbs, much like frequency adverbials, are to be given an analysis in terms of generalized quantification (see e.g. Lewis(1975), Partee(1991), von Fintel(1994,1995), etc.). This does not only allow for an analysis of graded modal adverbials such as *probably, likely,* etc. in terms of generalized quantificational structures, but more importantly allows to account for the context dependence and vagueness of modal constructions. As pointed out recently by von Fintel(1995), generalized quantifiers can be taken to anaphorically refer to a contextually given (or reconstructed) variable of an appropriate type, which – in conjunction with an explicit restrictive clause, if any – constitutes the domain of quantification. While von Fintel approaches the contextual dependence of quantificational domains from the viewpoint of the problem of semantic partition (of material ending up in the restrictor and scope parts of adverbially quantified sentences), Beaver(1995) comes to very similar conclusions by investigating the status of so–called "intermediate" accommodation of presuppositions triggered in the nuclear scope of quantified sentences (2). Van der Sandt's theory of presupposition as anaphora (van der Sandt(1992)) predicts (2) to have a (preferred) reading, on which every woman *who owns a Cadillac* and who buys a new car, will sell her Cadillac.

[1] Geurts(1995) takes generalized quantifiers to *presuppose* their domain argument, which in his framework – roughly speaking – comes down to the same. He generalizes this assumption to modal operators, yet his final analysis follows Kratzer's definition of "graded modality", which is not exactly equivalent to a generalized quantification analysis (cf. Geurts(1995:90)).

(2) Every woman who buys a new car sells her Cadillac.

This reading is obtained by intermediate accommodation of the presupposition triggered by *her Cadillac* in the restriction argument. Intermediate accommodation of presuppositions stemming from the nuclear scope thus leads to what is generally known as "domain restriction".

Beaver's main point is that the reading in question is *not* obtained via intermediate accommodation, but in terms of contextual restriction of the domain argument by anaphoric reference to a "discourse topic". Beaver's claim is that in absence of any contextual setting, given the non–plausibility of the local accommodation reading, the interpreter is asked to *accommodate* a suitable context, or topic to provide the quantificational restriction.

> What is going on when people interpret such isolated sentences involves a complex procedure of second–guessing what the *topic* of a hypothetical discourse containing the sentence would have to be. In a sense, people do not accommodate presupposed material so much as accommodate a topic, or, more precisely, accommodate that a certain set of individuals is topical, and that the sentence is about that set. Beaver(1995:5)

In fact, the contrast in (3)[2] shows that the required domain restriction – given the contextual setting of the first sentence – cannot be effected by presupposition accommodation: "if [intermediate] accommodation of presuppositions of the nuclear scope into the restrictive clause existed, we would expect [(3a)] to be just as coherent as [(3b)], contrary to fact." (von Fintel(1995b:3))

(3) a. Not every player on the team is married.
But everyone loves their spouses.

b. Not every player on the team is married.
But everyone who IS married loves their spouses. von Fintel(1995b:3)

The essence of both investigations is that the domain argument of a quantified structure is *anaphoric* to a contextually provided antecedent, which both authors coin as a "discourse topic". We willingly subscribe to this view, and claim – as von Fintel does in his comments – that modal adverbial quantification is characterized by essentially the same phenomenon: anaphoric dependence of the (implicit or explicit) restriction argument upon some contextually salient antecedent context.

This characteristic property of modal adverbs, analyzed as generalized quantifiers, will provide the basis for our unified analysis of (multiple) relative modality and modal subordination. We will even go further and claim that these insights should be generalized to the analysis of attitudinal predicates, which – much like modal (ad)verbs – display graded meanings, relativization to (multiple) contextual backgrounds and subordination effects. An analysis of attitudinal predicates in terms of generalized quantification will not only

[2] We have chosen the example from von Fintel's(1995b) comments on Beaver(1995), which is made up following Beaver's recipe.

account for these properties, but also shed some new light on the connections and interrelatedness of modal and attitudinal expressions.[3]

At various places in Chapter 2 the context dependent nature of modal operators was stressed: most prominent in this respect is the work of Stalnaker and Kratzer. Stalnaker is only concerned with (epistemically based) conditionals and focusses on their inherent dependence on the actual context (set), which determines the selection of (most similar) accessible worlds. For (4a–b), e.g., this guarantees the selection of accessible worlds where Max has in fact just bought a book, such that the pronoun *it* can be bound appropriately.

(4) Max has just bought a new book.

a. If he has enough time tomorrow, he'll read and finish it.

b. If he had had enough time today, he would have read and finished it.

This characteristic of conditional sentences is best to be captured in terms of anaphoric reference of the (explicitly restricted) domain argument of the modal quantifier to a contextual referent, to be associated with the context set up by the first sentence.[4]

Kratzer's insight is the relativization of modal operators (and *if*–conditionals) to various kinds of intensional contexts (to wit deontic, bouletic, epistemic, circumstantial, etc.), which accounts for the meaning of the respective "types" of modality, as e.g. in (5).

(5) a. John's father is ill. We must help him.

b. If John's father is ill, we must help him.

c. You should come to see me more often.

d. Max should be in Paris by now.

e. Max can ride a unicycle.

It directly emerges from Kratzer's work that this can be accounted for once the theory provides appropriate representations for intensional contexts of various kinds, and allows for anaphoric reference to contextual referents which "stand proxy" for such intensional contexts.

We have nothing substantial to add to the important insights of Kratzer's, but simply want to draw attention to some observations that illustrate the close intertwinedness of modality and attitudinal states, which is in fact best captured in terms of anaphoric reference of the modal operator's domain argument to some salient or accommodated context(ual referent), to be determined pragmatically.

[3]Although we will to some extent discuss the strong parallelism between modals and attitude verbs as well as the dependence of modal expressions on attitudinal contexts, we will not provide an analysis of attitude predicates. Approaching this issue is far beyond the scope of this work. The reader is referred to Kamp&Reyle(1996).

[4]In fact, things are not quite so easy, especially for non–epistemic and counterfactual modality (see Sections 4.2 and 4.3).

First, although in many cases – and this holds in particular for examples we find in linguistic discussions – the reference context for modal operators is underspecified, in everyday language the antecedent context relative to which some modal statement is to be interpreted is more or less constrained, either by linguistic means, or via the non–linguistic contextual setting. Where the antecedent context is marked linguistically, we find that it is often conveyed by means of attitudinal predicates. In (6a) the deontic modal verb *must* can be interpreted as *relative to* the desire context that is established by the first sentence,[5] while our preferred reading of (6b) is the one that takes the speaker's (partial) belief state introduced by *know* to provide the domain argument for epistemic *might.* In (6c–d) the relation to attitudinal states is more indirect: the verb *study* in (6c) licenses the implicature that the speaker – to a certain extent – is informed about the content laid down in the studied object. So the second sentence can be interpreted as either being anaphoric to this "extended" or "updated" belief state of the speaker, or else as being directly dependent upon the informational content referred to by *the timetable.*[6] Example (6d) is unambiguous in this respect: here it is the informational content referred to by the phrase *the handbook of medicine* that provides the background context for the modal *can* (the "circumstantial modal base" in Kratzer's terminology). Although at first sight no direct relation to attitudinal states is given here, it is arguable that we may conceive even of wellknown scientific facts as some kind of "shared" common knowledge, a relevant subpart of which is here referred to by *the handbook of medicine.* Anyway, as long as the representation obained for the latter phrase provides a propositional referent that "stands proxy" for the informational content that is conveyed by the denoted object, the circumstantial reading of *can* in (6d) again emerges by anaphoric reference to this propositional referent, to establish the modal's domain argument.

(6) a. Max's mother *wants* to make him an artist. He *must* take piano lessons regularly.

b. I *know* that Clarissa has sold her old car. She *might* have bought a Cadillac this time.

c. I've *studied the timetable.* John *should* be in Paris by now.

d. *The handbook of medicine* is clear about it. No human *can* move his leg if its nervous system is cut.

Alternatively, contextual domains for the interpretation of modals can be provided by complex nominals referring to intensional objects, such as *Grundsatzurteil des Bundesgerichtshofs* in (7a), or adjectival expressions like *wünschenswert* in (7b), which introduces a desire context (namely Sager's). A further example is (7c).

[5]There are, of course, epistemic uses of *must*, but in the example at hand this interpretation would require the use of a progressive (*He must be taking piano lessons regularly*) instead of the bare infinitive. The reason is that there is a strong preference for *must* to be read deontically if it takes an event–type argument, while it is open for both epistemic or deontic interpretation with stative arguments (see also Section 4.1.3). But note that even on an epistemic interpretation of the example there is some indirect dependence upon the desire context introduced by *want*: The desire of Max's mother can be taken as a motive or cause for the supposition that Max is taking lessons regularly.

[6]I do not favour this last alternative, since many other factors still must play a role in the speaker's contention that John has arrived in Paris.

(7) a. DDR–Richter und –Staatsanwälte können *nach einem Grundsatzurteil des Bundesgerichtshofs (BGH)* für die Verfolgung von Republikflüchtigen und zahlreichen Regimekritikern in der Regel nicht bestraft werden. Den DDR–Juristen müsse für eine Verurteilung wegen Rechtsbeugung ein "offensichtlicher schwerer Willkürakt bei der Anwendung des DDR–Rechts" nachzuweisen sein. (StZ:16.10.1995:1)

b. Sager formuliert für sich ein *wünschenswertes* Profil der CDU: sie solle "wirkliche Werte" nicht für Technologie und Wachstum opfern, die Ökologie ebenso fördern wie die Integration der Ausländer, von der Atomenergie Abschied nehmen und für einen modernen Sozialstaat eintreten. (StZ:4.11.1995:2)

c. Nach Angaben der UN müssen die Serben nicht alle schweren Waffen aus der Umgebung von Sarajewo abziehen. *Nach einem in Belgrad unterzeichneten Abkommen* dürfen die Belagerer alle Granatwerfer ab Kaliber 82 Millimeter, Geschütze des Kalibers 100 Millimeter und darunter behalten. (StZ:16.9.1995:1)

A special characteristic of some specific classes of texts – in particular journalistic reporting style – is that the reference context for the domain argument of the modal is not introduced in an "orderly" way, namely as an *antecedent* for the anaphoric domain argument, but is only provided as a kind of afterthought, as in (8). Here the domain argument of the modal operator is "pending", or remains underspecified. The relevant contextual setting, or reference context is only provided by the ongoing discourse. This stylistic effect is not only found with modals, but also with pronominal expressions, as illustrated in (9).

(8) Die einen, zum Beispiel Italiener und Spanier dürfen nicht dabeisein. Die anderen, vor allem Briten und Dänen, wollen nicht dabeisein. Kompliziert wird es bei den Deutschen: Sie dürfen zwar dabeisein, wissen aber nicht, ob sie auch wirklich wollen sollen. Es geht um die Europäische Währungsunion, um das Eurogeld, das Anfang 1999 die D–Mark ersetzen soll. *So haben es die Staats– und Regierungschefs im Februar 1992 in Maastricht beschlossen.* (StZ:4.11.1995:1)

(9) a. Heute hat er nun glücklich und endlich geheiratet. *Michael Schuhmacher* ...

b. 5 Minuten Redezeit, das sei ihm zu wenig. So die Begründung *Helmut Kohls* für sein Fernbleiben bei den UN Feierlichkeiten in New York.[7]

Kratzer already noted that many modal operators by their lexical meaning are relativized to some specific kind of modal context (as e.g. German (indicative) *dürfen*, or English *have to*, which are tied to a deontic reference context). But besides the lexically (or contextually) induced restrictions as to the particular kind of intensional context, under certain conditions we also find rather firm pragmatic restrictions as to the "source" or "bearer" of such an intensional context. These pragmatic restrictions originate from the "syntax of discourse",

[7]In fact, the example is again an illustration of postponed setting of a modal's reference context: here it is the subjunctive *sei*, indicating indirect speech, whose reference context is provided subsequently by the phrase *die Begründung Helmut Kohls.*

or communication, which provides strong implicatures to the effect that, for example in (10a–b) and (11a–b) the reference context for the modal operators *might* and *should* is (preferrably) constrained to the speaker's epistemic state or his conception of what is advisable for the addressee in the particular contextual setting. This is corroborated by the oddity of the (a) examples, which explicitly contradict these implicatures.[8] The (c) examples show that this does only hold for modals occurring in the matrix clause. The (a) examples are instances of "Moore's paradox", discussed in Hintikka(1962) and Gazdar(1979), and which are explained either in terms of conversational maxims, as by Gazdar's reformulation of the Maxim of Quality (ibid:46), or in terms of an "epistemic implication", as done by Hintikka.[9]

(10) a. ??# John might be at home, but I do not think so.

b. John might be at home, but Peter doesn't think so.

c. Max told me that John might be at home, but I don't think so.

(11) a. # You should go to Paris, but in fact, I think this is not advisable.

b. You should go to Paris, even if Peter thinks this is not advisable.

c. Max told me that you should go to Paris, but I think this is not advisable.

But not only are modal expressions closely related to attitudinal predicates in that they often are contextually dependent on attitudinal contexts. Attitudinal predicates display the very same semantic properties we find with modal operators: various quantificational forces, contextual dependence upon more or less specifically constrained "reference contexts", and modal subordination effects.

The attitudinal predicates in (12) can be taken to display various forces: while for (12a) to be true *all* worlds characterizing John's belief state must support that Clarissa is in London, for (12b) we only require that those of John's belief worlds that satisfy the embedded proposition are assigned a high relative probability. (12c) only requires that here be some belief world which satisfies the embedded proposition, and finally (12d) states that there is no belief world that supports the assumption that Clarissa is in London. Thus, the varying "forces" of these attitudinal predicates correspond to the modal forces of the modal (ad)verbs *necessarily, probably, might* and *impossible*, respectively. Similarly the predicates in (13) display varying quantificational forces, and thus differ from (12) only in being contextually dependent not upon John's belief state, but his intentions.

(12) a. John believes that Clarissa is in London.

b. John (strongly) suspects that Clarissa is in London.

---

[8]Relativization of epistemic *might* in (10a) to the speaker's epistemic state is – though the preferred option within a "neutral" context – not the only choice. Some speakers accept a reading for (10a) where, e.g. in a dialogue, *might* is to be interpreted relative to the epistemic state of another participant, made explicit within the discourse, and with whom the speaker does not agree.

[9]This observation is due to Ede Zimmermann.

c. John supposes that Clarissa is in London.

d. John doesn't believe/denies that Clarissa is in London.

(13) a. John intends to buy a piano.

b. John is rather positive about buying a piano.

c. John is indifferent to/ponders whether to buy a piano.

d. John refrains from buying a piano.

(12) and (13) also illustrate that attitudinal predicates differ from modal operators in being much more explicit about the context that the domain argument is dependent on: the reference context is highly restricted by lexical semantics, which clearly indicates an epistemic or a particular kind of intentional background context. Moreover, via the subject argument also the bearer of the attitudinal context in question is determined.

Finally, both modal and attitudinal predicates partake in modal subordination phenomena. Not only is modal or "attitudinal" subordination possible across sequences of epistemically modalized sentences (14), it is possible also across non–epistemically modalized sequences (15), and – pending appropriate restrictions – also across sentences of distinct modal "types" (16) and (17).[10]

(14) a. Patrick might get a cello. He will play it/his cello in a famous orchestra.

b. Patrick suspects that his mother will buy him a cello. He believes that it/his cello will take up a lot of space.

(15) a. Patrick's mother should buy him a cello. He should play it/his cello in a famous orchestra.

b. Patrick wants his mother to buy him a cello. He wants to play it/his cello in a famous orchestra.

(16) a. Suppose that Patrick owns a cello. He should then sell it.

b. Patrick is under the misconception that he owns a cello and he wants to sell his cello. Heim(1992:183)

(17) a. Patrick's mother should buy him a cello, although it/his cello would take up a lot of space.

b. Patrick wants me to buy him a cello, although he believes that his cello is going to take up a lot of space. Heim(1992:201)

At least for epistemic contexts (see (14)) – given an analysis of modal and attitudinal predicates in terms of generalized quantification, as hinted at above – both kinds of modal subordination phenomena can be treated in a uniform way, in terms of anaphoric reference of the domain argument of the subordinated operator to the context set up by the scope of the antecedent (modal or attitudinal) construction. An analysis along these lines will be illustrated for the modal cases in more formal detail in the next Sections. For non–epistemic contexts things will turn out to be more problematic (see our discussion of Kratzer, Roberts and Geurts for non–epistemic modality in Sections 2.2.3 and 2.3.2). We will consider these cases in Chapter 4.

To conclude, modal and attitudinal expressions are closely related (i) in that they both are best understood as denoting generalized quantifiers, the domain argument of which anaphorically depends upon some pragmatically or contextually salient (and to some extent lexically constrained) antecedent context, and (ii) in that modal expressions can be understood as "underspecified", or "neutral" attitudinal predicates, which are dependent upon attitudinal contexts (epistemic, deontic, etc.), the bearer of which can only be determined pragmatically.

These two aspects are best illustrated by the contrasting pairs in (18), where the attitudinal reference contexts (the speaker's desires and beliefs, respectively) are directly specified by the attitude predicates in (18a), while the modal adverbs in (18b) do only constrain their reference context to some deontic/bouletic vs. epistemic context. But once (18b) is understood as a direct utterance, by pragmatic implicature the preferred interpretation is that the speaker is the bearer of these deontic/bouletic and epistemic attitude contexts (see examples (10) and (11) above).

(18) a. I *wish* that Max would go to the cinema more often.
I *believe* that he would enjoy himself, if he only tried.

b. Max *should* go to the cinema more often.
He *would* enjoy himself, if he only tried.

Before we turn to a first sketch of our DRT analysis of (multiple) relative modality, conditionals and modal subordination, it should be mentioned that the analysis of modality in Geurts(1995), which takes modals to *presuppose* their domain, is very similar to the view we just advocated – to conceive of modals as anaphoric in their domain argument – in that he conceives of presuppositions as anaphoric expressions (cf. van der Sandt(1992)).[11]

> *Anaphora*
> A presuppositional expression functions anaphorically whenever it (or more accurately, its semantic correlate) is bound to some discourse entity which is at the focus of attention. Geurts(1995:43)

[10]Examples of type (15b) and to a certain extent also (17b) are problematic on Heim's(1992) analysis of presupposition projection in attitude contexts.

[11]But note that – while he explicitly motivates the presuppositional nature of modal operators by analogy with generalized quantifier structures (Geurts(1995:80)) – modals are *not* treated in terms of generalized quantification. Modal operators are instead analyzed in terms of Kratzer's graded modality (see in particular Geurts(1995:90)).

He assumes that presuppositional expressions (pronouns, etc.) in general function anaphorically, but may on occasion be construed by accommodation. Traditionally, three different functions of pronominals are distinguished, according to different uses in discourse, namely (a) deictic, (b) anaphoric, and (c) bound variable use, as illustrated in (19).

(19) a. Did you see *her* car?

b. Mary owns a car. But she couldn't find *her* car.

c. Everyone who owns a car has to pick up *her* car.

Corresponding to these three types of uses of pronominals we can distinguish three modes of presupposition satisfaction: In the same way that the pronoun *her* in (19a–c) is to be construed as (i) deictic, (ii) anaphoric and (iii) bound, the presupposition triggered by *her car*, that the person referred to by the pronoun owns a car, is satisfied by (i) accommodation or by binding to (ii) a referring or (iii) a bound (state) variable, respectively.

Are there any criteria to distinguish between anaphoric binding (or accommodation) for presupposition satisfaction on the one hand, and anaphoric, bound (or deictic) uses of pronominal expressions on the other? I do not think so, and it will therefore be just a matter of taste if we will couch the potential of contextual dependency we find in modal and attitudinal constructions in terms of *anaphoric dependency* rather than in terms of a theory of *presupposition as anaphora.*

The theory of "presupposition as anaphora" conceives of pronouns – the anaphoric expressions par excellence – as presuppositional expressions which are almost devoid of descriptive content, while other presuppositional expressions, such as the possessive, or verbs such as *manage* or *stop* trigger much more specific semantic presuppositions, to be satisfied by the context. Presuppositional expressions are therefore taken to constitute a continuum of semantically more and more specific expressions which in turn trigger more and more specific semantic presuppositions.

Yet, the very same has been claimed for anaphoric expressions, as e.g. in Partee(1989), who focusses on the diversity of contextually dependent elements, ranging from the "limit case" of pronouns, having essentially no descriptive content of their own, to open classes of contextually dependent elements, which do have lexical descriptive content, as e.g. *local, enemy, arrive, away, ahead, foreign*, etc., and which display the same range of contextual dependencies, namely deictic, anaphoric and bound variable use:

(20) a. An *enemy* is approaching.

b. John faced an *enemy.*

c. Every participant had to confront and defeat an *enemy.* Partee(1989:11)

As can be seen from (21)–(23), the same distinctions arise with modal and attitudinal predicates, if analyzed in terms of generalized quantification and conceived of as anaphoric in their domain argument: in (21a) an epistemic context (preferrably the speaker's) is to be accommodated, which supports the possibility of John still being in London, whereas in (21b) the phrase *as far as I know* explicitly introduces the epistemic context of the speaker, such that the domain argument of *might* is most naturally understood to anaphorically refer to, or to be anaphorically bound to this epistemic context. Finally, in (21c) the domain argument of *might* acts as a bound variable, anaphoric to the epistemic context B_x introduced by *believe(x,* B_x*)* in the scope of the universal quantifier.

(21) a. John might still be in London.

b. As far as I know, John might still be in London.

c. Everyone believes/thinks that John might still be in London.

The same observations hold for non–epistemic modal adverbs, here a deontic use of *must*, which in (22a) requires accommodation of some person's *desire* context D_x, which – depending on pragmatic conditions – may be determined as John's, his trainer's or some other person's desire, while in (22b) by explicit introduction of *his trainer's will*, the domain argument of *must* will be chosen to anaphorically refer to the desire context of the trainer D_t. In (22c) the domain argument of *must* will again be chosen to act as a bound variable, referring to the desire context D_x introduced by the predicate *demand(x,*D_x*)* within the scope of the universal quantification over trainers x. So, for each trainee y of some trainer x the desire context D_x of x will have to satisfy the condition that y will win.

(22) a. John must defeat his competitors.

b. According to his trainer's will, John must defeat his competitors.

c. Each trainer demands that his trainee must win.

As we have motivated above (see (12)–(17)), attitude predicates share important semantic properties with modal operators, as regards varying quantificational forces, their anaphoric potential and subordination properties and therefore, by analogy, may also be analyzed in terms of generalized quantification (see also Partee(1991)). Yet, they differ from modal operators in being much more explicit about the context that the domain argument refers to, in fact they constitute the "overt case", in that they specify, or introduce by themselves an attitudinal context that in turn may constitute the antecedent, or reference context for subsequent modal or attitudinal constructions. The distinction between deictic, anaphoric and bound variable use of their anaphoric domain arguments is therefore more difficult to illustrate. In fact, examples (23b–c) turn out to instantiate "attitudinal subordination" contexts.

Example (23a) illustrates the deictic use of the anaphoric domain argument: given that the context is silent about Clarissa's (entire) belief context, some such context B_c must be accommodated that satisfies the condition that there is some familiar individual named *John*, who lives in London and who has an uncle living at some distance from London. This accommodated context B_c then serves as the antecedent context for the anaphoric domain argument of the universally quantified structure for *believe*, such that the presuppositions triggered by *John*, *leave to visit* and *his uncle* can be satisfied, or bound. In (23b) the first sentence establishes a (partial) belief state B_c of Clarissa's (in the way just described for (23a)), which then is available as an antecedent context for the second belief statement, which is constrained by the lexical semantics and the denotation of the subject argument to anaphorically refer to, or depend on, a belief state of Clarissa's. Again this choice of the reference context for the anaphoric domain argument of the universally quantified structure for *believe* allows for binding of the presuppositions triggered in its scope argument. Finally (23c) is built upon (23b) to illustrate a bound variable use of the anaphoric domain argument of *believe*. Here the *believe*–predicates are embedded within the scope of a universal quantification over individuals x in a certain room, such that for each such individual there is an (accommodated) belief context B_x that satisfies the familiarity condition for *John*, and which provides the reference context for the domain argument for the first *believe* statement. The extended belief context B'_x established by the scope argument of this first quantificational structure for *believe* then serves in turn as the reference context for the domain argument of the quantified structure for the second use of *believe*, and allows for binding of the presuppositons (*leave to visit*, etc.) triggered in its scope.

(23) a. Clarissa believes that John has left London to visit his uncle.

b. Clarissa believes that John lives in London and has an uncle who lives in Paris. She believes that John has left London to visit him.

c. Everyone in this room believes that John lives in London and has an uncle who lives in Paris, and believes that John has left London to visit him.

So it turns out that modal and attitude predicates display the same variety of uses as do pronominals, including cataphoric uses, exemplified in (24), and we also find that modal and attitudinal operators lie at different positions on the scale that indicates the degree of specificity as to their semantic constraints on appropriate antecedents, exactly as we had it for the anaphoric expressions in (19) vs. (20). However, they differ from these latter expressions as to the type of entity they depend on: modal and attitude predicates anaphorically refer to *contexts* instead of individuals.

(24) a. Owners of cars *must* pay higher taxes next year. The government has passed *a new tax law* which will come into force by January 1996.

b. Clarissa *believes* that John has left London to visit his uncle. She *believes that John lives in London, while his uncle lives in Paris.*

Since we tend to conceive of the contextual dependence of modal and attitudinal operators more in terms of anaphoric reference rather than presuppositional binding,[12] the most

[12] One might be tempted to regard the potential for cataphoric use, which modal and attitude predicates share with pronominals, as an indication that they are to be distinguished from presuppositions. After all, the typical cases of presupposition triggers, such as possessives or verbs like *stop*, *manage*, etc. do not seem to allow for such uses: (ia) is rather odd. (ib), by contrast, does not just introduce the presupposed content, but provides more specific information (which of course implies the former). The same holds for (ii).

(i) a. John's car is broken. # He owns a car.

b. John's car is broken. He owns a Cadillac.

natural move in the framework of DRT is to introduce discourse referents standing proxy for contexts (see Kamp(1991), Asher(1986), and also Geurts(1995)). These context(ual) referents, as we shall call them, can then be accessed by the anaphoric domain argument of modal and attitudinal operators in terms of anaphoric binding, a process that is highly constrained by semantic and pragmatic restrictions – which however is a desirable fact.

Something along these lines has already been put forward in Partee(1989), where the representation for (25) involves boldface variables $\mathbf{C}_0$ – $\mathbf{C}_3$ that represent "nested contexts: $\mathbf{C}_0$ the external context of utterance, $\mathbf{C}_1$ the context of the discourse at the point at which [(25)] is evaluated, $\mathbf{C}_2$ the (quantified) context of the restrictor clause, and $\mathbf{C}_3$ (understood as an extension of $\mathbf{C}_2$) the context of the matrix [nuclear scope]." (Partee(1989:16)) The context dependent expression *later* can then be "indexed" to some accessible context, here the context of the restrictor. Such "indexed" context dependent elements are interpreted as "functions from contexts to semantic values or referents" (ibid:18).

(25) Every man who stole a car abandoned it 2 hours later.

$\mathbf{C}_0$

$\mathbf{C}_1$	
$\mathbf{C}_2$ e1 u v man(u) car(v) e_1: steal(u,v)	$\mathbf{C}_3$ e2 2 hours later^{C_2}(e_2) e_2: abandon(u,v)

(ii) a. Fred has stopped smoking. # Before, he had been smoking.

b. Fred has stopped smoking. Before, he had been smoking 20 cigarettes a day.

But before drawing this conclusion, one has again to take into account the varying degrees of content specificition, which distinguishes the presuppositions in (i) and (ii) from the presuppositions triggered by pronominals. The poor lexical content associated with the pronominal in (iii) does not easily allow for accommodation, so the interpretation cannot but be delayed until some suitable referent is introduced by the subsequent discourse, while for the rather specific presuppositions triggered in (i) and (ii) accommodation is much more easy and natural, and therefore is at odds with subsequent assertion of the presupposed content. (This was drawn to my attention by Ede Zimmermann).

(iii) a. Today he finally got married. We're talking about Michael Schuhmacher.

b. Today he finally got married. Michael Schuhmacher's wedding was ...

If under this perspective we consider (iv) and (v), it emerges that a similar contrast exists between cataphoric uses with modal and attitude predicates, for which we argued that they differ wrt. the degree of lexically determined specificity determining the choice of an appropriate "reference context". While for (iv.a) it is rather natural to proceed by stating the "reference context" that provides the domain for epistemic *must* (here Clarissa's communicated beliefs), explicit statement of the "source", or domain that is presupposed by the attitude predicate *believe* in (v.a) is rather odd. Similarly for the intentional predicate *demand* in (vi) (on the assumption that the appropriate antecedent context for *demand* is a belief context).

(iv) a. Fred must still be in New York. At least, this is what Clarissa said yesterday.

b. Fred must still be in New York. Clarissa told me that his negotiations are difficult.

(v) a. Clarissa believes that Fred will leave New York. # Clarissa believes that Fred is in New York.

b. Clarissa believes that Fred will leave New York. She believes that he'll start a new job in SF.

(vi) a. Clarissa demands that Fred come back to Paris. # She believes that Fred is not in Paris.

b. Clarissa demands that Fred come back to Paris. She believes it is better for him to leave SF.

So in sum the differences as regards the ease to engage in cataphoric usage cannot be considered as a criterion to distinguish between presuppositional and (typically) anaphoric expresssions.

Partee's discussion does not aim at a formal account for the introduction of context referents into the DRT language – there are no indications to be found as to the denotation of the newly introduced contextual objects in DRT and the interpretation of these enriched structures in the model, nor is there a hint at modifications of the construction algorithm, in order to get at representations of the form (25). The analysis to be presented below, which will make use of very similar devices, will come up with a formalization of an extended DRT fragment, providing for contextual referents and, with them, an analysis of the different forms of context dependence in modal constructions, as there are: (multiple) relative and graded modality, non–epistemic and counterfactual modality, and cases of "Practical Inference", which will be investigated with regard to their contextual dependence on attitudinal or other intensional contexts as well as their modal subordination characteristic.

It should be noted at this point that in the literature on intensional constructions in DRT various conceptions are around as to the denotation of such intensional, or context referents. While Kamp(1990) is silent about the modeltheoretic denotation of propositional referents, both Kamp&Reyle(1996) and Geurts(1995) define propositional referents to denote sets of world–sequence pairs. By contrast, Asher(1986) and Asher(1993) design a modeltheoretic structure which provides DRSs as denotations for propositional referents, and thus offers a much *richer* denotation for context (referent)s. On the other hand, in the related framework of dynamic semantics in Heim(1992), which investigates the presuppositional properties of (modal and) attitudinal predicates, contexts are given a much *weaker* denotation, namely sets of worlds.

In our analysis we will go along with the somewhat simpler conception offered by DRT and let context referents denote sets of world–sequence pairs. On the basis of this framework we will work out the theory of context dependence in modal constructions, the principal desiderata of which we have briefly sketched at the beginning of this Section.

Only in Chapter 6 will we come to discuss the weaknesses of this proposal, which in last consequence does away with the most pervasive characteristic of DRT, namely its representational character. Even though we will not offer a reformulation of our analysis, to reintroduce the representational notions that build the backbone of DRT, this discussion may be viewed as a plea for the representational component of DRT.

3.2 Modal operators anaphorically refer to contexts – a first sketch

Before we proceed to the formal issues, let us begin with an informal exposition, to give an intuitive idea of the approach. We will then, in Section 3.3, introduce the formal apparatus for our DRT analysis of context dependence in modal constructions. In Section 3.4 we will review some specific phenomena, in particular graded modality in modal subordination contexts, to motivate and illustrate the working of the analysis stated in 3.3. In Section 3.5 we will digress in an examination of disjunction, since previous analyses have resorted to the notion of modal subordination to get hold of a specific kind anaphoric binding into opaque disjunction contexts. We will argue against a modal subordination account for these examples, while motivating an analysis of nonmodal discourse subordination to account for "extended disjunctive contexts". Chapters 4 and 5 will then investigate in more detail the various phenomena which we do not touch, or only briefly discuss in the present Chapter, especially non–epistemic modality, Practical Inference, counterfactuality, as well as conditional vagueness and variability.

3.2.1 Annotated DRSs and the logical form of modally quantified structures

We have been arguing, in the preceding Section, that modal operators are best analyzed as generalized quantifiers which are anaphoric in their domain argument. In order to obtain an appropriate representation of this contextual dependency, the domain argument of modal operators must, for one, be marked as anaphoric, and furthermore, the representation of the discourse context must provide for appropriate discourse referents, such that anaphoric relations can be established to such "antecedent contexts", or "reference contexts" to settle the contextual relativization of modal operators in discourse.[13]

To this end we will extend the DRS language to provide *annotated DRSs*. An annotated DRS $F :: K$ is a pair consisting of a context referent F and a DRS K, where the context referent denotes the (contextually constrained) set of world–sequence pairs that verify K. To shorten reference to such world–sequence pairs, we will call them states. An annotating context referent F can be taken to "stand proxy" for the context denoted by the DRS K it is associated with. As annotated DRSs will appear as subordinate DRSs (see (26)), the annotating contextual referents will – as discourse referents and subject to the standard accessibility conditions – be available for anaphoric binding.

In particular, in (26) the context referent X, standing proxy for a DRS K', is accessible as an antecedent for the anaphoric domain argument of a modally quantified structure, which we have represented in (26) as an additional parameter in the logical form of the generalized quantifier structure: the (anaphoric) context referent X' can then – by anaphoric binding – be resolved to the antecedent context (referent) X, to establish and represent the contextual dependence of this modal construction to the context K' represented by X.

(26)
$$\boxed{\begin{array}{l} \mathrm{X}\ \mathrm{X}'\ \mathrm{G}\ \mathrm{H} \\ \mathrm{X} :: \boxed{K'} \\ \mathrm{X}' = ? \\ \mathrm{G} :: \mathrm{X}' + \boxed{K''} \left\langle \mathrm{Q} \right\rangle \mathrm{H} :: \boxed{K'''} \end{array}}$$

In the logical form (26) – our preliminary representation format for modally quantified structures – the context referent G that annotates the restrictor DRS is defined as the *update* of the anaphoric context referent X' with the DRS K'', the representation of the *if*–clause in conditional modal sentences.[14] This new semantic form for modally quantified structures characterizes the modal quantifier as anaphoric within its restrictor clause, or – in Kratzer's terminology – as *relative to* an antecedent context to serve as its modal base.[15]

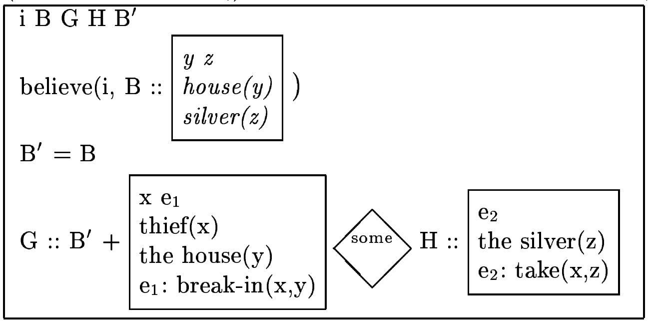
[13]In the following, we will often refer to the antecedent context as a "reference context" to avoid terminological confusion with the antecedent, or *if*–clause of conditional sentences. Also, we will often choose to refer to the conditional's antecedent clause as its "restrictive clause".

[14]The update condition will be defined in the obvious way below. For the moment we delay the discussion of how precisely the semantics of G and H is to be defined. See Section 3.3.

[15]This representation is very similar to the semantic form that von Fintel(1995) associates with overtly restricted frequency adverbials (i) (abstracting away, of course, from the differences due to the particular framework, Kratzer's situation semantics, he is working in). Here, "f is a function from (evaluation) situations to sets of (accessible) situations. It plays a role very similar to Kripke's accessibility relations or Kratzer's conversational backgrounds. Its identity is largely contextually determined." (von Fintel(1995:5)).

Thus, if in (27) we take the epistemic modal *might* to introduce a generalized quantifier structure that is to be interpreted as dependent on the speaker's belief context,[16] here represented by the annotated DRS $B :: K'$, this contextual dependency will be encoded in terms of anaphoric binding: the context referent B' that represents the anaphoric domain argument of the modal quantifier *some* is anaphorically bound to the context referent B that "stands proxy" for the speaker's belief context.[17] The context represented by the referent B' will then be "updated" with the antecedent DRS K'', and the conditional will be verified iff some state in the denotation of G (where G denotes every world–function pair that verifies the update of B' with K'') can be extended such that it also verifies the scope DRS K'''.[18]

(27) (As far as I know,) if a thief breaks into the house, he might take the silver.



(i) $[\![[\delta \text{ when } p \ q]]\!] = \left\{ s : [\![\delta]\!]\langle min(f(s) \cap [\![p]\!]), \left\{ s' : \exists s'' \left(s' \leq s'' \& \ s'' \in [\![q]\!]^{s'/r} \right) \right\} \rangle \right\}$

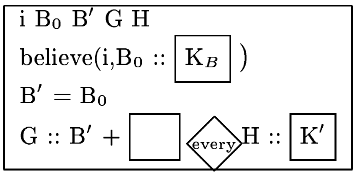
von Fintel(1995:10)

But note that his final analysis in terms of anaphoric dependence upon some contextually supplied set of situations C is only given for non–overtly restricted adverbial quantification (ii): "I will leave aside the issue about what to do with restrictive *when*–clauses now. Somehow, we want to devise a treatment that would intersect the *when*–proposition with the set of accessible situations. But how this can be done is quite a puzzle. See my dissertation and Roberts(1994) for some ideas." (ibid:11,fn)

(ii) $[\![[\delta_C \ q]]\!] = \left\{ s : [\![\delta]\!]\langle min(C(s)), \left\{ s' : \exists s'' \left(s' \leq s'' \& \ s'' \in [\![q]\!]^{s'/r} \right) \right\} \rangle \right\}$ von Fintel(1995:11)

[16]At this point, we use a standard attitudinal predicate *believe*, which takes as arguments an individual reference marker and an annotated DRS to represent the denoted individual's belief state.

[17]Of course, we will not want to assume that $B :: K'$ in (27) conveys the full content of the speaker's belief state. As we argued in the preceding Section, attitudinal predicates can be analyzed, like modal operators, as generalized quantifiers, which are anaphoric in their domain argument. I.e. *believe(i,*$B :: K'$*)* should here be understood as a shorthand for a representation as in (i), where the domain argument is anaphorically dependent on the referent B_0 that is associated with the speaker's (entire) belief state, represented by K_B.

(i)


[18]We have introduced *accommodated* conditions for *the house* and *the silver* into the DRS $B :: K'$ in (27), in response to the familiarity presuppositions triggered in the antecedent and scope of the conditional structure. This is highly provisional, but since we will not go into discussion of presupposition projection and accommodation, we will go along with such simplified representations, where unbound presuppositions are accommodated to what we consider the "highest" possible projection level. See also below, p. 122.

Similarly for non–restricted modals, as in (28), we assume a generalized quantifier structure, anaphoric in its restrictor argument in the same way as is (27), yet with an empty antecedent DRS K''. Here the conditional structure will be verified iff there is some state in the denotation of B', or the "vacuous" update G of B', that can be extended such that it verifies the scope DRS K'''.

(28) (As far as I know,) a thief might break into the house.

i B G H B′
believe(i, B :: [*y* / *house(y)*])
B′ = B
G :: B′ + [ ] ⟨some⟩ H :: [x e / thief(x) / e: break-in(x,y)]

The logical form given in (26) is a direct reconstruction, at the level of the DRS, of Kratzer's notion of "relative modality", appropriate to represent the contextual dependence of modal operators on various attitudinal or intensional "background contexts". It allows not only to directly represent, at the level of the discourse representation structure, epistemic readings of *might*, etc., in a way as roughly sketched above, it also offers a means to represent deontic, or other types of non–epistemic modality, by anaphoric reference to deontic, or other types of intensional "background contexts" that may be directly introduced by the preceding context, or else have to be accommodated.

Yet, two objections must be raised against this approach. First, one may question the particular representation that has been given for (27) and (28) to render an *epistemic* reading of *might*. While the bracketed supplements *as far as I know* may be taken to justify the introduction of the condition *believe(i,B* :: K') to make available a context referent B that stands proxy for the speaker's belief state, this is not so evident for modal sentences where such an explicit qualification is missing. Rather, for such sentences it seems more natural to take the conditional structure to be part of a DRS that by itself represents the belief context of the speaker, as indicated in (29).

But this representation does not allow for appropriate instantiation of the modal's domain argument by anaphoric binding of the context referent X', to render the contextual dependence on the (preceding) epistemic context, and to get anaphoric references right.

(29) believe(i, B :: [
y z G H X′
house(y)
silver(z)
X′ = ?
G :: X′ + [x y′ e_1 / thief(x) / the_house(y′) / y′ = ? / e_1: break-in(x,y)] ⟨some⟩ H :: [e_2 z′ / the_silver(z′) / z′ = ? / e_2: take(x,z′)]
])

The same problem arises for the interpretation of modal operators as "metaphysical" modalities, i.e. as not dependent on a belief state, but rather as dependent on factual information which may be introduced by the preceding context, as in (30). Again it is not possible to anaphorically refer to a context referent that represents the information introduced by the preceding context to establish the domain argument of the modal operator.[19]

(30) There are two people in the room. If one of them leaves the room, there will still be one person in the room.

<table>
<tr><td>Y x G H X′</td></tr>
<tr><td>people(Y) | Y | = 2
room(x)   in(Y,x)
X′ = ?
G :: X′ + <table><tr><td>y</td></tr><tr><td>y ∈ Y   leave(y,r)</td></tr></table> every H :: <table><tr><td>z</td></tr><tr><td>z ∈ Y   in(z,r)</td></tr></table></td></tr>
</table>

Standard DRT analyses of conditionals account for such cases in that the verification conditions define the quantification to range over states that qualify as extensions of those that verify the preceding context, or DRS–conditions (see K&R 1993), or else postulate some set of propositions $m(w)$ to instantiate the modal base (Roberts(1989)). Yet, we have argued at length, in Section 2.3.2, that for a *generalized* account of context dependence in modal constructions the antecedent context to provide the domain argument of the modal quantifier must be accessible at the level of the discourse representation structure. This is indispensible not only to distinguish the meaning of epistemically vs. non–epistemically modalized sentences at the level of the DRS, but also for a unified analysis of *relative modality* and its special instance of *modal subordination.* We therefore opt to stick with the logical form we proposed in (26) and account for these problematic cases by a novel approach to the *representation* of contextual dynamics in DRT.

3.2.2 Representing contextual dynamics in DRT

The main insight of DRT is that the meaning of a sentence cannot be determined in terms of its truth conditions proper, to be computed compositionally from its constituents. In particular *anaphoric* expressions – pronouns, tenses, presuppositional expressions, and finally modal expressions – depend, for their interpretation, on meaningful expressions introduced by (or to be accommodated within) the preceding context. See e.g. Kamp(1981), Partee(1973), van der Sandt(1992).

To capture this *context dependent* view of sentence meaning, each sentence must be interpreted *relative to its preceding context*, or “as an addition to, or ‘update’ of, the context in which it is used” (van Eijck&Kamp(1996:1)).[20] On this *dynamic perspective*, the meaning of a sentence is to be captured in terms of context change conditions rather than in terms of truth conditions proper (see (vE&K 1996:2)).

In Kamp(1981), and Kamp&Reyle(1993) this is achieved in terms of a dynamic view of DRS–construction, where for each new sentence S_i that occurs in a sequence of sentences $S_1 \ldots S_n$, the new discourse referents and DRS–conditions that are determined by the structure and the lexical elements occurring in S_i are (i) added to the DRS representation K_{i-1} constructed for the sequence $S_1 \ldots S_{i-1}$, (ii) the referents and conditions occurring in K_{i-1} are accessible for binding of anaphoric expressions occurring in S_i (subject to

[19]Note that Geurts(1995) is confronted with the very same difficulties, but does not discuss the problem. Although in his analysis the referents x and Y are accessible from within the conditional, the modal quantification is not restricted to the set of worlds that verify the preceding factual context.

[20]Henceforth (vE&K 1996), for short.

structural conditions on accessibility), and finally (iii) the result of updating K_{i-1} with the discourse referents and DRS–conditions introduced for S_i yields a new DRS K_i, which then serves as the context for interpretation of the next sentence S_{i+1}.

The approach taken in Asher(1993) differs slightly from this view in that it does not refer to "stages during the construction process", but defines a notion of *DR–theoretic union.*[21] However, if anaphora resolution is assumed to take place *after* DRS construction and union have been completed, as suggested by Asher(1993:73), this leaves open the semantics of partial DRSs with (still) unresolved anaphoric dependencies.

(vE&K 1996) offer – besides the *static* meaning $[\![D]\!]_M$ of a DRS D[22] – a relational, or *dynamic* semantics for DRSs (31), where the meaning of a DRS is stated as a relation between input and output assignments s and s' from U into M: ${}_s[\![D]\!]_{s'}$.[23]
The relation between the static and dynamic semantics for DRSs is characterized in (32).

(31) **Relational Semantics of pDRSs** (vE&K 1996:21,22; see also footnote 22)
1. ${}_s[\![v]\!]^M_{s'}$ *iff* $s[v]s'$.
2. ${}_s[\![\top]\!]^M_{s'}$ *iff* $s = s'$.
3. ${}_s[\![P(t_1, \ldots, t_n)]\!]^M_{s'}$ *iff* $s = s'$ *and* $\langle V_{M,s}(t_1), \ldots, V_{M,s}(t_n)\rangle \in I(P)$.
4. ${}_s[\![v \doteq t]\!]^M_{s'}$ *iff* $s = s'$ *and* $s(v) = V_{M,s}(t)$.
5. ${}_s[\![\neg D]\!]^M_{s'}$ *iff* $s = s'$ *and for no* s'' *it is the case that* ${}_s[\![D]\!]^M_{s''}$.
6. ${}_s[\![D; D']\!]^M_{s'}$ *iff there is an* s'' with ${}_s[\![D]\!]^M_{s''}$ *and* ${}_{s''}[\![D']\!]^M_{s'}$.

where **pDRSs** $::= v \mid \top \mid Pt_1 \ldots t_n \mid v \doteq t \mid \neg D \mid (D_1; D_2)$.

Truth in relational semantics for pDRSs
D is true in M, given s, notation $M, s \models D$, *iff there is an* s' *with* ${}_s[\![D]\!]^M_{s'}$.

(32) If $D = (X, C)$ then: ${}_s[\![D]\!]^M_{s'}$ iff $s[X]s'$ and s' verifies D in M.[24] (vE&K 1996:18)

[21] DRS–update(K$_1$, K$_2$) = <($U_{K_1} \cup U_{K_2}$), ($Con_{K_1} \cup Con_{K_2}$)> = $K_1 \uplus K_2$ Asher(1993:73)

[22] vE&K(1996) give a reformulation of the standard truth conditions to provide a compositional semantics for DRT along the following lines:

Let $\mathcal{M} = \langle M, I\rangle$ be an appropriate model for DRS D. An assignment s for $\mathcal{M} = \langle M, I\rangle$ is a mapping of the set of reference markers U to elements of M. The term valuation determined by $\mathcal{M}$ and s is the function $V_{\mathcal{M},s}$ defined by $V_{\mathcal{M},s}(t) := I(t)$ if $t \in A$ (A a set of constants) and $V_{\mathcal{M},s}(t) := s(t)$ if $t \in U$. In the following definition we use $s[X]s'$ for: s' agrees with s except possibly on the values of the members of X. vE&K(1996:13)

As values for DRSs in $\mathcal{M}$ we use pairs $\langle X, F\rangle$ consisting of a finite set of reference markers $X \subseteq U$ and a set of functions $F \subseteq M^U$, and as meanings for conditions we use sets of assignments.

Semantics of DRSs
1. $[\![(\{v\}, \emptyset)]\!]_M := (\{v\}, M^U)$.
2. $[\![(\emptyset, \{\top\})]\!]_M := (\emptyset, M^U)$.
3. $[\![(\emptyset, \{P(t_1, \ldots, t_n)\})]\!]_M := (\emptyset, \{f \in M^U \mid \langle V_{M,f}(t_1), \ldots, V_{M,f}(t_n)\rangle \in I(P)\})$.
4. $[\![(\emptyset, v \doteq t)]\!]_M := (\emptyset, \{f \in M^U \mid f(v) = V_{M,f}(t)\})$.
5. $[\![(\emptyset, v \neq t)]\!]_M := (\emptyset, \{f \in M^U \mid f(v) \neq V_{M,f}(t)\})$.
6. $[\![-D]\!]_M := -[\![D]\!]_M$.
7. $[\![D \oplus D']\!]_M := [\![D]\!]_M \oplus [\![D']\!]_M$.

where $\langle X, F\rangle \oplus \langle Y, G\rangle := \langle X \cup Y, F \cap G\rangle$ and $-\langle X, F\rangle := \langle \emptyset, \{g \in M^U \mid \neg\exists f \in F \text{ with } g[X]f\}\rangle$.

Verification and Truth
– *s verifies D in M iff* $[\![D]\!]_M = \langle X, F\rangle$ *and* $\exists s' : s' \in M^U$ *with* $s[X]s'$ *and* $s' \in F$.
– *D is true in M iff* $[\![D]\!]_M = \langle X, F\rangle$ *and* $F \neq \emptyset$. (vE&K 1996:16–18)

[23] See also Kamp&Reyle(1996). The relational semantics in (31) follows the spirit of Heim(1982:Ch.4) and Groenendijk&Stokhof(1991), where context dependent meaning is defined in terms of updates.

Not only does the dynamic definition of truth in (31) account for the *dynamic semantics* of (sentences in) discourse: by extension of the DRS language with the sequencing operator ";" in (31.6) DRS representations now explicitly *represent* the dynamics of discourse.

This is illustrated by way of (33a–b): the two variants differ in the relative order of the sentences that make up this mini–discourse, yet this difference is not rendered by the *standard* DRS representation, stated below, which is an appropriate representation for both of these sequences, and thus assigns them the same meaning. Yet, it is well known that – even for sentences without overt anaphoric expressions – the order in which sentences appear may carry an additional meaning component.[25] Asher(1993), e.g. defines various sorts of discourse relations to hold between DRS constituents β and α, which are order sensitive in that they define an attachment of α to β: "... we take as assumption that we are to attach the second constituent to the first, and that this attachment must proceed by means of some discourse relation. This premise is significant, because the putative attachment of α to β implies some relevance of β to α. We have a general relevance rule to the effect that if α is to be attached to β, it must be so in virtue of some discourse relation." (Asher(1993:273)). Due to this implicit ordering constraint, the theory of rhetorical relations in SDRT is able to account for interpretational differences as in (33a–b), where either the baking of the cake can be understood as an explanation for Mary's smiling in (33a), or else, in (33b), John's baking the cake can be understood as being induced by Mary's smiling (which of course must be supported by further world knowledge in the contextual setup).[26]

(33) a. John baked a cake. Mary smiled.
b. Mary smiled. John baked a cake.

j m x e e′ n
john(j)   mary(m)   cake(x)
e: bake(j,x)   e < n
e′: smile(m)   e′ < n

Also, the standard DRS representations, which do not reflect the dynamics of discourse, do not account for the contrast in (34) if anaphora resolution takes place after DRS construction, as suggested by Asher(1993). In (34b) the discourse referent defined by the indefinite NP *a cake* is accessible for the anaphoric pronoun *it* within the first sentence.

(34) a. John baked a cake. Mary ate it.
b. # Mary ate it. John baked a cake.

This is different in the *dynamic* DRT version defined in (31) – which is enriched by the sequencing operator ";" – in conjunction with the dynamic semantics for DRSs. The representations to be constructed for (34a–b) are displayed in (35a–b), where we see that the anaphoric pronoun in the first DRS D_1 of (35b) cannot be bound: for ${}_s[\![D_1]\!]^M_{s'}$ there will be no appropriate referent in the domain of s to bind the referent x'.

[24] Cf. the definition of verification in footnote 22.

[25] See in particular Partee(1973) for temporal anaphora, and Asher(1993) for rhetorical relations in SDRT.

[26] These interpretational differences go along with the establishment of distinct temporal relations to hold between e and e'. The default assumption is that for (33a) e (partly) precedes e', while for (33b) we assume that e' precedes e. Yet the latter assumption crucially depends on the particular rhetorical relation assumed. This is brought out by the famous example *John fell. Mary pushed him.*

(35) a. John baked a cake. Mary ate it.

$$\begin{array}{|l|}\hline \text{j x e} \\ \text{john(j)} \\ \text{cake(x)} \\ \text{e: bake(j,x)} \\ \hline \end{array} \; ; \; \begin{array}{|l|}\hline \text{m e}' \text{ x}' \\ \text{mary(m)} \\ \text{x}' = \text{x} \\ \text{e}'\text{: eat(m,x}'\text{)} \\ \hline \end{array}$$

b. # Mary ate it. John baked a cake.

$$\# \begin{array}{|l|}\hline \text{m e}' \\ \text{mary(m)} \\ \text{x}' = \text{?} \\ \text{e}'\text{: eat(m,x}'\text{)} \\ \hline \end{array} \; ; \; \begin{array}{|l|}\hline \text{j x e} \\ \text{john(j)} \\ \text{cake(x)} \\ \text{e: bake(j,x)} \\ \hline \end{array}$$

The context dependent, or *dynamic* aspect of meaning that is thus built into the semantics of DRT is able to deal with the aspects of compositionality and the problems illustrated in (33) and (34).[27] Yet, it is still of no help for our problem with (30): the assignments s, s' that are used to "record", or "store" the assignments for discourse referents used in the preceding, or "input" context are not in the object language, and therefore cannot serve as contextual objects to provide the "background context" or modal base for a modal operator.

In the previous Section – at a still informal level – we have introduced the notion of (annotating) *context referents*, standing proxy for contexts, to allow for a representation of context dependence in modal contexts, in terms of *updates* on previously established context referents. A context referent was characterized to denote a set of pairs, consisting of a world w and an embedding function f from a set of discourse referents into U_M. Thus – modulo the intensional framework – there is a direct correspondence between the relational semantics of DRSs in (31) and update conditions defined on context referents, as in (36b) (see below for fuller definition): an update condition $G :: F + K'$ characterizes the "update" of an "input" context (referent) F with the DRS K' to yield the "output" context (referent) G, where $e(G)$ denotes the set of states $\langle w', g\rangle$ for which there is a state $\langle w', f\rangle \in e(F)$ such that $\langle w', f\rangle$ and $\langle w', g\rangle$ constitute correct input and output states in the relational meaning of K': ${}_{\langle w', f\rangle}[\![K']\!]_{\langle w', g\rangle}$.[28] The annotated DRS (36a) is a shorthand for an update condition $F :: \Lambda + K'$, with Λ the "empty" context referent ($e(\Lambda) = W \times \{\lambda\}$, λ the empty function).

(36) a. $\langle w, e\rangle \models_M F :: K'$ iff $e(F) = \{\langle w', f\rangle : {}_{\langle w', \lambda\rangle}[\![K']\!]_{\langle w', f\rangle}\}$, λ the empty function.

b. $\langle w, e\rangle \models_M G :: F + K'$ iff $e(G) = \{\langle w', g\rangle : (\exists\langle w', f\rangle \in e(F))\ {}_{\langle w', f\rangle}[\![K']\!]_{\langle w', g\rangle}\}$.

Instead of using context referents F, annotated DRSs $F :: K'$ and "update conditions" $G :: F + K'$ for "subordinate" contexts only, as suggested above,[29] we will now extend the use of update conditions to explicitly *represent*, or "record" the dynamics of a (main) discourse within the DRS that is to represent its *dynamic* meaning.

This is illustrated for (34) in (37): In (37a) the first sentence S_1 is represented to be

[27] To be concrete, the above argument only goes through if the sequencing operator relates DRSs D that correspond to DRSs constructed for individual sentences S_i in a sequence of sentences. The DRS construction principles must be designed accordingly.

[28] Note that in formulae such as $\forall\langle w', g\rangle \in e(G)\ \exists\langle w', f\rangle \in e(F)$ the parameter w' is bound by $\exists$ and therefore cannot be identified with the parameter w' that is bound by $\forall$. This is only possible if we rewrite the formula as: $\forall w' \forall g \exists f : \langle w', g\rangle \in e(G)\ \& \langle w', f\rangle \in e(F)$. Similarly, in (36b) the world parameters w' cannot be identified, since w' is bound by the $\exists$ quantifier, although this is just what we need. Nevertheless, in order to keep our definitions somewhat more readable, we will only use this more sparse notation, where we assume w' to be bound/identified across the quantifiers.

[29] See also Geurts(1995), where propositional referents p, q and update conditions $q = p + K'$ are only used for "subordinate" contexts.

contextually dependent upon an antecedent context F in terms of the update condition $G :: F + K_1$, where K_1 corresponds to the DRS that is to be constructed for S_1. The second sentence S_2 is in turn characterized to be *contextually dependent* on the antecedent context established by the first sentence, represented by G, in terms of the update condition $H :: G + K_2$, with K_2 the representation of the partial DRS to be constructed for S_2.[30]

Once the accessibility conditions for anaphoric reference are in place (see Section 3.3), it will fall out that in (37b) there is no antecedent available for the referent x' introduced by the anaphoric pronoun *it*, such that the discourse will be judged as semantically odd.

(37) a. John baked a cake. Mary ate it.

$$\boxed{\begin{array}{l} \text{F G H} \\ \text{G :: F + } \boxed{\begin{array}{l} \text{j x e} \\ \text{john(j)} \\ \text{cake(x)} \\ \text{e: bake(j,x)} \end{array}} \\ \text{H :: G + } \boxed{\begin{array}{l} \text{m e}' \text{ x}' \\ \text{mary(m)} \\ \text{x}' = \text{x} \\ \text{e}'\text{: eat(m,x}'\text{)} \end{array}} \end{array}}$$

b. # # Mary ate it. John baked a cake.

$$\boxed{\begin{array}{l} \text{F G H} \\ \text{G :: F + } \boxed{\begin{array}{l} \text{m e}' \\ \text{mary(m)} \\ \text{x}' = ? \\ \text{e}'\text{: eat(m,x}'\text{)} \end{array}} \\ \text{H :: G + } \boxed{\begin{array}{l} \text{j x e} \\ \text{john(j)} \\ \text{cake(x)} \\ \text{e: bake(j,x)} \end{array}} \end{array}}$$

While for contextual dependence in modal constructions we suggested a representation where the domain argument of the modal quantifier is characterized as *anaphorically bound* to an accessible context referent, in the representation (37) we assume the update condition $X_i :: X_{i-1} + K_i$ that is to be constructed for a sentence S_i to be *locally bound* to the annotating discourse referent X_{i-1} established by (the update condition constructed for) the preceding sentence S_{i-1}.[31]

In general then, for each sentence S_i in a sequence of sentences $S_1 \ldots S_n$, where X_{i-1} is the annotating referent of the update condition generated for sentence S_{i-1} and K_i is the DRS to be constructed for S_i, we define a new update condition $X_i :: X_{i-1} + K_i$ for S_i, which yields the new "output" context X_i.

---

[30]A presumably more appropriate representation of (37a–b) is given in (ia–b), where the (familiarity) presuppositions triggered by the proper names *John* and *Mary* are "projected" to the "initial" context referent F, where they induce accommodation of the corresponding discourse referents and conditions. In the following, we will generally adopt this convention. See also p. 122.

(i) a. John baked a cake. Mary ate it.

$$\boxed{\begin{array}{l} \text{F G H} \\ \text{F :: } \boxed{\begin{array}{l} j\ m \\ john(j) \\ mary(m) \end{array}} \\ \text{G :: F + } \boxed{\begin{array}{l} \text{x e} \\ \text{cake(x)} \\ \text{e: bake(j,x)} \end{array}} \\ \text{H :: G + } \boxed{\begin{array}{l} \text{e}' \text{ x}' \\ \text{x}' = \text{x} \\ \text{e}'\text{: eat(m,x}'\text{)} \end{array}} \end{array}}$$

b. # # Mary ate it. John baked a cake.

$$\boxed{\begin{array}{l} \text{F G H} \\ \text{F :: } \boxed{\begin{array}{l} j\ m \\ john(j) \\ mary(m) \end{array}} \\ \text{G :: F + } \boxed{\begin{array}{l} \text{e}' \\ \text{x}' = ? \\ \text{e}'\text{: eat(m,x}'\text{)} \end{array}} \\ \text{H :: G + } \boxed{\begin{array}{l} \text{x e} \\ \text{cake(x)} \\ \text{e: bake(j,x)} \end{array}} \end{array}}$$

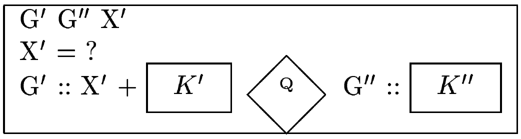
[31]But see Section 3.5 for anaphoric binding of "input" context referents in disjunctive contexts of "modal splitting".

3.2.3 Relative modality

In the previous Section we have – still informally – sketched an extension of the standard DRT representation format for dynamically extended discourses. Not only do these structures explicitly *represent* the dynamics of a continuously evolving discourse in terms of update conditions, marking each new piece of discourse as *contextually dependent* on the previously established context; moreover, this new representation format *makes accessible* these successive "stages" of the continuously extended discourse in terms of context referents, which are available (i) for *local binding* to establish update conditions for new incoming sentences in the way just outlined[32] – or else (ii) for *anaphoric binding* to establish the "reference context" for modally quantified structures.

Given this new representation format, it is possible to maintain (26), restated as (38), as the *general, invariable* logical form of modal operators. Fully in the spirit of Kratzer's conception of "relative modality" this logical form characterizes modal operators to *anaphorically refer to* or *presuppose* an antecedent context, which may be of different "kinds" (factual, epistemic, deontic, etc.) depending on pragmatic, contextual factors, and in part on the lexical semantics of modal operators. As mentioned in Section 3.1 these antecedent contexts may be overtly introduced by the preceding discourse,[33] or else must be accommodated.

(38)



In particular, our new representation format for *dynamic discourses* solves the problem of how to couch sentences involving *factual* and *epistemic* modality into the logical form (38) in case the relevant antecedent context is introduced by the directly *preceding* context.

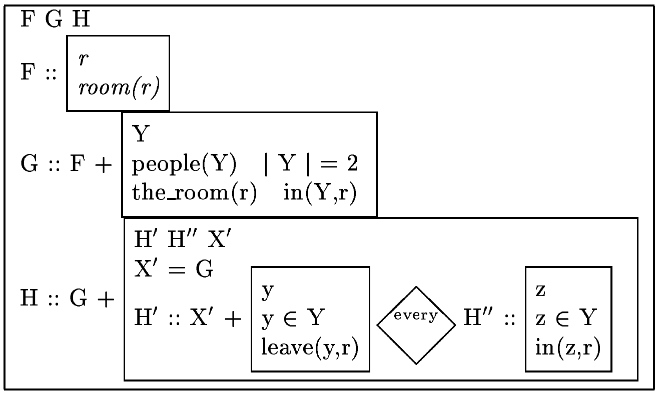
In (39) the conditional is to be understood as being "relative" to the *factual* context introduced by the previous discourse. Notably, the expressions that appear in the conditional sentence trigger presuppositions that are satisfied by the preceding context. The DRS for this sentence characterizes the import of the two sentences in terms of successive update conditions $G :: F + K_1$ and $H :: G + K_2$, such that the context referent G – standing proxy for the context introduced by the first sentence – can serve as the antecedent context referent for the contextual referent X', the anaphoric domain argument or modal base of the (implicitly) universally quantified conditional.[34]

(39) There are two people in the room. If one of them leaves the room, there will still be one person in the room.

[32] Local binding must be hard-wired in the syntax–semantics interface, roughly as a principle of "local binding", relative to a "syntax of texts" (see also p.122).

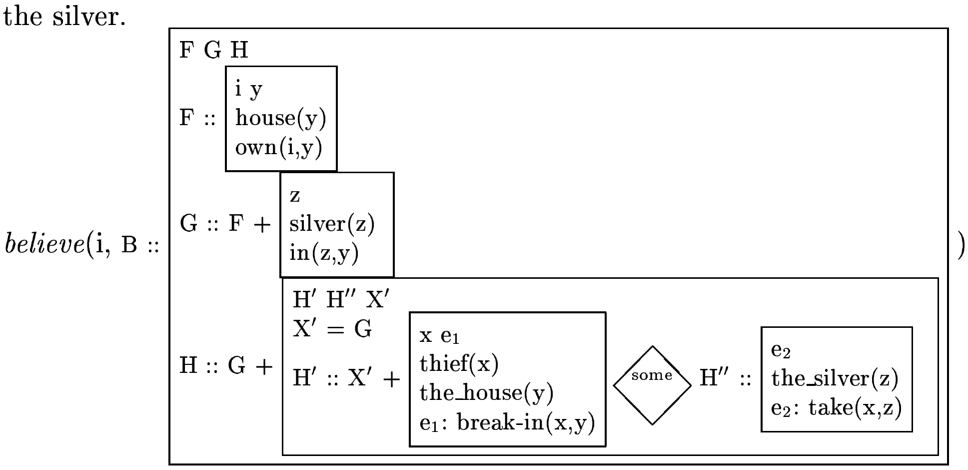
[33] In fact, also by the following discourse, in contexts of cataphoric use. See examples (8) and (24) of Section 3.1.

[34] The DRS in (39) lacks temporal conditions and therefore is inconsistent. The reader may complete the missing details.



In (40) the discourse introduces information that (partially) characterizes the belief context of the speaker. The modal *might* is most naturally understood to be interpreted as relative to, or contextually dependent on the epistemic context of the speaker. If we choose to represent the content of the utterance as establishing an annotated DRS $B :: K_B$, which itself figures as a complement to the predicate *believe(i,* $B :: K_B$*)*, to represent the utterance as an assertion of what i believes,[35] the epistemic modal *might* can be represented as contextually dependent on the preceding *epistemic* antecedent context in the same way as in (39), where we assumed the antecedent context to be factual.[36] Again, the context referent G that represents the antecedent context does not only establish the informational content for evaluation of the conditional, but also serves to satisfy the presuppositions triggered by linguistic material within the conditional's antecedent and consequent clause.[37]

(40) I own a house. There's silver in it. If a thief breaks into the house, he might take the silver.



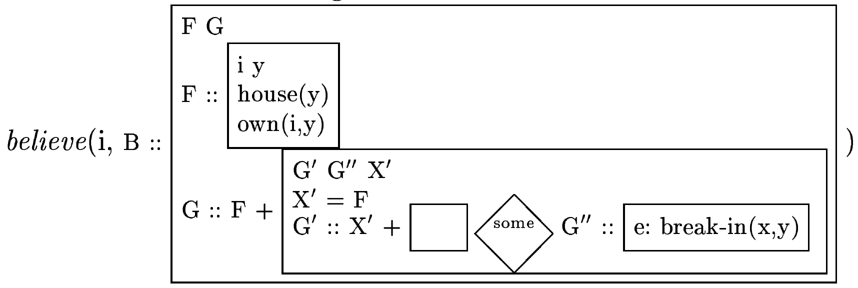
[35]See Kamp&Reyle(1996) for an account of speech acts in DRT. See also Eberle(1995).

[36]One might well argue that *any* assertion is to be characterized as epistemic (assuming Gricean Maxims of communication), i.e. as being based on some person's (or some social or scientific communities) belief state (see Mudersbach(1984)). In examples like (39) this is not so striking as e.g. in (40) and (41), where for one we have the modal *might* that strongly invites for an epistemic reading, and where the utterance is characterized by the first person pronoun as an assertion of the speaker, who – following Gricean Maximes – is assumed to state something he or she believes to be true.

[37]Although we will not discuss presupposition binding and accommodation in any detail, we assume throughout that "presuppositions as anaphora" (see van der Sandt(1992)) can be bound to *accessible* antecedents – accessibility to be defined in Section 3.3 – while we adopt the convention that *accommodation* of unbound presuppositions takes place, if possible, in the annotated DRS $F :: K$ the discourse starts out with. Accommodated conditions will be marked by use of italics.

The analysis of non–restricted modals, as in (41), is fully analogous to the restricted, conditional structure in (40), except for the fact that the antecedent DRS of the quantified structure is empty. Still, also these non–restricted modals depend, for their interpretation, on a given, or accommodated antecedent context, here the preceding epistemic context F.

(41) I own a house. A thief might break in.



So it turns out that our reconstruction of Kratzer's analysis of relative modality – together with a revised representation format for dynamically evolving discourses – will be able to account for the interpretation of a modal operator as being based on a *factual* antecedent context, as well as being dependent on *epistemic* antecedent contexts.

For the latter (conditional) cases this analysis will make explicit what is known as the "Ramsey rule" for the interpretation of conditionals.[38]

> [...] first, add the antecedent (hypothetically) to your stock of beliefs; second, make whatever adjustments are required to maintain consistency (without modifying the hypothetical belief in the antecedent); finally, consider whether or not the consequent is then true. Stalnaker(1968:44)

Yet, given the much broader perspective on the contextual dependence of modal operators that emerges from Kratzer's theory, it will carry over to cases like (42a–b), where the epistemic context to provide the modal base is *not* the speaker's belief state, but is introduced by way of an adverbial expression (42a), or else is established by the embedding *believe* predicate (42b). See Section 4.1 for more extensive discussion of these various kinds of "relative modality", including the analysis of modal expressions that are to be interpreted as contextually dependent on, or relative to, non–epistemic background contexts (such as *must, may, can*, etc.) (42c–d). We will then – yet only briefly – address the question of DRS–construction principles for these and further types of modal sentences.

(42) a. According to Claire, Peter might still be in Paris (yet I believe he's already back).

b. Claire believes that Peter might still be in Paris (yet I believe he's already back).

c. According to German law, if Max drives a car, he must pay taxes.

d. Max may take the dog for a walk.

[38] Modulo the second step, which is concerned with counterfactuality (see below, and especially Section 4.3.1).

3.2.4 Relative modality and modal subordination

One of our objectives is to devise a unified analysis of relative modality and modal subordination (see (1).i). We have already noted, in Section 2.3.2, that modal subordination is subject to rather severe restrictions, which are closely related to the notions of relative (and graded) modality, or modal base and ordering source, and which could not (or not fully) be accounted for by the analysis of Roberts(1989) and Geurts(1995).

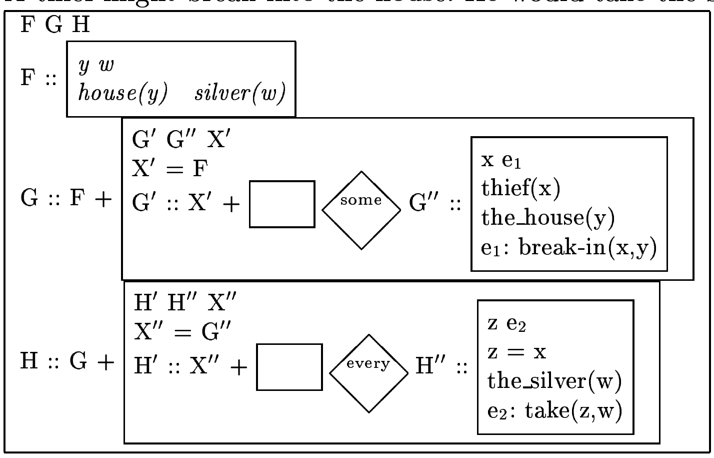
Also, as (43) is intended to illustrate, modal subordination is just a special kind of relative modality: while in (43a) the antecedent context for the modal base of *might* is not given by linguistic means, and is thus accommodated as a factual background context (which we indicate by use of italics), in (43b) the antecedent context for the modally subordinated sentence is overtly introduced by the scope argument of the first, *modalized* sentence (which in turn is to be interpreted as relative to some implicitly given background context).

(43) a. *Clarissa is nominated for the first race.* Clarissa might win the first race.

b. Suppose Clarissa were nominated for the first race. She would certainly win.

Thus, the analysis of relative modality, which represents a modally quantified structure as being anaphoric within its restrictor argument to a (pragmatically salient) accessible context referent, can be straightforwardly extended to the analysis of modal subordination, as displayed for the classical example (44), with non–restricted modal sentences. Here we take the second modal to be anaphorically dependent upon the (hypothetical) context set up by the scope argument of the preceding, modally quantified sentence. Formally this is represented by anaphoric binding of the referent X'' to the context referent G'' that annotates the nuclear scope of the antecedent modal construction.

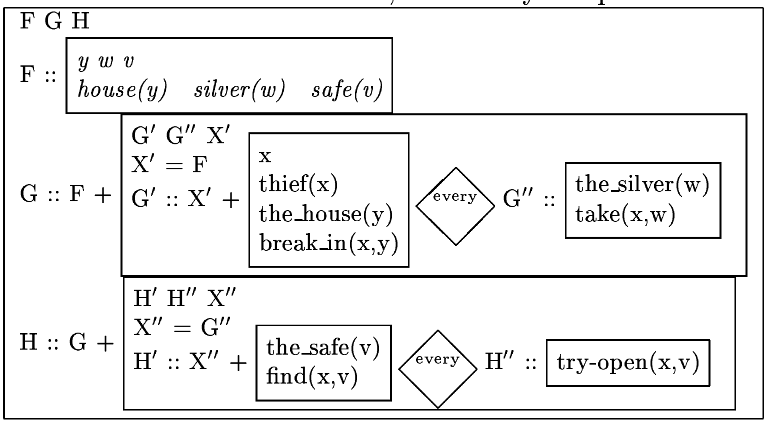
(44) A thief might break into the house. He would take the silver.



But of course this representation will only capture the meaning of (44) correctly if the context referent G'' that annotates the scope DRS K'' of the first quantifier is defined to denote the *update* of G' with K'' (where G' itself is to be defined as the (here vacuous) update of X' with the antecedent DRS K'). I.e. the domain argument of the second modal quantifier must in fact be anaphoric to a context where a thief breaks into the house, for which it states that such a context necessarily evolves to one where the thief will take the silver. This will be ensured by the definition of annotated DRSs in Section 3.3.

This analysis of modal subordination extends straightforwardly to examples with overtly restricted *if*–conditionals:

(45) If a thief breaks into the house, he will take the silver.
If in addition he finds the safe, he will try to open it.



Several aspects will have to be addressed in order to defend this sketch of an analysis for relative modality and modal subordination.

First of all, as briefly noted at the end of Section 3.1, everything hinges on the question whether the denotation of a context referent, a set of states, i.e. world–sequence pairs, provides a rich enough structure to convey the meaning of the DRS K that this context referent annotates. Only if this condition is fulfilled, an analysis of relative modality and modal subordination where context dependence is mediated via anaphoric reference to context referents will have a chance of being adequate and successful. Referring to the discussion in Kamp(1996) we will put this aspect aside, almost throughout this dissertation, and will address the issue only in our concluding remarks ("Summary and Conclusions").

Secondly, as noted above, the verification conditions for modally quantified conditions must ensure that the context referent G'' that annotates the scope DRS qualifies as the *update* of the annotating referent G' (representing the restrictor argument, itself an update of the modal base X' with the antecedent K') with the scope DRS K''. This contextual dependence within the duplex condition can either be defined implicitly in the verification conditions, thus "hidden" syntactically, or else can be represented explicitly by a slightly revised logical form for modal operators: $G' :: X' + K' \diamond G'' :: G' + K''$ (see Section 3.3).

Thirdly, on the assumption that the denotation of context referents is a sufficiently rich concept to convey, or "carry" the meaning of a DRS, one could take the analysis just sketched to be largely equivalent to the accommodation account of modal subordination in Roberts(1989). Yet, while Roberts' accommodation device is fairly unrestricted – material to be accommodated into the restrictor argument of a modal operator can in principle be taken from any, even from (sub)parts of a DRS, and it is not obvious how and under which conditions the mechanism should be "triggered" – the analysis that we advocate is much more constrained.[39] For what may be conceived of as an "indirect" accommodation mechanism is dependent on an anaphoric relationship, which can only be established, or "triggered" by the anaphoric domain argument of a modally quantified structure. Moreover, anaphoric binding is subject to DRT's structural accessibility conditions. Finally, while it was not obvious how in Roberts' framework we could state semantic restrictions to guide the accommodation mechanism, this will be possible in our analysis (see Section 3.4).

Fourth, and relatedly, it is immediately obvious that – not only for the analysis of relative modality and modal subordination along the lines sketched above – but also for our new representation format for dynamic contexts, we have to revise the standard accessibility conditions for anaphoric reference, which in the traditional set–up are defined in terms of the hierarchical structure of DRSs. The standard accessiblity conditions preclude anaphoric binding of, e.g., z to x, and of y in (44).

This revision can be obtained in two ways. Given that annotating context referents denote sets of world–sequence pairs – to wit, those (contextually determined) world–sequence pairs that verify the DRS they annotate –, accessibility can be defined in *semantic terms*: by making use of the denotation of the context referent that annotates the local DRS which contains the anaphoric referent to be bound. In (46) we give a tentative definition along these lines, where we define a referent y to be accessible for a referent x that occurs in a DRS K' annotated by a referent G iff y is in the domain of the function g in every state $\langle w', g\rangle$ that is in the denotation of G.

(46) Given a DRS K' annotated by G, a discourse referent y is *accessible* for a discourse referent x occurring in K' iff $y \in dom(g)$ for all $\langle w', g\rangle$ in the denotation of G.

The second option is to extend the structural, or *syntactic* definition of subordination $\geq$, holding between DRSs K' and K'' (with $K' \geq K''$ to be read as: K'' is subordinate to K')[40] to yield the correct results for our new representation format, as well as for relative modality and modally subordinated sentences: $\geq$ is to be defined as the smallest relation that (besides the conditions in Kamp&Reyle(1993)) satisfies the conditions in (47).[41] [42] Accessibility is then, as usual, defined such that a discourse referent $y \in U_{K'}$ is *accessible*, within a DRS K where $K \geq K'$, for a discourse referent x occurring in a DRS K'' iff $K' \geq K''$.[43]

(47) For K_0 a DRS, $\geq$ is the smallest relation that satisfies the following conditions:

a. if $G :: F + K''$ in Con_{K_1}, and $F :: X + K'$ or $F :: K'$ in Con_{K_1}, for $K_0 \geq K_1$, then $K' \geq K''$ and $K_1 \geq K'$ and $K_1 \geq K''$;

b. if $G :: F + K'' \diamond H :: K'''$ in Con_{K_1}, for $K_0 \geq K_1$, then $K'' \geq K'''$, $K_1 \geq K''$ and $K_1 \geq K'''$;

c. if $\neg[G :: F + K'']$ in Con_{K_1}, for $K_0 \geq K_1$, then $K_1 \geq K''$;

d. $K' \geq K'$, and if $K' \geq K''$ and $K'' \geq K'''$ then $K' \geq K'''$.

[39] This point has also been made in Geurts(1995), who also defends the anaphoric, or presuppositional account of modal subordination.

[40] See Kamp&Reyle(1993:154,155); Asher(1993:76).

[41] This definition is still provisional and in need of several amendments and restrictions (see Section 3.3).

[43] The semantic condition (46) may be viewed as a necessary precondition for the correctness of the syntactic accessibility conditions in (47). We will come back to this aspect in Section 3.3.

The revised definition of accessibility also affects the accessibility of context referents, which are not only used as annotating "labels" for DRSs,[44] but – as discourse referents – are introduced into the universe of the DRS in which the annotated DRS appears as a condition, such that they are subject to the accessibility constraints for anaphoric binding.

Finally, one further aspect has to be considered for the analysis we want to pursue. We have chosen to represent the concept of *contextual dependence* in terms of anaphoric reference to context referents, and we have seen that this construal applies to different kinds of constructions that are inherently context dependent:

(a) Individual sentences S_i within a sequence of sentences $S_1 \dots S_n$ forming a discourse are characterized as context dependent by repeated *update* of the context referent X_{i-1} (established by the previous update condition, generated for sentence S_{i-1}), to yield a new context referent X_i in terms of the update condition $X_i :: X_{i-1} + K_i$. I.e. the "input" argument for the update condition of the current sentence S_i must be instantiated by the referent X_{i-1} representing the previous discourse. This instantiation can only be understood as a degenerate concept of anaphoric binding, in that it is essentially *local* binding.[45]

(b) The representation of the context dependent nature of modal operators differs from these former constructions in that their context dependent nature is not represented in terms of "local binding" of a context referent, but in terms of *anaphoric* binding.

Yet, while we have chosen a unified representation format (38) for modal operators, anaphoric binding of the domain argument can be obtained in a variety of ways: (i) binding to a context referent established within the modalized sentence (see (42a), (42c)), or by an attitude predicate (42b), (ii) anaphoric binding to a context referent established by the directly preceding discourse (39)–(41) or by more "distant" linguistic expressions, as in examples (5)–(7) of Section 3.1, or else in the classical modal subordination cases (44)/(45). (iii) And finally in a large class of examples there is no overtly expressed "reference context" available for anaphoric binding, such that an appropriate "reference context" must be accommodated, subject to pragmatic conditions and potential constraints imposed by the lexical semantics of the modal expression.

This variety of ways to establish the antecedent context for the modal's anaphoric domain argument again reminds us the different uses of anaphoric pronominals in discourse: (iii) deictic, (ii) referring, and (i) bound variable use, which we discussed in Section 3.1.

3.2.5 Accessing opaque contexts

The analysis will also account for problematic cases of modal subordination relative to apparently opaque contexts. As an illustrative example we use Geurts' (48) (Geurts(1995:95)), which could not be given a satisfactory analysis in his framework.[46]

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[43] Condition (47b) will be superflous if we decide to explicitly represent the internal contextual dynamics in quantified structures in terms of an update condition $H :: G + K'''$. $K'' \geq K'''$ is then defined by (47a).

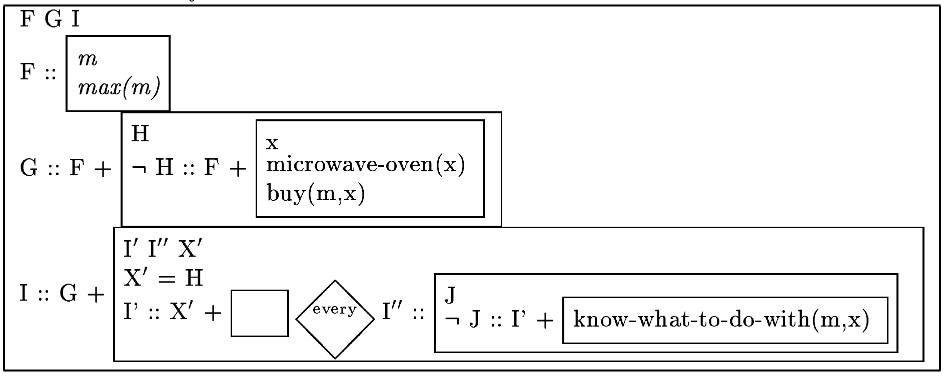
[44] In Reyle(1995) annotating labels of UDRSs are defined to denote sets of embedding functions, but are not used as discourse referents. But see his analysis of dependent readings of plurals, which makes use of anaphoric reference to the label of a verb in the preceding discourse to ensure a parallel interpretation in case of dependent plural arguments.

[45] We will see, in Section 3.5, that our new discourse representation format extends to disjunctive sentences, where (local) binding of context referents can be somewhat more flexible, allowing for modal subordination effects (subject to a notion of parallelism), namely "modal splitting" (see Landman(1986)).

[46] See Section 2.3.2, page p. 76.

In our framework of annotated DRSs sentential negation will be defined to introduce a DRS condition $\neg H :: F + K'$, i.e. we introduce, within the scope of the negation operator, an update condition $H :: F + K'$, where H denotes the set of states (world–function pairs) that verify K' relative to context F in the model M. In (48) these will only consist of states $\langle w', h \rangle$ where w' does not figure in the set of states denoted by G, which represents the actual main context. Given that H will figure in the universe of the DRS annotated by G, the counterfactual modal *would* can in fact anaphorically refer to this context referent H, to constitute its modal base X'. Since the referent x is defined in K' of $H :: F + K'$, and X' is anaphoric to H, the pronoun *it* within the nuclear scope DRS $I'' :: K'''$ can in turn be anaphorically bound to x (see (46) and Sections 3.3 and 3.4 for more detail).

(48) Max didn't buy a microwave oven. He wouldn't know what to do with it.



Modal subordination relative to contexts introduced within the scope of attitude predicates, as in (49), can then be accounted for in a similar way, by use of annotated DRSs to represent the attitudinal DRS in attitude predicates like e.g. *consider.*

(49) I have considered buying a microwave oven, but frankly I wouldn't know what to do with it. Geurts(1995:95)

In both (48) and (49) the use of *annotated* DRSs makes available discourse referents that are otherwise not accessible for anaphoric binding. These referents do *only* get accessible, in an indirect manner, by anaphoric reference of a modal's domain argument to the (annotating) context referent that identifies such a non–accessible context.

It should be kept in mind, however, that even though (standardly) non–accessible discourse referents are now available for anaphoric binding, the analysis is by no means unrestricted: As we argued above, *anaphoric* relations to context referents are restricted to domain arguments of (modally) quantified structures. Thus, the analysis guarantees that discourse referents in standardly non–accessible contexts are not available for anaphoric binding without further ado.[47] Also, given that such anaphoric relations are only mediated by the context dependent, anaphoric nature of modal quantifiers it will be possible to

[47]In this respect our analysis differs from accounts such as Fernando(1993), where quantification is made externally dynamic such that the referents introduced in implicative or quantificational structures "survive", and therefore are uniformly available for anaphoric reference in subsequent discourse. As can be seen from (ic–d) and (iia–c), such readings are not generally available. It seems to be quite difficult to constrain anaphoric dependencies in this kind of analysis. Yet, in Section 3.4 we briefly discuss an externally dynamic

impose semantic and/or pragmatic restrictions for appropriate antecedent referents for (at least a subset of) modal (ad)verbs (see in particular Section 3.4). This will considerably constrain anaphoric binding into standardly non–accessible contexts.

3.2.6 Counterfactuality and vagueness

Finally, our analysis of "multiple relative modality" will have to account for the problem of counterfactuality – or more generally the problem of inconsistent modal bases – and the problem of vagueness and variability of (indicative and counterfactual) conditionals. These problems will be discussed in Sections 4.2, 4.3 and in Chapter 5.

While in (48) the negated sentence introduces a context referent that denotes counterfactual worlds (or states, to be precise) and therefore establishes an appropriate antecedent context for the anaphoric domain argument of the counterfactual modal operator, this is not so in the general case: counterfactual conditionals may be asserted without such an explicit counterfactual antecedent context. For these cases the analysis must provide a means to establish an "adjusted" modal base that is appropriate for the evaluation of a counterfactual conditional, as suggested by the "Ramsey rule" (see above p. 102). The determination of such a revised, or reduced modal base will lead us directly to the problems of vagueness and conditional variability.

The problem of inconsistent modal bases also arises with non–epistemic modality (recall the Samaritan Paradox and Practical Inference). This will be discussed in Section 4.2.

3.3 Annotated DRSs and the representation of contextual dynamics

Having presented the motivations for and a rough outline of a "generalized" analysis of context dependence in modal constructions in DRT, we now turn to the formal details.

We will first, in (50), characterize an intensional model $\mathcal{M}$ for the interpretation of (ordinary) intensional DRSs, following Kamp&Reyle(1996), and then introduce the requisite concepts for a representation of contextual dynamics in DRT along the lines sketched above.

3.3.1 Truth conditions for intensional DRSs

(50) defines an intensional model $\mathcal{M}$, consisting of a set W of worlds, interpretation functions $U_{w,M}$, $Name_M$ and $Pred_{w,M}$, and a generalized quantifier relation $Quant_M$:[48] We also state a *normalcy* selection function $*$, which will be needed for the interpretation of modally quantified structures, but which we will not discuss in detail at this point.

analysis for *context* referents only.

(i) a. If a farmer owns a donkey, he beats it. It will kick back.
b. If a farmer owns a donkey, he beats it. It might kick back.
c. ?? If a farmer owns a donkey, he beats it. It kicks back.
d. # If a farmer owns a donkey, he beats it. It would kick back.

(ii) a. # If a farmer owned a donkey, he would beat it. It will kick back.
b. ? If a farmer owned a donkey, he would beat it. It might kick back.
c. # If a farmer owned a donkey, he would beat it. It kicks back.
d. If a farmer owned a donkey, he would beat it. It would kick back.

[48] See Kamp&Reyle(1993,1996). For the moment we fully disregard the temporal dimension of meaning. See however Section 5.1.4.

(50) $\mathcal{M} = \langle W, U_{w,M}, Name_M, Pred_{w,M}, Quant_M, * \rangle$

W: a nonempty set of possible worlds w.

$U_{w,M}$*:* a function from $w \in W$ to individuals in $\mathcal{M}$, with $U_M(w) = U_M(w')$ for all $w, w' \in W$.

$Name_M$*:* a function from names of DRL to individuals in $\mathcal{M}$.

$Pred_{w,M}$*:* a function from predicates P^n of DRL and worlds $w \in W$ to n–tuples over elements in $U_M(w)$.

$Quant_M$*:* a function mapping quantifiers Q of DRL to sets of pairs, such that:

$Quant_M(\text{every}) = \{ \langle A, B \rangle : A \subseteq A \cap B \}$
$Quant_M(\text{some}) = \{ \langle A, B \rangle : A \cap B \neq \emptyset \}$
$Quant_M(\text{most}) = \{ \langle A, B \rangle : \mid A \cap B \mid > \mid A \backslash B \mid \}$.

***:** A *normalcy selection function* which maps a world w and a set of world–function pairs $\mathbf{G}$, intuitively a context, into a set of worlds where *everything holds that, relative to w, is normally the case in a context* $\mathbf{G}$ (see below and Section 5.2.4).

The verification conditions for (a fragment of)[49] the *standard* DRT language DRL (51) in an intensional model (50) are as stated in (52) (cf. Kamp&Reyle(1993)).

(51) DRS Conditions in *standard* DRL:

a. $\text{pred}(x_1, \ldots, x_n)$ — $x_1 \ldots x_n$ discourse referents

b. $x_1 = x_2$ — x_1, x_2 individual or plural discourse referents

...

d. $\boxed{K'} \; \overset{Q}{\underset{dr}{\Diamond}} \; \boxed{K''}$ — *dr* a discourse referent, K', K'' DRSs

e. $\neg \boxed{K'}$ — K' a DRS

Verification of a DRS $K = \langle U_K, Con_K \rangle$ according to DRL is defined in (52) relative to a pair $\langle w, f \rangle$, f an embedding function into the model $\mathcal{M}$ of (50), with f: $U_K \rightarrow \cup_{w \in W} U_{w,M}$. The static and relational truth of a DRS K is now evaluated relative to *states* $\langle w, f \rangle$.[50]

(52) $\langle w, f \rangle \models_M K$ iff $\exists g : f \subseteq_{U_K} g \;\&\; \forall \gamma \in \text{Con}_K : \langle w, g \rangle \models_M \gamma$.

a. $\langle w, f \rangle \models_M \text{pred}(x_1, \ldots, x_n)$ iff $\langle f(x_1), \ldots f(x_n) \rangle \in \text{Pred}_{w,M}(\text{pred})$.

b. $\langle w, f \rangle \models_M x_1 = x_2$ iff $f(x_1) = f(x_2)$.

...

d. $\langle w, f \rangle \models_M \boxed{K'} \; \overset{Q}{\underset{dr}{\Diamond}} \; \boxed{K''}$ iff $\langle A, B \rangle \in Quant_M(\text{Q})$, where

$A = \{ b : b \in U_{w,M} \;\&\; (\exists g)(f \cup \{\langle dr, b \rangle\} \subseteq_{U_{K'} - \{dr\}} g \;\&\; \forall \gamma \in \text{Con}_{K'} : \langle w, g \rangle \models_M \gamma) \}$ &

$B = \{ b : b \in U_{w,M} \;\&\; (\exists g)(f \cup \{\langle dr, b \rangle\} \subseteq_{U_{K'} - \{dr\}} g \;\&\; \forall \gamma \in \text{Con}_{K'} : \langle w, g \rangle \models_M \gamma) \;\&$
$\forall g (f \cup \{\langle dr, b \rangle\} \subseteq_{U_{K'} - \{dr\}} g \;\&\; \forall \gamma \in \text{Con}_{K'} : \langle w, g \rangle \models_M \gamma \rightarrow$
$(\exists h)(g \subseteq_{U_{K''}} h \;\&\; \forall \gamma \in \text{Con}_{K''} : \langle w, h \rangle \models_M \gamma)) \}$.

[49]See Kamp&Reyle(1993:425ff,676ff) for the complete language.

e. $\langle w, f\rangle \models_M \neg \boxed{K'}$ iff $\neg\exists g : (f \subseteq_{U_{K'}} g \;\;\&\; \forall\gamma \in \mathrm{Con}_{K'} : \langle w, g\rangle \models_M \gamma)$.

Static truth: $[\![K]\!]_{\langle w,f\rangle} = \{\langle w, g\rangle : \; f \subseteq_{U_K} g \;\&\; \forall\gamma \in \mathrm{Con}_K : \langle w, g\rangle \models_M \gamma\}$.

Relational truth: ${}_{\langle w,f\rangle}[\![K]\!]_{\langle w,g\rangle}$ iff $f \subseteq_{U_K} g \;\&\; \forall\gamma \in \mathrm{Con}_K : \langle w, g\rangle \models_M \gamma$.

3.3.2 Truth conditions for annotated DRSs

The *standard* DRT language of (51) will now be extended to a (preliminary) language DRL$_1^*$ for *annotated* DRSs, which does not only represent the *dynamics* of discourse in terms of update conditions, but will also allow for anaphoric reference to "pieces", or "stages" of discourse. We will then define a more restricted representation language DRL$_2^*$, which we consider as better suited the representation of natural language.

DRL$_1^*$ defines a new type of *intensional* discourse referents, context referents $F, G, H \in U_{c\_K}$, which denote sets of states, i.e. pairs of a world $w \in W$ and an embedding function f into $\mathcal{M}$ (see (54)). We also define a special constant Λ, which denotes the *empty context.*

On the basis of this new type of discourse referents DRL$_1^*$ introduces two new basic types of DRS conditions, an update condition (53e) and a truth predicate (53f). (Sentential) negation is now defined to apply to the truth predicate for a context referent (standing proxy for a DRS K'), instead of taking scope over the corresponding DRS K' (53g). And finally for modal quantifiers the relational quantifier is defined to apply to context referents G and H instead of DRSs K' and K'' (53h).

The atomic conditions of standard DRL in (51a–d) with their verification conditions (52a–d) carry over without modification.

(53) DRS Conditions in DRL$_1^*$:

a. – d. see (51), with (51b) extended to context referents

e. $\mathrm{G} := \mathrm{F} + \boxed{\mathrm{K}'}$ — update condition

f. $^{\vee}$ G — truth predicate on context referent

g. $\neg$ $^{\vee}$ G — (sentential) negation defined on truth predicate

h. G $\langle \mathrm{Q} \rangle$ H — relational quantifier Q defined on context referents

Of primary interest are the update condition (53e) and the "truth predicate" (53f) with their respective verification conditions in (54e–f). The update condition (54e) relates a context referent F and a (sub)DRS K' to yield a context referent G, and will be verified – if occurring in the condition set of a DRS K to be verified by a state $\langle w, e\rangle$ and where e is defined for both F and G – iff the denotation $e(G)$ that $\langle w, e\rangle$ assigns to G is such that G denotes the set of all states $\langle w', g\rangle$ for which there is a state $\langle w', f\rangle$ in the denotation assigned to F by $\langle w, e\rangle$ such that $\langle w', e \cup f\rangle$ and $\langle w', g\rangle$ constitute correct input and output states in the relational semantics for K' (${}_{\langle w',e\, \cup f\rangle}[\![K']\!]_{\langle w',g\rangle}$), or, equivalently, $\langle w', g\rangle$ is among the set of states defined as the static semantics for K' relative to the state $\langle w', e \cup f\rangle$.

The reason why the "input" state is chosen as $\langle w', e \cup f\rangle$ has to do with the accessibility

[50]For a compositional (static and relational) semantics of DRSs see (vE&K 1996). See also Section 3.2.

of context referents defined by e from K', which we will discuss in more detail below.[51]

Taken by itself, (54e) does nothing but represent the "context change potential" of K' by encoding, in the denotation of the context referents F and G, sets of states $\langle w', f\rangle$ and $\langle w', g\rangle$ that describe a correct dynamic, or relational meaning for K', relative to a state $\langle w, e\rangle$. Nothing follows from condition (54e) as to the truth of K' relative to $\langle w, e\rangle$. That K', characterized by the update condition (54e), holds true relative to a state $\langle w, e\rangle$ can be expressed by way of condition (54f), a "truth predicate" applied to a context referent G, and which will be verified relative to $\langle w, e\rangle$ iff there is some state $\langle w', g\rangle$ in the denotation $e(G)$ s.th. $w' = w$. If $^\vee$ is applied to the "output" referent G of the update condition in (54e), this comes down to the statement that there is some state $\langle w', g\rangle$ in the denotation of G – which verifies K' – that is tied to the world of evaluation w in $\langle w, e\rangle$.

(54) Let K be a DRS $\langle U_K = U_{ind\_K} \cup U_{c\_K}, Con_K\rangle$ according to DRL$_1^*$, $\mathcal{M}$ an intensional model (50), and e a *wellfounded* embedding function[52] $e = e_1 \cup e_2$ where e_1: $U_{ind\_K} \to \cup_{w \in W} U_{w,M}$ and e_2: $U_{c\_K} \to \wp(W \times G)$ (G a set of embedding functions), with $e_2(\Lambda) = \{\langle w, \lambda\rangle : w \in W\}$, λ is the empty function.

$\langle w, e\rangle \models_M K$ iff $\exists f : e \subseteq_{U_K} f$ & $\forall\gamma \in Con_K : \langle w, f\rangle \models_M \gamma$.

$[\![K]\!]_{\langle w,f\rangle} = \{\langle w, g\rangle :\ f \subseteq_{U_K} g$ & $\forall\gamma \in \mathrm{Con}_K : \langle w, g\rangle \models_M \gamma\ \}$.

${}_{\langle w,f\rangle}[\![K]\!]_{\langle w,g\rangle}$ iff $f \subseteq_{U_K} g$ & $\forall\gamma \in \mathrm{Con}_K : \langle w, g\rangle \models_M \gamma$.

a. – d. see (52)

e. $\langle w, e\rangle \models_M$ G := F + $\boxed{K'}$ iff
$e(G) = \{\langle w', g\rangle : \exists\langle w', f\rangle \in e(F)$ s.th. ${}_{\langle w', e\ \cup f\rangle}[\![K']\!]_{\langle w', g\rangle}\ \}$.

f. $\langle w, e\rangle \models_M\ {}^\vee G$ iff $\exists\langle w, g\rangle \in e(G)$.

g. $\langle w, e\rangle \models_M \neg{}^\vee G$ iff $\neg(\exists\langle w, g\rangle \in e(G))$.

h. $\langle w, e\rangle \models_M$ G ⟨Q⟩ H iff $\langle A, B\rangle \in Quant_M(\mathrm{Q})$, where

$A = \{\langle w', g\rangle : \langle w', g\rangle \in e(G)$ & $w' \in *(w, e(G)))\}$ &
$B = \{\langle w', g\rangle : \langle w', g\rangle \in e(G)$ & $w' \in *(w, e(G))$ &
$\forall\langle w', g\rangle : \langle w', g\rangle \in e(G)$ & $w' \in *(w, e(G)) \to \exists\langle w', h\rangle \in e(H)\}$.

Thus, while formerly the content of a sentence was represented as an atomic (partial) DRS K', we can now use the more structured representation (55), where (i) we represent the "context change potential" of K' in terms of an update condition on context referents, and where (ii) the truth of K' (in the context of F) is stated in terms of the truth predicate $^\vee$ G, which requires there to be a state $\langle w', g\rangle$ in the denotation of G where $w' = w$, w the world of evaluation for the DRS.

[51] E.g. to allow for anaphoric binding to the referent F from the domain argument X' of a modal quantificational structure that is contained in the condition set of the DRS K' of (54e), F must be defined in every function g in the denotation of G in order to allow for verification of the condition $X' = F$ within K'. This is obtained by the extension of $e \cup f$ to g, such that context referents that are in the domain of e, as e.g. F, end up to be defined in g. Yet, this will also cause G, which is also defined by e, to be in the domain of g, such that g turns out to be non–wellfounded. Such cases will have to be ruled out by a wellfoundedness constraint on embedding functions (see below).

[52] For discussion and definition of wellfoundedness see below.

(55) *Assertion:*

$$\boxed{\begin{array}{l} \mathrm{F\ G} \\ \mathrm{G} := \mathrm{F} + \boxed{\ K'\ } \\ {}^{\vee}\,\mathrm{G} \end{array}}$$

Similarly, the basic conditions in (53) can be used to build complex ADRS conditions for negation and modal quantification, as indicated in (56) and (57): For sentential negation (56) we first define an update of the "input" context referent F with the DRS K' to yield the referent G, as for non–negated assertive sentences. The negation operator does then not apply to K', but to the truth predicate for G.[53]

(56) *Negation:*

$$\boxed{\begin{array}{l} \mathrm{F\ G} \\ \mathrm{G} := \mathrm{F} + \boxed{\ K'\ } \\ \neg\ {}^{\vee}\,\mathrm{G} \end{array}}$$

Further we can use update conditions to establish the domain and scope argument of a generalized modal quantifier, as indicated in (57). Given an accessible context referent X' to establish the anaphoric domain argument, the update of X' with the restrictor DRS K' yields a referent G, and the update of G with the scope DRS K'' a context referent H. The referents G and H can then be taken to provide the arguments of the generalized quantifier Q, as defined in (53h) and (54h).

(57) *Generalized modal quantification:*

$$\boxed{\begin{array}{l} \mathrm{X'\ G\ H} \\ \mathrm{G} := \mathrm{X'} + \boxed{\ K'\ } \\ \mathrm{H} := \mathrm{G} + \boxed{\ K''\ } \\ \mathrm{G}\ \ \mathrm{Q}\ \ \mathrm{H} \end{array}}$$

Such an approach necessitates, of course, an appropriate definition of the quantifier relation denoted by Q. At first sight it seems to be sufficient to define the sets A and B that constitute the arguments of the relational quantifier in (54h) in terms of the set of states $\langle w', g\rangle$ denoted by G, and the set of states $\langle w', g\rangle \in e(G)$ that can be extended to states $\langle w', h\rangle$ that figure in the denotation of H, respectively (cf. (50) for the denotation of generalized quantifiers). The meaning of *necessarily*, e.g., would then be represented in terms of the quantifier **every**, applying to sets A and B, such that the set of states A (the states $\langle w', g\rangle \in e(G)$ that verify K' in the context of X') forms a subset of the set of states $A \cap B$, with B the set of states $\langle w', g\rangle \in e(G)$ that verify K' in the context of X' and where every such state can be extended to a state $\langle w', h\rangle \in e(H)$ that verifies K'' in the context of G, i.e. of X' and K'.

Yet, there are several problems for an analysis of generalized modal quantification along these lines:

[53] We restrict ourselves to sentential negation. The representation format in (56) can only be extended to non–sentential negation if the representations provide discourse referents that represent verifying states for partial DRSs that correspond to subsentential constituents. See also below.

First, as outlined in Section 3.2, in modal subordination cases the context referents that represent the restrictor and scope argument of a modal quantifier will serve as "hooks" to allow for anaphoric binding of the domain argument of a "subordinated" modal operator.

If, as just outlined, the generalized quantifier applies to the full denotation of the context referent G (and H), this works well for modal subordination relative to a universally quantified "antecedent" modal construction, and also for cases of "graded modality" (e.g. *probably*) where the denotation of H, according to the semantics of the quantifier, is non–empty. But the approach will not work for modal quantifiers corresponding to the semantics of *no* (as e.g. *under no circumstances, in no case*), which require that the set that constitutes the second argument of the relational quantifier be empty. In such a case, modal subordination relative to the scope argument could not be analyzed appropriately by anaphoric reference to the referent H. In Section 3.4 we will discuss such examples in detail.

Another, related problem for this definition of $G\ Q\ H$ is the vagueness and variability of conditionals, which was discussed in Section 2.2.2.

Recall that examples involving conditional variability, (such as Lewis' *If Otto comes, the party will be dreary, if Mary comes too, it will be lively, but if Waldo will come as well, it will be dreary again.*) are typically construed as modally subordinated wrt. their antecedent clauses (here indicated by anaphoric or presuppositional expressions like *too* and *as well*).

Now, according to the first conditional, in *every* world where Otto joins the party, the party will be dreary. I.e. both G_1 and H_1, the context referents that determine the arguments of the universal quantifier, will *only* denote worlds where Otto comes and the party is dreary. Anaphoric reference to G_1, to instantiate the anaphoric domain argument of the modally subordinated second conditional will be possible, but will not allow for verification of the second conditional in the context of the first one: updating G_1 with the antecedent DRS of the second conditional will determine a context referent G_2 where Otto *and Anna* join the party, yet – given that G_1 does only comprise worlds where the party is dreary, further extension, or update of G_2 with the scope DRS of the second conditional will not be possible, in fact will result in a referent H_2 that denotes the empty set.

So it turns out that in modally quantified structures the truth determining predicate – the quantifier relation – cannot be defined in terms of the full denotation of the context referents G and H that represent the contexts denoted by the (updated) antecedent and scope DRSs K' and K''.

It is for this reason that we defined the sets A and B in the denotation of the modal quantifier in (54g) not as determined by the full denotation of G, but in fact constrained the verification of the modally quantified structure in such a way that the quantificational domain gets further restricted to *normal*, or "maximally similar" worlds. This is obtained by use of the *normalcy selection function* *, defined in the model (50) to yield, for a world w and a context, or set of world–function pairs $\mathbf{G}$, a set of worlds $*(w, \mathbf{G})$ where *everything holds that is normally the case, relative to world w, in a context* $\mathbf{G}$. Thus, by restricting the domain argument of the modal quantifier to range over states $\langle w', g \rangle$ where w' figures in the set of "normal" worlds $*(w, e(G))$, the quantifier's domain is restricted to a set of states pertaining to "normal" worlds where the conditional antecedent holds true. By contrast, the denotation of the referents G and H will still give us the (context dependent) "intension" of K' and K'', i.e. they will also denote states that pertain to more "far–fetched" worlds.

By this move it is possible to avoid the problems just mentioned. The definition in (54g) will allow us not only to get a handle on conditional variability, but also to account for modal subordination relative to the scope argument of the quantifier *no*. The latter case will be discussed shortly, in Section 3.4, while the problem of conditional variability will only be addressed in Section 5.3.

While in principle it would be possible to go along with DRS representations of the form in (55), (56) and (57), we consider these representation schemata to be rather inappropriate, or unnatural as a representation format for natural language. This is most obvious for (55): the representation (55) for an assertive sentence not only characterizes the context dependent meaning of the sentence in terms of the update condition $G := F + K'$, but also *represents* that the content conveyed by the sentence holds true. Taken literally, this means that a sentence like *Mary came to dinner* is assigned a representation that roughly corresponds to a paraphrase such as *Mary came to the dinner and this is true.*

Therefore, we strongly prefer a more constrained representation language, defined in (58), which focusses on the *representation of discourse dynamics*, while the "assertion of truth" will not be *represented* at the level of the DRS, but will be captured by the verification, or truth conditions for annotated DRSs directly.

In particular, we dispense with the truth predicate $^\vee$ as a representational device, and instead define its semantic contribution as a constraint on the *verification* of update conditions, as it is natural in the DRT framework. Also, negation and modal quantifiers are now defined to apply to *update conditions.* In order to clearly distinguish the two DRL languages we used the relation $:=$ for updates in DRL_1^* (54), as opposed to $::$ in DRL_2^* (58).

We now state the verification conditions for the slightly revised language DRL_2^*, where we do not have the truth predicate $^\vee$, and where negation $\neg$ and modal quantifier relations Q apply to update conditions of the form $G :: F + K'$.

For atomic conditions and non–modal quantifiers (58a–d) the definitions in (52) carry over without modification. Conditions (58e'–g) are all built up from the basic update condition (58e), where in (58e') we allow for an abbreviated notation $F :: K'$ for $F :: \Lambda + K'$, with Λ the *empty context*, or "null" context referent, denoting the set of states $\{\langle w', \lambda\rangle : w' \in W\}$, with λ the empty function. Conditions (58h–i) do only take context referents as arguments, to define the relations of *merge* $(+)$ and *reduction* $(\subseteq)$ between context referents. We will make use of these relations for the analysis of non–epistemic modality and counterfactuals.

The verification conditions do now divide into two components: (i) they define the verification conditions for updates, just as in (54e), and (ii) enforce the truth of the (updated) DRS along the lines of (54f), relative to the evaluation state $\langle w, e\rangle$.

As before in (54) the embedding function e into the intensional model $\mathcal{M}$ consists of two component functions e_1 and e_2, where e_1 – as usual – maps discourse referents for (different types of) individuals to corresponding entities in the model, while the domain of e_2 consists of context referents which are assigned sets of states (consisting of a world and an embedding function).

Verification of a DRS K relative to a state $\langle w, e\rangle$ is defined as usual (cf. (52)) and again we state definitions for static and relational truth of a DRS K relative to a (pair of) state(s). What differs from the usual setup is that – due to our new representation format – the embedding function that verifies the uppermost (or main) DRS will only be defined for context referents that occur in update conditions for the successive sentences that make up the discourse the DRS is to represent.

Let us still delay the definition of *wellfoundedness* for embedding functions and go through the individual verification conditions.

(58) Let K be a DRS $\langle U_K = U_{ind\_K} \cup U_{c\_K}, Con_K \rangle$ according to DRL$_2^*$, $\mathcal{M}$ an intensional model (50), and e a *wellfounded* embedding function $e = e_1 \cup e_2$ with e_1: $U_{ind\_K} \rightarrow \cup_{w \in W} U_{w,M}$ and e_2: $U_{c\_K} \rightarrow \wp(W \times G)$ (G the set of wellfounded embedding functions) and $e(\Lambda) = \{\langle w', \lambda \rangle : w' \in W\}$, λ the empty function.

$\langle w, e \rangle \models_M K$ iff $\exists f : e \subseteq_{U_K} f \;\&\; \forall \gamma \in Con_K : \langle w, f \rangle \models_M \gamma$.

$[\![K]\!]_{\langle w,f \rangle} = \{\ \langle w, g \rangle :\ f \subseteq_{U_K} g \;\&\; \forall \gamma \in \mathrm{Con}_K : \langle w, g \rangle \models_M \gamma\ \}$.

${}_{\langle w,f \rangle}[\![K]\!]_{\langle w,g \rangle}$ iff $f \subseteq_{U_K} g \;\&\; \forall \gamma \in \mathrm{Con}_K : \langle w, g \rangle \models_M \gamma$.

Thus, ${}_{\langle w,f \rangle}[\![K]\!]_{\langle w,g \rangle}$ iff $\langle w, g \rangle \in [\![K]\!]_{\langle w,f \rangle}$.

a. – d. see (52)

e. $\langle w, e \rangle \models_M$ G :: F + $\boxed{K'}$ iff
(i) $e(G) = \{\langle w', g \rangle : \exists \langle w', f \rangle \in e(F)$ s.th. ${}_{\langle w',e\ \cup f \rangle}[\![K']\!]_{\langle w',g \rangle}\ \}$ &
(ii) $\exists \langle w, g \rangle \in e(G)$.

e'. $\langle w, e \rangle \models_M$ F :: Λ + $\boxed{K'}$ or $\langle w, e \rangle \models_M$ F :: $\boxed{K'}$ iff
(i) $e(F) = \{\langle w', f \rangle : \exists \langle w', \lambda \rangle \in e(\Lambda)$ s.th.${}_{\langle w',e\ \cup \lambda \rangle}[\![K']\!]_{\langle w',f \rangle}\}$ &
(ii) $\exists \langle w, f \rangle \in e(F)$.

f. $\langle w, e \rangle \models_M \neg$ G :: F + $\boxed{K'}$ iff
(i) $e(G) = \{\langle w', g \rangle : \exists \langle w', f \rangle \in e(F)$ s.th. ${}_{\langle w',e\ \cup f \rangle}[\![K']\!]_{\langle w',g \rangle}\ \}$ &
(ii) $\neg\ \exists \langle w, g \rangle \in e(G)$.

g. $\langle w, e \rangle \models_M$ G :: X' + $\boxed{K'}$ Q H :: G + $\boxed{K''}$ iff
(i) $e(G) = \{\langle w', g \rangle : \exists \langle w', x' \rangle \in e(X')$ s.th. ${}_{\langle w',e\ \cup x' \rangle}[\![K']\!]_{\langle w',g \rangle}\ \}$ &
$e(H) = \{\langle w', h \rangle : \exists \langle w', g \rangle \in e(G)$ s.th. ${}_{\langle w',e\ \cup g \rangle}[\![K'']\!]_{\langle w',h \rangle}\ \}$ &
(ii) $\langle A, B \rangle \in Quant_M(\mathrm{Q})$, where
$A = \{\langle w', g \rangle$: $\langle w', g \rangle \in e(G)$ &
$w' \in *(w, \{\langle w'', g' \rangle : \exists \langle w'', x' \rangle \in e(X')$ s.th. ${}_{\langle w'',e \cup x' \rangle}[\![K']\!]_{\langle w'',g \rangle}\})\}$ &
$B = \{\langle w', g \rangle$: $\langle w', g \rangle \in e(G)$ &
$w' \in *(w, \{\langle w'', g' \rangle : \exists \langle w'', x' \rangle \in e(X')$ s.th. ${}_{\langle w'',e \cup x' \rangle}[\![K']\!]_{\langle w'',g \rangle}\})$ &
$\forall \langle w', g \rangle$: $\langle w', g \rangle \in e(G)$ &
$w' \in *(w, \{\langle w'', g' \rangle : \exists \langle w'', x' \rangle \in e(X')$ s.th. ${}_{\langle w'',e \cup x' \rangle}[\![K']\!]_{\langle w'',g \rangle}\})$
$\rightarrow \exists \langle w', h \rangle \in e(H)\}$.

h. $\langle w, e \rangle \models_M G = F + D$ iff
(ii) $e(G) = \{\langle w', g \rangle : \exists \langle w', f \rangle \in e(F)\ \exists \langle w', d \rangle \in e(D)$ s.th. $\langle w', g \rangle = \langle w', f \cup d \rangle\}$.

i. $\langle w, e \rangle \models_M G' \subseteq G$ iff
(ii) $\forall \langle w', g \rangle \in e(G)\ \exists \langle w', g' \rangle \in e(G')$ s.th. $g' \subseteq g$.

(58e) defines (i) verification of the update condition $G :: F + K'$ (cf. (54e)). $\langle w, e\rangle$ is constrained to assign values to F and G such that $e(G)$ denotes the set of all states $\langle w', g\rangle$ that result from an update with K' of some state $\langle w', e \cup f\rangle$ where $\langle w', f\rangle$ in $e(F)$, i.e. $e(G)$ denotes the set of states $\langle w', g\rangle$ that are in the denotation of K' relative to $\langle w', e \cup f\rangle$.

K' is defined to hold true in the world of evaluation w by condition (ii), which is satisfied iff there is a state $\langle w, g\rangle$ in the denotation assigned to G by $\langle w, e\rangle$. This corresponds exactly to the verification condition of the truth predicate $^{\vee}$ applied to G in (54f).

Condition (58e') is a special case of (58e), where the "input" context referent is the *null context referent* Λ ($F :: \Lambda + K'$), and which we abbreviate as $F :: K'$. This condition will in general be used to represent the first sentence of a discourse if it is interpreted relative to the "empty context". Alternatively we make use of this special condition to serve as a place where unbound presuppositions are accommodated in K', and represent the first sentence of the discourse (which may trigger such presuppositions) by use of the general update condition (58e).

Condition (58f) for negation is restricted to sentential negation.[54] The interpretation of K' is defined to be *relative to* an "input" context (referent) F, which in general will be identical (locally bound) to the annotating referent of the DRS for the preceding sentence. This ensures that anaphoric expressions will be interpreted as dependent on material occurring in the preceding context.[55] While the "update condition" (i) is identical to the non–negated condition (58e.i), the truth condition (ii) constrains the states denoted by G *not* to contain a state that pertains to the world of evaluation w. It is worth noting that by (58f.i) G is constrained to denote the *context dependent intension* of K' (relative to F), i.e. the intension of $F + K'$. This will be important for the analysis of modal subordination relative to negated contexts (see (48) above and Section 3.4).

One might argue that the truth conditions for (58f) are too weak in that it is not brought out by condition (ii) that the negation takes scope only over the content defined by K': the definition is consistent with F being false relative to $\langle w, e\rangle$.[56] We can easily extend the definition (ii) of (58f) to impose the stronger constraint that there be a state $\langle w, f\rangle \in e(F)$ with w the world of evaluation. On the other hand, note that DRT's original definition of negation in (52e) is equally weak in this respect: the condition for negation settles that there be no extension g of f that verifies K', without stating explicitly that the embedding DRS K that is verified by f, and which serves as the antecedent context for K' is true. Also, it might turn out advantageous to choose the weaker definition in order to account for sequences like (59), where we can represent the negated update condition for the second sentence as contextually dependent on the output context referent of the negated update condition for the first sentence, which enables anaphoric binding of the pronoun *it* to *a car*.[57] [58]

[54] As noted above, extension to nonsentential negation is only possible if the language provides for discourse referents that denote verifying states for partial DRSs corresponding to nonsentential constituents. See Reyle(1995) where such denotations appear as labels of UDRSs.

[55] See below for the definition of accessibility for anaphoric binding.

[56] This observation is due to Ede Zimmermann.

[57] This argument was raised by Hans Kamp.

[58] See below for accessibility of discourse referents, and Section 3.4 for pragmatic restrictions for anaphoric binding of context referents in negation contexts.

(59) I don't have a car. So I don't have to park it.

$$\begin{array}{|l|}\hline \Lambda\ \mathrm{F}\ \mathrm{G} \\ \mathrm{F} :: \Lambda + \boxed{\begin{array}{l} \mathrm{F}' \\ \neg\, \mathrm{F}' :: \mathrm{F} + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{car(x)} \quad \mathrm{own(i,x)} \end{array}} \end{array}} \\ \mathrm{G} :: \mathrm{F} + \boxed{\begin{array}{l} \mathrm{G}' \\ \neg\, \mathrm{G}' :: \mathrm{F}' + \boxed{\begin{array}{l} \mathrm{y} \\ \mathrm{y} = \mathrm{x} \quad \mathrm{park(i,y)} \end{array}} \end{array}} \\ \hline \end{array}$$

Finally (58g) states the verification conditions for modally quantified structures, where we now choose a representation that explicitly represents contextual dependence *within* the quantified structure: similar to the restrictor part – which is represented by an update condition that induces interpretation of K' relative to the "modal base" X', to yield the "updated" context referent G – the scope DRS K'' is represented to extend the context G that is defined by the update condition of the restrictor part: $H :: G + K''$. Verification of these update conditions is defined in the now familiar fashion in (i).

But, as motivated above, the verification condition (ii) for "truth" of the quantified structure cannot be defined exclusively in terms of the denotations of the context referents G and H. As for (54g), the sets A, B in the quantifier denotation are further restricted such that the quantification ranges over a subset of the states denoted by G, which pertain to "normal" worlds w'. This is again obtained in terms of the *normalcy selection function* * of (50), which closely follows the normalcy selection function defined in Morreau(1992), to be discussed in detail in Chapter 5. At this point it is sufficient to give its intuitive meaning by the paraphrase: $*(w, \mathbf{G})$ yields a set of worlds where *everything holds true which is normally the case, relative to w, in a context* **G**. In (58g) the second argument of * is defined as the set of all states $\langle w'', g\rangle$ that constitute correct output states in the relational meaning of K', for input states $\langle w'', e \cup x'\rangle$, where $\langle w'', x'\rangle$ figures in the denotation $e(X')$ of the modal base. I.e., the second argument of * in (58g) denotes the "update" of the modal base X' with the antecedent K'. For ease of reference we will adopt the convention of referring to this normalcy restriction by means of the considerably sparser notation $*(w, e(X' + K'))$, where e figures in the verifying state for the quantified condition. In sum, then, the modal quantifier is restricted, in (58g), to range over a set of states $\langle w', g\rangle$ that pertain to "normal" worlds w' where the antecedent K' is true *in the context of* X'.

This additional restriction of the quantificational domain will not only allow an account of the vagueness and variability of conditionals, but also accounts for modal subordination relative to modally quantified structures where the meaning of the (antecedent) modal construction corresponds to the quantifier **no** (as e.g. *in no case*) (see Section 3.4). If the set A in the quantifier relation $Q < A, B >$ were constituted by the full denotation of G, given the meaning of **no**, which constrains the second argument, B, to constitute the empty set, the referent H that annotates the scope DRS would have to denote the empty set. Modal subordination relative to such a context could then not be accounted for by anaphoric reference to H. By contrast, the definition in (58g) allows us to account for these cases: Given the additional restriction to "normal" worlds selected by $*(w, e(X' + K'))$, the set B in the quantifier relation may well denote the empty set to render the meaning of **no** – there are no "normal" worlds that verify K' and K'' (relative to X') – while the *intension* denoted by H may still be nonempty, denoting a set of states pertaining to (more) abnormal worlds where K' and K'' hold true (relative to X'). Modal subordination relative to the referent H is then possible, and is predicted to be *relative* to those abnormal worlds.

Condition (58h) will be needed for the analysis of non–epistemic modality (*must, may, can/be able to*) in Chapter 4. For instance, it will provide a (consistent) *complex modal base* $F + D$, where the context referent F represents an epistemic or factual backgound context, while D stands proxy for a deontic context D, which will be introduced by a (possibly accommodated) intensional deontic predicate. The verification condition defines this "merged" context G to denote the set of states $\langle w', f \cup d \rangle$ that by their world parameter qualify as verifying states for both F and D.

Finally, (58i) defines verification of conditions $G' \subseteq G$ which will be used in Chapters 4 and 5 to deal with inconsistent modal bases. These we find with non–epistemic modality (e.g. Samaritan Paradox, Practical Inference) and with counterfactual modality. Condition (58i) defines a "reduced" context G' that is less restricted than is G, i.e. some assumptions defined by G are "retracted" in G'.[59] Viewed from another perspective we could also characterize G' as a context (referent) that can be consistently extended (updated with some DRS K') to yield the more constrained context (referent) G.

3.3.3 Wellfoundedness of embedding functions for annotated DRSs

The verification conditions in (58) are still deficient in that the verifying embedding functions for annotated DRSs are not yet ensured to be *wellfounded*.

E.g., a DRS K may consist of a universe $U_K = \{F, G\}$ and a set of conditions $Con_K = \{F :: K', G :: F + K''\}$. According to (58) a state $\langle w, \lambda \rangle$ will verify K iff there is a state $\langle w, e \rangle$ s.th. $F, G \in dom(e_2)$ and $\langle w, e \rangle$ verifies every condition $\gamma \in Con_K$.

Now, according to (58e'.i) we must build a function $e \cup \lambda$ s.th. $\forall \langle w', f \rangle \in [\![K']\!]_{\langle w', e \cup \lambda \rangle}$: $\langle w', f \rangle \in e(F)$. Given that $F \in dom(e_2)$, F will be in the domain of $e \cup \lambda$ and by definition of ${}_{\langle w', e \cup \lambda \rangle}[\![K']\!]_{\langle w', f \rangle}$ in (58) F will also figure in the domain of f. But since F in turn denotes a set of states $\langle w'', f \rangle$, f is then not wellfounded.

Thus, the problem of non–wellfoundedness arises even for the simplest form of update conditions (58e'), as just explained, and in general whenever an update condition of the form $G :: F + K'$ occurs in a DRS or complex DRS condition. The problem also shows up, in a slightly different form, with conditions of the form (58h).

We have argued that update conditions must be evaluated relative to the "conjoined" function $e \cup f$ to ensure that context referents in the domain of e are available for anaphoric binding from within K'. E.g. in (58e) we want F to be in the domain of functions g denoted by $e(G)$ in order to be able to establish a modal base $X' = F$ for a modally quantified structure within K', but we do not want – and do not need to have – G be in the domain of g. Similarly we do not want to have context referents H, I to be in the domain of g in the denotation of $e(G)$ where H, I result from further update conditions $H :: G + K'''$, $I :: H + K''''$ that may occur in K, since H and I being in the domain of g would give rise to further problems of non–wellfoundedness for g.

To ensure that embedding functions e for annotated DRSs are *wellfounded*, we define a partial order upon the set of context referents $\mathcal{X}$ relative to a function e.

The ordering relation $<$ is defined in (60): Context referents $F, G \in \mathcal{X}$ stand in the relation $F < G$ relative to e ($F <_e G$) iff (i) G is in the domain of the function e and for every $\langle w', g \rangle \in e_2(G)$, $F \in dom(g_2)$, i.e. F is *locally* defined within G relative to e ($F <_e G$)

[59] Corresponding to *contraction* in Gaerdenfors(1988).

or (ii) G is in the domain of e and for every $\langle w', g\rangle \in e_2(G)$, there is some $X \in dom(g_2)$ s.th. $F < X$ relative to g, i.e. F is *non–locally* defined within G relative to e ($F <_g X <_e G$).[60]

(60) $F <_e G$ is the smallest relation between context referents $F, G \in \mathcal{X}$ relative to an embedding function e s.th.
(i) $\forall\langle w', g\rangle \in e_2(G)$: $F \in dom(g_2)$ or
(ii) $\forall\langle w', g\rangle \in e_2(G)$: $\exists X \in dom(g_2)$: $F <_g X$.

The relation $<$ in (60) is used to define a *partially ordered system* $\langle \mathcal{X}, <\rangle$ on the set of context referents $\mathcal{X}$, relative to an embedding function e (61): $<$ is constrained to be transitive and irreflexive.[61]

(61) $\langle \mathcal{X}, <\rangle$ is a *partially ordered system* of a set $\mathcal{X}$ of context referents relative to an embedding function e iff $<$ is transitive, irreflexive and asymmetric.

(62) then defines a partially ordered system $\langle \mathcal{X}, <\rangle$ as in (61) to be *wellfounded* iff every nonempty subset of $\mathcal{X}$ has a minimal element. I.e. the *wellfounded* ordering system $\langle <, \mathcal{X}\rangle$ does not allow for circularity wrt. the ordering relation $<$. Given that $<$ is defined to encode the (recursive) embedding structure of context referents – in that $F <_e G$ holds if F figures in the domain of functions g in the denotation of $e(G)$, or else if $F <_g X$ holds for some referent X in the domain of every g in the denotation of $e(G)$ – the constraint on wellfoundedness on the partially ordered system $\langle \mathcal{X}, <\rangle$ of context referents $\mathcal{X}$ will preclude non–wellfoundedness of a function e iff $dom(e_2) \subseteq \mathcal{X}$, with $\langle \mathcal{X}, <\rangle$ *wellfounded* as in (62).

(62) $\langle \mathcal{X}, <\rangle$ is *wellfounded* iff $<$ is a *partial order* of $\mathcal{X}$ and
$\forall \mathcal{Y} \subseteq \mathcal{X}$ and $\mathcal{Y} \neq \emptyset$, $\exists Z \in \mathcal{Y}$ s.th. $\forall X \in \mathcal{Y}, X \neq Z : Z < X$.

(63) A function $e = e_1 \cup e_2$ for annotated DRSs is *wellfounded*
iff $dom(e_2) \subseteq \mathcal{X}$ and $\langle \mathcal{X}, <\rangle$ is *wellfounded*, with $<$ defined as in (60) and (61).

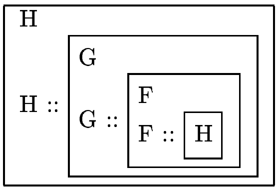
It is now easy to see why $<$ is chosen not to allow for reflexivity: If $G < G$, then $\forall\langle w', g\rangle \in e_2(G) : G \in dom(g_2)$. This predicts g to be non–wellfounded. So in general the constraint on non–reflexivity will ensure that a DRS K annotated by a referent G will not denote states $\langle w', g\rangle$ where g is defined for G ($G \in dom(g_2)$). I.e. a DRS structured like (64) will be ruled out.

(64) $$\boxed{\begin{array}{l} \mathrm{G} \\ \mathrm{G} :: \boxed{\mathrm{G}} \end{array}}$$

Similarly, the constraint on wellfoundedness of $\langle \mathcal{X}, <\rangle$ rules out embedding functions e that lead to indirect recursion, as e.g. described by: $H <_g F <_h G <_e H$. Such a situation could arise in a recursively embedding DRS like (65) if the context referent H denotes, by $e(H)$ a set of states $\langle w', h\rangle$ such that $G \in dom(h_2)$, and the referent $G \in dom(h_2)$ is assigned by h_2 a set of states $\langle w'', g\rangle$, such that $F \in dom(g_2)$, and finally g_2 assigns a value to F such that for every $\langle w''', f\rangle$: $H \in dom(f_2)$.

[60] Alternatively, $<_e^* = \bigcup_n <_e^n$ where (i) $F <_e^0 G$ iff $\forall\langle w', g\rangle \in e(G) : F \in dom(g_2)$
(ii) $F <_e^{n+1} G$ iff $\forall\langle w', g\rangle \in e(G) : \exists X \in dom(g_2) : F <_g^n X$.

[61] Reflexivity just corresponds to non–wellfoundedness (see below).

(65) 

While the *wellfoundedness* constraint on embedding functions (63) is appropriate to rule out the problematic cases illustrated by (64)/(65), it is not sufficient to just impose it as a general wellfoundedness constraint on embedding functions e for annotated DRSs in (58).

Reconsider e.g. the basic update condition in (58e): the DRS K' is evaluated relative to a state $\langle w', e \cup f \rangle$, and as we have argued above, it is just the union of $e \cup f$ that will cause the functions g in the result states $\langle w', g \rangle$ to be non–wellfounded: the problem arises immediately if G figures in the domain of e_2 – which it *will* if e is to verify condition (58e).

Thus, even if embedding functions are generally constrained to be wellfounded, such that both e and f by themselves satisfy wellfoundedness, the result of the union operation $e \cup f$ will necessarily cause the resulting function g to be non–wellfounded.

Note that it is *not* sufficient to just *define* or *constrain* g to be wellfounded, thereby ruling out *by definition* that its domain contains context referents that violate wellfoundedness: $e \cup f$ is defined in terms of ordinary set theoretic union of $dom(e)$ and $dom(f)$:[62] thus, if $G \in dom(e)$, in (58e) evaluation of K' relative to a state $\langle w', e \cup f \rangle$ will necessarily result in some g with $G \in dom(g)$, such that g will be non–wellfounded and thus undefined.

Since on the other hand we need to make reference to the embedding function e for evaluation of K' in update conditions of the form $G :: F + K'$ in order to make *some* referents $X \in dom(e_2)$ (such as e.g. F) available for anaphoric binding from within K', wellfoundedness of g must be ensured "on the fly".

This will be done by (i) constraining *any* embedding function for annotated DRSs to satisfy *wellfoundedness*, and (ii) by defining a function $e_{\prec X}$, with $e_{\prec X} \subseteq e$ and where X is a context referent in $dom(e)$, which then will be used, e.g. in (58e), to build the complex function $e_{\prec_G} \cup f$ instead of $e \cup f$. The idea is that $e_{\prec_G}$ can be defined to contain only context referents that do not violate the constraint on wellfoundedness in the definition of update conditions. I.e. by evaluation of K' relative to a state $\langle w', e_{\prec_G} \cup f \rangle$ in an update condition of the form $G :: F + K'$ wellfoundedness of g will be preserved, in that those context referents in the domain of e that violate wellfoundedness will not be defined in the domain of $e_{\prec_G}$.

The definition of $e_{\prec_G}$ is given in (66): It defines the maximal function e', $e' \subseteq e$, such that $e'_1 = e_1$ and e'_2 is restricted ($\lceil$) to only those context referents $X \in dom(e_2)$ that are different from G and which do not directly or indirectly embed G: $G \not\prec_e X$ relative to e. Thus, if occurring in the verification condition for an update conditions of the form $G :: F + K'$ (see (67e)), the context referent G, denoting the set of states $\langle w', g \rangle$ that are in the denotation of $[\![K']\!]_{\langle w', e_{\prec_G} \cup f \rangle}$, will be constrained, by (66), *not* to embed – locally or non–locally – a context referent G, since this would cause g to be non–wellfounded.

(66) Let $e = e_1 \cup e_2$ be a *wellfounded* embedding function for annotated DRSs (according to (58)/(63)) then $e_{\prec_G} = e_1 \cup e'_2$, where $e'_2 = e_2 \lceil \{X \in dom(e_2) : X \neq G \;\&\; G \not\prec_e X\}$.

[62] $g = e \cup f$ iff
$dom(g) = dom(e) \cup dom(f)$ $\&\forall x \in dom(g) \cap dom(e) : g(x) = e(x)$ $\&\forall x \in dom(g) \cap dom(f) : g(x) = f(x)$.

In (67) then we state the slightly revised verification conditions for annotated DRSs, making use of the restricted function $e_{\prec G}$ of e when defining the verifying states $\langle w', e_{\prec G} \cup f \rangle$ for K' in an update condition $G :: F + K'$, to ensure wellfoundedness.

(67) Let K be a DRS $\langle U_K = U_{ind\_K} \cup U_{c\_K}, Con_K \rangle$ according to DRL$_2^*$, $\mathcal{M}$ an intensional model (50) and e a *wellfounded* embedding function $e = e_1 \cup e_2$ acc. to (63) with e_1: $U_{ind\_K} \to \cup_{w \in W} U_{w,M}$, e_2: $U_{c\_K} \to \wp(W \times G)$ (G the set of wellfounded embedding functions) and $e(\Lambda) = \{\langle w', \lambda \rangle : w' \in W\}$, λ the empty function.

$\langle w, e \rangle \models_M K$ iff $\exists f : e \subseteq_{U_K} f$ & $\forall \gamma \in Con_K : \langle w, f \rangle \models_M \gamma$.

$[\![K]\!]_{\langle w,f \rangle} = \{ \langle w, g \rangle : f \subseteq_{U_K} g$ & $\forall \gamma \in \mathrm{Con}_K : \langle w, g \rangle \models_M \gamma \}$.

${}_{\langle w,f \rangle}[\![K]\!]_{\langle w,g \rangle}$ iff $f \subseteq_{U_K} g$ & $\forall \gamma \in \mathrm{Con}_K : \langle w, g \rangle \models_M \gamma$.

Thus, ${}_{\langle w,f \rangle}[\![K]\!]_{\langle w,g \rangle}$ iff $\langle w, g \rangle \in [\![K]\!]_{\langle w,f \rangle}$.

a. – d. see (58)

e. $\langle w, e \rangle \models_M$ G :: F + $\boxed{K'}$ iff
(i) $e(G) = \{\langle w', g \rangle : \exists \langle w', f \rangle \in e(F)$ s.th. ${}_{\langle w', e_{\prec G} \cup f \rangle}[\![K']\!]_{\langle w', g \rangle}\}$ &
(ii) $\exists \langle w, g \rangle \in e(G)$.

e'. $\langle w, e \rangle \models_M$ F :: Λ + $\boxed{K'}$ or $\langle w, e \rangle \models_M$ F :: $\boxed{\text{K'}}$ iff
(i) $e(F) = \{\langle w', f \rangle : \exists \langle w', \lambda \rangle \in e(\Lambda)$ s.th. ${}_{\langle w', e_{\prec F} \cup \lambda \rangle}[\![K']\!]_{\langle w', f \rangle}\}$ &
(ii) $\exists \langle w, f \rangle \in e(F)$.

f. $\langle w, e \rangle \models_M \neg$ G :: F + $\boxed{K'}$ iff
(i) $e(G) = \{\langle w', g \rangle : \exists \langle w', f \rangle \in e(F)$ s.th. ${}_{\langle w', e_{\prec G} \cup f \rangle}[\![K']\!]_{\langle w', g \rangle}\}$ &
(ii) $\neg\, \exists \langle w, g \rangle \in e(G)$.

g. $\langle w, e \rangle \models_M$ G :: X' + $\boxed{K'}$ $\Diamond$Q H :: G + $\boxed{K''}$ iff

(i) $e(G) = \{\langle w', g \rangle : \exists \langle w', x' \rangle \in e(X')$ s.th. ${}_{\langle w', e_{\prec G} \cup x' \rangle}[\![K']\!]_{\langle w', g \rangle}\}$ &
$e(H) = \{\langle w', h \rangle : \exists \langle w', g \rangle \in e(G)$ s.th. ${}_{\langle w', e_{\prec H} \cup g \rangle}[\![K'']\!]_{\langle w', h \rangle}\}$ &
(ii) $\langle A, B \rangle \in Quant_M$(Q), where
$A = \{\langle w', g \rangle$: $\langle w', g \rangle \in e(G)$ &
$w' \in *(w, \{\langle w'', g' \rangle : \exists \langle w'', x' \rangle \in e(X')$ s.th. ${}_{\langle w'', e_{\prec G} \cup x' \rangle}[\![K']\!]_{\langle w'', g \rangle}\})\}$ &
$B = \{\langle w', g \rangle$: $\langle w', g \rangle \in e(G)$ &
$w' \in *(w, \{\langle w'', g' \rangle : \exists \langle w'', x' \rangle \in e(X')$ s.th. ${}_{\langle w'', e_{\prec G} \cup x' \rangle}[\![K']\!]_{\langle w'', g \rangle}\})$ &
$\forall \langle w', g \rangle$: $\langle w', g \rangle \in e(G)$ &
$w' \in *(w, \{\langle w'', g' \rangle : \exists \langle w'', x' \rangle \in e(X')$ s.th. ${}_{\langle w'', e_{\prec G} \cup x' \rangle}[\![K']\!]_{\langle w'', g \rangle}\})$
$\to \exists \langle w', h \rangle \in e(H)\}$.

h. $\langle w, e \rangle \models_M G = F + D$ iff
(ii) $e(G) = \{\langle w', g \rangle : \exists \langle w', f \rangle \in e(F)\ \exists \langle w', d \rangle \in e(D)$ s.th. $\langle w', g \rangle = \langle w', f \cup d \rangle\}$.

i. $\langle w, e \rangle \models_M G' \subseteq G$ iff
(ii) $\forall \langle w', g \rangle \in e(G)\ \exists \langle w', g' \rangle \in e(G')$ s.th. $g' \subseteq g$.

What we have to show then is that constraining the verification of update conditions in the way we did in (67e) – and analoguously in (67e'–g) – by evaluation of K' relative to a state $\langle w', e_{\prec_G} \cup f\rangle$ instead of $\langle w', e \cup f\rangle$ (i) preserves wellfoundedness of g and (ii) does this non–vacuously.

A case in point is a DRS K, to be verified relative to a state $\langle w, e\rangle$, which contains update conditions $F :: \Lambda + K_0$, $G :: F + K'$ and $H :: G + K''$, as displayed in (68).

The second update condition in (68) will be verified according to (67e) iff (i) $e(G)$ denotes the set of states $\langle w', g\rangle$ for which $\exists\langle w', f\rangle \in e(F)$ s.th. $\langle w', g\rangle \in [\![K']\!]_{\langle w', e_{\prec_G} \cup f\rangle}$ and (ii) $\exists\langle w, g\rangle \in e(G)$. And similarly, the third update condition will be verified iff (i) $e(H)$ denotes the set of states $\langle w', h\rangle$ for which $\exists\langle w', g\rangle \in e(G)$ s.th. $\langle w', h\rangle \in [\![K']\!]_{\langle w', e_{\prec_H} \cup g\rangle}$ and (ii) $\exists\langle w, h\rangle \in e(H)$.

Assume e to be defined such that $F <_e G$, $F <_e H$ and $G <_e H$. If we made use of our first version (58) of verification conditions for annotated DRSs, evaluation of K' relative to a state $\langle w', e \cup f\rangle$ would cause the states $\langle w', g\rangle$ denoted by G to be non–wellfounded: the domain of g would include H, which was assumed to satisfy $G <_e H$, i.e. we would get a cyclic structure: $G <_e H <_e G$.

By contrast, according to (66) and (67e) G is constrained to denote a set of states $\langle w', g\rangle$ where g is restricted to only those referents $X \in dom(e_2)$ for which $X \neq G$ & $G \not<_e X$. This predicts $G, H \notin dom(g)$ – since by assumption $G <_e H$ –, while $F \in dom(g)$.

Similarly, according to (66) and (67e) H is constrained to denote a set of states $\langle w'', h\rangle$ where h is not defined for $H \in dom(e_2)$, but is defined for $F, G \in dom(e_2)$.

(68)
$$\boxed{\begin{array}{l} \mathrm{F\ G\ H} \\ \mathrm{F} :: \Lambda + \boxed{K_0} \\ \mathrm{G} :: \mathrm{F} + \boxed{K'} \\ \mathrm{H} :: \mathrm{G} + \boxed{K''} \end{array}}$$

Since the states $\langle w', e_{\prec_G} \cup f\rangle$ for verification of K' in (68) are all defined for F, the "input" referent F can serve as an antecedent for anaphoric binding of a (context) referent X' within K' – according to the provisional *semantic* definition of accessibility we have given in (46). And correspondingly, along with F the "input" referent G will be defined for all states $\langle w'', e_{\prec_H} \cup g\rangle$ for verification of K'' in the third condition of (68), and therefore is available to serve as an antecedent for an anaphoric referent X'' occurring in K''.

This is just what we want: anaphoric binding of a context referent X' should only be possible if the antecedent referent that is chosen in fact stands proxy for an "antecedent" context. I.e. anaphoric reference to a referent Y that "results" from the actual piece of discourse K' should be excluded from the set of accessible context referents. For K' in (68) this corresponds to the referents G, H, and for K'' to the referent H. And of course the same considerations are in order for local (vs. anaphoric) binding of "input" context referents in update conditions.

These observations lead us straightforwardly to the notion of accessibility of context referents for anaphoric (or local) binding.

Yet before, we will state some basic assumptions for the construction of representations for the DRS language DRL_2^* we introduced above.

3.3.4 A note on DRS construction for annotated DRSs

To get at the dynamically structured discourse representations we motivated above, the syntax–semantics interface for DRS–construction must be defined in such a way that each discourse unit S_i (typically a sentence) introduces a DRS condition $X_i :: X_{i-1} + K_i$, with K_i the representation to be constructed for S_i, and where X_{i-1} is identified with or locally bound to the context referent X_{i-1} that in turn annotates the update condition $X_{i-1} :: X_{i-2} + K_{i-1}$ constructed for the previous sentence S_{i-1}.

There are various ways to implement this idea, which depend heavily on the preferred framework for DRS–construction. The easiest way will be to reserve a special type of variable, or attribute for the annotating referent of an update condition, which can be directly accessed to *instantiate* the input context referent for the respective subsequent sentence. Such *direct*, or *local* binding can then be distinguished from *anaphoric* binding proper, as in modal constructions, where the modal operator's anaphoric domain argument X' can be represented to be *anaphorically* bound to some accessible context referent F in terms of an explicit equation condition $X' = F$.

We further assume that the annotating context referents of update conditions in (67e–g), as well as G and G' in (67h–i), respectively, are introduced into the universe of the local DRS K in which conditions are introduced.

Finally, since it is beyond the scope of the present work to go into the subject of presupposition and presupposition projection in any detail, we will – for the purpose of our analyses – follow the "presupposition as anaphora" analysis of van der Sandt(1992), and go along with the convention we adopted above, whereby unbound presuppositions are – if possible – accommodated to the "highest" level of the DRS, which in our framework is the DRS that is interpreted relative to the "null context" Λ. Accommodated material will be indicated by use of italics. By following van der Sandt's conception of presupposition as anaphora, binding of presuppositions is easily accounted for once we have defined the accessibility constraints for anaphoric binding in our fragment of annotated DRSs.

Except for some brief observations in Section 4.1 we will not go into any more detail as regards the DRS construction principles for annotated DRSs.

3.3.5 Accessibility

It is easy to see, given the above discussion of wellfoundedness, that accessibility of discourse referents for anaphoric binding can be defined in *semantic* terms (see above Section 3.2).

In (69) we define a (contextual or individual) discourse referent y to be accessible from a referent x within a DRS K' that is annotated by a context referent G iff y is in the domain $dom(g)$ of every embedding function g defined in a state in the denotation of G.[63]

(69) The context referent G in an update condition $G :: X + K'$ that occurs as an atomic condition or within a complex DRS condition in a DRS K we call the *annotating* referent of this condition or of the DRS K'.
Given a DRS K' with annotating referent G and a state $\langle w, e\rangle$ with $G \in dom(e)$, a discourse referent y is *accessible* from a referent x occurring in K' iff $y \in dom(g)$ for all $\langle w', g\rangle \in e(G)$.

[63] The use of a semantic definition for accessibility was suggested to me by Uwe Reyle.

For ordinary DRSs K' that may occur within update conditions $G :: F + K' \in Con_{K_0}$, where K_0 is verified relative to e, it is obvious that a referent y that is defined within $U_{K'}$ is accessible for any referent x occurring within K' itself, and so is any referent y defined within U_{K_0}, if it is also defined within $dom(e_{\prec G})$ (see (66)). In particular, F will be available from within K', since by (67e) $F \in dom(e)$ will also be in $dom(e_{\prec G})$.

For sentential negation, the DRS K' in the update condition $G :: F + K'$ for the full negated sentence will host an embedded negated update condition $\neg H :: X + K''$, where X can be bound to F according to semantic accessibility. By (67f) both context referents that are in accordance with wellfoundedness (among them F) and any non–contextual referents that are defined in the universe of K' are semantically accessible from within K'', such that a referent x within K'' can be anaphorically bound to a referent y occurring within K' or which is in turn accessible from K'.

And it is also obvious in which way the semantic definition of accessibility will account for anaphoric dependencies from and within modal quantificational structures (67g), which now consist of two update conditions that figure as arguments of the quantifier relation, and where the second argument is defined as the update of the context referent established by the first one. First, depending on the choice of the antecedent referent for X', the modal base of the quantifier, any referent that is in the domain of functions x' in the denotation of X' will be available for anaphoric reference from within the restrictor DRS K'. This fact will be crucial for the analysis of modal subordination (see below). Moreover, any referent that is in the domain of the function e that is to verify the modal condition will be available for anaphoric reference from within K', if it is defined within $e_{\prec G}$. Secondly, due to the local binding of the scope argument, defined by the update with the scope DRS K'' of the referent G that annotates the restrictor argument, every referent y defined within K' or accessible from within K' will be available for anaphoric binding from K''.

Finally, for the merge relation $G = F + D$ in (67h), all referents that are in the domain of functions f and d in the denotation of F and D will be in the domain of functions g in the denotation of G, and therefore will get accessible for binding from within any DRS K' that is characterized as contextually dependent on G. For reduction $G' \subseteq G$ in (67i), depending on the choice of G', a particular subset of the referents in the domain of g in the denotation of G will be defined in the domain of g' in the denotation of G', and thereby are made available for anaphoric reference from within DRSs K' that are characterized as contextually dependent on G', by choosing this referent as the "input" referent for an update with K' (see in particular Section 4.3).

For the syntactic definition of accessibility, the provisional characterization of the subordination relation $\geq$ that we have given in (47) is to be revised, in (70), according to the slightly diverging language DRL_2^*, which is easily obtained. Things are more complicated for the merge relation $+$ and reduction relation $\subseteq$ of (67h–i).

(70) For K_0 a DRS, $\geq$ is the smallest relation to satisfy the following conditions[64]

a. if $G :: F + K''$ in Con_{K_1}, and $F :: X + K'$ or $F :: K'$ in Con_{K_1}, where $K_0 \geq K_1$, then $K' \geq K''$ and $K_1 \geq K'$ and $K_1 \geq K''$;

b. if $G :: F + K'' \diamond H :: G + K'''$ in Con_{K_1}, where $K_0 \geq K_1$, then $K'' \geq K'''$, $K_1 \geq K''$ and $K_1 \geq K'''$;

c. if $\neg[G :: F + K'']$ in Con_{K_1}, where $K_0 \geq K_1$, then $K_1 \geq K''$;

d. if $F :: X_F + K_F \in Con_{K_1}$ & $D :: X_D + K_D \in Con_{K_2}$, where $K_0 \geq K_1$, $K_0 \geq K_2$, and $G = D + F \in Con_{K_3}$, (where $K_1 \geq K_3$, $K_2 \geq K_3$)
then if $Y :: G + K_Y \in Con_{K_4}$, with $K_3 \geq K_4$, then $K_F \geq K_Y$ & $K_D \geq K_Y$.

e. if $G :: X_G + K_G \in Con_{K_1}$ & $G' \subseteq G \in Con_{K_2}$, (where $K_0 \geq K_1$ and $K_1 \geq K_2$)
then if $Y :: G' + K_Y \in Con_{K_3}$, with $K_2 \geq K_3$, then $K_G \geq K_Y$.

f. $K' \geq K'$, and if $K' \geq K''$ and $K'' \geq K'''$ then $K' \geq K'''$.

But it is evident that if the relation of accessibility is fully determined in terms of the structural relation of subordination defined by (70) – such that a referent $y \in U_{K'}$ is accessible for a referent x occurring in K'' iff $K' \geq K''$ – we will run into the problem of non–wellfoundedness that we just tackled on the semantic level, since according to the syntactic definition of subordination there are context referents available for anaphoric binding that induce non–wellfoundedness of verifying embedding functions.

One way to solve this problem is to stick with a notion of accessibility that is fully based on the subordination relation (70), i.e. to allow for anaphoric reference to context referents that induce non–wellfoundedness of embedding functions, and simply consider these unwarranted DRSs as being ruled out on semantic grounds, since the embedding functions violate the wellfoundedness condition (63).
Another way is to further constrain the syntactic relation of subordination in order to rule out these unwarranted DRSs in terms of syntactic conditions.[65]

An attempt to do this is sketched in (71), where we define a new relation $\ll$ between context referents. The relation defines a syntactic equivalent to the semantic relation $<$ between context referents defined in (60). For atomic update conditions and those that show up in complex conditions (cf. (67e–g)), (71a) defines the "input referent" F of an update condition $G :: F + K' \in Con_{K_1}$, $K_0 \geq K_1$, as being *subordinate* to G, and further we state that any context referent $Z \in U_{K'}$ is *subordinate* to G. Correspondingly, in (71b) the component referents F and D of a merge relation that defines a new referent G are stated to be both *subordinate* to G. And finally, for the relation of context reduction $G' \subseteq G$ we state G' to be subordinate to G. The last clause (71d) defines *non–local subordination* to hold between context referents F and H in case F is (non)locally *subordinate* to G and G is (non)locally *subordinate* to H.

(71) For any DRS K_0, $\ll$ is the smallest relation to satisfy the following conditions:

a. if $G :: F + K'$ occurs in Con_{K_1}, $K_0 \geq K_1$, then $F \ll G$ and $\forall Z \in U_{K'} : Z \ll G$;

b. if $G = F + D$ occurs in Con_{K_1}, $K_0 \geq K_1$, then $F \ll G$ and $D \ll G$;

c. if $G' \subseteq G$ occurs in Con_{K_1}, $K_0 \geq K_1$, then $G' \ll G$;

d. if $F \ll G$ and $G \ll H$ then $F \ll H$;

[64]We assume that additional conditions on $\geq$ carry over from the traditional framework – as far as their syntax is identical to the conditions used in the present framework.
[65]This alternative was suggested to me by Hans Kamp.

Just as we did for the relation $<$ in (60) we must then constrain the partially ordered system $\langle \ll, \mathcal{X} \rangle$, $\mathcal{X}$ the set of context referents, to be *wellfounded* in order to rule out anaphoric relations that violate wellfoundedness. Alternatively we can directly state stronger constraints on accessibility, as in (72), which – besides the general condition (i) that $y \in U_{K'}$ is accessible for x from K'' iff $K' \geq K''$ – imposes, for context referents x and y, the further constraint in (ii) that y is only accessible for x in K'' if x is not $\ll$–*subordinate* to y.

(72) A discourse referent $y \in U_{K'}$ is accessible, within a DRS K where $K \geq K'$, for a discourse referent x occurring in a DRS K'' iff
(i) $K' \geq K''$ and
(ii) if x and y are context referents, then $x \not\ll y$.

For successions of update conditions as in (73), the stronger condition (72) predicts that the input referent X'' of the second update condition in (73a) cannot be chosen as G or H, although both are structurally accessible according to (71)/(72i). Since $\Lambda \ll F$, $X'' \ll G$ and $X''' \ll H$, equating X'' with G is immediately ruled out by (72ii). It is possible, at this stage, to choose H as an antecedent for X'', as displayed in (73b), yet by transitivity this predicts $X''' \ll G$, such that it is then impossible to choose G as an antecedent for X'''. That is, we end up with DRS (73b), with substitution of equivalences. The only way to resolve X''', then, is by equation with F, which gives us (73c). This is of course not a natural choice for a context dependent interpretation of a succession of sentences, but it is in accordance with wellfoundedness.

(73) a.
$$\begin{array}{|l|}\hline \Lambda\ F\ G\ X''\ H\ X''' \\ \hline F :: \Lambda + \boxed{K'} \\ G :: X'' + \boxed{K''} \\ H :: X''' + \boxed{K'''} \\ \hline \end{array} \qquad \Lambda \ll F,\ X'' \ll G,\ X''' \ll H$$

b.
$$\begin{array}{|l|}\hline \Lambda\ F\ G\ H\ X''' \\ \hline F :: \Lambda + \boxed{K'} \\ G :: H + \boxed{K''} \\ H :: X''' + \boxed{K'''} \\ \hline \end{array} \qquad \Lambda \ll F,\ X''' \ll H \ll G$$

c.
$$\begin{array}{|l|}\hline \Lambda\ F\ G\ H \\ \hline F :: \Lambda + \boxed{K'} \\ G :: H + \boxed{K''} \\ H :: F + \boxed{K'''} \\ \hline \end{array} \qquad \Lambda \ll F \ll H \ll G$$

Obviously, what we want is (74), which is in accordance with (72). As noted above, the appropriate choice of the input referents for successive update conditions must be hard–wired in the syntax–semantics interface, such that we in fact end up with (74) instead of (73c).

(74)
$$\begin{array}{|l|}\hline \Lambda\ \mathrm{F}\ \mathrm{G}\ \mathrm{H} \\ \mathrm{F} :: \Lambda + \boxed{\mathrm{K}'} \\ \mathrm{G} :: \mathrm{F} + \boxed{\mathrm{K}''} \\ \mathrm{H} :: \mathrm{G} + \boxed{\mathrm{K}'''} \\ \hline \end{array} \qquad \Lambda \ll F \ll G \ll H$$

As for anaphoric reference from within more embedded DRSs, as in the structure shown in (75) where K''' embeds a conditional DRS structure, we predict that – if the remaining anaphoric dependencies are resolved as indicated – X'' cannot be chosen as anaphoric to I, H, H' or H'', since X'' is characterized as $\ll$*–subordinate* to these context referents. The only possible choices are therefore Λ, F and G. In (75) we have chosen the most likely candidate, G, since we assume that in general the conditional will be relativized to the "largest" antecedent context possible.

This preference we could implement as a pragmatic constraint on anaphoric binding, requiring that from a set of context referents $\mathcal{Y}$ that are accessible from X'' according to (72) and which also allow for binding of anaphoric referents that occur within DRSs annotated by referents Z, where $X'' \ll Z$, we have to choose the "largest" one possible according to the relation $\ll$. Since in (75), for $\mathcal{Y} = \{\Lambda, F, G\}$, we have $\Lambda \ll F \ll G$, G will be chosen as the antecedent for X''.

The rules we stated above for the syntax–semantics interface to construct update conditions for subsequent sentences of a discourse are in accordance with this pragmatic constraint.

(75)
$$\begin{array}{|l|}\hline \Lambda\ \mathrm{F}\ \mathrm{G}\ \mathrm{H}\ \mathrm{I} \\ \mathrm{F} :: \Lambda + \boxed{\mathrm{K}'} \\ \mathrm{G} :: \mathrm{F} + \boxed{\mathrm{K}''} \\ \mathrm{H} :: \mathrm{G} + \begin{array}{|l|}\hline \mathrm{H}'\ \mathrm{H}''\ \mathrm{X}'' \\ \mathrm{X}'' = \mathrm{G} \\ \mathrm{H}' :: \mathrm{X}'' + \boxed{\mathrm{K}_1} \ \langle\text{every}\rangle\ \mathrm{H}'' :: \mathrm{H}' + \boxed{\mathrm{K}_2} \\ \hline \end{array} \\ \mathrm{I} :: \mathrm{H} + \boxed{\mathrm{K}''''} \\ \hline \end{array}$$
$$\Lambda \ll F \ll G \ll H,\ X'' \ll H' \ll H'' \ll H \ll I$$

The syntactic subordination and accessibility constraints in (70), (71) and (72) are more involved than the semantic definition of accessibility in (69) since they have to mimic, at the syntactic level, the dependencies that are imposed by the semantics assigned to individual DRS conditions in our new representation format, and also must mirror the wellfoundedness restriction that is independently captured at the level of semantics.

Given this "dependence" of the syntactic definitions on the semantics assigned to the syntactic constructs, we consider the *semantic* definition of accessibility given in (69) as more basic, in that it more directly conveys the basic principle underlying the notion of *accessibility*, and therefore is more independent from the syntactic peculiarities of the particular representation format chosen. For note that the *semantic* accessibility constraint must be considered a *necessary precondition* for anaphoric binding of discourse referents: If binding of an anaphoric referent x appearing in K'' is represented by introducing, into the local DRS K'', an equation condition $y = x$, where y is to be chosen as an accessible antecedent discourse referent, then in order to verify this condition, y must by necessity be defined by, i.e. be in the domain of the function f that verifies K''.

In the following Section, we will show how the constraints on accessibility for anaphoric binding interact with the analysis of modal constructions we introduced in Section 3.2 to account for various data in modal (subordination) contexts. We will most of the time refer to the semantic definition of accessibility, which, besides being more basic, we consider as more intellegible than its syntactic correspondant.

But we should mention at this point already that – given the new representation format we have chosen to *represent* the dynamic process of discourse interpretation (together with the wellformedness constraints for embedding functions) – the analysis now rules out anaphoric – in fact cataphoric – reference of pronominals to discourse referents introduced in subsequent discourse (or in subsequent *sentences*, to be precise).

In this respect, the structured representation (76) for multisentential discourses is stronger than the usual representation format, where the incrementation of DRSs by subsequent sentences is not represented explicitly at the DRS–level, but is obtained by *insertion* of the DRS K constructed for a new sentence to the DRS K_{i-1} constructed from the previous discourse to yield the *incremented*, or *updated* DRS K_i.[66]

(76) a. Max saw a film. He enjoyed it.

$$\begin{array}{|l|}\hline \text{F G} \\ \text{F} :: \Lambda + \begin{array}{|l|}\hline \text{m x}\\ \text{max(m)}\\ \text{film(x)}\\ \text{see(m,x)}\\\hline\end{array} \\ \text{G} :: \text{F} + \begin{array}{|l|}\hline \text{y x}'\\ \text{y} = \text{m}\\ \text{x}' = \text{x}\\ \text{enjoy(y,x}')\\\hline\end{array}\\ \hline\end{array}$$

b. # He enjoyed it. Max saw a film.

$$\begin{array}{|l|}\hline \text{F G} \\ \text{F} :: \Lambda + \begin{array}{|l|}\hline \text{y x}'\\ \text{y} = ?\\ \text{x}' = ?\\ \text{enjoy(y,x}')\\\hline\end{array} \\ \text{G} :: \text{F} + \begin{array}{|l|}\hline \text{m x}\\ \text{max(m)}\\ \text{film(x)}\\ \text{see(m,x)}\\\hline\end{array}\\ \hline\end{array}$$

First note that – following the verification conditions for updates (67e) and the definition of $e_{\prec_G}$ in (66) – in (76a–b) the referent F is accessible from the second update condition for local binding of the "input" referent. Further, given the verification conditions for updates (67e), the states $\langle w', g\rangle$ in the denotation of G will all be extensions of states $\langle w', f\rangle$ in the denotation of F (where g will in addition be defined for F). I.e. all referents y defined within K' and thus within the domain of f will figure in the domain of g.

Thus in (76a) the functions f that figure in the denotation of F will be defined for referents m and x such that the anaphoric referents generated by the second sentence can be bound according to (69), while in (76b) the anaphoric pronouns appear in the first sentence, which is updated relative to the empty context Λ. The denotation of F will therefore not provide appropriate antecedent referents to resolve the equation conditions.[67] And of course the same result is predicted by the syntactic definition of accessibility.

[66] But recall the relational DRT semantics in van Eijck&Kamp(1996), discussed in Section 3.2, where a sequencing operator allows for similar distinctions. In the traditional set–up such cases can only be avoided if anaphora resolution is already completed during DRS construction, as in Kamp&Reyle(1993) – whereas in Asher(1993) anaphora resolution is supposed to take place after DRS–construction is completed.

[67] We must of course rule out trivial equations like $y = y$ and $x' = x'$, which bind the anaphoric referent to itself, which in principle is not ruled out by our analysis.

We get different predictions for the slightly diverging representation in (77), where the DRS annotated by F is used as an accommodation site for presuppositions, such that (the representation for) the proper name Max will end up in $F :: K_0$ in both (77a–b).

We take it that this is a welcome feature, since cataphoric reference is not generally odd, but – as far as we can see – is restricted to cases where the target of binding is interpreted as definite, or specific (relative to the cataphoric pronoun).

Thus, in both (77a–b) cataphoric reference of *he* to *Max* is possible, while for (77a) binding of the pronominal *it* to the indefinite *a film* is still ruled out. In cases like (77b), however, with a definite NP *the film*, cataphoric binding of the pronominal is licensed.

(77) a. # He enjoyed it. Max saw a film.

F G H	
F :: Λ +	*m* *max(m)*
G :: F +	y x′ y = m x′ = ? enjoy(y,x′)
H :: G +	x film(x) see(m,x)

a. He enjoyed the film. Max saw it twice.

F G H	
F :: Λ +	*m x* *max(m)* *film(x)*
G :: F +	y x′ y = m x′ = x the_film(x′) enjoy(m,x′)
H :: G +	x″ x″ = x′ see-twice(m,x″)

To sum up, we have introduced a new representation format for contextual dynamics in DRT, which – by means of update conditions on context referents – explicitly characterizes the meaning of a sentence in a discourse as contextually dependent on the preceding discourse. This new representation format allows us to overcome a serious problem of Geurts' reconstruction of Kratzer's relative modality in DRT: the modal operator, anaphoric within its restrictor argument, can now be characterized as contextually dependent upon the factual antecedent context (see example (30) of Section 3.2). Moreover, the analysis improves over both Roberts' and Geurts' reconstructions of Kratzer's *relative modality* in that both of the context dependent parameters – the *modal base* and the *ordering source* – can be represented at the DRS level. The syntactic representation of the "ordering source" is important in particular for deontic modality – which we did not yet discuss in detail – in order to be able to represent relativization to a deontic context that is explicitly introduced within the discourse by use of an adverbial phrase as in e.g. (78a), or an attitudinal predicate, as in (78b)

(78) a. According to German tax law, Max must pay taxes for his car.

b. Max's mother wants him to become a famous artist. He must take piano lessons.

Before, in Chapter 4, we (re)consider in more depth the analysis of diverse modal constructions, as there are: (multiple) relative and graded modality, counterfactuality and non–epistemic (deontic) conditionals, including their potential to engage in modal subordination, we will in Section 3.4 anticipate the discussion of some special modal subordination cases, to illustrate the motivations and the working of the analysis we just presented.

3.4 Modal subordination – or what you can and cannot do with ADRSs

It will be useful for a better understanding and for additional motivation of the analysis we just presented to discuss some special cases of modal subordination. In particular, we will investigate examples where modal subordination is *relative* to negation and non–universally quantified modal contexts.

In Section 3.2 we have characterized modal subordination as a special instance of *relative modality*, where the "reference" context that provides the modal base for the subordinated modal construction is itself established by means of a modally quantified sentence. In our analysis this contextual dependency is established by anaphoric binding of the context referent X' that represents the "input" context for the subordinated modal construction to the context referent that annotates the restrictor or nuclear scope of the "antecedent" modal construction.

We will now illustrate in detail how – in the framework we introduced above – this analysis accounts for various kinds of modal subordination data, in particular with the problem of anaphoric binding to referents that are "locked" within negated or modally quantified antecedent contexts.

Consider e.g. the classical example (79). Again we use the "initial" context, represented by the DRS annotated by F, as the preferred accommodation site for non–bound presuppositions. The first sentence induces an update condition $G :: F + K'$ – with F accessible within K to serve as a locally bound input referent, and the modally quantified structure is introduced as a condition within K'. As argued at length, the anaphoric referent X' that fills the "input" argument of the restrictor's update condition will have to choose some accessible context referent. According to the semantic definition of accessibility (69) F is accessible for X' iff $F \in dom(g_2)$ for every state $\langle w', g\rangle \in e(G)$. According to (66) and (67e) F will figure within the domain of such g, while G and H will not. The only context referent that is accessible for anaphoric binding of X' in (79) is therefore F.[68]

The second sentence of (79) introduces a new update condition $H :: G + K''$ (together with introducing the new referent H into the universe of K), with local binding to G, the "output" referent of the previous update condition. While this must be hard–wired by the syntax–semantics interface, local binding to G is still in accordance with the semantic (and also the syntactic) definition of accessibility (see above).

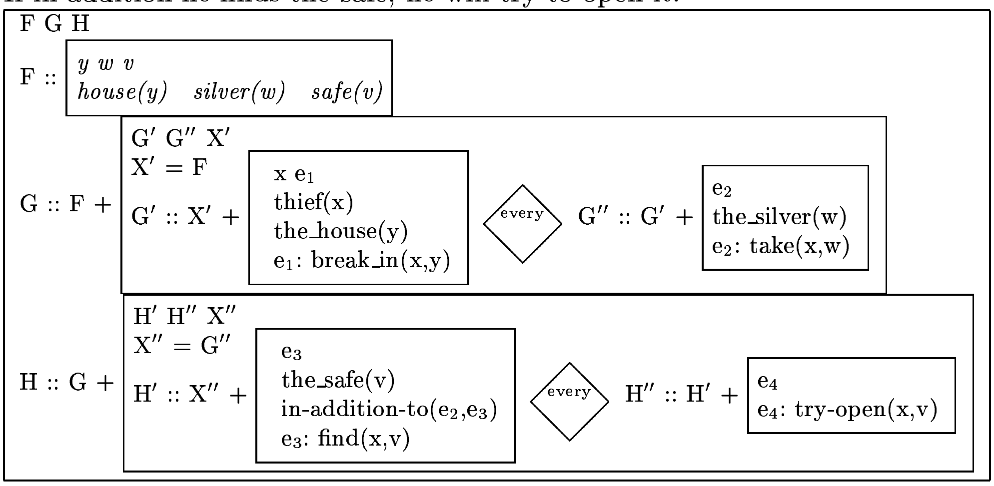
The conditional in the second sentence again introduces a modally quantified structure into K'', where the anaphoric referent X'' must be bound to some accessible context referent. While in the first sentence X' was bound to the referent F that provided the "input" argument of the local update condition, given that the referents G' and G'' are defined within K' – and thus are defined in the domain of functions g and h in states denoted by G and H – both G' and G'' will be accessible for anaphoric binding of X'' from within K''. If we choose the referent G'' that annotates the first conditional's scope argument, as we did in (79), the verification conditions for modally quantified structures in (67g) determine that the antecedent DRS K_1'' is evaluated relative to a state $\langle w', e_{\prec_{H'}} \cup x''\rangle$. I.e. K_1'' is interpreted *relative to* the context represented by $X'' = G''$, such that every referent y that is defined by G'', G', X' and F is accessible for anaphoric binding from within K_1''.

[68]There is of course also the constant Λ, the "null context". But we assumed above that pragmatic conditions on anaphora resolution will determine that F is to be preferred over Λ.

The anaphoric or presuppositional expressions *in addition* and *the safe* will then find accessible antecedents within the DRSs annotated by these respective context referents.[69]

Finally, note again that given the constraint on wellfoundedness of embedding functions for annotated DRSs and the cautious definition of $e_{\prec_G} \cup f$ in the verification conditions for updates in (67), and following the syntactic constraints for accessibility in (72), X'' *cannot* be chosen to be anaphorically bound to H, or to other context referents I, J etc. that may be defined in U_K on the basis of subsequent update conditions that are contextually dependent on H. Anaphoric reference to G, however, is licensed by the accessibility conditions. But this choice doesn't make accessible the referents that are defined within the antecedent and consequent DRS of the first conditional, to resolve the anaphoric or presuppositional dependencies within the second modal context. I.e. the choice of G is not appropriate for the modal subordination example (79).

(79) If a thief breaks into the house, he will take the silver.
If in addition he finds the safe, he will try to open it.



Whether the subordinated modal construction is to be analyzed as anaphoric to the restrictor or scope argument of the "antecedent" modal construction depends on various factors. In particular, the choice of the antecedent context is determined (i) by the consistency requirement, (ii) by constraints on presuppositional or anaphoric binding, (iii) by sentence mood, and (iv) by a variety of further pragmatic factors which for the major part are beyond the scope of our concerns (e.g. factors of salience or relevance, and world knowledge). Also, it is evident that a theory of *rhetorical* or *discourse relations* such as Asher's(1993) SDRT will considerably help constraining the choice among potential antecedent context referents. Remaining, unwarranted ambiguities we can restrict by assuming a pragmatic constraint to choose the "largest" possible referent Y from the set of accessible context referents $\mathcal{Y}$ that are in accordance with the criteria in (i)–(iv), if $\langle \ll, \mathcal{Y} \rangle$ determines a linear ordering.

In example (79), for instance, the choice of the referent G'' that annotates the scope argument of the first quantified structure will be preferred as the antecedent context for the

[69] Strictly speaking, G'' covers all of the information defined within the successively extended contexts F and G' if we use the semantic definition of accessibility.

modally subordinated construction: the phrase *in addition* in the antecedent of the second sentence triggers a presupposition to the effect that the subject (the thief) performed some (predatory) action before finding the safe, which could be successfully bound by the events introduced in the restrictor and scope of the first modal structure, respectively.[70] Thus, both G' and G'' will figure in the set $\mathcal{Y}$ of potential antecedent context referents, while F and G, which do not provide for antecedents for the presupposition triggered in H' will not. Since $G' \ll G''$, we prefer selection of G''.

3.4.1 Modal subordination relative to negated antecedent contexts

Besides these "standard" cases of modal subordination we also mentioned, in Section 3.2, Geurts' problematic examples where modal subordination is *relative* to opaque contexts, as e.g. negation (80).

(80) I didn't buy a microwave oven. I wouldn't know what to do with it.

DRT's accessibility conditions for anaphoric binding prohibit discourse referents introduced within a negated DRS from being accessible from a superordinate DRS. Otherwise (81) could not be ruled out, with *it* taken as coreferential with *a bike.*

On the other hand there are examples (80) and (82), where the subjunctive modal must be analyzed as dependent upon the context that is closed up within the scope of the negation operator, to allow for anaphoric binding of pronominals.

(81) Clarissa doesn't own a bike. # She loves it.

(82) a. Fred didn't draw a picture.
If he had made a mess of it, the paper would have been ruined.

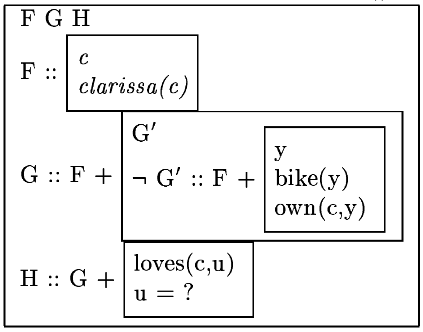
b. Fred didn't buy a book.
If Mary had seen it, she would have taken it away immediately.

We have already described, in our informal introduction, how we will account for such cases. Recall that negated update conditions come with an annotating discourse referent G', denoting the set of states that verify the (negated) DRS K' relative to an antecedent context (referent) F. According to (67f) the world of evaluation will not figure within states in this set. Since the context referent G' is defined in the universe of the DRS K that contains the negated update condition, anaphoric reference to this context referent G' is possible from the restrictor argument of a quantificational structure of the appropriate (i.e. modal) type, as in (82), while it is *not* in cases like (81), where the second sentence cannot possibly be taken to introduce a quantificational structure.[71] The DRSs in (83) and (84) illustrate the relevant distinctions.

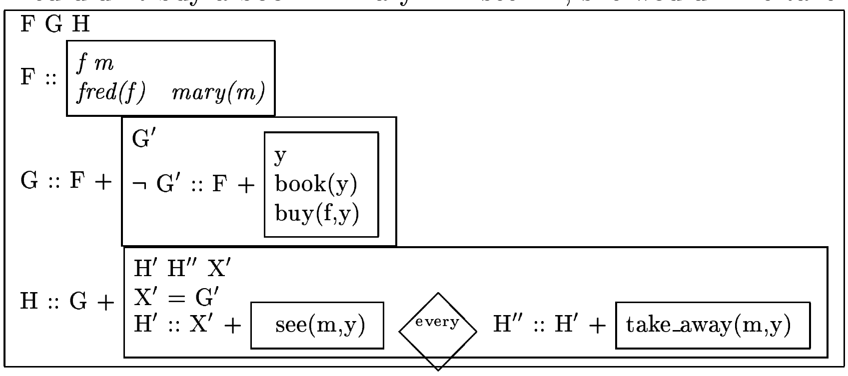
[70] We have represented this presupposition only very sketchily by introducing a condition *in addition to*, which we take to be anaphoric in its first argument position and locally bound to the event referent of the local sentence structure.

[71] No genericity operator possible here.

(83) Clarissa doesn't own a bike. # She loves it.



(84) Fred didn't buy a book. If Mary had seen it, she would have taken it away.



In (85) we observe that modal subordination relative to a negated context is subject to a constraint on sentence mood: the subordinated sentence must be in subjunctive mood.

(85) a. Fred didn't draw a picture. # If he has made a mess of it, the paper has been ruined.

b. Fred didn't buy a book. # If Mary has seen it, she has taken it away.

This contrast can be accounted for if for *indicative* modals we define a (pragmatic) constraint to the effect that the denotation of the annotating context referent of the restrictor argument must not be *counterfactual*, i.e. it must contain a state pertaining to the world of evaluation (cf. Stalnaker(1976)). For German we state as a further constraint that the annotating referent of a *subjunctive* modal may only denote *counterfactual* states, i.e. it may not contain a state that is tied to the evaluation world.

Let us adopt this generalization as a working hypothesis and see how far it will take us.[72]

[72] As we observed in Section 3.3, due to our new representation format the analysis also accounts for subordination cases as in (i), where the second, negated sentence must be analyzed as subordinate to the context that is under negation scope within the preceding sentence. Since the "counterfactual" context referent G' is accessible from within the DRS K'' annotated by H, the input argument of the negated update condition within K'' can be chosen as anaphoric to G'. This not only characterizes the negated context of the second sentence as an "extension" of the counterfactual context evoked by the first sentence, but also provides an appropriate antecedent referent for the pronoun *it*.

Corresponding to the above constraint for indicative vs. subjunctive modal sentences, the verification

3.4.2 Modal subordination relative to non–universally quantified antecedent contexts

In Section 3.2, we have argued that conditionals are best analyzed in terms of generalized quantification. The further assumption that generalized quantifiers are inherently context dependent immediately captures the context dependent nature of modal operators that Kratzer argued for. While Kratzer's analysis of "graded", i.e. of non–universally quantified modals was not given in terms of generalized quantification, this can alternatively be captured by giving "graded" modal (ad)verbs, such as *probably*, a semantics as roughly indicated in (86):[73] We assume P to assign a measure of probability to a given set of worlds.

For other, non–graded quantifiers like *necessarily*, *might/possibly* and *in no case*, we can stick with the usual generalized quantifiers **every**, **some** and **no** (see Section 2.3.1), or else define them, analogously to (86), by making use of a measure P of probability (see below).

(86) $\text{Quant}_M(\textit{probably}) = \{\ \langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) \geq .75\}$

Given that in our analysis of modally quantified structures (see (67g)) the denotations of the annotating context referents of restrictor and scope are *independent* of both the quantificational force of the operator and the normalcy restriction – in that they denote the (context dependent) intension of the (updated) restrictor and scope DRSs – modal subordination relative to modal sentences with non–universal quantifiers can be dealt with in a very flexible way.

In (87), for instance, the first conditional will quantify over "normal" worlds (or states) where Max goes to China, and the quantified condition will be verified iff those worlds where he in addition buys many books are assigned a sufficiently high relative probability.[74] The context referent G'', however, will denote the (context dependent) *intension* of the scope DRS, i.e. a set of states where Max goes to China and buys many books, which are *not* restricted to "normal worlds".

Taking the second modal construction to be anaphoric to the context referent G'' will constrain the universal quantification to range over worlds where Max goes to China and

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condition for negation in (67f) constrain the annotating referent of the negated update condition not to contain a state that is tied to the world of evaluation. This is in accordance with anaphoric reference to G' in (i) to instantiate the input context referent for the update condition within K$''$.

(i) I don't own a car. So I don't have to park it.

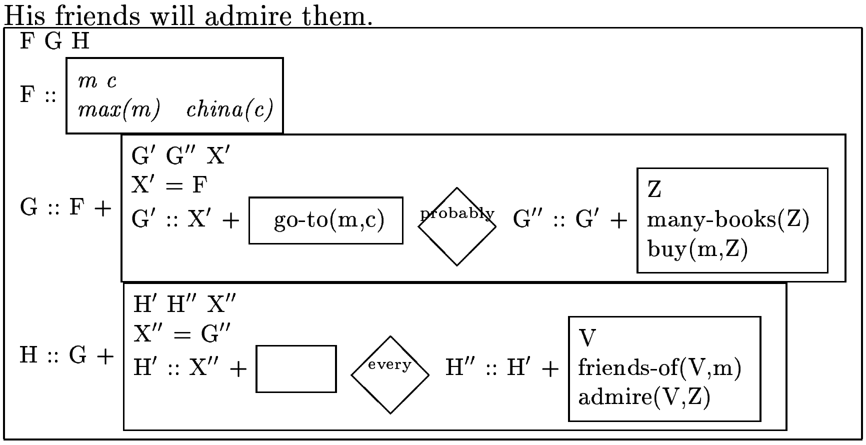
$$\boxed{\begin{array}{l} \text{F G H} \\ \text{F} :: \boxed{\begin{array}{l} i \\ \textit{speaker}(i) \end{array}} \\ \text{G} :: \text{F} + \boxed{\begin{array}{l} \text{G}' \\ \neg\ \text{G}' :: \text{F} + \boxed{\begin{array}{l} \text{x} \\ \text{car(x)} \quad \text{own(i,x)} \end{array}} \end{array}} \\ \text{H} :: \text{G} + \boxed{\begin{array}{l} \text{H}' \\ \neg\ \text{H}' :: \text{G}' + \boxed{\text{have-to-park(i,x)}} \end{array}} \end{array}}$$

[73]In the following we assume the arguments A, B to be defined according to the verification conditions for modally quantified structures in (67g). Since $cs(A)$ and $cs(B)$ yield the sets of worlds pertaining to the states in A and B, $cs(A) \cap cs(B)$ is of course equivalent to $cs(B)$ according to our definition of modal quantification. We will nevertheless stick to the definition in (86).

[74]The choice of the value .75 for *probably* in (86) is quite arbitrary.

buys many books – but now again with further restriction to those worlds that correspond to what is normally the case in *such* a situation ($*(w, h(G''+K''))$, where h in the denotation of H). The condition will be verified iff all the states $\langle w', g'' \rangle$ in the denotation of G'' that pertain to such normal worlds extend to states $\langle w', h'' \rangle$ that verify the scope DRS, i.e. that Max's friends will admire the books he (probably) will buy if he goes to China.

(87) If Max goes to China, he probably will buy many books.
His friends will admire them.



A more interesting case is (88). Here the first sentence hosts a modal quantifier that is assigned the meaning of **no**. I.e. for all possible worlds (or situations) where Max goes to China (and where things evolve as is assumed to be the normal course of events), there will be *no* extended situation where Max will buy many books. In this case the second argument of the relational quantifier **no** is required to be the empty set, if the condition is to be verified. If the denotation of G' and G'' were defined in terms of the sets A, B of the relational quantifier, it would not be possible to refer to G'' to establish a modal subordination reading: G'' would denote the empty set. According to our *semantic* definition of accessibility then, anaphoric reference to Z would not be possible.[75]

Yet, since in (67g) we chose to let the annotating referents G' and G'' denote the (context dependent) intension of the DRSs they annotate, G'' will denote states $\langle w', g'' \rangle$ where w' does *not* belong to the set of "normal" worlds $*(w, g(F+K'))$ where Max goes to China, but rather to those quite *abnormal* worlds w', where Max goes to China and against all reason *will buy books* he is unable to read. According to the second modal quantification, then, in *all* of such abnormal worlds – again further restricted to a subset of those where things evolve as you would normally expect – it will be the case that he doesn't read *them*.[76]

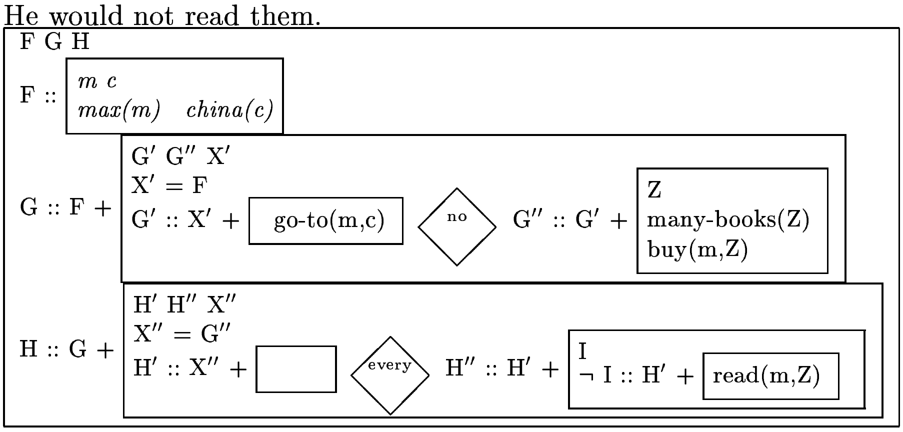
Cases of modal subordination relative to the scope argument of the quantifier **no** are quite similar to cases of modal subordination relative to a simple negation context discussed in (84). What differs is that in the latter cases the subordinated modal quantification is constrained to range over *counterfactual* worlds/states, while in the present case the

[75] In this respect a syntactic definition for accessibility may be weaker than the semantic notion of accessibility: in a fully precise representation we have to introduce a referent Y in the universe of the negated DRS in (88), together with an equation condition $Y = Z$. So Z must be defined in the domain of any state $\langle w'', i \rangle$ that is to verify this condition. The discussion shows that with slightly distinct verification conditions this is not necessarily ensured by a syntactic definition of accessibility.

[76] There might be miraculous worlds where he learns Chinese within one day, which are ruled out by the normality assumption.

quantification is constrained to worlds that are in some respect *abnormal* worlds where Max is going to China.

(88) If Max goes to China, in no case will he buy many books.
He would not read them.



Finally, it is brought out by (89a–b) that both types of modal subordination we considered now – modal subordination relative to negation, and relative to the scope argument of a modal quantifier **no** – can also be construed with an explicit antecedent clause in the modally subordinated sentence, which contradicts the "empty restrictor constraint" that Corblin(1994b:13,14) established on the basis of French data.[77]

(89) a. Max didn't buy books when he went to China.
If he had brought them back, he would not have been able to read them.

b. If Max goes to China, in no case will he buy many books.
If he brought them back, he would not be able to read them.

The similarity that in our analysis arises for these different cases of modal subordination relative to "negative" contexts is corroborated by the fact that modal subordination relative to the scope argument of the quantifier **no** is constrained to *subjunctive* mood (compare to (88)/(89)), just as modal subordination relative to a negation context (see (84) vs. (85)).

(90) a. If Max goes to China, in no case will he buy many books.
He will not read them.

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[77] Corblin's claim is that in cases of modal subordination to negative contexts ("Le mode du cas contraire") (i) the subordinated sentence does not support an overt restrictive clause (ii), unless postponed, as in (iii). It is irrelevant, as indicated by the contrast between (iii) and (iv) whether the restrictive clause itself hosts an anaphor to be bound by modal subordination (Corblin(1994b:13,14)).

(i) Jean n'a pas de voiture. (*Dans le cas contraire*) je l'aurais vue.

(ii) Pierre n'a pas de voiture. S'il ?l'avait prise aujourd'hui, ?elle nous aurait été utile.

(iii) Pierre n'a pas de voiture. Je l'aurais conduite, si son père avait accepté.

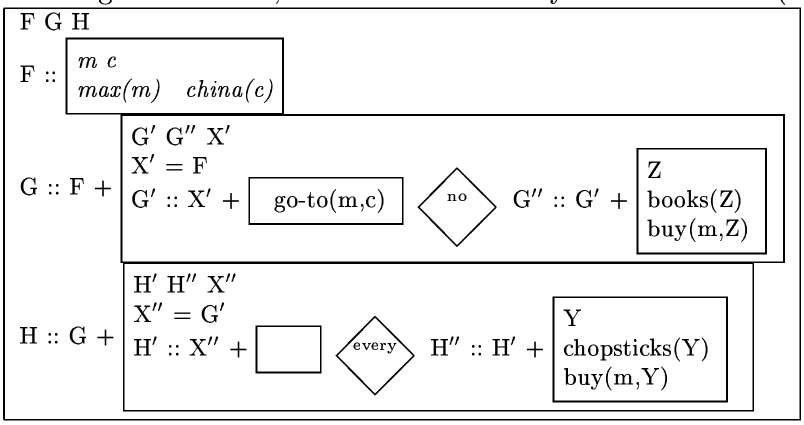
(iv) Pierre n'a pas de voiture. S'il avait eu son permis de conduire, il ?l'aurait prise.

The examples in (89) illustrate that in English – as in German – this constraint is not valid.

b. If Max goes to China, in no case will he buy many books.
   # If he brings them back, he will not be able to read them.

By contrast, once modal subordination can be understood to be relative only to the *restrictor* argument of the modal quantifier **no**, as in (91), indicative mood is fine.

(91) If Max goes to China, in no case will he buy a book. He will (only) buy chopsticks.



The question is now whether for the present cases we can simply carry over our earlier hypothesis that for modals in *indicative* mood the context referent that annotates the restrictor argument must contain a state that is tied to the world of evaluation.

If we assume – as we will do later on – that with *indicative* conditionals the normalcy selection function * will be centered,[78] i.e. the world of evaluation w will figure within the set of "normal worlds" that verify the conditional's antecedent ($w \in *(w, e(X' + K'))$), then the denotation of the annotating referent of the restrictor will contain a state that is tied to the evaluation world, and our working hypothesis is confirmed by the present data:

If the set of normal worlds that make up the quantificational domain includes the world of evaluation, then modal subordination relative to the context referent that annotates the *scope* argument of the quantifier **no** can only involve quantification over a set of worlds that does not include the world of evaluation, such that modal subordination will only be licensed if the subordinate sentence is in *subjunctive* mood (see (88) vs. (90)).

By contrast, if modal subordination is relative to the *restrictor* argument of the indicative conditional headed by the quantifier **no**, the world of evaluation will figure within the denotation of the antecedent's annotating referent, and modal subordination is licensed with indicative mood, as brought out by (91).

3.4.3 The lexical meaning of modal quantifiers and constraints on mood

As can be seen from (92), besides *in no case* there are other modal operators, such as *unlikely* in (92d), which is weaker than the quantifier **no**, and which seems to require subjunctive mood in order to allow the following sentence to engage in modal subordination.

Yet, with *unlikely* the second argument of the quantifier relation will not be the empty

[78] But, following Morreau(1992), we will *not* assume the normalcy selection function * to be centered in general (see Chapter 5).

set. Thus, there will be some "normal" worlds that verify the scope DRS – and among them, potentially, the world of evaluation. The constraint on subjunctive mood with modal subordination relative to the scope argument in (92d) is therefore not brought out by our working hypothesis.

(92) a. If Max goes to China, he (*necessarily*) will buy a book.
He will have a hard time reading it.

b. If Max goes to China, he *probably* will buy a book.
He will have a hard time reading it.

c. If Max goes to China, he *might/it's possible that he will* buy a book.
He will have a hard time reading it.

d. If Max goes to China, *it's unlikely that* he will buy a book.
i. # He will have a hard time reading it.
ii. He would have a hard time reading it.

e. If Max goes to China, *in no case* will he buy a book.
i. # He will have a hard time reading it.
ii. He would have a hard time reading it.

At first sight one could think of a constraint that restricts the use of subjunctive mood to cases where modal subordination is relative to a referent G that "picks out" a subset of worlds $cs(A) \cap cs(B)$ that is assigned a quite low probability (relative to the probability $P(cs(A))$), where $cs(A)$ corresponds to the set of "normal" A–worlds picked out by the normalcy selection function (see definition of cs in (93)): According to the tentative definitions given in (93), this would apply to *unlikely* and *no*, while for *possibly* it is not excluded that the probability $P(cs(A) \cap cs(B))\ /\ P(cs(A))$ reaches a high value.

(93) a. $\mathrm{Quant}_M(\textit{necessarily}) = \{\ \langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) = 1\}$

b. $\mathrm{Quant}_M(\textit{probably}) = \{\ \langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) \geq .75\}$

c. $\mathrm{Quant}_M(\textit{possibly}) = \{\ \langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) \geq 0\}$

d. $\mathrm{Quant}_M(\textit{unlikely}) = \{\ \langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) \leq .25\}$

e. $\mathrm{Quant}_M(\textit{no}) = \{\ \langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) = 0\}$

where cs the *context set* of a set of states $\mathbf{X}$: $cs(\mathbf{X}) = \{w'\colon (\exists x')\langle w', x\rangle \in \mathbf{X}\}$.

We could argue that this constraint also covers cases of modal subordination relative to simple negation, by assigning the probability 0 to $P(cs(A) \cap cs(B))\ /\ P(cs(A))$ for the negation condition $\neg\ G :: F + K'$, with A the denotation of F and B the set of states denoted by F that can be extended to states in the denotation of G.[79] I.e. we could turn context dependent negation into a generalized quantifier **no** as in (93e).

[79]What differs then relative to (93e) is the missing restriction to "normal" worlds.

But there seem to be other factors that influence the choice of indicative vs. subjunctive mood for modal subordination relative to non–universally quantified modal contexts.

Consider first the contrasting pair in (94), with the modal expression *there is a slight chance that*, which presumably denotes the same relational meaning that we assigned to **unlikely** in (93d), and which assigns a quite low relative probability to the worlds that verify both restrictor and scope argument. For (94a) modal subordination with indicative mood is fine, while addition of *only* in (94b) makes indicative continuation rather odd.

Provided the addition of *only* doesn't change the denotational meaning of the complex quantifier (to express increased relative probability), this contrast seems to indicate that the choice of indicative vs. subjunctive mood is not determined solely by a low relative probability of the nuclear scope relative to the restrictor argument. Some additional factor comes in, which intuitively comes down to some kind of "perspective" or "polarity".

(94) a. If Max goes to China, there's a slight chance that he will buy books.
If he gives them to his friends, they will admire them.

b. If Max goes to China, there's only a slight chance that he will buy a book.
If he will give them to his friends, they will admire them.
He would not be able to read it.

Another contrasting pair is (95) and (96). The first sentences differ only wrt. the quantifier that hosts the modal construction: *es ist wenig wahrscheinlich* (there is a low probability) vs. *es gibt eine geringe Chance* (there is a slight chance). We take it that these two lexical forms denote the very same relational quantifier, corresponding to *unlikely* in (93d). But again these different lexical forms of the quantifiers determine a clear–cut distinction as to the possibility of licensing modally subordinated sentences in indicative vs. subjunctive mood. In (95) we cannot continue with the indicative sentence (95a), but only with the subjunctive (95b). Example (96), by contrast, does only license modal subordination in indicative mood, while prohibiting a subjunctive subordinated sentence.[80]

(95) Wenn Fritz nach China reist, ist es *wenig wahrscheinlich* daß er ein Buch kauft.
'If Fritz is going to China, it is hardly probable that he will buy a book.'

a. # Er wird es zwar nicht lesen können, aber er wird sich an der Schrift erfreuen.
'He will not be able to read it, but he will adore the script.'

b. Er würde es nicht lesen können.
'He would not be able to read it'.

(96) Wenn Fritz nach China reist, *gibt es eine geringe Chance, daß* er ein Buch kauft.
'If Fritz is going to China, there is a slight chance that he will buy a book.'

a. Er wird es zwar nicht lesen können, aber er kann sich an der Schrift erfreuen.
'He will not be able to read it, but he will adore the script.'

[80] Some speakers found it helpful to use an intonation for (96) which has *geringe* downstressed.

b. # Er würde es nicht lesen können.
'He would not be able to read it'.

We will first sketch a possible solution to account for this contrast, which in our view is not fully convincing.

At least for (95) vs. (96) one could claim that the quantifier *es gibt eine geringe Chance* is to be analyzed as *es ist nicht sehr wahrscheinlich* (there is not a high probability).[81] The modal quantifier (*sehr wahrscheinlich*) could then be taken to be either within the scope of the negation operator, or as taking the negation in its nuclear scope. In our analysis, however, none of these possibilities licenses anaphoric reference of the pronoun *it* to *a book*.

One could argue that this is a weakness of our present analysis, and that modal subordination of subjunctive sentences should be licensed by some "inherent" force of the subjunctive, which is to anaphorically refer to *the other case*, to be computed as the complement set of some accessible context (referent). On this assumption we could, in sequences like (97), take the subjunctive modal to compute *the other case* as the complement set of the set of worlds in which the first sentence is true, and similarly for (95) we could assume that the subjunctive modal in (95b) computes *the other case* from the scope argument of the preceding quantified structure.

(97) Max doesn't own a car. I would have noticed.

While this might seem to be an attractive solution, it suffers from the difficulty that the use of subjunctive mood by itself does not generally license computation of such a complement set of worlds to establish modally subordinated discourses. This is illustrated by (98), where continuation with (98a) is completely incoherent. However, once we add the particle *otherwise* or a restrictor clause that explicitly introduces the *other case*, as in (98b), the discourse is perfectly wellformed and intellegible. In our view, the example strongly suggests that the computation of the complement set, *the other case*, is induced by the explicit particle *otherwise* or by negation within the conditional antecedent, but not triggered by subjunctive mood itself.[82] The wellformedness of examples like (97) can still be explained on this assumption, if we assume – as we do in our analysis – that negation introduces a "counterfactual" context referent which is accessible for anaphoric reference to establish the modal base of the subjunctive modal in the second sentence. There is no need, then, to assume computation of *the other case* to be triggered by subjunctive mood itself. See also Section 4.3.4 for more detailed discussion.

(98) Fred got a letter today.

a. # He would have been unhappy.

b. Otherwise/ If not/ If he hadn't, he would have been unhappy.

So we will stick with the assumption that for both (99a) and (99b) we have to assume a quantifier (**unlikely**) that assigns a quite low (relative) probability to Fred buying books

[81] Ede Zimmermann and Uwe Reyle (p.c.) mentioned this possibility.

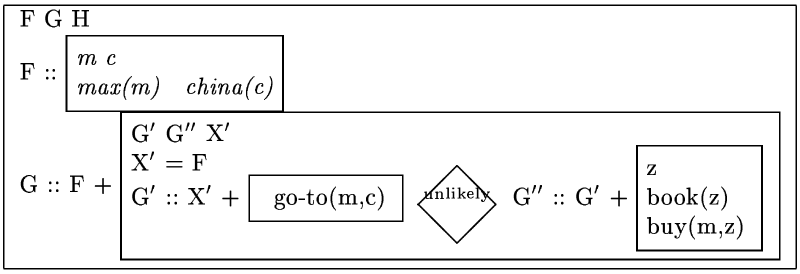
[82] In French you use the particle *sinon*, which also nicely renders the meaning of *the other case*.

in China, and which *in principle* makes accessible the context referent G'' as an antecedent to establish the anaphoric modal base of a subsequent, modally quantified sentence.

The difference as regards the licensing of modally subordinated discourse in indicative vs. subjunctive mood must then be explained in terms of additional restrictions (or meaning components) of *eine geringe Chance* vs. *wenig wahrscheinlich* that further distinguish these two quantifiers, and which correspond to their intuitive difference in "polarity" or "perspective".

(99) a. Wenn Fritz nach China fährt, *ist es wenig wahrscheinlich* daß er ein Buch kauft.

b. Wenn Fritz nach China fährt, *gibt es eine geringe Chance* daß er ein Buch kauft.

c. 

An analysis of modal subordination that is closely related to a 'compset' approach to modal subordination is Kibble(1996), who independently investigates modal subordination with graded modals – while not accounting for subordination relative to negation contexts.[83]

In order to capture the restrictions in (100) he introduces a notion of *focus* which he takes to be related to the monotonicity properties of relational quantifiers. The assumption is that for monotone decreasing quantifiers such as *wouldn't* and *unlikely* both the "refset" (the set of worlds here Mary takes the bus) and the "compset" (those worlds where she doesn't take the bus) are put into focus, such that, in principle, both are available for subsequent reference, i.e. modal subordination. Monotone increasing quantifiers, on the other hand, are assumed to put only the "refset" in focus. The compset can only be picked up by use of extraneous mechanisms, e.g. the use of *otherwise*.

This analysis predicts that – by selection of the compset – *She would cycle* in (100) can be interpreted to state that in those worlds where Mary doesn't take the bus she will cycle. Selection of the refset, by contrast, is claimed to be ruled out by inducing contradiction: Mary cannot simultanously take the bus and cycle.

(100) Mary **wouldn't/is unlikely to/#might/#would probably** take the bus to work. She would cycle. Kibble(1996:4)

Kibble(1996) doesn't state additional restrictions to constrain modal subordination. E.g. he doesn't rule out a modal subordination reading for (101b) that is equivalent to (101a). Yet, according to our intuition the indicative continuation in (101b) cannot be read as modally subordinate.

[83]His framework is Update Semantics. As his work came to my attention only recently, I will discuss it only briefly.

(101) a. Mary **wouldn't/is unlikely to** take the bus to work. She would fall asleep.

b. Mary **wouldn't/is unlikely to** take the bus to work. She will fall asleep.

Also, for modal subordination relative to monotone decreasing quantifiers the selection of the compset vs. refset is not constrained in any way – besides ruling out those cases where selection of one or the other set leads to inconsistency. It is not possible to constrain the selection in terms of constraints on sentence mood: in (100) the subjunctive sentence is relativized to the compset, while in (101a) the subjunctive is relativized to the refset. Constraints on sentence mood to distinguish (101a–b) are therefore not easily captured in this analysis.

But more importantly, – and here the discussion ties up with what we discussed above – we doubt that with monotone decreasing quantifiers the "compset" can be freely chosen, even with subjunctive mood. A case in point is (102), where the subordinated sentence is not in contradiction with the scope argument of the quantified modal sentence. Here the 'refset' corresponds to the worlds where Mary takes the bus to drive to a distant place, while the 'compset' comprises worlds where she doesn't go to such a place, or uses some other device, maybe a taxi or her own car.
(102a) with indicative mood we consider as odd on a modal subordination reading.[84] (102b) is fine on a modal subordination reading, yet only with relativization to the 'refset': Mary would get lost if she took the bus. We cannot get subordination to the 'compset', meaning that Mary would get lost if she took e.g. a taxi or went on her own car. We also do not get the 'compset' reading by use of *otherwise* in (102c), which is what Kibble predicts to be possible for monotone increasing quantifiers.

(102) a. Mary **wouldn't/is unlikely to** take a bus to drive to a distant place.
She will get lost.

b. Mary **wouldn't/is unlikely to** take a bus to drive to a distant place.
She would get lost.

c. Mary **wouldn't/is unlikely to** take a bus to drive to a distant place.
Otherwise she would get lost.

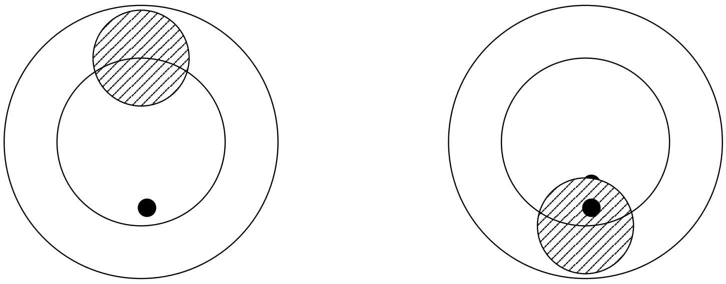
Given the data in (102) we reject an analysis of (monotone decreasing) graded modals to make accessible the 'compset' of their scope argument to license modal subordination contexts. Instead we propose an analysis of modal subordination with graded modals that is in accordance with distinct monotonicity properties of modal quantifiers.

Recall that for *indicative* conditionals we assume the normalcy selection function to be centered, i.e. the world of evaluation figures within the set of "normal" worlds where the antecedent is true (cf. Stalnaker(1976)). Thus, when evaluating the conditionals in (99a–b), the world of evaluation w will be a member of the set of "normal" worlds $*(w, g(F+K'))$, g in the denotation of G, where "everything holds which normally holds, in w, relative to a context F where Max goes to China". But note that a subset of these "normal" worlds,

[84] See below for the non–subordination reading.

where Max in addition will buy a book in China, may or may not contain the evaluation world w.

The two possibilities are graphically illustrated below.



In both figures the outermost circle is to represent all worlds (relative to F) where Fred goes to China, while the inner circle indicates the subset of "normal worlds" out of these, relative to the evaluation world w which we represent by the black dot. The shaded region is intended to correspond to the set of worlds where Fred goes to China and where he buys books there, which (by its little size) is here graphically represented to be quite improbable (relative to the set of normal worlds where he visits China). These common aspects of the two figures we can take to correspond to the invariable meaning of the relational quantifier **unlikely** that is denoted by the two quantificational terms in (99).

The critical meaning component that distinguishes these two quantifiers, and which is responsible for the contrast between (95) and (96), can now be seen to be grounded in the fact that the set of (normal) worlds where Fred goes to China *and* buys books does not contain the world of evaluation in the first figure, which is to illustrate the meaning of *wenig wahrscheinlich*, while the situation in the second figure, illustrating the meaning of *es gibt eine geringe Chance*, is characterized by the fact that the subset of (rather improbable) worlds out of those normal ones where Fred is in China, namely those where he buys books, *does* include the world of evaluation.

Thus, we assume that the difference in meaning between the two quantifiers *es ist wenig wahrscheinlich* and *es gibt eine geringe Chance* is to be captured by way of a restriction that constrains the second argument in the quantifier's denotation (i) to contain a state pertaining to the evaluation world with *es gibt eine geringe Chance*, and (ii) *not* to contain such a state in the case of *es ist wenig wahrscheinlich*.[85]

The differences in licensing modally subordinated contexts in indicative vs. subjunctive mood can then be accounted for by our working hypothesis that worked well for modal

[85] If these different constraints that the two quantifiers impose on the denotation of their second argument are *semantic* constraints, then these constraints could be defined along the lines of (i) and (ii), where A and B are as defined in Section 3.3, and cs as in (93) above.

(i) $\langle w, f\rangle \models_M$ Quant(*wenig wahrscheinlich*)(A, B) iff
$\langle A, B\rangle \subseteq \{\langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) \leq .25\}\ \&\ w \notin cs(B)$
[or else: $\langle A, B\rangle \in$ Quant$_M$(unlikely)$(A, B)\ \&\ w \notin cs(B)$].

(ii) $\langle w, f\rangle \models_M$ Quant$_M$(*geringe Chance*)(A, B) iff
$\langle A, B\rangle \subseteq \{\langle A, B\rangle : P(cs(A) \cap cs(B))\ /\ P(cs(A)) \leq .25\}\ \&\ w \in cs(B)$
[or else: $\langle A, B\rangle \in$ Quant$_M$(unlikely)$(A, B)\ \&\ w \in cs(B)$].

subordination relative to negation contexts: that for modals in *indicative* mood the denotation of the annotating referent of the restrictor must contain a state that is tied to the world of evaluation, while – as we assume for German – modal expressions in subjunctive mood are constrained in such a way that the denotation of the annotating referent of the restrictor does *not* contain such a state.

Thus, the modally subordinated sentences in (95) are anaphoric to a context referent G'' whose denotation does *not* contain the evaluation world, such that only the subjunctive (95b) is appropriate, which asserts that in all such improbable and "counterfactual" worlds (if everything holds that is assumed to be normally the case there) he would not read the book. In (96), however, the denotation of G'' will contain the evaluation world, and therefore the indicative sentence (96a) is predicted to be wellformed.

It is then also predicted that modal subordination relative to conditionals headed by the quantifiers *wenig wahrscheinlich* and *eine geringe Chance* – besides the constraints on sentence mood illustrated by (95) and (96), where subordination is relative to the *scope argument* – will only be licensed with indicative mood, in both cases, if it is relative to the *restrictor argument.* This is borne out by (103).

(103) a. Wenn Fritz nach China fährt, ist es *wenig wahrscheinlich* daß er Bücher kauft.
Er wird viele Kulturdenkmäler besichtigen.
Er würde viele Kulturdenkmäler besichtigen.
'He will/would visit monuments.'

b. Wenn Fritz nach China fährt, *gibt es eine geringe Chance* daß er Bücher kauft.
Er wird viele Kulturdenkmäler besichtigen.
Er würde viele Kulturdenkmäler besichtigen.
'He will/would visit monuments.'

Also, going back to indicative conditionals that host the quantifier **no**, our generalization still accounts for the fact that modal subordination relative to the scope argument in (88) requires subjunctive mood, while in (91) the subordinated sentence, being relative to the restrictor argument, is wellformed in indicative mood: restricting the indicative conditional to quantify over a set of normal worlds w' that *includes* the world of evaluation w, given the semantics of the quantifier **no**, will constrain the worlds in the denotation of G'', the referent that annotates the scope DRS, not to contain the world of evaluation. Modal subordination relative to G'' can therefore only succeed if in subjunctive mood. The referent G' that annotates the restrictor argument of the indicative conditional, however, *will* contain a state pertaining to the evaluation world, and therefore modal subordination in indicative mood, as in (91), is predicted to be wellformed.

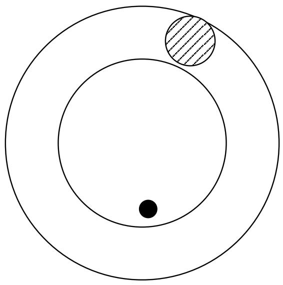
A closer look at our pragmatic constraint for *wenig wahrscheinlich* – in particular when compared to the semantics of *in no case* – brings out that the additional restriction that the second argument of the quantifier must not contain the world of evaluation makes *wenig wahrscheinlich* equivalent to *in no case* in one particular respect: it is predicted that from both (99a) and (88) we can conclude that in none of the worlds that might turn out as the actual world (i.e. in none of the worlds that are in the context set, in Stalnaker's terminology), Fritz will buy a book in China:[86] if for every state $\langle w, g \rangle$ in the denotation

[86]This has been observed by Tim Fernando and Hans Kamp.

of G in (99c) the centered normalcy selection function $*(w, g(X' + K'))$ yields a set of normal worlds where Fritz goes to China that includes w, and we demand that for *wenig wahrscheinlich* w is not within the subset of those normal worlds where Fritz buys books in China, then in fact *none* of the worlds that are in the denotation of G support that Fritz will go to China and buy a book. And it is obvious that for (88), with *in no case*, we get the very same result.

At first, this seems to be rather bewildering. On closer inspection however, this might not be an unwelcome feature.

First note that the denotational meanings of *wenig wahrscheinlich* and *in no case* are still distinguished. This is illustrated by help of the figure below, where we characterize the meaning of *in no case*, and which is to be contrasted to the above (lefthand side) figure for *wenig wahrscheinlich.* In both cases the normal worlds where Fritz goes to China, the innermost sphere, contains the world of evaluation, while the worlds where in addition he buys books, the shaded region, does not include the evaluation world. The distinct quantificational forces, however, are reflected by the fact that for *wenig wahrscheinlich* there are still some (yet rather improbable) worlds within the set of normal ones that support that Fritz will buy a book in China, albeit not the evaluation world, while for *in no case* we find that none of the "normal worlds" where Fritz is visiting China, and especially not the evaluation world, is a world where he will buy a book there.



Moreover, the constraints that we assumed for the quantifiers *wenig wahrscheinlich* and *eine geringe Chance* turn out to be in accordance with their monotonicity properties.[87] As illustrated by (104a–b), *wenig wahrscheinlich* behaves like a monotone decreasing quantifier, while *eine geringe Chance* behaves like a monotone increasing quantifier.[88]

(104) a. Wenn Max nach China fährt, ist es wenig wahrscheinlich daß er Bücher kauft.
$|\!\sim$ Wenn Max nach China fährt, ist es wenig wahrscheinlich daß er Bücher über Semantik kauft.
$|\!\not\sim$ Wenn Max nach China fährt, ist es wenig wahrscheinlich daß er etwas kauft.

b. Wenn Max nach China fährt, gibt es eine geringe Chance daß er Bücher kauft.
$|\!\not\sim$ Wenn Max nach China fährt, gibt es eine geringe Chance daß er Bücher über Semantik kauft.
$|\!\sim$ Wenn Max nach China fährt, gibt es eine geringe Chance daß er etwas kauft.

[87] See e.g. Barwise&Cooper(1981), Partee et al(1990).

[88] For modal quantifiers we use the sign $|\!\sim$ for nonmonotonic inference (see Chapter 5).

These typical monotonicity properties can be read off from the above figures that characterize the meaning of *wenig wahrscheinlich* and *geringe Chance*:

For *wenig wahrscheinlich* (on the lefthand side) every subset of worlds $B' \subseteq B$ of the shaded region, to represent the worlds that verify the scope argument, will be assigned a low(er) probability relative to the set of "normal" worlds that verify the restrictor, and necessarily, it will not contain the world of evaluation. This is in accordance with the valid (defeasible) inference in (104a). For supersets B'' of B, it is not necessarily the case that they are assigned a low relative probability. I.e. the second conclusion in (104a) can only be true on a weak reading, since Max buying something in China may be much more probable than buying books. However, it is *not* the case that any superset B'' of B will not contain the world of evaluation. This predicts the failure of the second inference in (104a).

For *eine geringe Chance*, on the other hand, it is the case that any subset $B' \subseteq B$ will be a set of worlds that is assigned a low relative probability, but it will not necessarily include the world of evaluation. This predicts the failure of the first (defeasible) conclusion in (104b). But it is necessarily the case that every superset B'' of B will contain the world of evaluation, and thus we expect the second conclusion in (104b) to go through on a weak reading, since the set of worlds where Max buys something in China might be much more probable than those where he buys books.

Finally, as noticed above, in examples like (105a–b) the indicative sentences cannot be analyzed as modally subordinate to the scope argument of the preceding modal.

Therefore, what we see by (105a–b) is that even the weaker *unlikely* is perfectly consistent with the non–subordinated *assertion* that Mary will cycle, i.e. that there is no world within the (new) context set where Mary takes the bus, and correspondingly for (105b), which we interpret to mean that Mary would (possibly) not get lost if she took the bus. Even though the semantics of *unlikely* predicts that there is a set of possible worlds with low relative probability where Mary takes the bus (and thus will not get lost), it is perfectly consistent to continue with the assertion that she will get lost (in the actual world or context set).

This is in accordance with our constraint for graded modals like *wenig wahrscheinlich* and *unlikely*, that the set of normal worlds that verify both the restroctor and scope argument may not contain the world of evaluation, which in our analysis predicts that the actual context set does not contain a world where the antecedent and scope of the graded modal hold true.[89]

(105) a. Mary **wouldn't/is unlikely to** take the bus. She will cycle.

b. Mary **wouldn't/is unlikely to** take the bus. She will get lost.

But how then to account for Kibble's example (100)? Since we do not allow for direct reference to the 'compset', it seems as if we couldn't account for these cases. But a closer look at the example shows that the modal quantifiers *wouldn't* and *unlikely* are to be read as implicitly restricted, as in (106). As for *wouldn't* in (106a), we will be able to give a

[89] In fact, *will* in (105b) could also be analyzed as an indicative modal, to be interpreted relative to the (main) context established by the preceding conditional. This then even more strongly supports our analysis of *unlikely*, which predicts that Mary will not take the bus in any of the worlds that make up the "context set".

sound analysis for the modally subordinated subjunctive sentence once we have dealt with counterfactual conditionals, in Section 4.3. The subordinated sentence will then be analyzed as being relative to the context set up by the restrictor argument. As for *unlikely*, we assume that the (here explicit) restrictor argument must be in indicative mood. Subordination relative to the restrictor argument will then also trigger indicative mood, as in (103).[90]

(106) a. If Mary wanted to go/went to work, she wouldn't take the bus.
She would cycle.

b. If Mary wants to go/goes to work, it's unlikely that she will take the bus.
She will cycle.

We have now anticipated quite a bit of what we will pursue further in Sections 4.1.5 and 4.3.4, where we try to establish (further) constraints on modal subordination. We did so to give a motivation for the particular analysis of modal constructions we proposed in Section 3.3: The modal operator is represented as a generalized quantifier that is characterized as anaphorically dependent in its restrictor argument. The truth of such quantified conditions is determined by the denotation of the quantifier Q that hosts the quantified structure, where the first argument of the quantifier is additionally constrained in terms of the *normalcy selection function* $*$. By contrast, the context referents G' and G'' that annotate the restrictor and scope arguments denote their full (context dependent) *intension*, i.e. they are not subject to the normalcy restriction.

We have been able to show that this analysis is flexible enough to account for the some problematic cases of modal subordination we investigated in this Section: modal subordination relative to negation contexts, and relative to the restrictor vs. scope argument of different "types" of non–universally quantified modal operators.

Another phenomenon that depends on this feature of the analysis is conditional variability, discussed in Section 2.2.2, but which we will only address in Chapter 5.

As a "side–effect" we have been able to illustrate that it is possible, in this *anaphoric* approach to modal subordination, to define constraints on sentence mood that severely restrict the potential of modal sentences to engage in modal subordination. These and other constraints will be further investigated in Sections 4.1.5 and 4.3.4.

3.4.4 A problem for the anaphoric account of modal subordination?

As shown above our anaphoric analysis of modal subordination copes with a wide variety of data. Yet there is one problem for it. The conditionals (107a–b) are semantically equivalent, but structurally distinct. While the modal expression in (107b) denotes the *single* relational quantifier **no**, the conditional in (107a) is universally quantified with embedded negation, i.e. the context referent that represents the negated context is defined within the conditional's scope and is not accessible for the subsequent modal sentence to induce modal subordination.

(107) a. If Max goes to China, he will *not* buy books. He would not read them.

[90] As far as we can see, Kibble's analysis, where we can have reference to the "compset", predicts a reading of (106) where Mary would/will cycle, but not necessarily to go to work.

b. If Max goes to China, *in no case* will he buy books. He would not read them.

Note also that both the analysis of Geurts(1995) and of Kibble(1996) – essentially anaphoric accounts – are plagued by the very same problem. In Kibble's analysis this goes easily unnoticed, since he treats *wouldn't* as a (single) monotone decreasing quantifier.

In principle, there are three possibilities to approach this problem.

First, one could take this as a weakness of the anaphoric approach to modal subordination, and either adopt the accommodation account of Roberts(1989), or else one could argue instead that the inherent force of subjunctive mood is to refer to *the other case*, computed as the complement (set) of some *accessible* context (referent) (cf. Corblin(1994b)). But as already noted, besides the wellformed subordination cases (107) and (108) this latter approach predicts a modal subordination reading of (109a) to the effect that Fred would have been unhappy if he *hadn't* got a letter. Yet (109b) shows that reference to *the other case* is only possible with *otherwise.*

(108) Max didn't buy a microwave oven. He wouldn't know what to do with it.

(109) Fred got a letter today.
a. # He would have been unhappy.
b. Otherwise/ If he hadn't, he would have been unhappy.

Another way to account for (107a) is to analyze it as structurally equivalent to (107b), given the equivalence of $\forall\neg$ and $\neg\exists$, as it has been implicitly assumed in Kibble(1996). This can be defended in view of the syntax–semantics interface, since the (implicit) modal quantifier and sentential negation are both located within the functional projection of sentence structure.

Finally one could consider an analysis of quantificational structures as *externally dynamic* (see Fernando(1993)), yet for *context referents* only, which – in conjunction with mood constraints on anaphoric binding – is considerably more restricted than an overall externally dynamic analysis. Pending closer investigation of the latter alternative we prefer the second.

3.4.5 A non–argument against the anaphoric account of modal subordination

Before concluding this Section, we have to point out a potential problem for our analysis of modal operators and modal subordination, where the annotating referent G'' of the modal's scope denotes the *update* of the restrictor's annotating referent G' with the scope DRS K''.

The critical example, (110), is mentioned in Corblin(1994a). Both the anaphoric pronoun *they* and the presupposition triggered by *refuse* in the scope of the second conditional require that the sentence be interpreted as modally subordinated to the scope argument of the first conditional.[91] Yet, it is not possible, in our framework, to analyze the antecedent of the

[91] In fact, given that the referent for John will figure in the universe of the main DRS, we may assume that the phrase *his parents* is interpreted as specific such that the corresponding referent and condition will also be introduced in the main DRS. Modal subordination is then only required to enable binding of the presupposition triggered by *refuse*.

second conditional to be modally subordinated to the consequent of the first conditional *without, at the same time, inducing modal subordination to its antecedent*: the context referent that annotates the scope of the first conditional denotes the extended context consisting of the antecedent *and* scope DRS. Now, in the problematic example (110) the antecedents of the first and second modal construction are incompatible.

So there is no way, in our framework, to account for examples of this type in terms of modal subordination, i.e. by anaphoric reference to the context referent introduced by the preceding modal's scope argument.[92]

(110) If John has finished his homework, he asked his parents to go and play outside.
If he has not finished his homework, they refuse. Corblin(1994a:15)

But the example is special in two ways: First, it involves a strong parallelism due to the contrasting antecedent DRSs and the related predicates *ask (for permission)* and *refuse (permission)* in the consequent.[93] Secondly, the predicate *refuse* presupposes that someone has asked for permission. So we could argue that the second conditional in (110) is not *modally subordinated* to the first, but – given the strong parallelism and the presupposition triggered by *(the parents) refuse* – involves *accommodation* of a condition corresponding to *John asks his parents for permission (to go and play outside)* that is contextually supplied by the first conditional's scope.

This solution is of course suspect in that it seems to undermine the anaphoric account of modal subordination. Yet, if modal subordination relative to the "isolated" scope DRS of a modal quantifier were a general option, we would expect (111) to be fine – yet it isn't.

So we tend to think of (110) as a case not of modal subordination, but of presupposition accommodation, which is favoured by the contrasting antecedents.

(111) If John has bought a car, he will ask Mary to go for a picnic with him.
If she refuses, it is because he has no car.

Now that we have laid down the main intuitions and the basic formal framework for our analysis of "generalized" context dependence in modal constructions, we can turn to investigate in more depth the analysis of the diverse phenomena to be discussed: graded and (multiple) relative modality, counterfactuality and non–epistemic *if*–conditionals, where for all of these varieties of modal contexts we will examine their potential to engage in modal subordination constructions. The topics of vagueness and variability of conditionals will get special attention in Chapter 5.

3.5 A digression: Modal subordination in disjunctive contexts

At first sight, disjunction does not seem to pertain to the subject of context dependence in modal constructions. Yet, it has been argued, in Roberts(1989), that a certain type of disjunctive contexts, exemplified by the famous bathroom example (112),[94] is to be analyzed

[92]We disregard the fact that the conditionals in (110) do not in fact invite for a *modal* interpretation. Changing the tenses to future tense will allow for a modal reading.

[93]See Asher(1993) for work on parallelism and contrast and their implications for rhetorical relations in discourse.

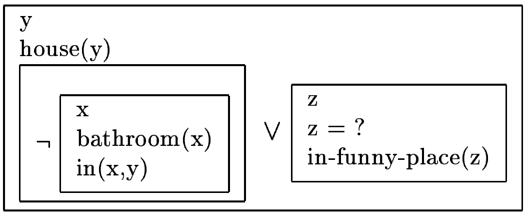
[94]The example is attributed to Partee in Roberts(1989).

as an instance of modal subordination.

The anaphoric pronoun *it* in the second conjunct is to be interpreted as dependent on the antecedent *(no) bathroom* in the first disjunct, although according to the standard accessibility restrictions of DRT, no such anaphoric relation is predicted (K&R(1993:185ff)).[95] In fact, the anaphoric link in (112) is twice unexpected, since the antecedent is not only within the scope of the first disjunct DRS, but still "further down" within the scope of the negation operator (113).[96]

(112) Either there is no bathroom in this house, or it is in a funny place. Roberts(1989:702)

(113)



On the other hand, as observed Kamp&Reyle(1993), these cases are in general more easily available than those not involving a negation operator, as e.g. (114).

(114) ?Jones owns a car or he hides it. K&R(1993:188)

Several solutions have been offered for these data, some of them making reference to modal subordination.

Kamp&Reyle(1993) focus, as an explanation, on the meaning of (exclusive) *or*, which in (112) and (114) can be made more explicit by adding *else* or *otherwise* to the second disjunct, which is thereby explicitly marked as *the other case*: the negation of the first disjunct. If this contrastive meaning of *or* is reflected by DRS construction, the representations to be obtained for the above examples are (115) and (116), respectively: Here the representation of the negation of the first disjunct is added to the representation of the second disjunct, where the negation of a negated DRS K' is – by double negation elimination – represented by the DRS K' itself. By this move the judgements for (112) and (114) are brought out: while the (accommodated) conditions in the second disjunct of (115) provide an antecedent for the pronoun *it*, this is not so in (116), where the antecedent for the pronoun is under the scope of negation.

So this analysis of bathroom–type sentences bears on (i) the meaning attributed to exclusive *or* ($\phi \vee \psi \equiv \phi \vee (\neg\phi \ \& \ \psi)$) and (ii) double negation elimination.

[95] The relevant examples are (i) and (ii), which both seem to be odd, unless, in (ii) *a Porsche* is interpreted specifically, i.e. gets introduced within the superordinate DRS.

(i) # Bill owns it or Fred owns a Porsche.

(ii) # Bill owns a Porsche or Fred owns it. K&R(1993:186)

[96] The observation that anaphoric pronouns cannot (in general) be bound to indefinite NPs within the scope of a negation operator is originally due to Karttunen(1976).

(115)
$$\begin{array}{|l|}\hline \text{x} \\ \text{house(x)} \\ \begin{array}{|l|}\hline \neg\ \begin{array}{|l|}\hline \text{y} \\ \text{bathroom(y)} \\ \text{in(y,x)} \\ \hline \end{array} \\ \hline \end{array} \ \vee\ \begin{array}{|l|}\hline \text{z} \\ \text{bathroom(z)} \\ \text{in(z,x)} \\ \text{funny-place(z)} \\ \hline \end{array} \\ \hline \end{array}$$

(116)
$$\begin{array}{|l|}\hline \text{j} \\ \text{Jones(j)} \\ \begin{array}{|l|}\hline \text{x} \\ \text{car(x)} \\ \text{owns(j,x)} \\ \hline \end{array} \ \vee\ \begin{array}{|l|}\hline \neg\ \begin{array}{|l|}\hline \text{z} \\ \text{car(z)} \\ \text{owns(j,z)} \\ \hline \end{array} \\ \text{hides(j,?)} \\ \hline \end{array} \\ \hline \end{array}$$

Roberts(1989) conceives of (112) as an instance of modal subordination.

> On pragmatic grounds, we may assume that neither disjunct of a disjunction is asserted, and hence that both are nonfactual. We have seen above that any sentence uttered in a nonfactual mood may justify the accommodation of a hypothetical common ground. We often take disjuncts to be alternative answers to the same topic of discussion. In [(112)], we may naturally assume that that topic is whether there is a bathroom in this house. The first disjunct entertains a negative answer to that question, so it seems perfectly natural to assume that the second disjunct pertains to the possibility of a positive answer to that same question. *Thus, the accommodation of the portion of the representation of the first disjunct which is under the scope of the negation operator may be seen as the most natural means of providing an antecedent for the second disjunct, and hence for the pronoun* it *within it.* We then may build a DRS for [(112)] such as [(117)].
> Roberts(1989:702, italics added)

We perfectly agree with the first part of Roberts' statement, to wit that each of the disjuncts can considered as a non–factual context, to be interpreted as disjunctive answers to an accommodated "hypothetical common ground". Yet it is not so clear to us how this contention motivates – without further assumption – the particular analysis that Roberts assigns to (112) in (117), where the negated portion of the first disjunct DRS is to be accommodated into the restrictor of a universal modal operator embedded within the second disjunct, which takes the representation for the second disjunct clause in its scope. As we will argue below, this particular analysis crucially relies on the semantics of exclusive *or*, which characterizes the two non–factual disjuncts as positive vs. negative answers relative to the accommodated "hypothetical common ground".

(117)
$$\begin{array}{|l|}\hline \text{x} \\ \text{house(x)} \\ \begin{array}{|l|}\hline \neg\ \begin{array}{|l|}\hline \text{y} \\ \text{bathroom(y)} \\ \text{in(y,x)} \\ \hline \end{array} \\ \hline \end{array} \ \vee\ \begin{array}{|l|}\hline \begin{array}{|l|}\hline \text{z} \\ \text{bathroom(y)} \\ \text{in(y,x)} \\ \hline \end{array} \ \Box\ \begin{array}{|l|}\hline \text{z} \\ \text{z = y} \\ \text{funny-place(z)} \\ \hline \end{array} \\ \hline \end{array} \\ \hline \end{array}$$

Also, though (117) is logically equivalent to (115), but this is not by itself sufficient to take (117) for granted as an appropriate discourse representation structure. To see this, let us first have a look at another type of disjunctive discourse, discussed by Landman(1986).

Landman(1986) takes (exclusive) disjunction $\phi \vee \psi$ to be equivalent to $\neg\phi \rightarrow \psi$ & $\neg\psi \rightarrow \phi$, yet he does not resort to the notion of modal subordination to motivate this equivalence. Also he remains uncommitted to whether the representation to be assigned to a disjunctive sentence should be (26) or (27).

> I will not discuss the semantics of disjunction here. I will simply assume that a disjunction is entered into the discourse as:
>
> (26) $< \varphi > \vee < \psi >$
>
> introducing subordinated discourses. If you want, you can also enter it like:
>
> (27) $< \neg\varphi > \rightarrow < \psi >, < \neg\psi > \rightarrow < \varphi >$
>
> I will assume anyway that the embedding conditions will give (26) and (27) the same interpretation. Landman(1986:202)

Landman is primarily concerned not with anaphoric reference "within" disjunctive sentences, as in (112), but with cases of "extended disjunctive contexts", dubbed *modal splitting*, where a pronoun or definite description within a disjunct of a subsequent sentence is bound to an antecedent within a disjunct of a preceding sentence, as in (118) and (119a).

(118) You will stay unmarried, or you will marry a tramp.
You'll become a nun, or the tramp will beat you regularly.
Either way you'll have a miserable life. Landman(1986:205)

(119) a. Call this number. The phone will be answered by either a doctor or a secretary. The doctor can tell you rightaway what's the matter with you, or the nurse can make an appointment for you.

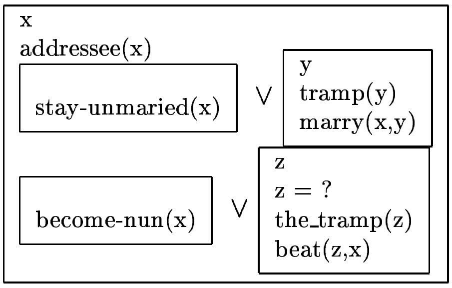
b. A doctor or a secretary will answer. If a doctor answers he can tell you what is wrong. If a secretary answers, she can make an appointment. Landman(1986:205)

For the analysis of this type of discourse subordination Landman refers to Roberts' notion and analysis of *modal subordination.*

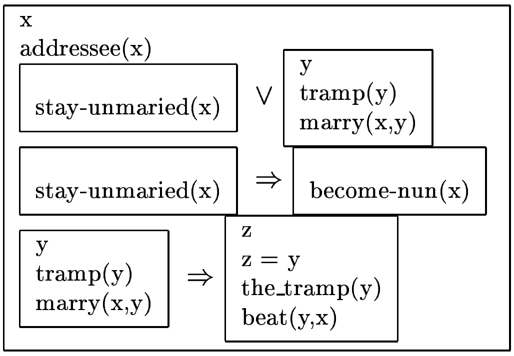
> It is not difficult to find examples of modal subordination with disjunction as well. I will here draw the attention to a particular kind of modal subordination, that I will call *modal splitting.*
>
> If in the discourse there are two subordinated lines of thought that are distinguished as competitive alternatives, and the discourse contains enough indications (like sameness of mood, relevance, etc.) that the asserted alternatives are continuations of the already present ones, then, instead of just adding this new sentence to the assertion level of the discourse, you can and often have to *split* it in its alternatives, and add the one alternative with modal subordination to one of the already present alternatives, and the other to the other present alternative. Landman(1986:204)

(118) will then be represented by (120b) instead of (120a) in order to allow for (presuppositional) binding of *the tramp.*

(120) a.



b.



According to our intuition, such examples of "modal splitting" are much more naturally conceived of as cases of modal subordination than are "ordinary" disjunctive sentences like (112), in that each of the disjuncts of the second sentence can – indeed must – be understood as a continuation of the non–factive contexts introduced by the respective disjuncts of the first sentence. So the type of examples given in (118) and (119a) fully complies with the characterization of "modal subordination" given in Landman(1986):

> Like a proof, a discourse contains various subordinated levels. Normally a new utterance is regarded as an assertion, and added to the assertion level [...] ; under certain conditions, however, a new utterance can be regarded as a *continuation of subordinated lines of thought*, pursuing certain suppositions; that is, not as an assertion, but as an assertion under certain assumptions, available at subordinated levels of the discourse. Of course, it has to be clear in the discourse that that is what is happening: it is not a coincidence that in examples [...] both parts of the discourse have similar mood.
>
> Landman(1986:203, italics added)

But it is clear that this characterization of *modal subordination* is not in accordance with the use of modal subordination for bathroom–type examples, with anaphoric reference from the second to the first disjunct. Here, while both disjuncts represent *alternative extensions* of the preceding discourse, it is not necessarily the case that the second disjunct is conceived of to *extend* the (negation of) the context introduced by the first disjunct.

The following observations should make this point more precise.

First consider (121), a case of modal splitting. The pronoun *it* in the second disjunct of the first sentence is dependent on the indefinite *a bike* introduced within the first disjunct, as in the bathroom–example. But in addition the pronominals in the second sentence's second disjunct anaphorically refer to the bike that Fred leaves in the hallway, as stated by the first sentence's second disjunct.

(121) Fred doesn't own *a bike* or he always leaves *it* in the hallway.
He is afraid of being run over by a car, or else *it* is quite old and he tries to hide *it*.

The first sentence is definitely an instance of the bathroom–type example, and thus, on Roberts' account, a case of modal subordination, where the content of the second disjunct will constitute the scope DRS of an embedded conditional structure that accommodates the negation of the first disjunct into its antecedent DRS.

If disjunction were throughout to be analyzed as claimed by Roberts, the second disjunct of the second sentence would have to be analyzed as modally subordinated to the negation of its first disjunct, yet the anaphoric pronoun *it* can only be resolved if it is understood as an extension of the first sentence's second disjunct, i.e. if it is modally subordinated to this disjunct as a case of "modal splitting". These requirements are not compatible.

We must therefore assume that the second sentence does not involve intrasentential modal subordination, but is to be represented as modally subordinated to the second disjunct of the first sentence, as in Landman's analysis of modal splitting.

Now, this is possible for an accommodation account of modal subordination, but not for an anaphoric account, as pursued by Geurts' and our analysis. Since the first disjunctive sentence involves modal subordination relative to its first disjunct (see (117)), the representation for its second disjunct is embedded within the second disjunct DRS, where it constitutes the scope DRS of the embedded modal operator, and hence is not accessible in terms of anaphoric reference (to a context referent standing proxy for this DRS) from the second disjunct of the second sentence.

Another objection against the modal subordination analysis to account for anaphoric binding within disjunctive contexts is that it *implicitly* relies on the semantics of exclusive *or*. This is illustrated by example (122), which involves non–exclusive disjunction. If the modal subordination analysis were generally available in disjunctive contexts, the representation to be assigned to (122) would come down to the paraphrase *John didn't give her a present for birthday, or if he had/has given her a present for birthday, he forgot her birthday and didn't buy it*, which is of course not appropriate. Moreover, contrary to fact Roberts' analysis predicts that the pronominal *it* can be bound to the indefinite *a present.*[97]

(122) Sue and John had a quarrel. John didn't give her a present for her birthday, or he forgot her birthday and didn't buy #it/one.

s j b
sue(s) john(j) birthday(b,s)
quarrel(s,j)
$\neg$ [x | present-for(x,b) give-to(j,s,x)] $\vee$ [[x | present-for(x,b) give-to(j,s,x)] $\Box$ [forgot(j,b) $\neg$ [y | y = x buy(j,y)]]]

[97]The wellformedness of the anaphor *one* doesn't mean that the referent x must be accessible for the pronoun y: *one*–anaphora is generally not subject to the accessiblity restrictions of DRT, as evidenced by (i) and (ii).

(i) Jones owns a bike or Sue will buy #it/one.

(ii) John doesn't own a bike. He has seen one/#it in a store.

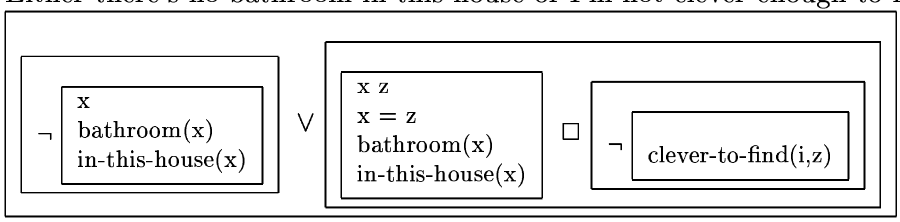
We take the above arguments as an indication that the analysis of the bathroom–type examples must necessarily make reference to the meaning of *exclusive or*, exactly as it has been claimed by Kamp&Reyle(1993). The meaning of exclusive *or* predicts that both disjuncts are to be understood as alternatives such that $\phi \vee \psi$ is equivalent to $\phi \vee (\neg\phi \;\&\; \psi)$. By assumption of double negation elimination it is then possible to dispense with modal subordination for the analysis of bathroom–type examples, while reference to modal subordination will be crucial for the analysis of extended disjunctive contexts, *modal splitting* (118)/(119a).[98]

As shown by (122), Roberts' modal subordination analysis of bathroom–type examples *implicitly* relies on the meaning of exclusive *or* without, however, restricting the analysis to contexts involving excusive disjunction. We do not see in which way the accommodation device could be restricted to exclusive disjunction contexts, to avoid unwarranted results such as (122).

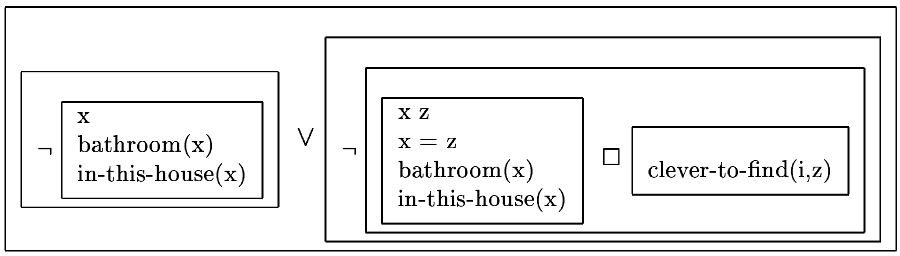
Geurts(1995) raises a further argument against Roberts' analysis of bathroom–type examples in terms of modal subordination: if in (123) the negated DRS provides the material to be accommodated into the restrictor of a universal modal, the analysis predicts an ambiguity wrt. the scope of the negation operator in the second disjunct, as displayed by the alternative DRSs (123a) and (123b). But such an ambiguity is not perceived.

(123) Either there's no bathroom in this house or I'm not clever enough to find it.

a.



b.



Yet, the consequences that Geurts draws from the rejection of modal subordination for the analysis of this type of sentences are, in our view, not appropriate. The analysis that is proposed instead makes reference to a notion of "contextual suppletion", which in our view is even more problematic than Roberts' concept of antecedent accommodation that Geurts criticizes as being too powerful.

As discussed in Section 2.3.2 Geurts pursues a presuppositional account of modal subordination, such that examples like (124), where the presupposition triggered within the second disjunct seems to be bound to material within the first disjunct, pattern with the anaphoric case in (123).

[98]It is, however, still an open question whether for cases of modal splitting we have to introduce modal quantificational structures, as proposed by Landman, or whether we can do with simple update conditions. We will address this question below.

For the presupposition projection problem that is posed by (124) Geurts argues correctly that accommodation of the presupposition triggered by *Walter's rabbit* to the factual context is prohibited by a conversational implicature associated with disjunction ϕ *or* ψ, that the speaker does not know whether ϕ or ψ is true. If the presupposition that Walter owns a rabbit were to project to the main DRS, this *issue* would be settled. "Therefore the presupposition must be accommodated in some other DRS, which can only be its home DRS." Geurts(1995:30)

(124) Either Walter doesn't have a rabbit or Walter's rabbit is in hiding. Geurts(1995:29)

While accommodation may be a viable option for presupposition projection in (124), the argument does not carry over without further ado for the typical bathroom–type examples involving anaphoric dependencies. Since the discourse referents of the first disjunct are not accessible from the second disjunct, (125) cannot be accounted for by way of anaphoric binding: the anaphor or definite description cannot be bound to the indefinite *a rabbit.*

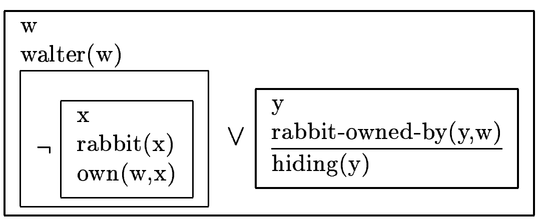
(125) a. Either Walter doesn't have a rabbit or it is in hiding.

b. Either Walter doesn't have a rabbit or the animal is in hiding. Geurts(1995:37)

Here, Geurts makes reference to a notion of "contextual suppletion", which in our view seems to be rather problematic: (Geurts(1995:38ff)

> [...] the root of the problem is DRT's crucial tenet that an anaphoric expression may only take up antecedents that are accessible to it. Examples like [(125a)] and [(125b)] suggest that this assumption is incorrect – or rather that it is overly restricted. [...] occasionally anaphors may simply lack an antecedent, strictly speaking, without therefore becoming unintellegible. The following are some cases in point:
>
> (126) a. The man who gave his paycheck to his wife was wiser than the one who gave *it* to his mistress. Karttunen(1969)
>
> b. When Jane drinks, she usually gets sick and poor Fred has to clean *it* up.
>
> [...] What I want to propose here is somewhat similar to the E–type analysis, but there are important differences too, as we shall see. The suggestion that I want to make is that, quite generally, the content of a presupposition is determined not only by the expression that triggers it, but may, in addition, depend on contextual factors. In a word, presuppositional content may be subject to contextual suppletion, as I propose to call it. Geurts(1995:38f)

For (125), the rather poor presuppositions triggered by *it* or *the animal* are "expanded via contextual suppletion into something like 'rabbit owned by Walter'." (Geurts(1995:40)).

(127)


Frankly, we do not see how this analysis could be any more constrained than Roberts' accommodation account. On the contrary, Roberts' analysis at least is constrained to pick up material provided by the previously constructed DRS, while the notion of "contextual suppletion" is much more liberal. One could, for instance, choose to replace the presupposition 'rabbit-owned-by Walter' by 'rabbit that Walter wants to own' or even by 'rabbit that Walter doesn't own', which should not be a possible meaning for (125).

Also, if contextual suppletion makes accessible an antecedent that is embedded within the scope of negation in a disjunctive DRS, it is not clear why this should not be possible in (128), on a non–specific interpretation of the indefinite.

(128) ?Walter owns a rabbit, or Mary has seen it/or he is hiding it.

The lesson to learn from this is that "accommodation of the negation of the first disjunct into the second" is not dispensed with in Geurts' analysis, but replaced by a different, and even more unconstrained notion of "contextual suppletion".

Still another analysis of bathroom–type examples has been offered by **Krahmer(1995)**, who develops a "Double Negation and Presuppositional DRT". Krahmer basically agrees with Roberts' analysis in terms of modal subordination (117).[99]

Given the equivalence of $\neg\Phi \lor (\Phi \Rightarrow \Psi)$ with $\Phi \Rightarrow \Psi$ (cf. (129) and (130)), Krahmer observes that if disjunction were represented as in (131b), as opposed to the standard (131a), the analysis of bathroom–type examples would reduce to the problem of double negation elimination: By use of (131b) (132) could be represented as (132a), which by reducion to (132b) allows for anaphoric binding of the pronoun within the second disjunct.

(129) Either there's no bathroom in this house, or it is in a funny place.

(130) If there is a bathroom in this house, it is in a funny place.

(131) a. $\boxed{\Phi} \lor \boxed{\Psi}$

b. $\boxed{\neg \boxed{\Phi}} \Rightarrow \boxed{\Psi}$

(132) Either there is no bathroom in this house, or it is in a funny place.

a. $$\boxed{\boxed{\neg \boxed{\neg \boxed{\begin{array}{l} \text{x} \\ \text{bathroom(x)} \\ \text{in-this-house(x)} \end{array}}}} \Rightarrow \boxed{\begin{array}{l} \text{y} \\ \text{y} = ? \\ \text{funny-place(y)} \end{array}}}$$

b. $$\boxed{\boxed{\begin{array}{l} \text{x} \\ \text{bathroom(x)} \\ \text{in-this-house(x)} \end{array}} \Rightarrow \boxed{\begin{array}{l} \text{y} \\ \text{y} = \text{x} \\ \text{funny-place(y)} \end{array}}}$$

[99]Krahmer brings up an argument in support of modal subordination, and against the Kamp&Reyle–style analysis for bathroom–examples, which we will discuss momentarily.

Rather than assigning disjunctive sentences an implicative DRS condition as in (132), Krahmer exploits this fact, within his “Double Negation DRT Semantics” (133) where negation is defined as a “flip–flop operator”, by assigning disjunction $\vee$ a meaning equivalent to $\Rightarrow$, except for the “polarity” of the antecedent (cf. (133c–d).

(133) Double Negation DRT semantics

...

c. $[\![\Phi \Rightarrow \Psi]\!] = \{g \mid \forall h(\langle g,h\rangle \in [\![\phi]\!]^+ \Rightarrow \exists k\langle h,k\rangle \in [\![\Psi]\!]^+)\}$

d. $[\![\Phi \vee \Psi]\!] = \{g \mid \forall h(\langle g,h\rangle \in [\![\phi]\!]^- \Rightarrow \exists k\langle h,k\rangle \in [\![\Psi]\!]^+)\}$

e. $[\![[\vec{x} \mid \phi_1, ..., \phi_m]]\!]^+ = \{\langle g,h\rangle \mid g\{\vec{x}\}h\&h \in ([\![\phi_1]\!] \cap ... \cap [\![\phi_m]\!])\} \Rightarrow \exists k\langle h,k\rangle \in [\![\Psi]\!]^+)\}$
$[\![[\vec{x} \mid \phi_1, ..., \phi_m]]\!]^- = \{\langle g,g\rangle \mid \neg\exists h(g\{\vec{x}\}h\&h \in ([\![\phi_1]\!] \cap ... \cap [\![\phi_m]\!]))\}$

g. $[\![\neg\Phi]\!]^+ = [\![\Phi]\!]^-$
$[\![\neg\Phi]\!]^- = [\![\Phi]\!]^+$ Krahmer(1995:57)

In addition, the accessibility constraints for anaphoric binding are defined in such a way that they enable anaphoric reference to antecedents in doubly negated contexts (134) (for more detail see Krahmer(1995:57–58)).

(134) It is not true that John didn’t bring an umbrella. It was purple and it stood in the hallway. Krahmer(1995:50)

Based on this semantics then, anaphoric binding is possible, in (135), from the second disjunct to material within the scope of negation in the first disjunct.

(135) Either there’s no bathroom in this house, or it is in a funny place.

<table><tr><td>¬</td><td>x
bathroom(x)
in-this-house(x)</td><td>∨</td><td>y
y = x
funny-place(y)</td></tr></table>

According to the “double negation DRT semantics” (135) is logically equivalent to (130). Yet, we may ask ourselves whether these sentence types are also equivalent from a discourse theoretical perspective.

In our view they are not. Consider the contrastive pair in (136). If we are confronted with (136a) out of context, it seems rather difficult to get at some sound interpretation, given that there is no obvious relationship available that causally connects John’s giving a present to his brother to offending him in another way (which one way, we may ask ourselves). In any case the interpretation we assign to (136a) radically differs from the one we associate with the disjunction in (136b).

(136) a. If John gave a present to his brother, he offended him in another way.

b. John didn’t give a present to his brother, or he offended him in another way.

This is also brought out by the following examples, where the anaphor *both* can be understood to refer to the alternatives presented by the disjuncts in (137a), while this is not possible for the (logically equivalent) implication in (137b).

(137) a. John (either) went out for dinner, or (else) he went to the movies.
In fact, he did both.

b. If John didn't go out for dinner, he went to the movies.
In fact, he did both.

Finally, it seems that examples involving *modal splitting* cannot be dealt with appropriately on this analysis of disjunction. If in Landman's example (138) – according to Krahmer's recipe – the disjunctive sentences are interpreted along the lines of (133d), first, it will *not* be analyzed as equivalent in meaning to (138a), but as the rather unintellegible (138b), and secondly, anaphoric reference from the first disjunct of the second sentence to *a doctor* in the first disjunct of the first sentence is not licensed – unless Landman's analysis of "modal splitting" is adopted as a special case of modal subordination, involving *accommodation* of the (DRS corresponding to the) first disjunct of the preceding sentence into the restrictor argument of an implicative condition that takes the first disjunct of the second sentence in its scope.

(138) Call this number. The phone will be answered by either a doctor or a secretary. The doctor can tell you rightaway what's the matter with you, or the nurse can make an appointment for you.

a. Call this number. A doctor or a secretary will answer. If a doctor answers he can tell you what is wrong. If a secretary answers, she can make an appointment. Landman(1986:205)

b. Call this number. If it is not the case that a doctor answers, a secretary will answer. If it is not the case that the doctor can tell you what is wrong, the nurse can make an appointment.

While in our discussion of Roberts' analysis of bathroom–sentences we rejected an account in terms of modal subordination, Krahmer brings up the following argument, which seems to favour the modal subordination approach to bathroom–sentences.

A case in point is a situation where there are two bathrooms in the house, one of them in a funny place. In such a situation the DRS (115) of Kamp&Reyle's analysis is verified, while this is not so for the DRS (117) that results from the modal subordination analysis of disjunction, resorting to implication. And this is is exactly what we want in such a case.

Now, note that double negation elimination, which Krahmer(1995) builds into DRT by means of the conditions in (133) is subject to a uniqueness condition, which Krahmer illustrates by means of (139). See also (140).

(139) a. It is not the case that there is no guest at this wedding.
#? He is standing right behind you.

b. It is not the case that there is no bride at this wedding.
She is standing right behind you. Krahmer(1995:51)

(140) A: I'm sure that John didn't buy a book, when he was in China.
B: Oh no, it is not the case that John didn't buy a book. # In fact, it is great.

Nevertheless he draws the conclusion that "[s]ince such apparent counterexamples on closer examination turn out to be no counterexamples at all, it seems we can take it *as a general rule* that as far as truth conditions and the possibility of anaphora are concerned double negations in standard English behave as if no negation at all were present." (Krahmer(1995:52), italics added).

In our view, given the constraint on uniqueness that is brought out by (139) and (140), we cannot generalize double negation elimination to the degree of building it into the semantics of DRSs generally, as Krahmer did, but have to relativize this rule to a uniqueness condition for discourse referents introduced under double negation scope.

Irrespective of how this could be done, if double negation elimination is subject to this constraint, the argument that Krahmer raised against the Kamp&Reyle–style analysis of bathroom–sentences breaks down: it relies upon a context that does not comply with the uniqueness constraint.

To sum up the discussion we had so far: We have argued that the analysis of bathroom–type sentences should not resort to modal subordination (of the second disjunct to the negation of the first disjunct). Arguments in case have been contexts involving "modal splitting" (see (121)) and contexts involving non–exclusive disjunction (122). On the other hand, we firmly support the use that Landman(1986) makes of modal subordination to account for cases of extended disjunctive contexts, *modal splitting*.[100]

Rather, we take the position that the analysis of bathroom–type sentences must rely on the meaning of exclusive *or* (ϕ or_{excl} ψ), which directly embodies the condition that the second disjunct ψ is to be interpreted as *the other case*, which implies the negation of the first disjunct.[101]

(141) $\phi \; or_{excl} \; \psi : \boxed{\Phi} \vee \boxed{\begin{array}{l} \neg \boxed{\Phi} \\ \Psi \end{array}}$

where Φ and Ψ are the DRS conditions to be constucted for ϕ and ψ.

This is exactly Kamp&Reyle's analysis. To account for the anaphoric dependencies that are characteristic for these sentences, we could either resort to a flip–flop semantics for negation, as developed by Krahmer, or else allow for application of the inference rule of double negation elimination in contexts that are in accordance with the uniqueness condition (see Kamp&Reyle(1991)). Below we will consider an analysis along these lines in the framework of annotated DRSs.

[100] Although we will propose a simplification of this analysis in our framework of annotated DRSs.

[101] Recall that this aspect of the meaning of *or* is missing in Geurts' analysis, which therefore must resort to the notion of "contextual suppletion" to account for this type of construction.

We should observe that Krahmer's analysis is very much in accordance with this view, in that it crucially relies on double negation elimination. Yet, the analysis seems somewhat unintuitive in that the meaning assigned to disjunction is exactly parallel to the meaning of implication. As pointed out by way of examples (136) and (137), the meaning of disjunction and implication is quite distinct from a discourse theoretic perspective, such that we would like to opt for an analysis that assigns these constructions distinct truth conditions.

While we consider it as rather misleading to resort to the notion of modal subordination for the analysis of bathroom–type sentences, contexts of modal splitting, brought up by Landman, are definitely to be ranged under this heading. Successions of disjunctive sentences like Landman's (142) can only be interpreted correctly if the disjuncts of the later sentence(s) are represented as disjunctive *extensions* of the contexts provided by the respective disjuncts of the previous sentence(s).

(142) You will stay unmarried, or you will marry a tramp.
You'll become a nun, or the tramp will beat you regularly.
Either way you'll have a miserable life. Landman(1986:205)

Modal splitting – or extended disjunctive contexts

In his approach to modal splitting Landman(1986) closely follows Roberts' analysis of modal subordination in modal contexts, in that the antecedent context – in this case one or the other of the preceding sentence's disjuncts – is accommodated to the restrictor of an implicative condition (or universally quantified modal operator) (see (120b)).

In our framework of annotated DRSs there is an alternative way to capture Landman's intuition that "instead of just adding this new sentence to the assertion level of the discourse, you can and often have to *split* it in its alternatives, and *add* [italics added] the one alternative with modal subordination to one of the already present alternatives, and the other to the other present alternative." (Landman(1986:204), see above p. 152). In our framework we can represent such *extended* disjunctive contexts by way of *disjunctive update conditions* on context referents associated with the respective disjuncts of a preceding disjunctive sentence.

This is illustrated by way of the preliminary DRS (144), where we make use of the representation format (143) for disjunctive sentences, to be discussed in more detail below. For the moment let us assume that the "input referents" X_1 and X_2 of the disjunctive update conditions constructed for the disjunct sentences ϕ and ψ are to be bound to the "input referent" F of the governing update condition for the entire disjunctive sentence $\phi \vee \psi$ in a *non–subordinated* reading (see X_1 and X_2 in (144)), to reflect the dependence of both disjuncts upon the factual antecedent context. For cases of *modal splitting*, however, X_1 and X_2 may be chosen to anaphorically refer to other accessible context referents, as e.g. G_1 and G_2 in (144), which are established by the disjunctive update conditions of the previous sentence.

(143) a. $\phi \vee \psi$

b.
$$\begin{array}{|l|}\hline \mathrm{G}_1\ \mathrm{G}_2\ \mathrm{X}_1\ \mathrm{X}_2\\ \mathrm{X}_1 = ?\\ \mathrm{X}_2 = ?\\ \mathrm{G}_1 :: \mathrm{X}_1 + \boxed{\Phi} \ \vee \ \mathrm{G}_2 :: \mathrm{X}_2 + \boxed{\Psi}\\ \hline\end{array}$$

(144) You will stay unmarried, or you will marry a tramp.
You'll become a nun, or the tramp will beat you regularly.
Either way you'll have a miserable life. Landman(1986:205)

$$\begin{array}{|ll|}\hline \multicolumn{2}{|l|}{\mathrm{F\ G\ H}}\\ \mathrm{F} :: & \boxed{\begin{array}{l} x\\ \textit{addressee(x)}\end{array}}\\ \mathrm{G} :: \mathrm{F} + & \boxed{\begin{array}{l} \mathrm{G}_1\ \mathrm{G}_2\ \mathrm{X}_1\ \mathrm{X}_2\\ \mathrm{X}_1 = \mathrm{F}\\ \mathrm{X}_2 = \mathrm{F}\\ \mathrm{G}_1 :: \mathrm{X}_1 + \boxed{\text{stay-unmaried(x)}} \vee \mathrm{G}_2 :: \mathrm{X}_2 + \boxed{\begin{array}{l} \mathrm{y}\\ \text{tramp(y)}\\ \text{marry(x,y)}\end{array}}\end{array}}\\ \mathrm{H} :: \mathrm{G} + & \boxed{\begin{array}{l} \mathrm{H}_1\ \mathrm{H}_2\ \mathrm{X}_3\ \mathrm{X}_4\\ \mathrm{X}_3 = \mathrm{G}_1\\ \mathrm{X}_4 = \mathrm{G}_2\\ \mathrm{H}_1 :: \mathrm{X}_3 + \boxed{\text{become-nun(x)}} \vee \mathrm{H}_2 :: \mathrm{X}_4 + \boxed{\begin{array}{l} \mathrm{z}\\ \mathrm{z} = \mathrm{y}\\ \text{the\_tramp(z)}\\ \text{beat(z,x)}\end{array}}\end{array}}\\ \hline\end{array}$$

Recall from Section 3.3 that the representation format in (143) could alternatively be spelled out as (145a) in the representation language DRL_1^* that disposes of a special truth predicate $^\vee$ on context referents. According to (145a) then, disjunction has scope over truth predicates applied to context referents G_1 and G_2, which are defined as updates of context referents X_1, X_2 with the respective DRSs K' and K'' that represent the meaning of the disjunct sentences. The verification condition for (145a) is then (145b).

(145) $\phi \vee \psi$

a.
$$\begin{array}{|l|}\hline \mathrm{G}_1\ \mathrm{G}_2\ \mathrm{X}_1\ \mathrm{X}_2\\ \mathrm{X}_1 = ?\\ \mathrm{G}_1 := \mathrm{X}_1 + K'\\ \mathrm{X}_2 = ?\\ \mathrm{G}_2 := \mathrm{X}_2 + K''\\ {}^\vee\mathrm{G}_1 \vee {}^\vee\mathrm{G}_2\\ \hline\end{array}$$

b. Verification condition:
$\langle w, e\rangle \models_M {}^\vee\mathrm{G}_1 \vee {}^\vee\mathrm{G}_2$ iff $\langle w, e\rangle \models_M {}^\vee\mathrm{G}_1$ or $\langle w, e\rangle \models_M {}^\vee\mathrm{G}_2$.

In Section 3.3 we have argued that we strongly prefer a more constrained DRS language which does not involve a truth predicate for explicit *represention* of the assertion of truth for a given sentence or piece of discourse. We therefore have chosen the more constrained representation language DRL$_2^*$ without the truth predicate, where the meaning component that is carried by the truth predicate is, as usual in DRT, encoded by way of the verification conditions for DRS conditions: e.g. for verification of an update condition $G :: F + K'$ we imposed the further constraint that the world of evaluation must figure within some state in the denotation of G. And this constraint exactly comes down to the verification condition for the truth predicate ${}^{\vee}G$ in the more general representation language DRL$_1^*$.

Within our more constrained representation language DRL$_2^*$ both the representation and verification conditions for disjunction differ from (145) in the way stated by (146): disjunction is represented to take as arguments two update conditions on context referents X_1 and X_2, with annotating context referents G_1 and G_2, where X_1 is updated by the DRS K' corresponding to the first disjunct sentence, and X_2 by K'', which corresponds to the second disjunct sentence. The verification condition for disjunction (or disjunctive update) is then simply a disjunction over the verification conditions for updates (146b). I.e. the truth condition for disjunction is strictly compositional (cf. Kamp&Reyle(1993:190)). Below we will state constraints for binding of the input referents X_1 and X_2.

(146) $\phi \vee \psi$

a.
$$\boxed{\begin{array}{l} \mathrm{G_1\ G_2\ X_1\ X_2} \\ \mathrm{X_1} = ? \\ \mathrm{X_2} = ? \\ \mathrm{G_1 :: X_1} + \boxed{K'} \vee \mathrm{G_2 :: X_2} + \boxed{K''} \end{array}}$$

b. Verification condition:
$$\langle w, e\rangle \models_M \mathrm{G_1 :: X_1} + \boxed{K'} \vee \mathrm{G_2 :: X_2} + \boxed{K''}$$
$$\text{iff } \langle w, e\rangle \models_M \mathrm{G_1 :: X_1} + \boxed{K'} \text{ or } \langle w, e\rangle \models_M \mathrm{G_2 :: X_2} + \boxed{K''}.$$

Our claim is that the representation and semantics for sentential disjunction given in (146) accounts for both "ordinary" disjunction as well as for "subordinated" disjunction ("modal splitting" in Landman's terminology). For the particular case of bathroom–type examples, to be discussed below, we then need a further constraint that reflects the meaning of *exclusive or*. Up to now (146) covers both *exclusive* and *inclusive or*.

The representation of *modal splitting* or "extended disjunctive discourse" that is given in (144) on the basis of (146) differs from Landman's analysis in two ways.

First, subordination is not obtained by accommodation of DRSs, but in terms of anaphoric reference to accessible context referents, and secondly, the subordinated disjuncts are related to their respective antecedent contexts not via implicative (or universally quantified modal) conditions (see (120b)), but rather in terms of update conditions.

Which criterion could be invoked in order to decide between these two options for the representation of subordination in contexts of "modal splitting"? Could we have contexts of modal splitting with other than universal modal force?

First note that modal splitting in fact is found with non–universal forces.

(147) You will stay unmarried, or you will marry a tramp.
You might become a nun, or you might have many children with the tramp.

> You might live in pauper, or the tramp might beat the children regularly.
> So in both cases you might well have a miserable life.

So at first sight we could conclude that we are better off with a representation along the lines of (120b), which is easily adjusted to account for non–universal modal forces.

But notice, by comparison of (144) and (120b), that the representation that Landman assigns to contexts of modal splitting is not directly guided by the structure of natural language. While for the first disjunctive sentence a *disjunctive* DRS condition is constructed, the second, subordinated disjunctive sentence, though equally conjoined with *or*, introduces *two implicative* conditions, one for each disjunct, which are interpreted conjunctively, rather than by disjunction. This is at odds with a principle based conception of DRS–construction, which must be driven by the structure of natural language.

The representation (144) based on (146), by contrast, directly follows the structure of the discourse in that for both disjunctive sentences disjunctive (annotated) DRS conditions are generated, where the annotated disjunctive conditions themselves are uniformly represented as (disjunctive) updates of an antecedent context referent.

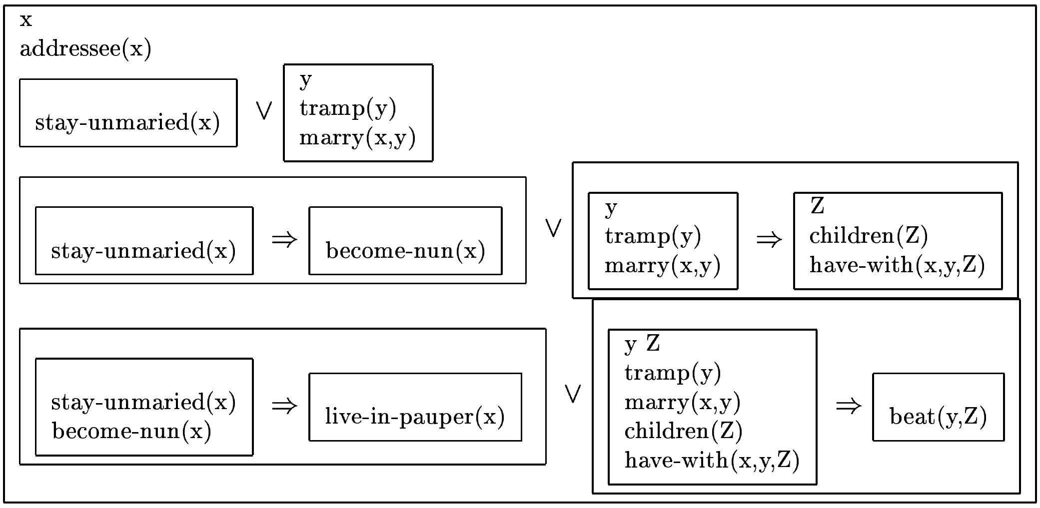
So exactly as we had it with modal operators, one unique logical form is attributed to "ordinary/non–subordinated" and "subordinated" disjunctive sentences: The disjuncts of the first sentence are both represented as (alternative) updates of the (non–disjunctive) antecedent context F, while the annotating referents H_1 and H_2 of the second disjunctive sentence are marked as updates of the context referents G_1 and G_2 defined by the respective disjunctive updates within the second sentence's "input" context G.[102] Since G figures as the "input" referent for the second sentence's update condition $H :: G + K_2$ in (144), the accessibility constraints defined in Section 3.3 predict both G_1 and G_2, defined within K_1 of $G :: F + K_1$, to be accessible from within K_2.

Let us now come back to the issue of nonuniversal modal force with modal spitting (147). Note that if Landman's representation (120b) were modified to more directly mirror the structure of natural language along the lines just sketched, the implicative conditions for the subordinated disjuncts were embedded within disjunctive subDRSs (see (148) for illustration). But then it emerges that with *repeated* disjunctive subordination contexts accommodation of material from one of the antecedent sentence's disjuncts into the restrictor argument of an implicative condition for the subordinated disjunctive sentence must be *nonlocal* in the sense of accessibility of the corresponding context referents: the DRSs to be accommodated are embedded within the disjunctive DRSs. In (148) e.g. (presuppositional) binding of *the children* to the children introduced by the second disjunct of the second sentence requires accommodation of the scope DRS of the implicative condition that is contained *within* the second sentences' second disjunct DRS.

So it seems as if in our *anaphoric* account of modal subordination – if we stick to a representation format that represents subordinated disjunctive sentences in terms of disjunctive DRS conditions along the lines of (144) – we cannot, for principled reasons of structural accessibility conditions, account for discourses like (147), where the linguistic structure overtly indicates an *embedded* modally quantified structure within the subordinated disjunctive clauses.

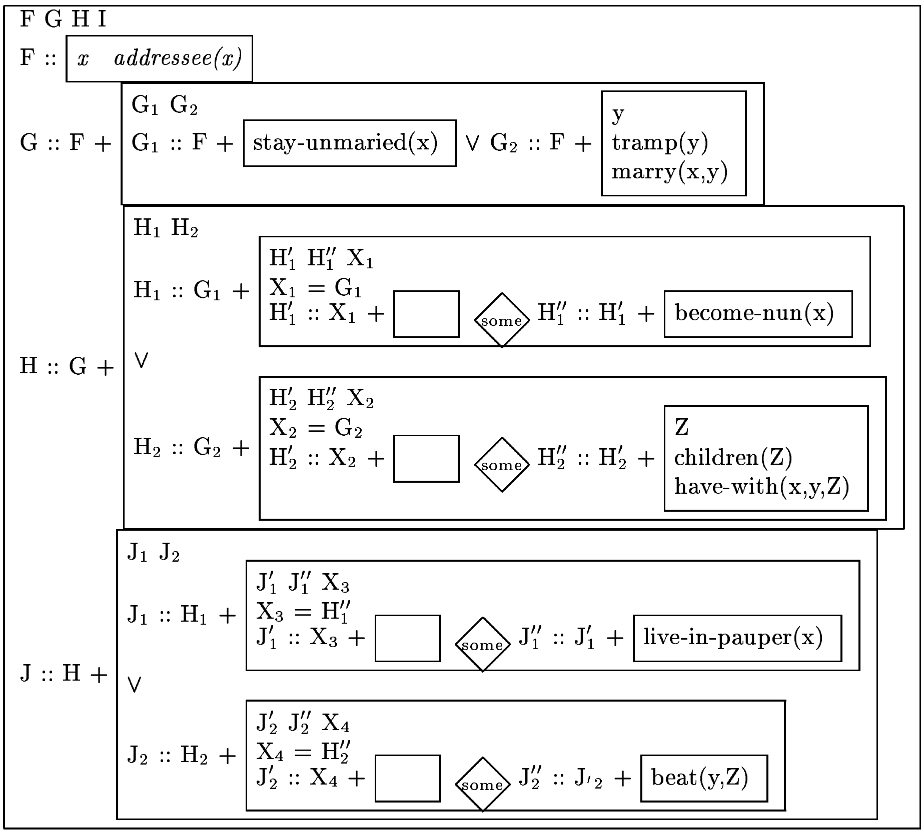
[102] Cf. the analysis of parallelism and contrast in Asher's(1993) SDRT.

(148) You will stay unmarried, or you will marry a tramp.
You'll become a nun, or you'll have many children with the tramp.
You'll live in pauper, or the tramp will beat the children regularly.
So either way you'll have a miserable life.



But now consider (149), where we represent (147) within our new representation format, which makes use of update conditions not only for successive assertive sentences, but also for (sentential) disjunction.

(149)



It turns out that – on the basis of a *uniform* logical form for disjunctive sentences – the context referents established by embedded modal quantificational structures, even if defined within preceding disjunctive contexts, are in fact accessible from within subordinated disjunctive DRS conditions to instantiate the modal base of an embedded (here existentially quantified) modal structure. This is due to the representation of disjunctive DRSs as involving updates. In cases of "disjunctive subordination", where the input referents of the disjunctive updates pick up the annotating context referents of disjunctive update conditions within the preceding context, this makes available the context referents of embedded modal constructions from within the "subordinated" disjunctive context(s).

In particular, the annotating referent H_2'' defined within the second disjunctive condition annotated by H_2 in the DRS annotated by H is accessible for X_4 within the disjunctive context annotated by J_2 on the basis of the (accessible) referent H_2 that is chosen as the input referent for the disjunctive update condition $J_2 :: H_2 + K_3$, which characterizes K_3 as an "extension" of the disjunct annotated by H_2.

So on the basis of the representation of disjunction as defined in (146) it is in fact possible to assign (147) an appropriate DRS. And in contrast to Landman's representation, the "subordinated" disjunctive sentences are now represented in terms of disjunctive DRS conditions, which reflects the structure of the linguistic form.

It is still an open issue whether we would like to assign subordinated disjunctive contexts like (148) a representation that involves *modally quantified* structures as in Landman's analysis, or as in (149), with universally quantifying modal force, or else whether we want to characterize such disjunctive discourses as disjunctive *assertive* discourse, in terms of simple update conditions, as in our initial representation (144). The example at hand, due to the presence of the modal *will* might be a case of debate, although according to our intuition *will* has a preferred futurate interpretation here, such that we favour the representation in (144), where the respective disjuncts are characterized as disjunctive assertive utterances. Yet, there may be other examples with a more salient modal interpretation, which can then be assigned a represenation along the lines of (149).

To sum up, we see the following advantages in the representation of disjunction in terms of disjunctive update conditions.

First, this representation can be used *uniformly* for both "ordinary" and subordinated disjunctive discourses, whereas Landman's proposal involves a representational difference for these two types of uses. Also it turned out that Landman's analysis of "disjunctive subordination" in terms of implicative conditions along the lines of Roberts' modal subordination account, if adapted to a uniform (standard) representation of disjunction, does not allow for an *anaphoric* account of modal subordination, which we pursued all along. It is in this respect that the new representation format for disjunction imports an improvement: by reference to a context referent that annotates a disjunctive condition in the previous discourse, referents that are defined within these disjuncts become available for anaphoric binding (see the contrast between (148) and (149)).

One could argue that our approach to *modal splitting*, or "extended disjunctive discourse" is by far too unrestricted in that the choice of input referents for disjunctive updates is quite unconstrained.

However, it is possible to impose strong pragmatic constraints upon the choice of antecedent contexts for the input referents X_1 and X_2 in disjunctive update conditions to prohibit unwarranted results. The theory of Structured DRSs of Asher(1993) could be very helpful to constrain these possibilities. In fact, Asher(1991,1993) defines rhetorical relations of contrast and parallelism that could be used to state constraints on the selection of antecedent referents for X_1 and X_2 in (146). Even though we cannot go into any detail about this theory, a very rough characterization of how this could be achieved is as follows. We can define a new discourse structural or rhetorical relation *parallel*(G_1, G_2) whenever a disjunctive update condition is introduced in a DRS by way of (146). Anaphoric binding of the input referents X_1 and X_2 can then be constrained such that either $X_1 = X_2$ (= Y) for the non–subordination case, or else *parallel*(X_1, X_2) for cases of *modal splitting* (see (150)).

This will immediately rule out a reading of disjunctive sentences where the second disjunct is characterized as contextually dependent on the context established by the first disjunct.

The construction schema given in (146) then rewrites as in (150), where the selection of X_1 and X_2 is restricted by the structural/rhetorical constraint on *parallel* contexts.

(150) $\phi \vee \psi$

a.
$$\boxed{\begin{array}{l} \mathrm{G_1\ G_2\ X_1\ X_2} \\ \mathrm{X_1} = Y_1 \\ \mathrm{X_2} = Y_2 \\ \mathrm{G_1 :: X_1} + \boxed{K'} \vee \mathrm{G_2 :: X_2} + \boxed{K''} \\ \mathit{parallel}(G_1, G_2) \end{array}}$$

Constraint: *parallel*($\mathrm{Y_1}$, $\mathrm{Y_2}$),
where: *parallel*($\mathrm{Y_1}$, $\mathrm{Y_2}$) if there is an accessible referent Y, $Y = Y_1$ and $Y = Y_2$

b. Verification condition:

$$\langle w, e\rangle \models_M \mathrm{G_1 :: X_1} + \boxed{K'} \vee \mathrm{G_2 :: X_2} + \boxed{K''}$$
$$\text{iff } \langle w, e\rangle \models_M \mathrm{G_1 :: X_1} + \boxed{K'} \text{ or } \langle w, e\rangle \models_M \mathrm{G_2 :: X_2} + \boxed{K''}$$

In sum, the representation (150) for sentential disjunction (i) provides a uniform representation format for both non–subordinated disjunction contexts as well as cases of *modal splitting*, where (ii) it accounts for subordinated disjunctive discourses with either universal or non–univeral modal quantification. In these respects the analysis improves over the analysis proposed by Landman(1986) – if we conceive of accommodation as restricted in terms of accessibility constraints for anaphoric binding.

Exclusive *or*

This leaves us with the problem of anaphoric reference in bathroom–type examples, which we argued above not to be an instance of modal subordination, if modal subordination is conceived of, with Landman, as "a continuation of subordinated lines of thought, pursuing certain suppositions". In fact, the rhetorical relation of *parallelism* that we just introduced in order to capture (rather severe) constraints on *modal splitting* characterizes the annotating context referents G_1 and G_2 of disjunctive update conditions as *parallel* lines of thought, as opposed to *extensions*, or *continuations* of thought.[103]

Besides our earlier objections, a further argument against the modal subordination account of bathroom–type sentences arises from Krahmer's observation that double negation elimination is subject to a uniqueness constraint (on indefinites introduced within the innermost negation scope).

As can be seen from (151), an indefinite NP that satisfies a uniqueness or specificity presupposition can escape double negation scope to allow for anaphoric binding (151a), and also provides an antecedent, from within single negation scope in the first disjunct of (151b), for the pronoun in the second disjunct. And similarly for (152).

(151) a. It is not true that Louis XIV didn't have a mistress. He hid her from his wife.

b. Either Louis XIV didn't have a mistress or he hid her from his wife.
Krahmer(1995:7)

(152) a. It is not true that there is no bride at this wedding. She is standing right behind you. Krahmer(1995:51)

b. Either there is no bride at this wedding, or they have made off with her.

But as soon as we consider sentences where the indefinite does not easily satisfy a uniqueness or specificity assumption, it turns out that parallel to double negation sentences (153a/154a), also the bathroom–type sentences (153b/154b) do not allow the indefinite NP to provide an antecedent for the anaphoric pronoun.

(153) a. It is not true that there is no guest at this wedding. #? He is standing right behind you. Krahmer(1995:51)

b. # Either there is no guest at this wedding, or he is standing right behind you.

(154) a. It is not the case that John didn't buy a book. # It is expensive.

b. # Either John didn't buy a book, or it is interesting.

So, as is claimed by Krahmer, the possibility of anaphoric binding in bathroom–type examples heavily depends on the possibility of double negation eliminiation. In his "Double

[103]This incompatibility/contrast can be made formally explicit by stating further constraints or postulates for the relation *parallel*, such that *parallel* context referents X and Y cannot qualify as continuations:

If *parallel*(X,Y) then $\neg$ *continuation*(X,Y) & $\neg$ *continuation*(Y,X).

where an update condition $X :: Y + K'$ must then be defined to satisfy the relation *continuation*(X,Y).

We must emphasize that these tentative definitions do not correspond to the definitions of *parallelism* and *continuation* in Asher(1991,1993), but must be carefully designed to fit into the theory of rhetorical relations in SDRT.

Negation and Presuppositional DRT" double negation elimination is built into the semantics, and disjunction *A or B* is defined to be equivalent to *If not A then B*. Given that there are in fact serious constraints on double negation elimination, we do not think that it should be built into the semantics as an unrestricted device.

Also, as hinted at above, this analysis does not immediately account for *modal splitting* – unless resorting to accommodation along the lines of Landman's analysis. Yet, with an *anaphoric* account of modal subordination as is ours, *modal splitting* cannot be accounted for if disjunction is defined in the way Krahmer does: in his analysis, if A does not involve negation, referents that are introduced within A are not accessible for anaphoric reference in contexts of modal splitting, irrespective of whether the dependent disjunct of the subsequent disjunctive sentence does or does not involve a negation operator.

We therefore opt for an analysis that is essentially Kamp&Reyle's, where, for an adequate representation of the semantics of *exclusive or*, the negated representation of the first disjunct is copied to (more precisely: merged to) the representation of the second disjunct.

In our framework this translates to (155), where an update condition $G_1' :: X_1 + K'$ that represents the meaning of the first disjunct is copied/merged to the representation K'' for the second disjunct, yet under the scope of the negation operator. While the verification conditions for disjunction carry over from (150) without modification, for *exclusive or* we impose a further constraint for anaphoric binding of X_1 and X_2: X_1 and X_2 must both refer to the same (accessible) context referent.

$$(155)\quad \phi \vee_{xor} \psi : \begin{array}{|l|}\hline \mathrm{G_1\ G_2\ X_1\ X_2} \\ \mathrm{X_1 = X_2 = ?} \\ \mathrm{G_1 :: X_1} + \boxed{K'} \vee \mathrm{G_2 :: X_2} + \begin{array}{|l|}\hline \mathrm{G_1'} \\ \neg\ \mathrm{G_1' :: X_1} + K' \\ K'' \\ \hline \end{array} \\ \hline \end{array}$$

The classical bathroom example is then represented as in (156).

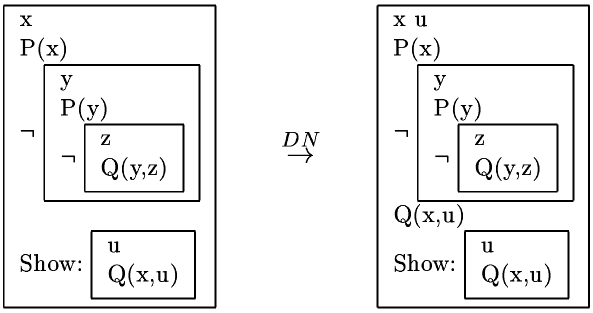
$$(156)\quad \begin{array}{|l|}\hline \mathrm{F\ G} \\ \mathrm{F ::} \begin{array}{|l|}\hline y \\ house(y) \\ \hline \end{array} \\ \mathrm{G :: F} + \begin{array}{|l|}\hline \mathrm{G_1\ G_2} \\ \mathrm{X_1 = X_2 = F} \\ \mathrm{G_1 :: X_1} + \begin{array}{|l|}\hline \mathrm{H_1} \\ \neg\ \mathrm{H_1 :: X_1} + \begin{array}{|l|}\hline \mathrm{x} \\ \mathrm{bathroom(x)} \\ \mathrm{in(x,y)} \\ \hline \end{array} \\ \hline \end{array} \\ \vee \\ \mathrm{G_2 :: X_2} + \begin{array}{|l|}\hline \mathrm{G_1'} \\ \neg\ \mathrm{G_1' :: X_1} + \begin{array}{|l|}\hline \mathrm{H_1'} \\ \neg\ \mathrm{H_1' :: X_1} + \begin{array}{|l|}\hline \mathrm{x} \\ \mathrm{bathroom(x)} \\ \mathrm{in(x,y)} \\ \hline \end{array} \\ \hline \end{array} \\ \mathrm{z = ?} \\ \mathrm{in\text{-}funny\text{-}place(z)} \\ \hline \end{array} \\ \hline \end{array} \\ \hline \end{array}$$

Here the referent x for *a bathroom* is still defined within the scope of double negation in the second disjunctive update condition. Therefore the reference of the anaphoric pronoun *it*, i.e. the referent z is still unresolved, as indicated by ? in (156).

The anaphoric referent z can only be bound to y if y becomes accessible via double negation elimination. In Kamp&Reyle(1991) Double Negation Elimination (**DN**) is defined, for classical DRT, as stated below:

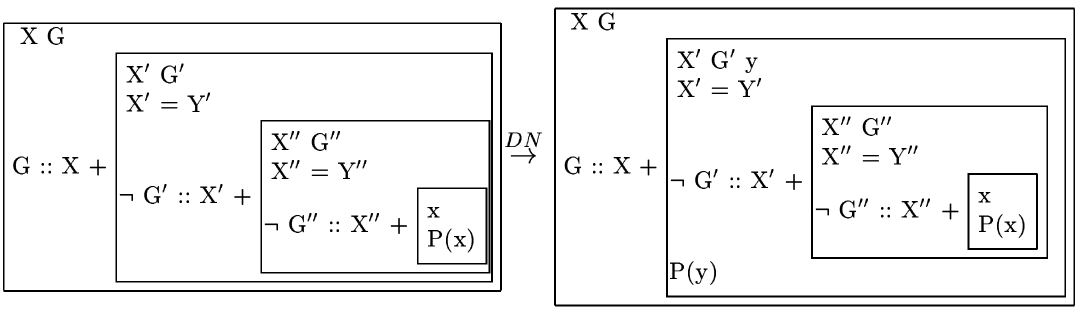
Double Negation (Elimination):

Suppose K contains a condition of the form $\neg K_1$ such that for some K_2 $\neg K_2 \in Con_{K_1}$ and suppose there is an embedding f of $K_1 \backslash \langle \{\}, \{\neg K_2\}\rangle$ into K. Let g be an extension of f to U_{K_2}, such that g\ f is 1–1 and such that g maps $U(K_2)$ to a set of discourse referents that are new to the (extended[a]) DRS K. Then we may add $g(K_2)$ to K. Kamp&Reyle(1991:17)



Transposed to our framework of annotated DRSs a rule of double negation elimination must be defined such that it applies to (partial) DRSs that are structured as given on the lefthand side in (157), where X' and X'' must be constrained to have the same denotation (modulo alphabetic variants of discourse referents). The output of Double Negation Elimination must then be a DRS as on the righthand side, where an alphabetic variant of the DRS K' under double negation scope is merged to the DRS K_0 of the update condition that hosts the double negation.

It is outside of the scope of this work to spell out this rule in detail. Also we can only give some vague hint at how we conjecture a uniqueness constraint could be imposed on *DN*. We can take advantage of the fact that a context referent G denotes a set of world–function pairs that verify the DRS that figures in the update condition that G annotates. A constraint on uniqueness for discourse referents x that are to be introduced to the DRS K_0 in (157) by application of *DN* can then be formulated by restricting its application to those referents x for which it is the case that every world–function pair in the denotation of G'' that has x in its domain maps x to a single individual in the model.

(157)


It is now evident that – provided a precise definition of *DN* along the lines suggested, and further constrained by way of a uniqueness constraint – application of *DN* to (156) yields the DRS (158), where the referent z finds an accessible antecedent x' for *a bathroom.*

$$
(158)\quad \boxed{\begin{array}{l} \mathrm{F}\ \mathrm{G} \\ \mathrm{F} :: \boxed{y \quad \mathit{house}(y)} \\ \mathrm{G} :: \mathrm{F} + \boxed{\begin{array}{l} \mathrm{G}_1\ \mathrm{G}_2 \\ \mathrm{X}_1 = \mathrm{X}_2 = \mathrm{F} \\ \mathrm{G}_1 :: \mathrm{X}_1 + \boxed{\begin{array}{l} \mathrm{H}_1 \\ \neg\ \mathrm{H}_1 :: \mathrm{X}_1 + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{bathroom(x)} \\ \mathrm{in(x,y)} \end{array}} \end{array}} \\ \vee \\ \mathrm{G}_2 :: \mathrm{X}_2 + \boxed{\begin{array}{l} \mathrm{G}'_1\ \mathrm{x}' \\ \neg\ \mathrm{G}'_1 :: \mathrm{X}_1 + \boxed{\begin{array}{l} \mathrm{H}'_1 \\ \neg\ H'_1 :: \mathrm{X}_1 + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{bathroom(x)} \\ \mathrm{in(x,y)} \end{array}} \end{array}} \\ \mathrm{bathroom(x')} \quad \mathrm{in(x',y)} \\ \mathrm{z} = \mathrm{x'} \quad \text{in-funny-place(z)} \end{array}} \end{array}} \end{array}}
$$

3.6 Summary of Chapter 3

We argued for an analysis of modal operators as generalized quantifiers that are *anaphoric*, in their restrictor argument, to a context–type referent, to model the notion of *relative modality* in Kratzer's theory. For a *unified* analysis of relative modality and modal subordination, we saw, it is necessary to extend the standard representation format of DRT, to explicitly *represent* the contextual dynamics of discourse at the level of the DRS.

Relying on the relational semantics for DRSs we proposed a new DRS representation format for dynamic discourse where each new sentence of a discourse is *represented*, in terms of an update condition on context referents, as *contextually dependent* on the preceding discourse. For a correct working of this analysis we had to guarantee the wellfoundedness of verifying embedding functions, and defined an adjusted subordination relation for this new DRS format, to constrain the accessibility of discourse referents for anaphoric binding.

This provided the basis for a *uniform* analysis of relative modality and modal subordination. We showed that the analysis not only deals with "classical" cases of modal subordination, but carries over to more specific contexts of modal subordination that have not been accounted for in alternative theories that dispensed with an *accommodation* device, such as subordination relative to negated and non–universally quantified antecedent contexts. For the analysis of these data we also made use of semantic constraints on sentence mood, to further restrict the range of wellformed modal subordination contexts.

Finally, we discussed two specific types of disjunctive discourse: For the classical "bathroom–type" sentences we reject an analysis in terms of modal subordination, therein following Kamp&Reyle(1993), who consider the meaning of exclusive *or* to lie at the heart of the phenomenon. As for *modal splitting*, we agree with Landman(1986), who characterized these contexts as involving "two subordinated lines of thought", i.e., as a case of *discourse subordination.* By extending our new representation format to disjunction, we provided an analysis of these data that makes use of a *uniform* construction rule for disjunction.

4 Relative Modality, Conditionals and Modal Subordination

4.1 (Multiple) relative modality

In our informal exposition of Section 3.2 we only addressed examples of *relative modality* where the modal operator is dependent on, or anaphoric to the directly preceding discourse, which either represents factive information, or else figures within some DRS that represents an epistemic background context.

From these cases of aletic/metaphysical or epistemic modality we distinguish *non–epistemic* modality where the modal operator is interpreted as being *relative* to a deontic, bouletic, or other kind of non–epistemic intensional background context.

Especially for *conditional* non–epistemic modality we diverge considerably from the analyses of Lewis(1973) and Kratzer(1991). Also, our analysis of both conditional and non–restricted non–epistemic modality dispenses with the notion of an "ordering source", i.e. no *partial ordering* of worlds is necessitated to deal with modal adverbs such as e.g. deontic *must/have to.* The open issue of how to deal with inconsistent modal bases in these non–epistemic modal contexts (recall the Samaritan Paradox and Practical Inference) will be addressed in Section 4.2, which will lead us straightforwardly to the analysis of counterfactual modality in Section 4.3.

4.1.1 Epistemic modality

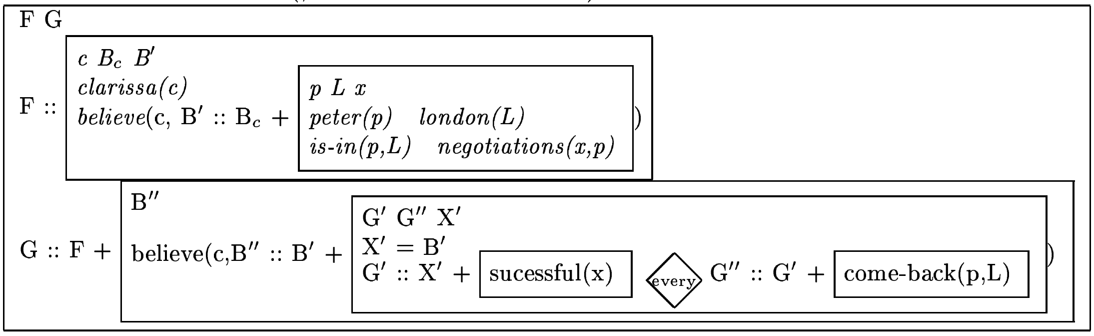
The examples we discussed in the previous Sections only dealt with epistemic (as opposed to deontic, bouletic, etc.) modality. The modal adverbs *will, might, would,* etc. were characterized as being dependent on a context referent that represented the (continuously updated) preceding discourse. If such a context can be interpreted as representing the speaker's epistemic state, as we argued it is generally the case in direct utterances (see Section 3.1), these modal adverbs do then qualify as *epistemic.*

Of course, epistemic contexts other than the speaker's can provide the reference context for epistemic modal operators, as e.g. in (1), where the *if*–conditional occurs within the scope of the attitude verb *believe.* The embedded modal construction must be interpreted as dependent on Clarissa's beliefs – this is brought out by the qualification *but I do not think so*, which explicitly rules out the speaker's beliefs as the reference context.

As argued in Section 3.1, we take the attitude predicate *believe* to be itself dependent upon some (accommodated) overall belief state of the attitude subject. For (1), this will be the belief state of Clarissa's, represented in terms of the referent B_c, which is additionally constrained to satisfy the DRS–conditions corresponding to the (unbound and therefore) accommodated presuppositions triggered by the complement sentence. Instead of introducing a generalized quantifier for the attitude predicate *believe*,[1] we will represent it as a two place predicate, where the second argument is filled by the update condition $B'' :: B' + K'$, where B' refers to the (here accommodated) "antecedent" belief context, and K' represents the complement of the verb *believe*: *believe(c,*$B'' :: B' + K'$*)*. The modal construction can then be interpreted as *relative to* Clarissa's beliefs by anaphoric reference to the contextual referent B', with additional restriction to worlds that qualify as "normal" relative to Clarissa's assumptions as to what corresponds to the normal course of events.

[1] Cf. our discussion in Section 3.2.

(1) Clarissa believes that, if Peter's negotiations are successful, he should soon come back from London (, but I do not think so).



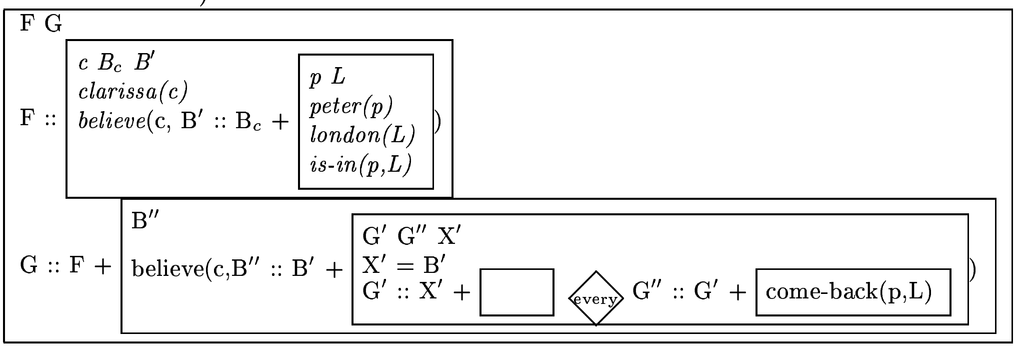
A related example is (2), where the epistemic antecedent context for the modal *should* is not introduced by way of an attitude verb, but in terms of the sentence initial adverbial *according to Clarissa's beliefs*. Again, the modal verb must be interpreted as being dependent on Clarissa's beliefs – as brought out by the qualification *but I do not think so*.

By analogy with (1) we assume the phrase *Clarissa's beliefs* to trigger accommodation of a condition *believe*$(c, B' :: B_c + K)$, to serve as an antecedent context for the belief–attribution of (2), where B_c represents Clarissa's overall belief state, and where the (unbound) presuppositions triggered in the main sentence, and which cannot be bound, are accommodated into K. We assume the main sentence to be interpreted within the scope of the adjunct, just like the complement sentence in (1) is within the scope of *believe*, such that the conditions to be generated for the main sentence appear within the DRS K' in the condition *believe*(c,$B'' :: B' + K'$), which is to represent the (context dependent) meaning of the phrase *according to Clarissa's beliefs*.

The semantic representation we assign to modal operators then allows for anaphoric reference to the context referent B', which represents Clarissa's belief state B_c updated with the accommodated presuppositions triggered by the phrases *Peter* and *come back*.

As in cases of epistemic modality considered above, the verification conditions for modally quantified structures will, in (2), induce an additional relativization to worlds that are considered as "normal", but now relative to the worlds in the denotation of B'', i.e. worlds that characterize Clarissa's belief state. Due to this relativization the conditional will be considered true even if Clarissa can imagine quite exceptional conditions, compatible with her beliefs, which, if taken into account, would falsify the conditional.

(2) According to Clarissa's beliefs, Peter should soon come back from London (but I do not think so).

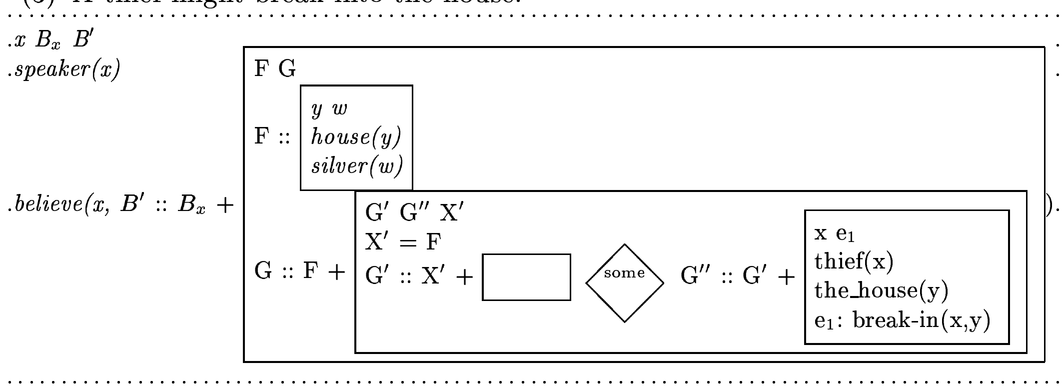


Recall that for examples of type (3) we had argued that – while the linguistic context does not overtly indicate an interpretation relative to an epistemic context – if the sentence constitutes a direct utterance of some speaker, we can in general assume relativization to the speaker's epistemic context to be licensed *pragmatically*, given the presence of the modal *might*, and the assumption of Gricean Maxims.[2]

The following is just a tentative representation where the DRS to be constructed for (3) is characterized as embedded within some pragmatic layer of discourse or dialogue representation, which we indicate by use of dotted lines. We assume that on the basis of pragmatic information or inferences we can define the existence of a speaker x and his or her belief state B_x, such that the DRS constructed for the sentence (3), which is recognized as a (putatively sincere) utterance of the speaker, defines an update of the belief context B_x to yield the extended context B'.

It is then possible, as we assumed in Sections 3.2 to 3.4, to represent the modal operator as dependent on the context established by the linguistic antecedent context (which here only consists of F, enriched by accommodated conditions for unbound presuppositions). Thus, as we try to illustrate by use of this very sketchy representation, the epistemic interpretation that is perceived for (3) can be characterized as being induced pragmatically, by representing the DRS that is to be constructed for the sentence as embedded within an accommodated DRS layer that represents the pragmatic, nonlinguistic context of the utterance, e.g. in a dialogue.

(3) A thief might break into the house.



So the different types of constructions involving *epistemic modality* we have been reviewing by now – relativization to a belief context introduced by linguistic means, via a *believe*–predicate or a corresponding adverbial expression as in (1) and (2), or else relativization to the directly preceding context, which is characterized as a belief context in terms of pragmatic inferences on the basis of some version of dialogue semantics, as in (3) – are characterized by the unifying feature that the context referent that provides the antecedent context for the anaphoric modal base of the modal operator qualifies as an *epistemic context*: the modal operator is either directly anaphoric to a context referent that is characterized as a belief context in terms of the predicate *believe* as in (1) and (2), or else, as in (3), the antecedent referent represents a context that is (pragmatically) characterized as a partial epistemic context.

[2] Although there may be contexts where the linguistic or pragmatic context favours relativization to some other person's belief state (see above Section 3.1).

4.1.2 Non–epistemic modality

The challenge of Kratzer's work on modality is that epistemic and non–epistemic modals are to be analyzed by one and the same "neutral" semantic form, while the differences in meaning arise through their context dependent nature. This context dependence has been implemented in Kratzer's framework in terms of the concepts of *modal base* and *ordering source*. Non–epistemic modality was characterized to involve (doubly) relative modality in terms of a circumstantial modal base and a deontic or buletic ordering source.[3]

In Section 2.2.3 we have presented various arguments against this analysis. One of our objections was concerned with the analysis of *conditional* deontic modality. We have argued that any serious analysis of conditional deontic modality must capture the distinctions in (4). Katzer's analysis falls short of this desideratum if all of these conditionals are to be covered by the same semantic form, namely by a single modal operator that is relative to a circumstantial modal base and a deontic ordering source: a single–operator analysis cannot account for the contrasting examples (4c/e/f).

As we have argued, the analysis can be adjusted by positing an embedded deontic operator within the scope of the conditional structure. But once we do so for (4c–f), we have to question the adequacy of a single–operator analysis for (4a–b). Especially for (4b) this is brought out by the fact that we may freely add the modal adverbial *necessarily*, i.e. an operator with distinct quantificational force, without changing the meaning of the sentence.

(4) a. If Max stays with Grandma, he **must** go to bed early.

b. If Max stays with Grandma, he **may** stay up late.

c. If Max stays with Grandma, he *might* **have to** go to bed early.

d. If Max stays with Grandma, he *might* **be allowed** to stay up late.

e. If Max stays with Grandma, he *probably* **must** go to bed early.

f. If Max stays with Grandma, he *probably* **is allowed** to stay up late.

Our aim is to provide an analysis of non–epistemic modality that accounts for the range of data in (4) for *conditional* non–epistemic modality, and for *non–restricted* non–epistemic modality, as in (5) below. However, we will have to defer the analysis of counterfactual non–epistemic modality to Sections 4.2 and 4.3.

Another objection we raised against Kratzer's analysis of non–epistemic modals in terms of *graded* modality was concerned with examples involving conflicting background contexts, in particular the case of "Practical Inference", where the analysis of *graded modality* yields unintuitive results (see Section 2.2.3).

We will first give a general outline of the analysis of non–restricted and conditional non–epistemic modality, and then, in Section 4.2, turn to the problem of how to deal with inconsistent modal bases, as in the "Samaritan Paradox" and "Practical Inference". This discussion will then lead us towards the analysis of counterfactual modality in Section 4.3.

[3] "[they] are analyzed as being *doubly relative*. They depend on two conversational backgrounds." Kratzer(1991:644).

4.1.3 Non–restricted non–epistemic modality

Although the sentences in (5) are taken out of context, the non–restricted modal adverb *must* in (5a) can (besides an epistemic interpretation) be interpreted deontically, i.e. relative to some intensional context that expresses obligations Max is subject to. What the sentence states is that *according to these obligations* it is necessary that Max goes to work early, or, put differently, that if Max acts in a way such that complete justice is done to these obligations, he will (always) go to work early. (5b) is slightly weaker in that the underlying intensional context does not so much express *obligation* as rather *recommendation*, or something like *advisability*. But this putative contrast can easily vanish when the sentences are uttered in specific situations, depending e.g. on the social or hierarchical status of Max relative to the person that expresses the respective attitudes of *demand* or *advice*.

The modal adverb *can* in (5c) is most naturally interpreted as dependent upon a characterization of Max's abilities, or skills (i.e. as "circumstantial" according to Kratzer's terminology: e.g. *in view of Max's capabilities*), although in specific contexts it may be interpreted epistemically (maybe even deontically). With subjunctive *could*, we may still have a circumstantial (or an epistemic) reading, but this will now be dependent upon a counterfactual context, where either Max has skills different from those he has in the actual world, or else the facts differ from the actual world in that, e.g. there is a unicycle available for use.

(5) a. Max must go to work early.

b. Max should go to work early.

c. Max can ride a unicycle.

d. Max could have ridden a unicycle.

What these examples should illustrate is that, while the underlying modal base is to some extent constrained by the lexical meaning of particular modal (ad)verbs, both the type of intensional context and its specific content can only be determined pragmatically, on the basis of the linguistic and/or non–linguistic context.

But it is also evident, as we argued in Section 3.1 by way of (6), that in some cases the linguistic context explicitly introduces an intensional context to provide the antecedent context for a non–epistemic, here deontic modal operator.

(6) DDR–Richter und –Staatsanwälte <u>können</u> *nach einem Grundsatzurteil des Bundesgerichtshofs (BGH)* für die Verfolgung von Republikflüchtigen und zahlreichen Regimekritikern in der Regel nicht bestraft werden. Den DDR–Juristen <u>müsse</u> für eine Verurteilung wegen Rechtsbeugung ein "offensichtlicher schwerer Willkürakt bei der Anwendung des DDR–Rechts" nachzuweisen sein. (StZ,16.10.1995:1)

While in Kratzer's analysis it is possible to identify the ordering source for the modal verbs with the context referred to by the phrase *nach einem Grundsatzurteil des Bundesgerichtshofs (BGH)* (pending a device that allows for anaphoric reference), it is not possible to do so in Roberts' and Geurts' reconstructions of Kratzer's theory. Recall that in both DRT analyses the ordering source is not represented at the level of the DRS, but only figures within the verification conditions for modal DRS structures, where it is defined as a set of propositions.

By contrast, in our analysis, in order to render the full meaning of non–epistemic modal sentences, we will represent the non–epistemic reference context (the "ordering source") at the level of the DRS. This will not only capture the difference in meaning between e.g. (7a–b), but will also make it possible to *represent* the anaphoric dependence of *müssen* in (6) on the deontic context introduced by the phrase *ein Grundsatzurteil des Bundesgerichtshofs.*

(7) a. Clarissa will necessarily go to Paris.

b. Clarissa must go to Paris.

Deontic *must (have to)*, *may (be allowed to)*

In the following we will restrict ourselves to the analysis of non–epistemic modality that is traditionally called *deontic.*

Before we turn to examples like (7b), where the appropriate (deontic) reference context is not explicitly introduced by the antecedent context, and therefore has to be accommodated, we will first examine cases like (8) where the intensional reference context to provide the deontic antecedent context for *must* is introduced by the phrase *a new tax law.*

(8) The government has passed a new tax law. Max must pay higher taxes now.

Now, as Kratzer noted, deontic modals are *neutral* modal operators that are "doubly relative – they depend on two conversational backgrounds". I.e. the modal verbs in (8) and (9) are not only relative to some deontic reference context (here *a new/German tax law*), but also to a circumstantial background context.

This additional relativization to a factual[4] context is obvious in (9), where we assume the relevant deontic context to define that *an owner of a dog pays taxes for his dog.* Now, (9) will only be judged true if the factual situation is such that Max owns a dog. So the analysis of deontic *must* must capture the fact that (the evaluation of) the modal operator is not only dependent on information stated in the deontic background context, but also on information that is defined within the relevant factual background context.

Yet, (9) also nicely illustrates that – while the deontic modal must be (partly) dependent on *both* a factual and a deontic context – the presupposition triggered by *his dog* may in no case be accommodated within the deontic reference context: there is no obligation, imposed by German tax law, that there be a dog that Max should own, but only that *dog owners pay taxes.* The presupposition that Max owns a dog may only be accommodated within the underlying factual background context. The problem of presupposition projection and accommodation with deontic modality will be discussed below.

[4]Recall from Section 2.2.3 that a circumstantial context defines a subset of the set of facts that hold true in the factual context. Since in our framework DRSs represent partial contexts, we will often use the notion of a factual context where we should more correctly choose the notion of a circumstantial context.

(9) According to German tax law, Max must pay taxes for his dog.

The analysis we introduced in Sections 3.2 and 3.3 offers a means to represent this "double" relativization of the modal operator: we have introduced, but not explicitly discussed a *merge*, or *union* operator $+$ on context referents, a relation between discourse referents F and D that yields a context referent G, and which is defined, by the verification conditions given in Section 3.3, to denote the set of states $\langle w', f \cup d\rangle$ s.th. $w' \in cs(e(F)) \cap cs(e(D))$. For convenience we restate the verification condition in (10) below.[5]

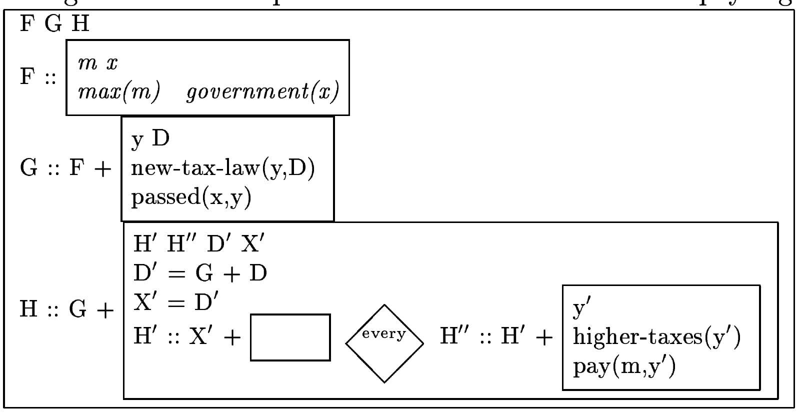
(10) $\langle w, e\rangle \models_M G = F + D$ iff
$e(G) = \{\langle w', g\rangle : \exists\langle w', f\rangle \in e(F)\ \exists\langle w', d\rangle \in e(D)$ s.th. $\langle w', g\rangle = \langle w', f \cup d\rangle\}$.

In order to render a deontic reading of *must* in (11), we characterize the modal operator as being both *dependent on* the intensional context (referent) D that figures as an argument of the predicate *new-tax-law(y,D)* and on the context referent G provided by the (factual) antecedent context. This is explicitly represented in the DRS in terms of the condition $D' = G + D$, which defines a *complex* modal base D' for deontic *must*.[6]

Relativization of the universally quantified modal to the complex modal base D' restricts the quantification to range over states $\langle w', d'\rangle$ such that w' is in accordance with both the facts that are introduced in the factual antecedent context G and the deontic context D.[7]

We represent the phrase *a new tax law* as a two–place predicate where the first argument is filled by an individual type variable y, and the second argument by a context variable D, which defines the intensional content laid down in the law. The lexical meaning of *law* then has to specify that what is referred to by D defines an intensional, deontic context.[8]

(11) The government has passed a new tax law. Max must pay higher taxes now.



Similar to the cases we reviewed above for epistemic modality, the (here deontic) background context can also be provided by material within the local sentence, e.g. by way of

[5]Recall the definition of a *context set*: $cs(\mathbf{X}) = \{w' : (\exists x')\langle w', x\rangle \in \mathbf{X}\}$, for $\mathbf{X}$ a set of states (see p. 138).

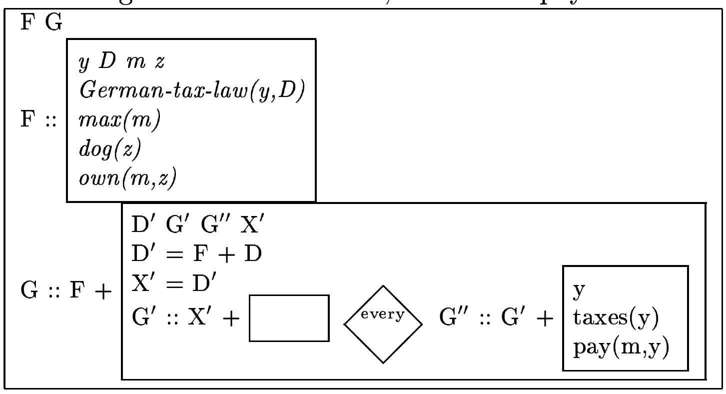
[6]We could also define X' as directly dependent on $G + D$ by use of the condition $X' = D + G$.

[7]Cases of deontic modality where the factual and deontic contexts are conflicting or inconsistent will be discussed in Section 4.2.

[8]So we do not introduce a further condition such as e.g. *obligation(D)*, to render the deontic nature of the context referred to by D. We take this to be part of the lexical meaning of *law*.

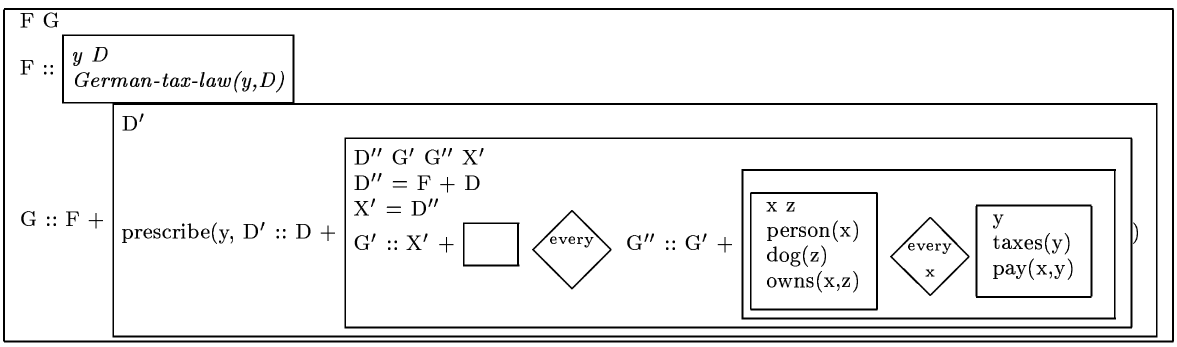
a topicalized adjunct as in (9), repeated below. Assuming, as we did for analogous cases of epistemic modality, that the modal is realized within the scope of the topicalized adjunct, it may locally bind the referent D to build its complex modal base D'.

(12) According to German tax law, Max must pay taxes for his dog.



Finally, we also find cases where the intensional context to provide (part of) the complex modal base is established by a governing attitudinal predicate, as e.g. by *prescribe* in (13). Since we have chosen to represent the phrase *German tax law* in terms of a two–place predicate *German-tax-law(y,D)*, we can assume – in analogy with the analysis of an epistemic modal within the scope of the attitude verb *believe* in (1) – that the predicate *German-tax-law(y,D)* establishes an overall deontic context D "attributed" to y, such that the verb *prescribe* can be represented as a predicate *prescribe(y,* $D' :: D + K'$*)*, where K' is the representation to be constructed for the sentential complement of *prescribe.*

(13) German tax law prescribes that every owner of a dog must pay taxes for it.



Note that in (13), given that the material within the scope of the modal operator is not dependent on factual information, we could also have chosen X' to anaphorically refer to the referent D alone, without further relativization to a factual background context – which besides the condition for *German tax law* is "empty" in (13), anyway.

This leads us to the first of several aspects we want to discuss in the following, concerning the choice of the particular representations in (11)–(13) and their semantic analysis.

Conditional laws

As we already noted in Section 2.2.3, juridical contexts are very often defined in terms of conditional or generic sentences. Recall the statements in (14), which we could take to establish (part of) a juridical context D.

(14) Any person who owns a car and is not handicapped pays taxes.
Any person who owns a car and is handicapped does not pay taxes.

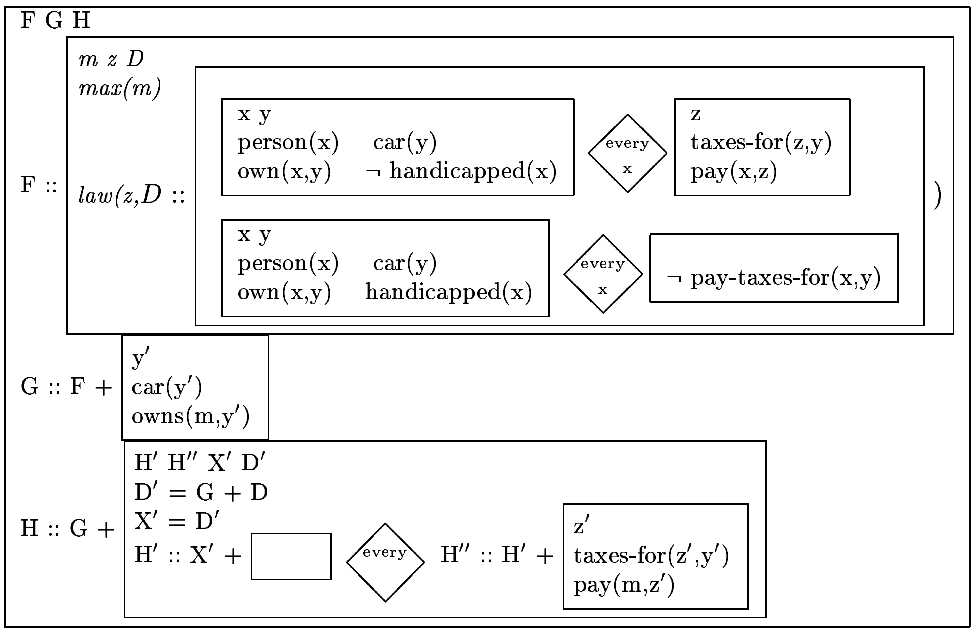
Let us assume that D in (15) and (16) is established by the assertions in (14). Given that the content of D is defined in terms of quantified conditions, it is now evident why in cases like (15) (and similarly for (13)) – where the scope argument of the modal operator contains a quantified condition that is a(n alphabetic) variant of a condition defined within D – the modal quantification is not dependent on the factual antecedent context: this type of deontic sentence conveys a statement *only* about the content of a particular deontic reference context.

(15) According to the law, any person who owns a car and is not handicapped must pay taxes.

However, in (16) the factual antecedent context is decisive. Again we assume D to be defined by quantified conditions, based on (14). The juridical context D by itself is therefore silent about (i) the existence of a person named *Max*, and (ii) whether or not this person Max (is obliged to) pay(s) taxes.

Only by "multiple" relativization of the modal operator, i.e. relativization to the *complex modal base* $D' = G+D$ in (16) can we derive that Max – given he owns a car, and assuming *per default* (see below) that he is not handicapped – is obliged to pay taxes.

(16) Max owns a car. According to the law, he must pay taxes for it.



How exactly is this derived by our theory? Assuming D is completely specified in terms of the DRS it annotates in (16), this referent will denote the set of states $\langle w', d\rangle$ that is defined by the condition $D :: \Lambda + K'$. I.e. the set of states that are in the denotation of D do *only* pertain to worlds w' that are in accordance with/verify the conditions within K'. The denotation of G on the other hand characterizes the set of worlds $cs(e(G))$ where the *law* is as characterized by the context D, and where there is a person named *Max* who owns a car (with e the verifying embedding function for the DRS (16)).

Building the *complex modal base* $D' = G + D$ – according to the verification condition for the *merge* operator in (10) – establishes a context referent D' that determines the set of worlds $cs(h(D')) = cs(h(G)) \cap cs(h(D))$, i.e. the set of worlds where it holds that *every person who owns a car and is not handicapped will pay taxes*; and *every person who owns a car and is handicapped will not pay taxes* **and** where it holds that *Max is a person who owns a car.*

Therefore, the modally quantified condition in the DRS annotated by H in (16) will be verified iff *every* state in the denotation of $X' = D'$ that pertains to a world w'' that qualifies as *normal* relative to X' (and the empty restrictor DRS K') wrt. the world of evaluation w (i.e. $w'' \in *(w, h(X' + K'))$), can be extended to a state $\langle w'', h''\rangle$ that verifies the scope DRS K''. Assuming that the *normal worlds* relative to X' and w will be worlds where Max is not handicapped, the scope DRS K'' in (16) will in fact be verified by every such state $\langle w'', h\rangle$.[9]

We will address the role of the *normalcy restriction* for non–epistemic modality below, and more extensively in Sections 5.1.1 and 5.2.

Presupposition projection and "triviality" problems

One of the problems we have to confront, given our analysis of deontic modality in terms of a "neutral" modal operator that is relative to a complex modal base $D' = F + D$, consisting of a factual context F and a deontic background context D, is the problem of presupposition projection, in particular presupposition accommodation and the related problem of unwarranted "trivial" deontic sentences.

Slight variation of example (16) illustrates the first point: if in (17) the context D referred to by *the law* is as in (16) above, and the factual antecedent context F is silent about whether Max does or doesn't own a car, then the presupposition triggered by *his car* within the scope argument of *must* cannot be bound, but will induce *accommodation* of a condition that tells us that Max (is presupposed to) own(s) a car.

As we noted in Section 3.3 we will not address the problem of presupposition projection and accommodation in much detail, but follow the spirit of van der Sandt's(1992) analysis of presupposition as anaphora, and provisionally adopted the convention of accommodating unbound presuppositions into the "initial" DRS K' in $F :: \Lambda + K'$. In cases of unbound presuppositions triggered within non–epistemic (deontic, etc.) modal contexts, such as in (17), this is in fact as it should be.

[9]This corresponds *roughly* to application of modus ponens for a syntactically based inference relation, applying to the merge of the DRSs annotated by D and G. But given that the restriction to "normal" worlds is not captured by the DRS representation, such a syntactic inference relation does *not* derive the DRS annotated by H''.

The subject of nonmonotonic, or default reasoning that is at stake here will be discussed in Chapter 5.

Yet, irrespective of whether we adhere to an analysis of presupposition as anaphora (as in van der Sandt(1992) and Geurts(1995)), or to the satisfaction theory of presupposition (Heim(1983)), there is nothing to predict that presuppositions triggered within an (extended) context that is dependent on a complex modal base $D' = F + D$ will be accommodated within F rather than within D. I.e. in principle we could end up with a representation of (17) that specifies, within the underlying deontic reference context for *must*, that Max owns a car. But it is certainly not a presupposition of (17) that the law demands that Max own a car (and similarly the sentence does not presuppose that the law demands that a person named Max does exist – if we assume proper names to come with an existence presupposition).

(17) According to the law, Max must pay taxes for *his car*.

Note that this is not a problem specific to this example, nor specific to deontic modal verbs, which could be taken as an objection against our analysis, where we assume the deontic context to be represented at the level of the DRS, and make use of the *merge* operation instead of using a Kratzer–style analysis in terms of *graded modality*, where the deontic context is used as an ordering source.

The very same problem arises with *attitudinal contexts*. In Heim(1992) the theory of presupposition projection of Heim(1983) is applied to the analysis of attitude verbs. The particular analysis that is developed there for the predicates *want, wish* and *be glad* predicts that presuppositions triggered within the complements of such predicates are bound or accommodated within the underlying belief context they are dependent on. I.e. the sentence (18a) is predicted to presuppose (18b). This follows from Heim's satisfaction theory of presuppositions together with a conditional analysis of *want* (19), which is defined in terms of a preferential relation $<_{\alpha,w}$ (20) between sets of worlds that in (19) are tied to the attitude subject's belief context Dox_α.[10]

(18) a. Patrick wants to sell his cello. Heim(1992:183)

b. Patrick believes that he owns a cello.

(19) $\mathrm{c} + \alpha$ *wants* $\phi =$ cf. Heim(1992:197ff.)
$\{ \mathrm{w} \in \mathrm{c}$: for every $w' \in \mathrm{Dox}_\alpha(w)$: $\mathrm{Sim}_{w'}(\mathrm{F}_\alpha(w) + \phi) <_{\alpha,w} \mathrm{Sim}_{w'}(\mathrm{F}_\alpha(w) + \textit{not}\ \phi)\}$

(20) For any $w \in W$, $X \subseteq W$, $Y \subseteq W$,
$X <_{\alpha,w} Y$ iff $w' <_{\alpha,w} w''$ for all $w' \in X$, $w'' \in Y$ Heim(1992:197)

[10]The presupposition theory is – roughly – captured by a definedness condition on updates $c + \phi$ (i), where c is defined as a set of possible worlds:

(i) Given a sentence ϕ with presupposition ϕ':
c + ϕ is *defined* iff c *implies* ϕ'. cf. Heim(1992:185)

Since $\mathrm{Dox}_\alpha(\mathrm{w})$ is a subset of $\mathrm{F}_\alpha(\mathrm{w})$ by (ii), presuppositions accommodated into $\mathrm{F}_\alpha(w)$ by (19) are also accommodated into $\mathrm{Dox}_\alpha(w)$.

(ii) $\mathrm{F}_\alpha(w) = \{w' \in W$: w' is compatible with everything that α in w believes to be the case no matter how he chooses to act.$\}$ Heim(1992:199)

Since this works well for cases like (18), and since it does so precisely because the analysis of *want* is only dependent on the attitude subject's belief context, one might be tempted to reject our analysis of non–epistemic modality in terms of a *complex* modal base, which involves a non–epistemic (here deontic) context.

But Heim's analysis of *want* does not account for presupposition projection in *attitudinal subordination contexts*, exemplified by (21a) and (22a). The analysis of *want* predicts (21a) to presuppose (21b), and (22a) to presuppose (22b), which is not appropriate.

(21) a. John wants Fred to come, and he wants Jim to come too. Heim(1992:192)

b. John believes that someone is coming.

(22) a. Patrick wants me to buy him a cello. He wants to play his cello in a famous orchestra.

b. Patrick believes that he owns a cello.

By contrast, the examples substantiate that presuppositions can project either into an epistemic background context (18), or else into a non–epistemic background context (21)/(22). But at the same time these data seem to call for a more fine–grained analysis of presupposition projection.

While in (18) we have a case of presupposition *accommodation* into an epistemic context, examples (21a) and (22a) involve *binding* of presuppositions within a non–epistemic context. Now, the data in (23) and (24) show that *accommodation* of presuppositions into a non–epistemic context is not an option: the sentences (23a) and (24a) do not presuppose (23b) and (24b), respectively.

(23) a. Patrick wants to sell his cello. Heim(1992:183)

b. Patrick wants to own a cello.

(24) a. Patrick wants to go to Paris. There he wants to sell his cello.

b. Patrick wants to own a cello.

These data drive us to the following hypothesis: there is a principled difference between *accommodation* and *binding* of presuppositions. *Accommodation* of presuppositions seems to be constrained to contexts that qualify as epistemically based (which we mean to subsume both factual and epistemic contexts). Presuppositions cannot be accommodated into non–epistemic contexts (deontic, bouletic, ect.). If we accept this restriction, the presuppositions triggered in (23a) and (24a) cannot be accommodated within the non–epistemic context itself (i.e. locally) in (23a), nor within the non–epistemic context established by the first sentence of (24a) if the second sentence is analyzed as "attitudinally" subordinated.

On the other hand, *binding* of presuppositions may occur in non–epistemic contexts, which applies to the cases in (21a) and (22a) if the second attitude predicate is analyzed as dependent on or relative to the non–epistemic context established by the first predicate.

And, of course, binding is also licensed within epistemically based contexts.
If we further assume – as it is by all extant theories of presupposition – that binding is preferred over accommodation, we also predict (21b) and (22b) to be odd.

We will not go any further into the subject of presupposition projection and accommodation. In defense of our analysis of non–epistemic modality we outlined some basic ideas to circumvent the problem of presupposition accommodation within non–epistemic contexts. An analysis that follows the hypothesis outlined above will predict the presupposition triggered in (17) to be accommodated into the underlying factual or epistemic reference context. Once we have shown how to account for modal subordination with non–epistemic modals in Section 4.1.5, an analysis along these lines will also predict that in (25) the anaphor or definite description is to be bound within the deontic context established by the first sentence, rather than accommodated within the underlying epistemic context.

(25) Fred must write a new song. He must compose it/the song for a famous singer.

To conclude, we take it as an advantage of our theory that for non–epistemic modality it makes available, for a theory of presupposition projection along the lines suggested, both an epistemic (or factual) and a non–epistemic (deontic, bouletic, etc.) antecedent context.

The second problem we referred to above is somewhat different, but related. Recall the discussion of deontic *if*–conditionals in Lewis' and Kratzer's theories (Sections 2.2.2 and 2.2.3). Both of these theories predicted deontic conditionals to be trivially true whenever the consequent states a fact that is either a trivial truth, or else explicitly states a presupposition triggered by the antecedent clause.
Similarly, Kratzer's analysis of non–restricted deontic modality, if relativized to a circumstantial modal base, predicts that (26b) is true whenever (26a) is, whether or not the deontic ordering source for *must* specifies that Clarissa is dancing (i.e. must/should dance).

(26) a. Clarissa is dancing.

b. Clarissa must dance.

As it stands up to now, our analysis suffers from the same deficiency. If the factual antecedent context F for a deontic modal implies some fact ϕ, e.g. (26a), whether or not the deontic context D implies ϕ, a sentence of the form *must* ϕ such as (26b), where *must* is dependent on $F + D$, will always be true.[11]

In discussing deontic *if*–conditionals in Section 2.2.2 we argued that the problem is grounded on the non–representational framework of a possible worlds analysis. Now, in our analysis, where we make use of context referents denoting sets of world–function pairs to establish an antecedent context for modal operators, we are confronted with the very same difficulties in this respect.
Earlier we noted that one could try to account for these problems in terms of a pragmatic constraint on the usage of deontic *must*, which requires the proposition ϕ in its scope argument not to be (historically) determined by the epistemic or factual antecedent context. This accounts for a tendency of *must*, which very often allows for a deontic interpretation

[11] Unless D implies $\neg\phi$, of course.

only if the sentence it takes within its scope gets a futurate, as opposed to a cotemporal interpretation.

Yet, while this (hardly) goes through for (27a), it definitely doesn't for (27b): here we can have a deontic reading of *must* even if the complement is stative and cotemporal. Also, a deontic reading is possible for (27c), although an epistemic reading is much easier to get.

(27) a. You must sit down. vs. #? You must be seated.

b. You must go to Paris. vs. You must be in Paris.

c. You must be angry now.

Besides these data, reconsider (26) above, where the (b) sentence can easily be read deontically if interpreted in the context of the (a) sentence and if it serves as an explanation for the fact stated by the (a) sentence. And finally, note that all of the sentences in (27) that take a stative complement become more acceptable (for a deontic reading) if *must* is replaced by *be obliged to*, which by its lexical semantics is constrained to a deontic interpretation, and in addition does not involve an intentional meaning component, which is in our view (at least by pragmatic implicature) present in most uses of deontic *must*, and in particular in imperative–like uses as in (27).

(28) a. You are obliged to be seated.

b. You are obliged to be in Paris.

c. You are obliged to be angry now.

So our conjecture is that the observed tendency of deontic *must*, to be preferably uttered relative to a context where the fact denoted by its complement is not yet "settled", has more to do with the pragmatic conditions associated with notions of *demand* vs. *obligation* rather than with the semantics of *obligation* proper. Given that these pragmatic constraints are rather weak, we cannot make use of them to account for the problem illustrated by (26), which is purely semantic.

Instead we will now propose a semantic constraint to rule out such unwarranted "trivial truths" of deontic sentences.

The basic idea can be illustrated by the following paraphrase of the deontic sentence (26b): *(Even) if Clarissa were not to dance, she would have to do so/dance.* This paraphrase explicitly conveys the *deontic* meaning aspect of the sentence, in that it focusses on the fact that the obligation is in force irrespective of whether or not the action or fact in question holds true in the factual context.

In our analysis of deontic modality this idea can be implemented in the following way: Assume F and D to be accessible context referents, F representing a factual and D a deontic context. Then the *complex* modal base $X' = D'$ of a (deontic) modal operator with scope DRS K'', interpreted relative to F and D, can be defined in terms of a condition $D' = F' + D$, where F' is either equal to F if K'' does not follow from F, or otherwise is characterized to differ from F in that K'' does not follow from F'.

This constraint on F' can be defined as indicated in (29): we make use of the relation of *context reduction* $\subseteq$ between context referents (see Section 3.3, p. 121), where $F' \subseteq F$ holds true (relative to a world w and an embedding e) iff for every state $\langle w', f \rangle$ in the denotation $e(F)$ of F there is a state $\langle w', f' \rangle$ in the denotation $e(F')$ of F' such that $f' \subseteq f$.

Based on the relation of context reduction $\subseteq$ we define a stronger relation $F' \ {}_{?K''}\!\subseteq F$, which defines F' as a reduction of F, with the further constraint that the content defined by K'' is not "settled" by F'. In (29) we define this relation to be verified relative to $\langle w, e \rangle$ iff $F' \subseteq F$ is verified by $\langle w, e \rangle$ and there is some state in the denotation of F' that verifies K'', and there is also a(nother) state in the denotation of F' that doesn't verify K''.

(29) Let $\langle w, e \rangle$ be the verifying state for a DRS K that contains a quantified condition for a (deontic) modal operator with scope DRS K'' that is to be interpreted relative to accessible context referents F and D, F representing a factual/ epistemic/ circumstantial context and D a deontic context. The modal operator will be evaluated *relative to* the context referent D', the *complex* modal base, defined as the *merge* of F' and D ($D' = F' + D$), where F' is defined by the DRS condition $F' \ {}_{?K''}\!\subseteq F$.

Verification of the condition $F' \ {}_{?K''}\!\subseteq F$ is defined below, where we assume the setting of definition (67) in Section 3.3, p.121.

$$\langle w, e \rangle \models_M F' \ {}_{?K''}\!\subseteq F \quad \text{iff} \quad \langle w, e \rangle \models_M F' \subseteq F \ \& \\ \exists \langle w', f' \rangle \in e(F') \colon \langle w', f' \rangle \models_M K'' \ \& \ \exists \langle w'', f' \rangle \in e(F') \colon \langle w'', f' \rangle \not\models_M K''.$$

The relation ${}_{?K''}\!\subseteq$ is reminiscent of *contraction* in Gaerdenfors(1988). Relying on the postulates for contraction given there[12] in (30.2)–(30.6) we define the following constraints on ${}_{?K''}\!\subseteq$, which correspond to his postulates (K $^-$ 2) – (K $^-$ 6).[13]

(30) Let K be an ADRS verified by $\langle w, e \rangle$, $G, G' \in dom(e)$, and K'' an ADRS.

2. If $\langle w, e \rangle \models_M G' \ {}_{?K''}\!\subseteq G$ then $\forall \langle w', g \rangle \in e(G) \ \exists \langle w', g' \rangle \in e(G') : g' \subseteq g$.
3. If $\langle w, e \rangle \models_M G' \ {}_{?K''}\!\subseteq G$ and $\exists \langle w', g \rangle \in e(G)$: $\langle w', g \rangle \models_M K''$ and $\exists \langle w'', g \rangle \in e(G)$: $\langle w'', g \rangle \not\models_M K''$ then $e(G') = e(G)$.
4. If $\langle w, e \rangle \models_M G' \ {}_{?K''}\!\subseteq G$ and not $\vdash K''$ then $\neg \forall \langle w', g' \rangle \in e(G') : \langle w', g' \rangle \models_M K''$.
5. If $\langle w, e \rangle \models_M G' \ {}_{?K''}\!\subseteq G$ and $\forall \langle w', g \rangle \in e(G) : \langle w', g \rangle \models_M K''$ then $\langle w, e \rangle \models_M G :: G' + K''$.
6. If [$\exists \langle w', f \rangle, \langle w', g \rangle$: ${}_{\langle w', f \rangle}[\![K''_1]\!]_{\langle w', g \rangle}$ iff ${}_{\langle w', f \rangle}[\![K''_2]\!]_{\langle w', g \rangle}$] then if $\langle w, e \rangle \models_M G'_1 \ {}_{?K''_1}\!\subseteq G$ and $\langle w, e \rangle \models_M G'_2 \ {}_{?K''_2}\!\subseteq G$ then $e(G'_1) = e(G'_2)$.

[12]Main postulates for contraction in Gaerdenfors(1988:ch.3.4):
(K $^-$ 1): For any sentence A and any belief set K, K^-_A is a belief set.
(K $^-$ 2): $K^-_A \subseteq K$.
(K $^-$ 3): If $A \notin K$, then $K^-_A = K$.
(K $^-$ 4): If not $\vdash A$, then $A \notin K^-_A$.
(K $^-$ 5): If $A \in K$, then $K \subseteq (K^-_A)^+_A$.
(K $^-$ 6): If $\vdash A \leftrightarrow B$, then $K^-_A = K^-_B$.
(K $^-$ 7): $K^-_A \cap K^-_B \subseteq K^-_{A\&B}$.
(K $^-$ 8): If $A \notin K^-_{A\&B}$, then $K^-_{A\&B} \subseteq K^-_A$.

[13]We do not consider (K $^-$ 7) and (K $^-$ 8), although they can be restated in our framework, as has been shown by Hans Kamp. Condition (30.3) differs slightly from (K $^-$ 3) in order to account for cases like (33.b).

With this new contraction, or reduction condition ${}_{?K''}\!\subseteq$ we can define, for *non–restricted* deontic modal operators, the introduction of referents and DRS conditions as displayed in (31): If a modal expression is interpreted as *relative to* a context referent F representing a factual context *and* a referent D that represents a deontic context, the anaphoric referent X' in the logical form of the modally quantified condition $G' :: X' + K' < Q > G'' : G' + K''$ (with K' the empty DRS) will be represented as anaphoric to the *merge* of $F' + D$, where F' is determined by the condition $F'\ {}_{?K''}\!\subseteq F$ to denote a (minimal)[14] reduction of F that does not determine the truth of the scope DRS K''.[15]

$$(31)\quad \boxed{\begin{array}{l} \mathrm{G'}\ \mathrm{G''}\ \mathrm{X'}\ \mathrm{F'} \\ \mathrm{F'}\ {}_{?K''}\!\subseteq \mathrm{F} \\ \mathrm{X'} = \mathrm{F'} + \mathrm{D} \\ \mathrm{G'} :: \mathrm{X'} + \boxed{K'}\ \langle \mathrm{Q} \rangle\ \mathrm{G''} :: \mathrm{G'} + \boxed{K''} \end{array}}$$

This analysis of non–restricted deontic modality accounts for problematic examples of the type illustrated by (26). If the deontic context referred to by *the law* in (32) is as e.g. in (16), the deontic sentence in (32a) will not come out true: within the denotation of G' there will be states that verify that Clarissa is dancing, while others will not. Given that D doesn't determine that Clarissa should be dancing, the merge X' of G' and D will also not "settle" that Clarissa is dancing. Consequently, not every state that verifies the restrictor DRS K' (relative to X') can be extended to a state that verifies the scope DRS K''.[16]

On the other hand the analysis predicts that the deontic sentence in (32b), with nonuniversally quantifying *may* will come out true. There will be some state in the denotation of X' (respecting normalcy) that can be extended to a state that verifies the scope DRS.

(32) a. Clarissa is dancing. According to the law she must do so.

$$\boxed{\begin{array}{ll} \multicolumn{2}{l}{\mathrm{F\ G\ H}} \\ \mathrm{F} :: & \boxed{\begin{array}{l} c\ D \\ clarissa(c)\quad law(D) \end{array}} \\ \multicolumn{2}{l}{\mathrm{G} :: \mathrm{F} + \boxed{\mathrm{dance(c)}}} \\ \mathrm{H} :: \mathrm{G} + & \boxed{\begin{array}{l} \mathrm{H'}\ \mathrm{H''}\ \mathrm{X'}\ \mathrm{G'} \\ \mathrm{G'}\ {}_{?\boxed{\mathrm{dance(c)}}}\!\subseteq \mathrm{G} \\ \mathrm{X'} = \mathrm{G'} + \mathrm{D} \\ \mathrm{H'} :: \mathrm{X'} + \boxed{}\ \langle \mathrm{every} \rangle\ \mathrm{H''} :: \mathrm{H'} + \boxed{\mathrm{dance(c)}} \end{array}} \end{array}}$$

[14]The minimality condition follows from (30.3) and (30.5).

[15]One could argue that the introduction of the new context referent F' is problematic since it allows for the possibility of (unwarranted?) subsequent anaphoric reference to F'. We do not pursue this question (mark) any further, but simply note that we can easily avoid this problem by choosing a slightly different syntax for the reduction relation, similar to Gaerdenfors': instead of conditions $F'\ {}_{?K''}\!\subseteq F$ we then use functional conditions of the form $\overset{\subseteq}{{}_{K''}}(F)$ such that $\langle w, e\rangle \models_M \overset{\subseteq}{{}_{K''}}(F)$ iff $\exists e', e \subseteq_{\{F'\}} e'$ s.th. $\langle w, e'\rangle \models_M F'\ {}_{?K''}\!\subseteq F$ and $e'(F') = e(\overset{\subseteq}{{}_{K''}}(F))$. The representation format (31) then changes to the one in (i).

$$(\mathrm{i})\quad \boxed{\begin{array}{l} \mathrm{G'}\ \mathrm{G''}\ \mathrm{X'} \\ \mathrm{X'} = \overset{\subseteq}{{}_{K''}}(F) + \mathrm{D} \\ \mathrm{G'} :: \mathrm{X'} + \boxed{\mathrm{K'}}\ \langle \mathrm{Q} \rangle\ \mathrm{G''} :: \mathrm{G'} + \boxed{\mathrm{K''}} \end{array}}$$

[16]The only way this would be so is in case the normalcy selection function $*(w, h(X' + K'))$ induces a restriction only to worlds where Clarissa is dancing. But we do not expect this to happen in (32).

b. Clarissa is dancing. According to the law she may do so.

F G H
F :: [*c D* | *clarissa(c)*, *law(D)*]
G :: F + [dance(c)]
H :: G + [H′ H″ X′ G′ |
  G′ ?[dance(c)] ⊆ G
  X′ = G′ + D
  H′ :: X′ + [ ] ⟨some⟩ H″ :: H′ + [dance(c)]]

The analysis also accounts for the cases in (33). In (33a) the antecedent context introduces a fact that corresponds to what is prescribed by the deontic context (we still assume the same legal context D as above). While the "reduced" context G' ($G'\ _{?K''} \subseteq G$) will not determine that Max pays taxes for his car, this will follow relative to the complex modal base $G' + D$, given that G' (by presupposition projection) will still determine that Max owns a car (reconsider example (17)).

Finally we also predict (33b) to be true. By presupposition accommodation the context F determines that Max owns a car. The reduced context (referent) G' will eliminate the fact defined within G that Max doesn't pay taxes for his car. Again the merge of G' with D will predict that (under normalcy assumptions) Max is obliged to pay taxes for his car.

(33) a. Max pays taxes for his car. He must/is obliged to pay taxes for his car.

F G H
F :: [*m y D* | *max(m)*, *car(y)*, *owns(m,y)*, *law(D)*]
G :: F + [z | taxes(z), pay-for(m,z,y)]
H :: G + [H′ H″ X′ G′ |
  G′ ?[z′ | taxes(z′), pay-for(m,z′,y)] ⊆ G
  X′ = G′ + D
  H′ :: X′ + [ ] ⟨every⟩ H″ :: H′ + [z′ | taxes(z′), pay-for(m,z′,y)]]

b. Max doesn't pay taxes for his car. But he must/is obliged to pay taxes for it.

Normalcy restriction in deontic modal quantification

One may object that the *normalcy* restriction – which we will argue to lie at the heart of the *vagueness* and *variability* of conditionals (see in particular Chapter 5) – is *not* a genuine characteristic of non–epistemic modality. After all, especially for *deontic* modality, whether or not some law holds in a given context is not a matter of variable or context dependent *normalcy assumptions*, but a matter of *yes or no*. In particular, in the present setting we do not want (34) to be judged true.

(34) Max owns a car and is not handicapped. According to the law he may not pay taxes.

On the other hand, if there is no information available in the context about whether or not Max is handicapped, as in (35), the normality assumption will drive us to assume Max to be a non–handicapped person, and thus we can derive that he is obliged to pay taxes. In fact, we relied upon this normalcy assumption in many of the above examples. However, this normality assumption can only be a default assumption, open to revision. I.e. as soon as the context informs us that Max is handicapped (or else makes salient the issue of him being handicapped), the (context dependent) normalcy assumptions for Max will differ.

(35) Max owns a car. According to the law he must pay taxes for it.

In Chapter 5 we will show that the nonmonotonicity that is induced by use of a context dependent normalcy selection function accounts for the vagueness and variability of conditionals and to a certain extent also allows for vagueness with non–restricted modals. At this point it may suffice to give some preliminary motivation for assuming a normalcy restriction for non–epistemic modal quantification.

Consider examples (36a–b).[17] They are cases of what Kratzer calls *circumstantial* modality, where the modal operator is relative to some specific subpart of factual information, here relevant biological facts.[18] The observation is that (36a) will be accepted to be true – given biological facts Timmy will pee sooner or later –, while the truth of (36b) – even if interpreted as relative to a set of relevant biological parameters – might be open to dispute.

(36) a. Little Timmy must pee.

b. Little Timmy must sneeze.

[17] The examples are by Carl Vogel (p.c), who drew my attention to the problem that one might object to the claim that *must* in (36b) is a universally quantifying modal, given that it may well turn out that Little Timmy does *not* sneeze.

[18] Recall Kratzer's illustrative example (i), where (ia) can be interpreted relative to the factual or a circumstantial background context, while (ib) can only be interpreted relative to the factual (or epistemic) background context. Differences in truth are then predicted if e.g. the exotic area in question has a climat appropriate for plum trees (such that (ia.) can be true on the circumstantial reading), while there has been no contact with cultures where plum trees grow (which makes (ib) false).

(i) a. Plum trees can grow in this area.

b. It is possible that plum trees grow in this area.

Our intuition is that this tendency to distinguish different "degrees of certainty" for (36a) and (36b) is not determined by distinct quantificational forces of the modal operators, but rather by two interacting factors that are present in our analysis of non–epistemic modality: (i) relativization to the complex modal base consisting of the factual and some "higher–order" contextual background, here relevant biological facts, and (ii) the context dependent normalcy restriction of modally quantified structures.

If the modal operators in (36a–b) are only interpreted as "relative to relevant biological facts", it is in fact predicted that (36a) is true, while (36b) false. It is biologically possible for a human being never to sneeze in his life.

Yet, we argued that non–epistemic modals are in most cases – in addition – relative to a factual antecedent context. In (36a–b) we have to accommodate such a nonempty factual antecedent context, since the modal base must at least provide for an individual named Timmy.

Once (36a–b) are interpreted relative to a factual antecedent context where Timmy is subject to a stimulus of peeing or sneezing, the normalcy assumptions for (36a) will not leave very much room for Timmy to resist the biological stimulus. Therefore the truth of the universally quantified sentence is easily accepted here: given the facts and relevant biological parameters, if everything holds what is normally the case, Little Timmy will pee. Nevertheless, also for (36a) the normalcy assumptions are defeasible: Little Timmy must pee, unless he's dying first, or is transported to desert conditions sufficiently for him to lose bodily fluids via evaporation.[19]

Now for (36b) there may be some uncertainty as to the criteria of normalcy to apply: it seems that some people are (sometimes) able to control a sneezing stimulus, i.e. make it disappear somehow. But sometimes there is no help. Also, the question whether you can avoid sneezing is dependent on the force of the stimulus. So given that there is more room for defeasibility with (36b), one could in fact question the *truth* of the universally quantified sentence – depending on which normalcy conditions are applied for little Timmy in the particular factual situation –, rather than the universal force of the operator.

In fact, given universal quantification, and assuming the person to utter (36b) to obey Gricean maxims, we can derive that the normalcy assumptions he considers for (36b) are such that Timmy – in general or in the particular situation – is not able to control the sneezing stimulus.

The previous examples gave some motivation for assuming the factual context to induce (defeasible) normalcy assumptions with non–epistemic modal quantification. But given that non–epistemic modals are relative to a complex modal base, the normalcy selection function $*(w, e(X' + K'))$ will apply to a context $e(X' + K')$ where $e(X')$ denotes the *merge* or *union* of a factual (epistemic, circumstantial) **and** a non–epistemic (deontic, etc.) context.

So the question is whether the normalcy selection function, if applied to such a "complex" context, will also allow for defeasible default or normalcy assumptions wrt. the information settled by the deontic background context. I.e. assuming for (37) that the juridical background context D distinguishes between handicapped and non–handicapped car holders, as we did all along, will (37) be true relative to a modal base $F + D$ where F is an empty factual context?

(37) According to the law, every person who owns a car must pay taxes.

[19] Carl Vogel, p.c.

Though at first sight it seems to be easier for our analysis to allow for vagueness of non–epistemic modals wrt. their non–epistemic background context, we do not think this is an option. If (37) is accepted as true, we conjecture it is because its modal base will not take into account the *entire* set of conditions that make up the deontic context D, but only those that are somehow *relevant* or at issue in the present context.[20] In our view it is difficult to accept the somewhat imprecise assertion in (37) as true, unless the context makes clear that we are not interested in subtle exceptional cases defined by law, but only with the "standard cases of application", and this can in turn only be the case if the factual antecedent context is not empty, but somehow is accommodated to be "about" the issue of tax paying for "normal car holders".[21] Thus, we take it that (37) can only be judged true if it is interpreted as (i) relative to a relevant subset D' of the deontic context D that is confinded to the "standard cases", and (ii) if it is subject to a normalcy restriction induced by the factual background context.

How does our analysis account for this characteristic of non–epistemic modal quantification, to allow for vagueness only wrt. the factual or epistemic background context? The normalcy selection function * is defined to apply to the *complex* context $e(X' + K')$ where $e(X')$ denotes the *union* of the factual and non–epistemic background context. So in principle nothing prevents the normalcy restrictions from constraining the domain of quantification by applying considerations of normalcy to the non–epistemic "part" of the complex modal base.

But note that the normalcy selection function for modal quantification (see verification conditions of Section 3.3) will be defined, in Section 5.2.4, to obey FACTICITY, such that the selected set of "normal worlds" must be a (possibly improper) *subset* of the set of worlds that make up the anaphoric (complex) modal base. If in (37) the entire context D contributed to the complex modal base X', then X' would determine a set of worlds $cs(h(X'))$ that are in full accordance with the laws defined by D.[22] I.e. the quantification would only range over worlds where non–handicapped car holders pay taxes, while handicapped car holders do not. There is then no way, by application of the normalcy restriction, to switch to *alternative worlds*, violating the quantificational constraints defined within D, to verify universal quantification over both handicapped and non–handicapped car holders in (37), to derive that they all pay taxes.

On the other hand, if (37) is interpreted relative to a subset D' of D, which only determines that non–handicapped car holders must pay taxes, the set of worlds determined by X' will contain worlds where handicapped car holders either do or do not pay taxes for their car. With empty F, and by application of the normalcy restriction, it is then possible to verify (37): normal worlds where non–handicapped car holders pay taxes are still worlds where non–handicapped car holders pay taxes,[23] but the context dependent normalcy selection function could be defined such that normal worlds where non–handicapped car holders are obliged to pay taxes are such that also handicapped car holders are obliged to do so. The domain of quantification will then be reduced to those worlds out of $cs(h(X'))$ where besides non–handicapped car holders also the handicapped ones pay taxes. On this normalcy assumption then the universal quantification in (37) will go through.

[20] Cf. our discussion of Practical Inference in 4.2.2.

[21] *Normal* is used here as a purely technical term, not to be misunderstood.

[22] See Section 4.2 for cases of conflicting factual and non–epistemic contexts.

[23] This will follow by FACTICITY of * (see Section 5.2.4).

The only open issue is then whether we can assume the normalcy selection function to give us this restriction. In our view this will only be possible if the factual antecedent context is in fact not empty, but (pragmatically) constrained to ignore any exceptional, complicating issues: we are only interested in exceptionless applications of laws. This line of explanation is consistent with the assumption that the modal base is restricted to a *relevant* subpart D' of D, to rule out any "special", or exceptional applications of tax law.

Thus, we tend to the view we advocated above: that (37) will come out true if the deontic context is not taken into account in its entirety, and if the factual antecedent context is somehow restricted to be about "standard car holders", such that handicapped people will not be considered at all.[24]

The subject of vagueness with (non–restricted) non–epistemic modality will be reconsidered in Section 5.1.1.

Deontic modals without "overt" antecedent context

In the previous paragraphs we have been assuming that the non–epistemic (deontic) antecedent context is explicitly introduced by the preceding discourse, either in terms of a phrase such as *the law*, which introduces a discourse referent D to stand proxy for an underspecified juridical context, or else by more explicit specification of the content defined by such D, as in (15)/(16), such that D is associated with a DRS that defines the corresponding conditions.

We now have to address the question of how to represent (deontic) non–epistemic modality in case the antecedent context does not explicitly introduce a deontic context referent in one of the ways just mentioned.

The fact that we analyzed the domain argument of modal quantifiers as *anaphoric*[25] strongly motivates that in such cases the underlying deontic context (referent) must be *accommodated*. Yet, in order to ensure that the DRS representation displays the deontic meaning component of a sentence like (38) (if interpreted as deontic, as opposed to an epistemic reading), it will not be sufficient to accommodate a context referent D without further restriction as to the "kind" of intensional context that D is to represent.[26] Thus, similar to the predicate *law* in the above examples we must accommodate, along with D, an intensional predicate that takes D as an argument, and which by its lexical meaning characterizes D to denote a deontic context.

So for an example like (38) one could think of accommodating an attitudinal predicate *demand(x,D)* where the context referent D supplies an (underspecified) reference context for a deontic interpretation of *must*. I.e. even if the linguistic context is silent about the source of the *demand* that Clarissa go to Paris, we may assume some person (or institution) to be the bearer of a respective attitudinal state. But things are not so easy.

First, there is the question whether for deontic *must* there is a tendency – similar to the

[24] Alternatively, it is possible to account for (37) by assuming the factual context to be constrained to be "about" normal (non–handicapped) car holders, and by taking into account the more fine–grained deontic context D in its entirety. Due to the normalcy restriction, the quantification will then only range over worlds with non–handicapped car holders, such that (37) will come out true.

[25] Which is broadly equivalent to Geurts' analysis, which views it as *presuppositional*.

[26] Recall our objections against Roberts' and Geurts' analysis of deontic modality, which could not be distinguished, in DR–theoretical terms, from e.g. epistemic modality.

one we observed for epistemc *might* – to be interpreted relative to the speaker's corresponding attitudinal state (*demand(i,D_i)*) if *must* is used in matrix sentences and without explicit introduction of a distinct attitudinal subject's demands. That this is not so is illustrated by the contrast (38a) vs. (38b). Thus, the individual discourse referent that represents the attitude subject of *demand* must be accommodated to denote some arbitrary individual x, to be determined by pragmatic conditions.

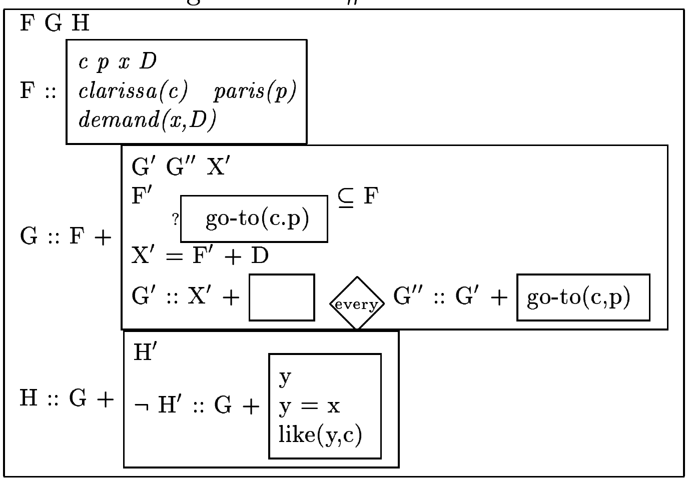
(38) Clarissa must go to Paris.

a. I want her to deliver these important documents.

b. The boss wants her to deliver these important documents.

One problem that could arise by accommodation of a predicate *demand* together with an individual discourse referent x to represent its attitude subject regards the possibility of anaphoric reference to such *accommodated* discourse referents.[27] For instance, in the case of (38), accommodation of x, D and the predicate *demand(x,D)* would allow for an extended discourse like (39) where a pronominal in the subsequent discourse is bound to x.[28] [29]

(39) Clarissa must go to Paris. # He doesn't like her.



But this is not a principled argument against accommodation of a referent x for the attitude subject of *demand.* The examples in (40) illustrate that discourse referents that are *accommodated* to satisfy unbound presuppositions are not in general available for anaphoric binding for subsequent *pronominals.* And it is remarkable that this is so even for presuppositions that are quite constrained, as e.g. those triggered by verbs like *manage*, or relational predicates like *author.*

[27]This has been observed by Ede Zimmermann.

[28]Note that the same argument could be made for the predicate *demand* itself, which could serve as an antecedent for a predicational anaphor, e.g. by VP–ellipsis or a presupposition triggered by *too* (*Fred does too*, in the sense of *Fred also demands that Clarissa go to Paris*).

[29]Hans Kamp observes (p.c.) that the example is much better with a plural pronominal: *Clarissa must go to Paris. They don't like her.* But it is arguable whether in this case the pronominal is to be understood as anaphorically bound to the first argument of the accommodated predicate *demand(x,D).* In this kind of usage *they* is more likely to trigger *accommodation* of a plural antecedent referent for *they*, which is not necessarily identical to the attitude subject of *demand.*

(40) a. Fred managed to sell the car. He did *so* 3 times. (*so* $\neq$ try to sell)

b. Today's author is well–known. # *It* appeared last month. (*It* $\neq$ the book/novel)

c. It wasn't Fred who took the money. *He* arrived this morning.
(*He* $\neq$ person other than Fred, who took the money)

d. Fred also came to the meeting. *They* arrived early.
(*They* $\neq$ people other than Fred that came to the meeting)

And note that in examples like (41) the referent that is taken up for anaphoric binding is *not* accommodated, but introduced by linguistic material.

(41) a. Fred's father is ill. *He* has been at the doctor's this morning.

b. Fred regrets that his father is ill. Peter also regrets *this*.

So one can argue that in general pronominal expressions cannot be anaphorically bound to *accommodated* discourse referents. The representation must then provide for some criterion to destinguish between accommodated referents on the one hand and referents that correspond to overtly realized linguistic expressions on the other. Based on such a device the problematic case (39) can then be ruled out along with the cases in (40).

The situation is different with definite descriptions, for which we assume that they carry an existence presupposition.[30] The examples in (40) all improve if a definite description is substituted for the pronominal expression, as in (42). One could therefore argue that the presuppositions triggered by the definite descriptions can be bound to the accommodated referents (or conditions) triggered by the presuppositions of the preceding sentences.[31]

(42) a. Fred managed to sell the car. He made *the effort* 3 times.

b. Today's author is well–known. *The novel* appeared last month.

c. It wasn't Fred who took the money. *The thief* entered trough the window.

d. Fred also came to the meeting. *The others* arrived first.

[30] Cf. Heim(1991).

[31] One might question whether examples (42) are in fact cases of anaphoric (or presuppositional) binding to referents that are in turn established by presupposition accommodation, and suggest, instead, that the existence presupposition triggered by the definite descriptions in (42) and (43) are satisfied by accommodation, instead of anaphoric binding. If this were the correct analysis for such cases, we could claim that anaphoric reference to *accommodated* referents is generally ruled out. Yet, if one takes this view of (42) and (43), one has to explain why we do not, e.g. in (42a), accommodate a referent for just *any* effort, but understand the sentence as saying that it is the effort of selling the car that Fred made three times.

Example (42b) is special and should perhaps not be grouped with the others. Van Deemter(1992) notes that this kind of anaphora is only possible with functional predicates, as is *the novel*. His example is (i), where *the people* cannot be anaphoric to the authors of the articles mentioned in the first sentence. A similar case is (ii), where *the woman* cannot be bound to the mother that the daughter can be presupposed to have.

(i) The articles were interesting. The people really liked them.

(ii) The daughter went to school. The woman watched after it.

And correspondingly we find that we can use a definite description in (43), the lexical content of which characterizes an individual that is licensed to give orders, and which can be anaphorically bound to the individual x, accommodated as the attitude subject of a presupposed and accommodated deontic predicate *demand(x,D)*.

(43) Clarissa must go to Paris. *The one/the person responsible/the boss* doesn't like her.

But there are other, more serious problems for the accommodation of an attitude predicate *demand(x,D)* in cases like (43). If the first sentence is interpreted in isolation, we may not simply assume there to be a person x who demands that Clarissa go to Paris. This *demand* of x could be weaker in that he or she only desires that *some person* go to Paris, and other constraints or demands – possibly to be attributed to other people – lead to the stronger requirement that Clarissa is the person to fulfull this demand. Therefore, accommodation of a predicate *demand(x,D)*, with x specifying the bearer of the attitude, would result in an overdetermined representation for *Clarissa must go to Paris.*

A more illustrative example may be (44), if this is what a teacher says to one of his scholars. There are three distinct types of situations where (44) can be true: (i) it is prescribed by the code of the school they belong to that scholars must wear a certain uniform *and* the teacher independently has strong desires that this is how things should be; (ii) wearing of the uniform is prescribed by the school's code, but not personally desired by the teacher, who has a more liberal state of mind; and (iii) the school code doesn't (or does not any more) prescribe that uniforms be worn by scholars, but this particular teacher does so, thereby imposing his personal ideal upon his pupils.

(44) You must wear this uniform.

Given these various interpretational possibilities, which may occur under certain contextual (or pragmatic) conditions, the best way to represent sentences like (44) is in terms of a condition *demand(D)* or *obligation(D)*, which is not committed to whether or not there is a (single) individual that is the bearer of a corresponding attitude *demand(x,D)*.

So we end up with assuming, for non–restricted *deontic* modal expressions that are not anaphorically bound to a context referent established by the overt linguistic context (in terms of deontic predicates like *the law*, or attitude predicates like *prescribe*, etc.), the accommodation of a predicate *obligation(D)*, which characterizes the (underspecified) context denoted by D as *deontic.* The intuition is that the semantics to be assigned to the predicate *obligation* is a quite general concept, which underlies the lexical meaning of these other, more specific deontic predicates. Within the scope of this work, however, we will not undertake any attempt to specify the lexical semantics of any of these intensional predicates.

4.1.4 Conditional non–epistemic modality

We have been arguing, when discussing the analysis of deontically modalized *if*–conditionals in Lewis' and Kratzer's theories (see Sections 2.2.2 and 2.2.3) that if we want to capture the distinctions in (45), the deontic modal adverbs *must (have to), may (be allowed to)* can only be interpreted as embedded within the scope of an epistemic modal operator, restricted by the *if*–clause, and which is implicit in (45a–b). In this respect the analysis we will present below differs crucially from the analyses of "conditional obligation" in Lewis(1973) and of "graded modality" in Kratzer(1991), which only distinguish between (45a–b).

(45) a. If Max stays with Grandma, he **must** go to bed early.

b. If Max stays with Grandma, he **may** stay up late.

c. If Max stays with Grandma, he *might* **have to** go to bed early.

d. If Max stays with Grandma, he *might* **be allowed** to stay up late.

e. If Max stays with Grandma, he *probably* **must** go to bed early.

f. If Max stays with Grandma, he *probably* **is allowed** to stay up late.

On Lewis' theory deontic conditionals are evaluated relative to a system of spheres of "comparative goodness of worlds", such that $\phi \Box\!\!\rightarrow \psi$ is true at a world i (if there are ϕ–worlds accessible from i) iff ψ holds at all the best ϕ–worlds, according to the ordering from the standpoint of i. This accounts for (45a), and the corresponding might–operator $\Diamond\!\!\rightarrow$ accounts for the meaning of (45b). But no analysis is possible, on the basis of a *single* operator, to account for (45c–f), with varying quantificational forces of an *epistemic* and a *deontic* modal expression.

Also, a single–operator analysis does not account for *counterfactual* deontic *if*–conditionals, such as (46). The selection of epistemically accessible antecedent worlds has been claimed by Lewis to be based on a relation of comparative similarity of worlds. The deontic modal in the consequent clause requires a structuring of possible worlds according to their comparative "goodness". But of course there cannot be a system of spheres that obeys both of these different ordering criteria at the same time, so the analysis of *counterfactual* deontic conditionals will have to involve an embedded deontic operator, within the scope of the counterfactual *if*–conditional.[32] In view of our observation of Chapter 2 (see in particular 2.2.2), that indicative and counterfactual conditionals share many important characteristics, an embedded analysis of deontic *have to* in (46) should then also motivate an embedded analysis of deontic *must* in (45a).

(46) If Max had stayed with Grandma, he would have had to go to bed early.

Quite similar objections were raised against Kratzer's analysis of deontic *if*–conditionals, which is also based on the assumption that the *if*–clause restricts a single (deontic) modal operator, and which therefore does not account for (45c–f). And – as we discussed at length in Section 2.2.3 – for the counterfactual case (46) the necessity operator would have to be interpreted relative to two distinct ordering sources – realistic and deontic – which is of course not possible.

[32] This requires – besides a system of spheres $\$_w^{sim}$ of comparative similarity of worlds – for every epistemically accessible world w' in $\$_w^{sim}$ a system of spheres of "comparative goodness of worlds" $\$_{w'}^{good}$, since for every possible world there may be differing standards to decide on the "goodness" of alternative worlds.

So we have argued that deontic *if*–conditionals – and this carries over to other types of non–epistemically modalized *if*–conditionals[33] – are to be analyzed in terms of an epistemically based (possibly implicit and universally quantified) operator that is restricted by the *if*–clause, and which takes the deontic or other non–epistemic modal operator in its scope.

An analysis that is similar in spirit to this conception can be found in Chellas(1980:276). He gives an analysis of the conditional obligation operator $\bigcirc(/)$ in terms of the (non–restricted) obligation operator $\bigcirc$ and the usual (epistemically based) conditional operator $\Rightarrow$, as given in (47). The evaluation of $\Rightarrow$ is based on a selection function f, as briefly stated in (47a), where f yields a collection of propositions in the model M. The semantics of the (non–conditional) deontic operator $\bigcirc$ is defined as in (47b), where N_α is a non–empty set of propositions in M that are standards of obligation relative to the world α.

(47) $\bigcirc(\mathrm{B}/\mathrm{A}) = \mathrm{A} \Rightarrow \bigcirc\ \mathrm{B}$

a. $\models^M_\alpha \mathrm{A} \Rightarrow \mathrm{B}$ iff $[\![\mathrm{B}]\!]^M \in f(\alpha, [\![A]\!]^M)$

b. $\models^M_\alpha \bigcirc\ \mathrm{A}$ iff $[\![\mathrm{A}]\!]^M \in N_\alpha$

The analysis we propose, then, for *if*–conditionals involving non–epistemically based modal verbs such as (deontic) *must, have to, may*, etc. is outlined for the indicative deontic conditional in (48), where we represent the *if*–clause to restrict an (implicit) universal operator, which takes a non–restricted universal deontic operator in its scope. Again we take the sentence to be uttered relative to a context F where the presuppositions triggered by the definite phrases *Max* and *(the) German tax law* are accommodated. The anaphoric modal base X' of the higher operator may be bound to this (factual) context referent F. The context referent X' is updated by the conditional's antecedent DRS, such that the annotating referent G' of the restrictor argument represents a context where Max owns a car. The conditional structure is verified iff every state $\langle w', g'\rangle$ denoted by G' that pertains to a *normal* world (determined by the selection function $*(w, g(X' + K'))$) can be extended to a state $\langle w', g''\rangle$ that verifies the scope DRS K''.

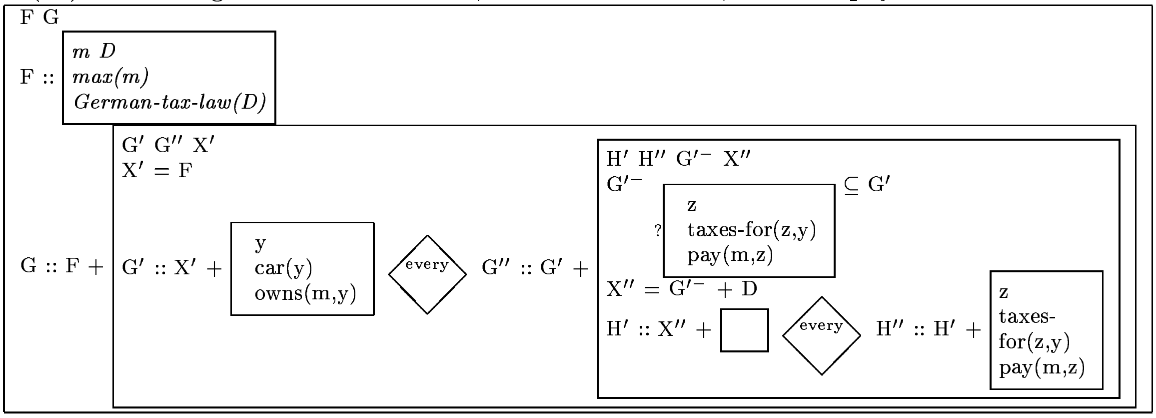
The scope DRS in turn contains a quantificational structure for the deontic modal expression. The conditions for the deontic modal are defined in exactly the same way as we did for the cases of non–restricted deontic modality investigated above. I.e. the modal base X'' is *complex*, consisting of the *merge* of the accessible deontic antecedent context D and the epistemic[34] *contracted* context G'^{-}, which is like the conditional's antecedent context G' except for not settling the "issue" of whether or not Max pays taxes. This embedded quantification is verified iff every state denoted by X'', and which is tied to a *normal* world relative to the evaluation world w' and the context $g''(X'' + K_2')$ $(*(w', g''(X'' + K_2'))$, can be extended to a state $\langle w'', h''\rangle$ that verifies the DRS K_2'' annotated by H''.

[33]Corresponding examples with non–epistemic uses of *can*, in the so–called circumstantial reading (here roughly *be able to*), are given in (i), where (ia) is not equivalent to (ib–c).

(i) a. If Max has grown up, he (*necessarily/certainly*) **can** ride a unicycle.
b. If Max has grown up, he *possibly* **can** ride a unicycle.
c. If Max has grown up, he *might* **be able to** ride a unicycle.

[34]as opposed to non–epistemic (deontic, bouletic, etc.)

(48) According to German tax law, if Max owns a car, he must pay taxes for it.



So we make use of the observation we made in Section 2.2.3, that a deontic operator that is embedded within the scope of a conditional can generally be interpreted as being (in part) anaphorically dependent on the context referent established by the conditional's antecedent clause, here the referent G'. This aspect is reconsidered in more detail below.

Obviously this analysis will account for the full range of data in (46), simply by varying the quantificational forces of the distinct modal quantifiers.

But what is more, it captures a much wider range of deontic conditionals as compared to the analyses of *conditional obligation* in Lewis(1973) and Kratzer(1991).

Recall that in a single–operator analysis of deontic conditionals the system of spheres of "comparative goodness" or the deontic ordering source are defined as being determined by the world w that is to verify the conditional. Therefore, such analyses only account for deontic conditionals where the "laws" that are prevalent in the world of evaluation w are identical to those holding at the worlds w' that are to verify the conditional's antecedent. An example in point is (49), were we assume that the laws prevalent in w also hold in the (maximally similar, or *normal*) epistemically accessible worlds where Jesse murders Girgl.

(49) If Jesse murders Girgl, he must go to jail.

But as we noted in passing in Section 2.2.2, there are other types of deontic conditionals, where the conditional's restrictive clause takes us to worlds w' where the relevant deontic context differs from the one prevalent in w. An example in point is (50).[35]

(50) If Luther hadn't brought about the Reformation, we would still have to pay indulgence.

[35]Whether or not (50) is considered true is heavily dependent on the notion of *normalcy*, which restricts the domain of quantification. If it is considered as normal that sooner or later a "necessary" historical process sets in, (50) will have to be judged false. Nevertheless, this falsity will *not* be determined by the laws that govern the actual world! It will be judged as false on the basis of additional assumptions as to how history would ("normally") have evolved if Luther hadn't acted the way he did. And if (50) is judged true, this will be so if e.g. the *normalcy* selection function chooses worlds where – once the opportunity for a change is missed, there will not by a second one.

The truth of such conditionals is typically open to dispute. The reason is that our intuitions about what is to be considered as *normal* in such exceptional or far–fetched situations are extremely fragile.

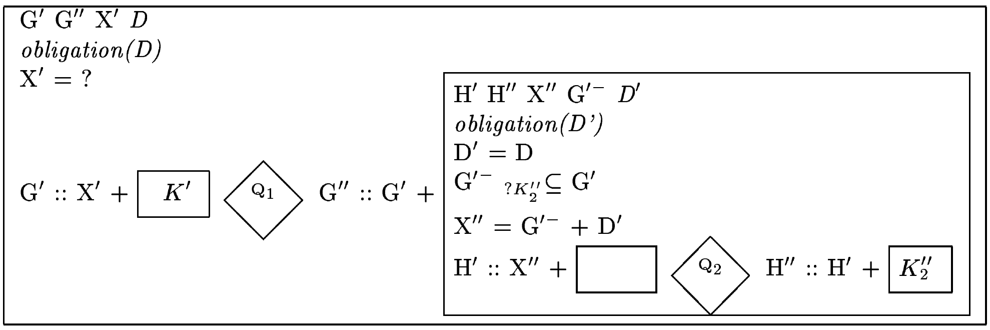
But we don't have to go as far as this. Even if the worlds that verify the conditional's antecedent are quite similar to the world of evaluation, they may induce critical changes to the underlying deontic context. In (51) e.g. the conditional's antecedent explicitly introduces a "new" deontic context, different from the one that prevails in the actual world, and which provides the basis for the truth of the consequent, which is in fact to be analyzed as the consequent clause of the embedded deontic operator.

(51) If the new laws for opening hours of shops go through, salespeople will have to work longer.

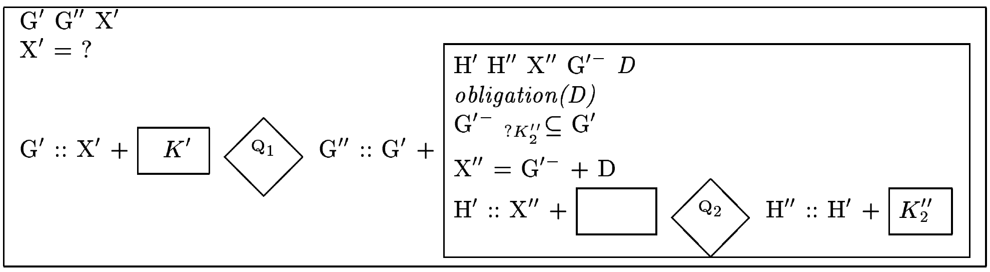
Deontic conditionals of this type, where the antecedent ranges over worlds where the relevant laws differ from those of the actual world, cannot be accounted for in Lewis' and Kratzer's analyses of deontic modality. In their single–operator analyses the conditional is to be evaluated relative to a system of spheres of "comparative goodness" of worlds $\$_i$, i the actual world, or else relative to a deontic ordering source $g(w)$, w the actual world.

How does our analysis capture the difference between these two types of conditionals? Given that the deontic conditional is broken down into two levels of quantification, this difference comes down to a matter of scope. In the latter type of deontic conditionals, exemplified by (50) and (51), the deontic context D that contributes to the complex modal base of the embedded quantifier has narrow scope within the epistemic quantification (as schematically given in (52b)). For the first type of deontic conditionals such as (48) and (49), the classical cases of *conditional obligation*, the relevant deontic context D that contributes to the deontic modal quantification has wide scope over the epistemic quantificational structure. In (52a) this is made explicit in terms of the equation $D' = D$.

(52) a.



b.



Since we have characterized the context referent within the restrictor argument of the modal quantifier as *anaphoric* – which is equivalent to the *presuppositional* analysis in

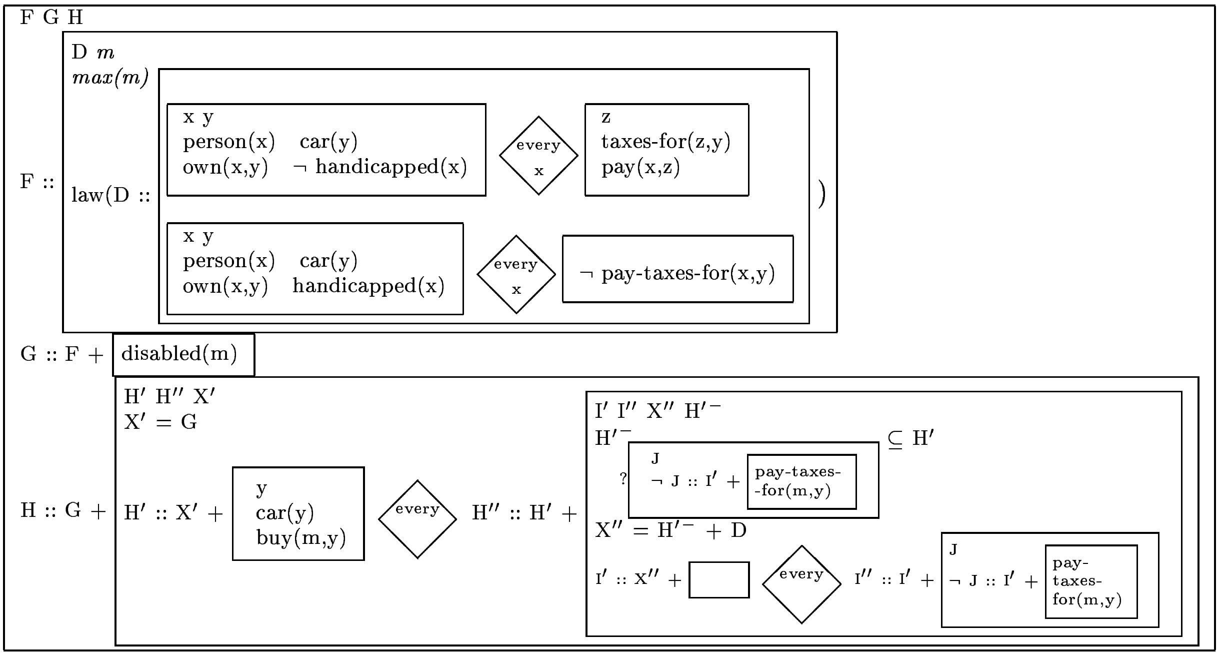
Geurts(1995) – it is then predicted that in cases like (50) and (51), where the antecedent clause evokes or explicitly introduces a relevant deontic backgound context, the deontic modal base is most naturally bound to this "local" deontic antecedent context. In cases like (48) and (49), by contrast, where no distinct deontic context is evoked within the conditional's antecedent or scope, the anaphoric referent D' in (52a) is most likely bound to some "higher" deontic context referent D, if available. This type of deontic conditional is then restricted to contexts where the relevant deontic background context is the same in the world of evaluation and the "normal" epistemically accessible worlds that constitute the quantificational domain of the conditional. In cases where this is implausible, as in (50), accommodation of a distinct deontic context will be local, as illustrated by (52b).

Up to now we have been assuming that the "factual" part of the modal base of the embedded deontic quantifier is anaphoric to the annotating referent G' of the conditional's restrictor argument (modulo contraction). As we already discussed in Section 2.2.3, this gives us, in the general case, (i) the appropriate restriction to the hypothetical context introduced by the conditional's antecedent, and (ii) takes into account the relevant (factual or else modal) information introduced by the preceding context the conditional is anaphorically dependent on.

The example we considered in Section 2.2.3 was (53b), where the relevant deontic context was defined by (53a).

(53) a. Every holder of a car who is not handicapped pays taxes for the car.
Every holder of a car who is handicapped does not pay taxes for the car.

b. Max is a disabled person. If he will buy a car, he must not pay taxes.



Since the referent H' represents the "update" of the antecedent context G with the conditional's restrictor DRS K', the embedded deontic quantification ranges over worlds where Max is a disabled person, buys a car, where it is not determined whether or not he pays taxes for the car and where everything holds that is defined by the deontic context D – *with additional restriction to what is considered as normal* in such a context. Obviously it then follows with necessity that Max will not pay taxes for the car.

By contrast, had it not been explicitly stated by the antecedent context that Max is a disabled person, as in (54), the *normalcy restriction* for both the higher and the embedded quantification would have led us to assume that Max is a non–disabled person, such that the law would require him to pay taxes.

(54) a. Every holder of a car who is not handicapped pays taxes for the car.
Every holder of a car who is handicapped does not pay taxes for the car.

b. If Max buys a car, he must pay taxes.

As our discussion in Section 2.2.3 brought out, the contrast between (53) and (54) can only be accounted for in Kratzer's analysis if either the modal base of the embedded quantifier is chosen to be anaphoric to the conditional's updated modal base, as we have chosen here, or else the embedded modal base is chosen to be *circumstantial*, i.e. comprise somehow relevant facts for the issue of whether Max has to pay taxes. In (53) this circumstantial modal base must then select worlds where Max buys a car and is a disabled person, while in (54) it will determine worlds where Max buys a car and is not handicapped.

But the restriction to worlds where Max is not handicapped in (54) seems to be parallel to the normalcy restriction of ordinary conditionals like (55), which in Kratzer's account is induced by way of a *stereotypical* ordering source.

(55) If Max walks to town, it'll take him half an hour.

So we have chosen the first alternative, of representing the deontic quantifier as anaphoric to the annotating referent of the governing conditional's antecedent – or, to put it differently, to the context referent that provides the "input argument" of the local DRS that contains the deontic quantifier.

Recall that in Section 2.3.2 we observed that counterfactual deontic conditionals potentially pose a problem for this kind of analysis. Or, more correctly, they do so if counterfactuals are analyzed as in Kratzer's framework, by use of an empty modal base and a realistic ordering source. In contexts like (56), relativization to a realistic ordering source constrains the conditional to quantify over worlds where Max is a disabled person. But the modal base of the conditional is empty, to allow for consistent update with the counterfactual antecedent. The (updated) modal base $f^{+}(w)$ of the conditional will therefore not convey that Max is a disabled person, and thus cannot be used to establish the modal base of the embedded deontic modal. Thus, in Kratzer's framework, the embedded modal base must be established by use of a circumstantial modal base that selects worlds where Max is handicapped.

By contrast, in our analysis of counterfactuals in Section 4.3 the modal base will not be restricted to be *empty*. It will retain as much information as possible from the factual antecedent context, while yielding a consistent update with the counterfactual antecedent.

So in (56) the conditional's modal base will determine that Max is a disabled person, and so will the modal base of the embedded deontic modal, if anaphoric to the updated modal base of the conditional.

(56) Max is a disabled person. If he were to buy a car, he would not have to pay taxes.

Finally, on the basis of our analysis of non–restricted deontic quantification (Section 4.1.3) the problem of unwarranted "trivial" truths is also avoided with deontic conditionals like (57). Taking the embedded deontic quantifier to be anaphorically dependent upon a relevant juridical context (referent) D' and the context referent G' that annotates the conditional's antecedent DRS, the complex modal base of the deontic quantifier is defined by $X'' = G'^{-} + D'$, where G'^{-} results from G' by contraction with the DRS K_2'', the scope DRS of the deontic quantifier: $G'^{-}\ {}_{?K_2''}\!\subseteq G'$. Since K_2'' just specifies that Jesse has a mother, even if G' supports this very fact, G'^{-} will not. And given that the deontic context D' will not determine that Jesse have a mother, (57) cannot be true on a deontic reading of *must*.

(57) If Jesse robs the bank and his mother gets notice of this, Jesse must have a mother.

It also seems possible to give an account of problematic cases of *even–if* conditionals like (58).[36] The conditional quantifies over worlds where Max doesn't pay taxes, while the scope argument of the deontic quantifier is to verify the contrary, that he (has to) pay taxes.

(58) Even if Max doesn't pay taxes for his car, he must pay taxes for it/ do so.

We could account for these cases by contraction of the annotating referent G' of the conditional's antecedent with the scope DRS K_2'' of the deontic quantifier, to yield a referent G'^{-} that does not determine whether or not Max pays taxes for his car. The embedded deontic quantification, based on the complex antecedent context $G'^{-} + D$, would then *non–vacuously* verify that Max will (i.e. must) pay taxes for his car. But since such "contradictory" cases only seem to be pragmatically wellformed with the special kind of *even–if* conditionals, or else must cooccur with particles like *nevertheless*, etc. we do not want to adopt this analysis.

Instead, the analysis of (58) should be tied to the specific characteristic of those *even–if* conditionals that do not depend on the truth of their antecedent.[37]

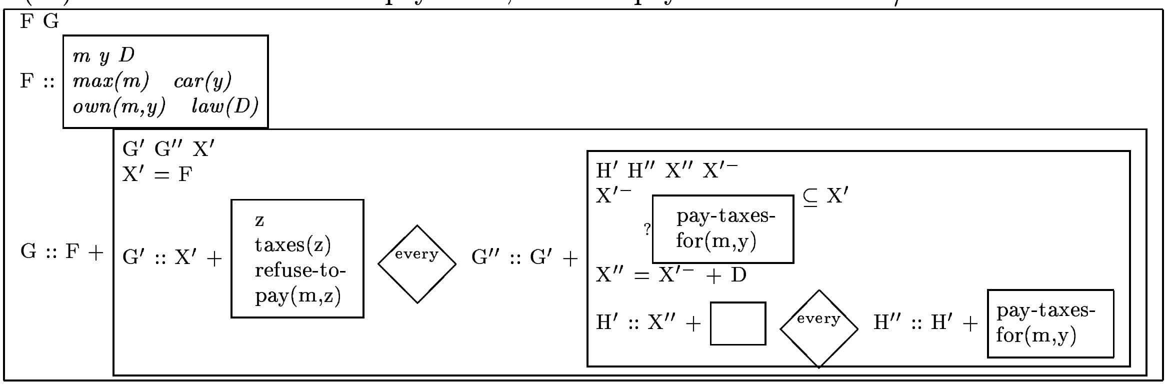
In our framework, one way of doing this is to represent the deontic quantifier to be (partly) dependent not upon the annotating context referent G' of the conditional's antecedent, but only upon its modal base X', which does not settle the issue of Max not paying taxes for his car.

[36] This needs immediate qualification. It is evident that we cannot give a satisfying analysis of *even–if* conditionals without investigation of the meaning of *even*, and thorough study of association with focus (see von Fintel(1994), Rooth(1992)). Also, as has been shown recently by Eckardt(1996), theories of focus association are confronted with serious difficulties when interacting with quantificational structures. One type of construction she considers are *only–if* conditionals.

Our proposal to account for (58) will therefore only consider one particular feature of *even–if* conditionals, to allow for so–called "entailed" readings, where the truth of the consequent is independent of the truth of the antecedent.

[37] As noted by e.g. von Fintel(1994), the truth of an *even–if* conditional is not necessarily independent of the truth of its antecedent. This is brought out by (i).

(59) Even if Max refuses to pay taxes, he must pay taxes for his car/ do so.



We have argued for an analysis of deontic *conditionals* where the non–epistemic modal operator is embedded within the scope of the conditional. The analysis of sentences with *non–restricted* non–epistemic modals we have given in Section 4.1.3 remains unaffected. There is no possible interpretation of (60a) that licenses the assumption of a governing epistemically based modal operator. Max's obligation to pay taxes is absolute, relative to the factual antecedent context and the deontic context in question. If this obligation is to be qualified as hypothetical or conditional, rather than as a given fact, a corresponding modal operator must be introduced *explicitly*, either non–restricted, as in (60b) or else conditional (60c).

(i) Don't drink at the office party!
Even if you drink only little, the boss will fire you.

There seems to be a distinction between two types of *even–if* conditionals, a distinction that goes along with a syntactic difference in V2 languages, as e.g. German. Von Fintel(1994:150) cites the following minimal pairs of ordinary *if* conditionals, where the entailed reading (iib) goes along with V3 position of the finite verb, i.e. the main clause is realized as a V2 sentence. The example is attributed to Köpcke&Panther(1989:687).

(ii) a. Wenn du Hilfe brauchst, bleibe ich den ganzen Nachmittag zuhause.
If you help need stay I the whole afternoon at–home
'If you need any help, then I'll stay home all afternoon.

b. Wenn du Hilfe brauchst, ich bleibe den ganzen Nachmittag zuhause.
'In case you need any help, I'm staying home all afternoon.'

The German translation of (i) as (iii) shows that the V3 construction (iiib) does not give us the reading of (i). (With some effort there seems to be a reading available for (iiib) on which the consequent is dependent on the truth of the antecedent. But this seems to be caused by the introducing sentence. If the boss will fire me anyway, and this is what my collegue wants to tell me, then there is no point to his advice, or warning not to drink even a little bit. Without this introductory sentence, however, (iiib) will only get the so–called "entailed" reading.)

(iii) Trink nichts auf der Büroparty.

a. Selbst wenn Du nur wenig trinkst, wird Dich der Boss feuern.

b. Selbst wenn Du nur wenig trinkst, der Boss wird Dich feuern.

Based on this syntactic criterion our example (58) can be shown to pertain to the kind of *even–if* conditionals that allow for the entailed reading: it allows for V3 position.

(iv) Selbst wenn Max sich weigert, Steuern für sein Auto zu zahlen, er muß es tun/Steuern für sein Auto zahlen.

(60) a. Max must pay taxes.

b. It is possible that Max must pay taxes.

c. If Max goes to work in Paris, he must pay taxes in France.

However, non–restricted deontic sentences in subjunctive mood, such as (61), seem to involve accommodation of an antecedent clause, restricting a governing universally quantifying epistemic modal operator. But accommodation does only succeed in specific contextual settings, which make available an appropriate salient (counterfactual) context. We will return to these cases in Section 4.3.3.

(61) a. Max would have had to pay taxes.

b. Max could have done this more easily/ on Monday.

Having argued that the *if*–clause in deontic conditionals must be analyzed as filling the restrictor argument of a governing, epistemically based modal operator, we are led to conclude that the restrictor DRS of the (anaphoric) deontic quantifier condition is *always* empty. The antecedent context that constitutes the modal base is provided in its entirety by the anaphoric context referent X'', i.e. by the "merge" of a (possibly contracted) factual or epistemic antecedent context G'^{-} and a deontic antecedent context D.

4.1.5 Modal subordination with non–epistemic modality

How does modal subordination work in contexts that involve non–epistemic modality?[38]

There are sequences of non–restricted modal sentences where a pronominal within the scope of a deontic modal must bind to an indefinite NP introduced within a preceding deontically (62a) or epistemically (62b) modalized sentence. Finally, an epistemic modal sentence can be subordinated to a preceding deontic sentence (62c)

(62) a. Max must write a letter. He must send it to his partner before tomorrow.

b. Max might be writing a letter. He must (then) hide it from his wife.

c. Max must write a letter. He will certainly hide it from his wife.

We can also have sequences of modally subordinated sentences with mixed occurrences of restricted and non–restricted deontic sentences, as illustrated by (63).

(63) a. If Fred is ill, he must take some medicine. If he is better, he may stop doing so.

b. If Fred is ill, he must take some medicine. He must take it regularly.

c. Fred must take strong medicine. If he goes abroad, he must take it with him.

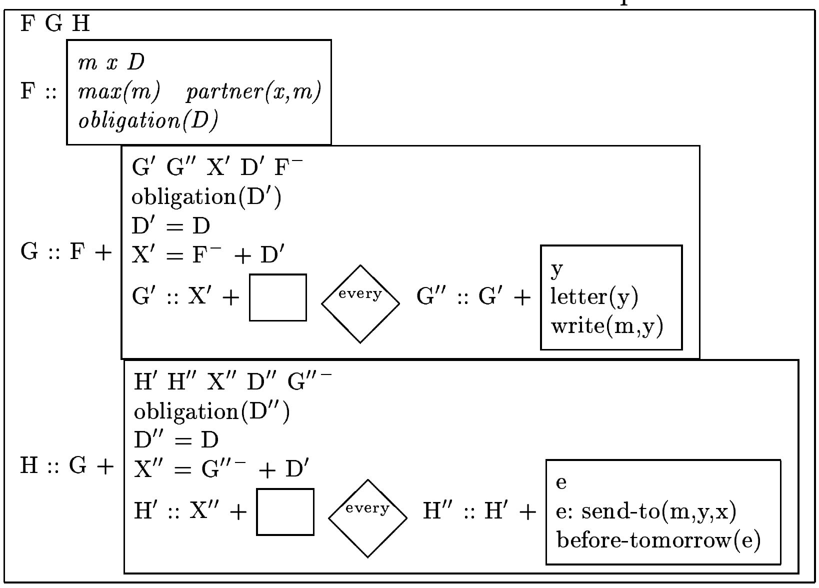
[38]Again we restrict ourselves to deontic modality.

Let us explore how these various possibilities work out in our analysis of modal subordination and epistemic vs. deontic modality.[39]

In (64a) the two uses of *must* are best understood as deontic, and moreover as dependent upon a unique, underspecified deontic background context D, to be accommodated in terms of the predicate *obligation(D)*. The first deontic sentence, relativized to this deontic background context $D' = D$, provides some specification for the referent D. On the Gricean assumption that it is meant to hold true, D is restricted to support the existence of a referent y for a letter to be written. Relativization of the deontic quantification in the second sentence to the same deontic context $D'' = D$ *and* the modal antecedent context G''^{-} – the scope referent of the preceding modal sentence (modulo contraction) – then allows for anaphoric binding of the pronominal *it* to the referent introduced by *a letter*.

One might argue that the second deontic modal could equally well be constrained to be dependent on the modal base $X'' = G^{-} + D''$, given that by the first sentence D is constrained to support the existence of a letter to be written. But first note that G'' is more specific than is G, such that relativization to G''^{-} certainly does no harm. Moreover, in the general case the content of D must not necessarily specify the existence of such a y. That a letter is to be written could e.g. *derive* from conditional statements within D *in conjunction with* additional background assertions within F (recall our discussion of conditional laws in Section 4.1.3). So we prefer the more general solution depicted in (64a)

(64) a. Max must write a letter. He must send it to his partner before tomorrow.

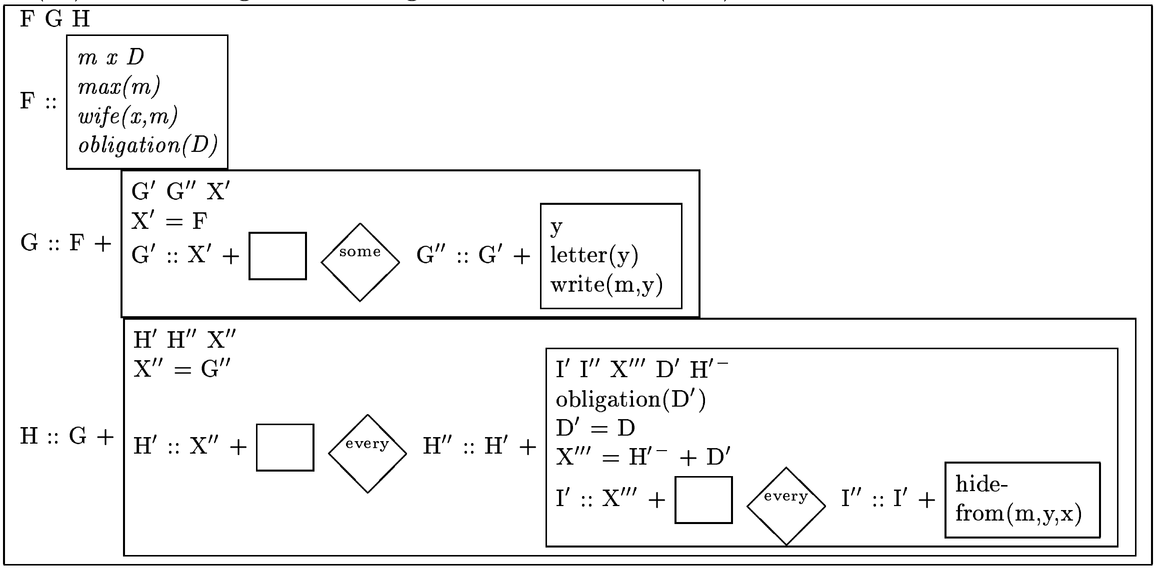


(64b) is a case where the pronominal within the deontic sentence is dependent on an indefinite NP introduced by the preceding epistemically modalized sentence. According to our intuition the sequence seems to require the precence of a *then*, or *If so*, which strongly motivates that we do not just have to introduce a non–restricted deontic modal as for the

[39]To keep the structures reasonably sparse, we do not, in the following, represent the contraction condition $G^{-}{}_{?K''} \subseteq G$ for deontic modality, with K'' the scope DRS of the deontic quantification. We simply state the resulting contracted referent G^{-}. Also, the DRS representations do omit many (necessary) details as regards e.g. temporal semantics.

first sentence of (64a), but rather a structure corresponding to a deontic *conditional*, which is modally subordinated to the scope argument G'' of the preceding modal quantification. One piece of evidence to support this analysis in terms of a governing epistemically based conditional is that the second sentence could well come with weaker epistemic force, by adding the modal *probably*: *He (then) probably must hide it from his wife.*

(64) b. Max might be writing a letter. He must (then) hide it from his wife.



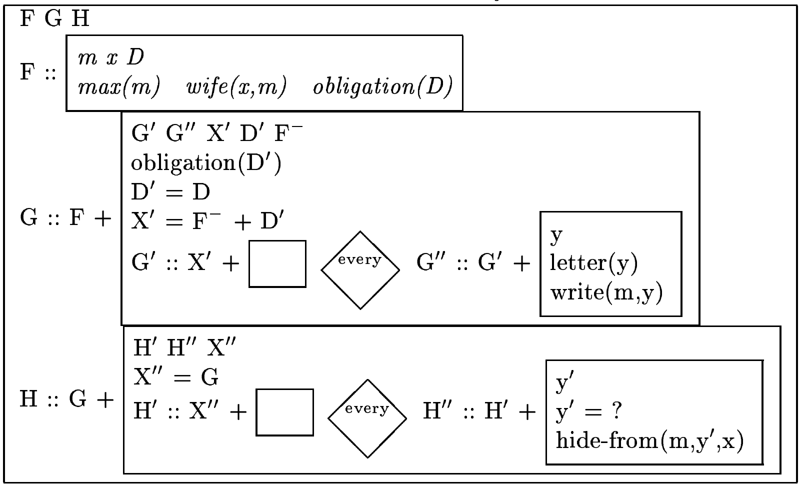
Cases like (64c) are a bit more subtle. In our view, sequences of this type, where an epistemic modal context is dependent on material within the scope of a preceding non–epistemic (deontic) modal quantification, are only acceptable with a short break between the two sentences and some kind of bridging, to be paraphrased as *if he does so*. In contrast to (64b) it is not sufficient to add an *if so* or *then*. I.e. the second sentence must be read as being dependent on the (default) assumption that Max will in fact act according to the demand in question, which could be argued to be supported by pragmatic considerations.[40]

One way to account for this is to rightaway disallow anaphoric binding of an epistemically based context referent G to a deontically dependent referent H, and leave the reference of the pronoun *it* in (64c) unresolved. It must then be left to inferential processes, relying on world knowledge and pragmatic principles of action, to establish an (accommodated) referent y'' for a letter written by Max, whose existence is supported by the default assumption that Max will act according to the obligation in question.

[40]The same type of connection is found in Heim's example (i) of attitudinal subordination. The intuition for (i) is that the presupposition triggered in the second clause can only be bound on the assumption that (Patrick believes that) the speaker of the sentence will act according to Patrick's will, such that he will in fact be in the possession of a cello.

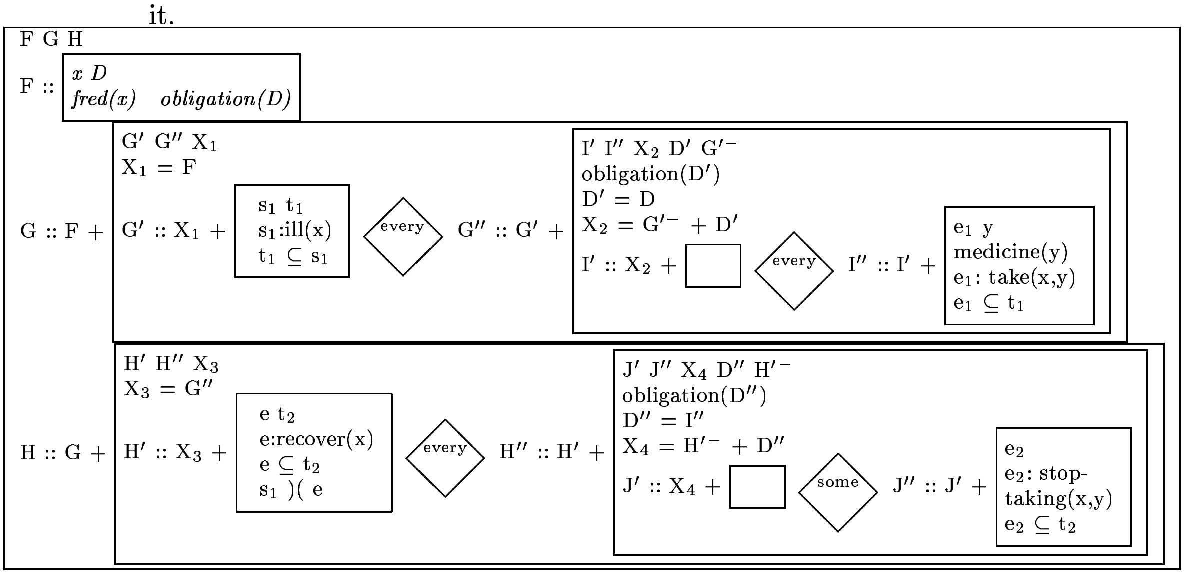
(i) Patrick wants me to buy him a cello, although he believes that his cello is going to take up a lot of space. Heim(1992:201)

(64) c. Max must write a letter. He will certainly hide it from his wife.



Let us now see how modal subordination works with deontic conditionals. In (65a) we have two deontic conditionals, where the second one must be analyzed as being dependent on the scope argument of the first one to satisfy the presuppositions triggered by *recover* and *stop*, and to bind the anaphoric pronoun *it* to the antecedent *some medicine.* According to our intuition, this reading is only available if s_1, the state of Fred being ill, is interpreted as temporally related to the event e of *recovering*, such that s_1 precedes e: s_1)(e.

(65) a. If Fred is ill, he must take some medicine. If he has recovered, he may stop taking it.



Binding the modal base X_3 to the referent G'', the scope argument of the preceding conditional, allows for binding of the presupposition of *recover*, which requires there to be a state s that precedes the event of *recovering*, and where the person in question is ill.[41]

As for the first deontic sentence there is the question of where to introduce the referent and the condition for *some medicine.* This depends very much on what particular deontic

[41] See the work of Kamp&Roßdeutscher(1994a,1994b).

context we want to assume D to stand for. The example is instructive in that it illustrates that the material that figures in the scope argument of the quantifier (together of course with additional material in the context) helps to constrain not only the value of D, but also its predicator *obligation*. For (65), we could possibly replace *obligation* by something like *medical-advice*. If so, the above question reduces to the following one. Is the *existence* of a particular medicine y for Fred's particular disease object of the medical advice, or does the predicate *medical-advice* establish that for every person x suffering from disease z there will be some medicine y that he or she will (must) take, such that y has narrow scope within this quantificational structure?

We suppose that this latter view is correct, and therefore decide to give the indefinite *some medicine* narrow scope within the deontic quantifier. I.e. as in the cases of conditional laws we considered in Section 4.1.3, the deontic context should contain quantificational conditions along the lines of the above paraphrase: for every person x' suffering from disease z' there is some medicine y' that he or she will (must) take, such that from the complex modal base X_2, where Fred is assumed to be sick we can then derive (assuming normal conditions) that there is some particular, but unspecified medicine y that Fred should take against his (not further specified) disease.

Given the anaphoric relation $X_3 = G''$ to establish modal subordination of the second conditional to the scope of the first one, the referents that live in the universe of the preceding conditional's scope DRS are accessible for anaphoric binding from within the consequent DRS of the second conditional, annotated by H''. It is therefore possible to establish the complex modal base X_4 of the embedded deontic quantifier by reference to the (epistemic) annotating referent H' of the second conditional's antecedent and the (deontic) referent I'' that annotates the scope argument of the deontic quantifier that is embedded within the scope of the first conditional.

Given that I'' is an extension of the deontic context D', combined with factual/epistemic information established by G', the complex modal base $X_4 = H'^{-} + D''$ will not only define the quantificational conditions stemming from D, which assign to people suffering from a particular disease a certain medicine they should take (during the period of their being ill), but will also state (by I'') that Fred, being ill at time t_1, has to take some (unspecified) medicine y, and (by H') that he has (in the meantime) recovered from his disease. From this context it then follows – provided D specifies a corresponding quantificational condition[42] – that Fred may now stop taking medicine y. I.e., by relativization of X_4 to I'' the referent y in the universe of the DRS annotated by I'' is in fact accessible from within the DRS annotated by J'' to bind the anaphoric pronoun *it* and to satisfy the presupposition of *stop*, which requires there to be a preceding event e_1, where Fred took medicine y.

Note that it will not do to choose the modal base X_4 to refer to $I''^{-} + D''$ with $D'' = D$. While this would certainly make y accessible for the pronoun *it*, the restriction of the deontic quantification would then not depend on the conditional assumption that Fred has recovered, and therefore would not give us a correct semantics for the deontic conditional.

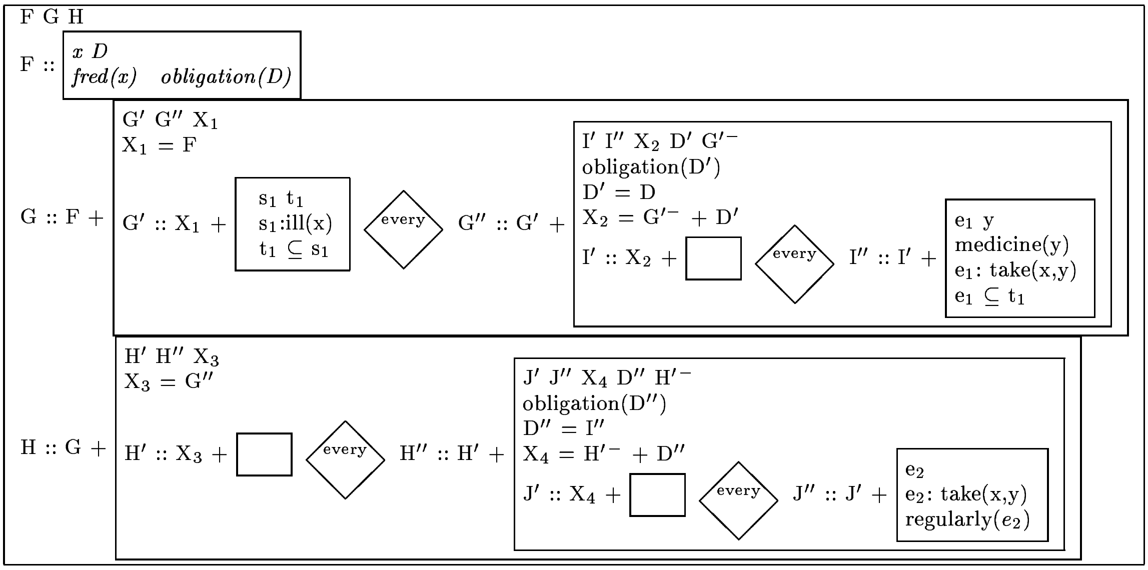
Also recall from Section 4.1.3 that we do not allow for presuppositions to be *accommodated* within a non–epistemic (deontic) context. Therefore we cannot either choose the embedded deontic quantification as being dependent on a modal base $X_4 = H'^{-} + D''$ with $D'' = D$: this context does not define the event e_1 of Fred's taking some medicine y, such

[42] to the effect that every person x suffering from disease z takes a certain medicine y during the time of his/her being sick.

that the anaphoric elements within the second deontic's scope could only be "satisfied" by way of *accommodation* into the deontic context D'', which we explicitly ruled out.

The next case, (65b), is one where a deontic conditional provides the antecedent context for a (modally subordinated) nonrestricted deontic sentence. The anaphoric pronoun *it* must intuitively be interpreted as being dependent on the indefinite *some medicine*. The DRS we assign to this sequence is structurally equivalent to the one given in (65a). I.e. the second sentence – although not restricted by an *if*–clause – is represented in the same way as is a deontic conditional, yet with an empty antecedent DRS and, as in (65a), with anaphoric binding of X_3 to the scope G'' of the preceding conditional. As in (65a) the embedded deontic quantifier is dependent on the complex modal base $X_4 = H'^{-} + I''$, where I'' represents the scope argument of the deontic quantification within the first conditional, representing the deontic context D "in conjunction with" the hypothetical context G'^{-}, thus stating that "given medical advice" and assuming that Fred is sick, he (has to) take(s) some medicine y. Based on additional (quantificational) conditions within D, prescribing e.g. that anyone who takes medicine has to do so regularly, we can then derive that relative to a context where Fred is assumed to be sick and forced (or advised) to take medicine y, he is advised to take *it* regularly. Again, anaphoric reference to I'' by X_4 makes available the referent y for anaphoric binding of the pronominal.

(65) b. If Fred is ill, he must take some medicine. He must take it regularly.



Recall that in example (64b) we observed that generation of an embedding epistemic operator for subordination of an (overtly) nonrestricted deontic sentence was only licensed with additional material such as *if so* or *then*. But nothing of the sort seems to be necessary in the case of (65b). Although we cannot explain why, our suspicion is that this difference is connected to the distinct quantificational forces of the introducing sentences. As (66) brings out, such sequences get considerably better if the first sentence is universally quantified.

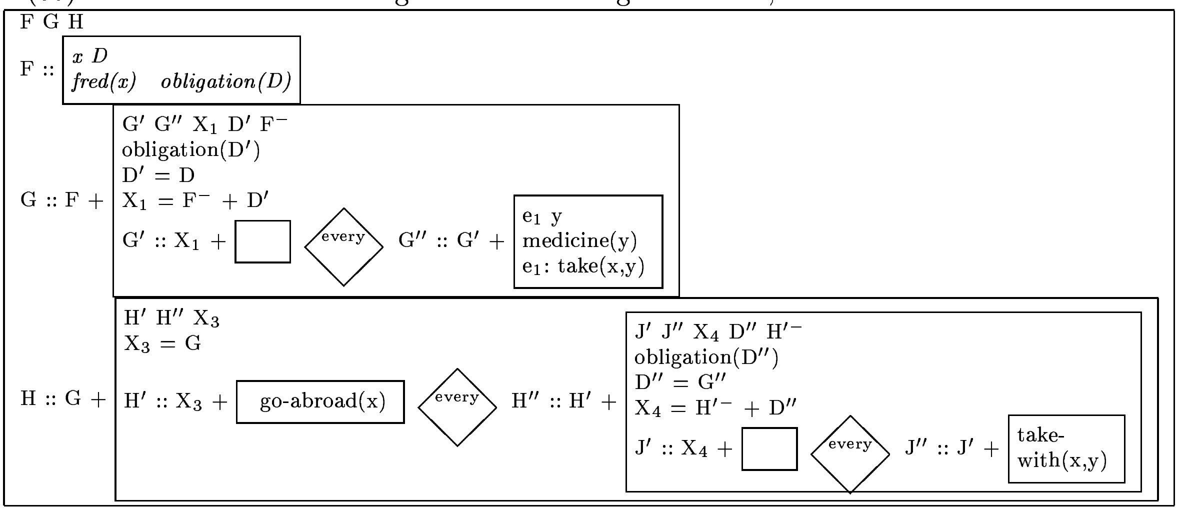
(66) a. If Fred goes to the opera, he will buy a programme. He must read it quickly.

b. Once at the opera Fred will certainly buy a programme. He must read it quickly.

Relying on this observation we can posit that *in principle* a nonrestricted deontic sentence allows for accommodation of a governing, universally quantified conditional – provided the preceding discourse supplies an appropriate (epistemic) modal antecedent context that is able to serve as an antecedent for the anaphoric domain argument. Yet for some reason we cannot explain, this possibility is restricted to cases where the modal antecedent context is universally quantified. Thus, in view of (66) and (65b) we have to qualify our earlier contention (see p. 203) that nonrestricted deontic sentences in indicative mood do not license accommodation of a governing epistemic modal quantification.

Finally, in (65c) we have a case where the deontic conditional is to be interpreted as being modally subordinated to the preceding nonrestricted deontic sentence, in order to bind the pronominal *it*. In (64c) we had seen that anaphoric binding of an epistemically based context referent to a deontic context referent is not possible. But the present example differs from (64c) in that the second sentence is an *epistemically* quantified structure that takes a *deontic* modal quantifier in its scope. So the epistemic conditional can be characterized as being dependent on its (factual) antecedent context G ($X_3 = G$), such that the context referents G' and G'' that are defined within the DRS annotated by G get accessible from within the DRS annotated by H''. Therefore the embedded deontic quantifier can anaphorically refer to the referent G'' to establish its modal base X_4, together with the referent H'^{-} to induce restriction to situations where Fred goes abroad. Given that y is defined in the universe of the DRS annotated by G'' this modal base then provides an antecedent referent for the anaphoric pronoun *it* within the scope of the deontic modal operator.

(65) c. Fred must take strong medicine. If he goes abroad, he must take it with him.



Review of the modal subordination cases in (64) and (65), with mixed occurrences of conditional and nonrestricted epistemic and/or deontic modal quantification brought out that our analysis of (multiple) relative modality and modal subordination is able to capture these data. Our basic assumption was that modal subordination is a special instance of relative modality. Since modal constructions are uniformly characterized as *anaphoric* within their restrictor argument, modally subordinated sentences can be analyzed as *relative to* accessible context referents established by contextually preceding modal sentences. Deontic modality was characterized as being *doubly* context dependent: the anaphoric modal base is *complex*, consisting of the merge of a deontic and a factual or epistemic context. Finally, our claim was that deontic conditionals must receive an analysis where the deontic modal operator is embedded within the scope of an epistemically based conditional structure.

We further assumed that non–epistemic (e.g. deontic) contexts do not allow for *accommodation* of unbound presuppositions, an assumption which was based on data of attitudinal subordination (see p. 183).

The only further restriction we had now, for the data in (64) and (65), to impose upon the establishment of anaphoric binding relations between context referents – besides the general accessibility restrictions (see Section 3.3) – was to prohibit binding (i.e. equation) of a purely *epistemically* based referent to a *non–epistemically (deontically)* based referent.

Finally we also allowed for the possibility to accommodate a governing epistemically based quantificational structure for nonrestricted deontic sentences, subject to a constraint that this requires an appropriate *non–factual* epistemically based context referent to be available in the preceding discourse to establish its modal base.

4.2 Inconsistent modal bases I: Samaritan Paradox and Practical Inference

Up to now we have been working with examples of non–epistemic (deontic) modality where we somewhat naively presupposed that the deontic context is *compatible* with the relevant factual (or epistemic) context, to build up a *consistent* complex modal base. But very often, if not most of the time this will not be so.

There are contexts like (67), where the first sentence explicitly denies that an essay was written by Claire, while the subsequent deontic sentence, contextually dependent on the first one, states that there was some obligation that she write such an essay in order to pass the examn of the class in question.

(67) Claire didn't write an essay for the literature class.
She had to write it in order to pass the examn.

So there is a general problem for the analysis of modal constructions in terms of *multiple* relative modality, the problem of inconsistent modal bases, which was one of the major reasons for Kratzer to give an analysis of non–epistemic (and counterfactual) modality in terms of the notion of an ordering source (see Section 2.2.3).

One of the classical examples that are successfully treated by her analysis of graded modality is the "Samaritan Paradox".

4.2.1 The Samaritan Paradox

To recapitulate the problem: in classical modal logic the analysis of sentences like (68a–b) constitutes a problem. If for (68a) every *deontically* accessible world w' is such that no murder occurs in w', then (68b) can be true only vacuously, if again evaluated relative to this same set of *deontically* accessible worlds w'. I.e. sentences like (68c), with arbitrary consequents, are on a same footing with (68b).

(68) a. No murder may occur.

b. If a murder occurs, the murderer must go to jail.

c. If a murder occurs, the murderer must be invited for dinner.

Kratzer's analysis in terms of an ordering source avoids these shortcomings in that for evaluation of a deontic modal relative to a modal base $f(w)$ and deontic ordering source $o(w)$ a partial order is defined by $o(w)$ over only those worlds that are determined by the modal base $f(w)$. I.e. for evaluation of (68a) we may assume the modal base $f(w)$ to be empty, such that the ordering source induces a partial order upon the entire set of worlds. The sentence will be judged true iff in all the "nearest" ones (according to the partial order defined by $o(w)$) it is true that no murder occurs.

For (68b), however, the modal base will only determine worlds w'' where a murder occured. I.e. none of them figures within the set of $o(w)$–"closest" worlds that constitute the quantificational domain for the modal in (68a). (68b) will then be true iff in all the $o(w)$–"closest" worlds *where a murder occurred*, the murderer will go to jail, as opposed to more remote worlds (according to $o(w)$) where the murderer is invited for dinner.

In our analysis of (multiple) relative modality the problem shows up in a slightly different way. Recall that in our analysis of deontic modality we want to allow for *conditional* laws to define a deontic context. I.e. we could take (69) to define a deontic context D.

(69) No murder occurs.
If a murder occurs, the murderer goes to jail.

D :: [Λ F G
F :: Λ + [L₁ ; ¬ L₁ :: Λ + [e₁ ; murder(e₁)]]
G :: F + [L₂ L₃ X′ ; X′ = Λ ; L₂ :: X′ + [e₂ *x* ; murder(e₂) ; *murderer(x, e₂)*] ⟨every⟩ L₃ :: L₂ + [go-to-jail(x)]]]

The first condition constrains the *juridically ideal* worlds that D is to represent in a way such that no murder will occur in any of them. As we had seen before, with negated update conditions of the form $\neg L_1 :: \Lambda + K'$ the context referent L_1 determines only counterfactual (here better "counterdeontic") worlds, i.e. the denotation of L_1 does not contain any state that is tied to the world of evaluation, i.e. no world parameter of states in the denotation of F will figure in any state in the denotation of L_1.

Therefore it is not possible to choose F as the antecedent context for the modal base X' of the subsequent conditional statement in (69). Instead, we can choose the empty context Λ to instantiate the value of X'.[43] X' is then updated with the conditional's antecedent (together with an accommodated referent and condition for the definite *the murderer*, due

[43] Alternatively we could characterize the second, conditional statement as dependent on the referent L_1, a context that has been established by the first condition as determining only worlds where the law is

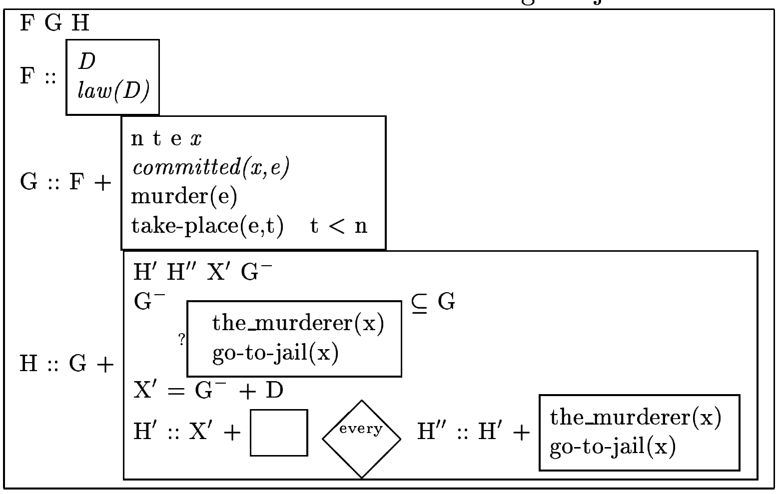
to the presupposition triggered by *the murderer* in the conditional's scope).

This condition then establishes, within D, that in every situation where the law is violated in that a murder is committed and which is considered as *normal* from the viewpoint of juridically ideal worlds, the person who committed the murder goes to jail.

So it seems as if, by representing a deontic context in terms of conditional laws, we had circumvented the problem of inconsistent modal bases for cases like (68).

But it will show up, in another way, in contexts like (70).[44] Here the factual context is stated to be such that a murder occurred. The deontic sentence is certainly to be interpreted as relative to this factual antecedent context, since the reference of *the murderer* is dependent on the crime that is introduced by the first sentence. And it is now obvious that, if D is defined as in (69), the contexts G^- and D, to provide the complex modal base $X' = G^- + D$, are inconsistent. X' will denote the empty set, such that the conditional is either vacuously true, if the material within the consequent DRS does not contain anaphoric expressions, or else is undefined in case it does so, as in (70).

(70) A murder occurred. The murderer must go to jail.



In Section 2.2.3, when discussing Kratzer's analysis of *graded* modality, we sketched an alternative analysis to account for inconsistent modal bases. The idea was to define the domain argument of a (deontic) modal operator, the complex modal base $F + D$, to denote some *maximally consistent* set of states, formed by union of the entire factual antecedent context and a maximally consistent subset of the deontic background context.

violated in that a murder occurs. This then predicts (i) to be fine, where the pronominal is intended to anaphorically refer to the referent introduced for *murder* in the first sentence. We are not sure about the status of (i), but we certainly want to rule out (ii).

(i) ?? No murder occurs. If *it* occurs, the murderer will go to jail.

(ii) # No one takes a card in this round. If someone takes *it*, he or she will skip two rounds.

However, this is not to say that conditional structures in a deontic context D cannot be anaphorically dependent on modal contexts defined within D. (iii) is a case in point.

(iii) If someone owns a car, he will pay taxes for it. If he sells it, he will not pay taxes any more.

[44] And in a similar way in contexts like (67).

There are two ways how this can be done in our framework. The first one makes use of the relation of *context reduction* between context referents G' and G ($G' \subseteq G$) that we introduced in Section 3.3 with verification condition (71). We use this relation to account for the problem of inconsistent modal bases in cases like (70), by definition of a *reduced* context D' of the deontic antecedent context D ($D' \subseteq D$), and by imposing a general constraint on annotated DRSs, such that the *merge* between referents $F + D'$ (where F and D' denote nonempty sets of states) is undefined if the outcome yields the empty set.

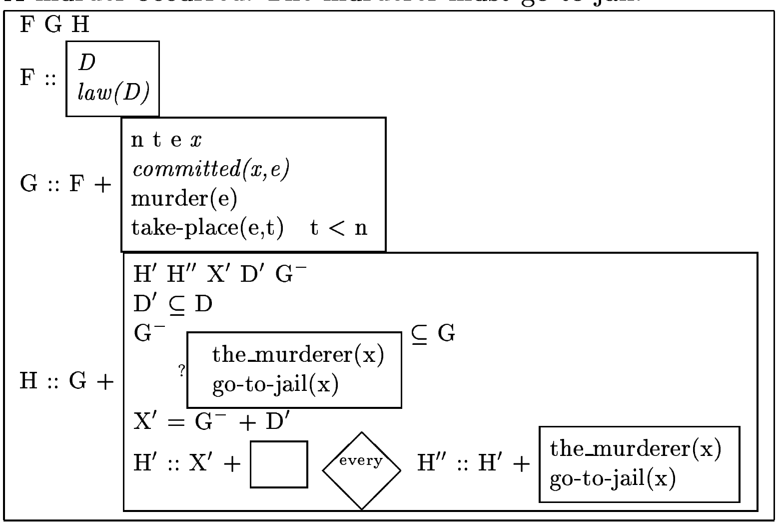
(71) $\langle w, e\rangle \models_M G' \subseteq G$ iff $\forall \langle w', g'\rangle \in e(G')\ \exists \langle w', g\rangle \in e(G)$ s.th. $g' \subseteq g$.

By using the the relation of *context reduction* in this way it is possible to circumvent the problem of an inconsistent modal base in (70). Again, for (72) we take the context referent D to be defined as in (69). $D :: K_D$ in (69) encodes *what the Law provides*: it explicitly states that in the juridically ideal worlds there be no murder, while in those alternative worlds that are accessible from such deontically ideal worlds, where such a crime is (nevertheless) committed, it will *normally* – from the standpoint of juridically ideal worlds – be the case that these are worlds where the one who committed the crime will go to jail.

The factual context F in (72) is updated with the information that a murder occurred. Now, for evaluation of the second, deontic sentence, which is contextually dependent both on G and D, the complex modal base X' is defined by referring to a *reduced* context D' of D, one which allows for consistent merge with G^-.

In the case at hand, this requires the choice of a context referent $D' \subseteq D$ that does not support the condition that there be no murder ($\neg L_1 :: \Lambda + K'$).[45] The remaining condition(s) of $D :: K_D$, taken together with G^-, do then provide a *consistent* complex modal base $X' = G^- + D'$ that is to verify that relative to such a context X', if everything holds that is *normally* the case in such a context, *the murderer will go to jail.*

(72) A murder occurred. The murderer must go to jail.



[45] As it stands, the analysis allows for the choice of a referent D' that is too weak. This will be discussed in more detail below.

How exactly is this derived? According to the verification conditions of Section 3.3 the denotation of X' in $X' = G^- + D'$ is constrained to denote a set of states $\langle w', g^- \cup d' \rangle$ where w' is in the denotation of both G^- and D'. We have assumed that D' is chosen such that every state in its denotation verifies the conditional structure according to which in every accessible "normal" world where a murder occurs, the murderer goes to jail. G^-, on the other hand, will support that a murder occured. Assuming further that in non–counterfactual cases the normalcy selection function will be centered, i.e. that the world of evaluation will be among the set of normal worlds where the antecedent is true, we can deduce that the state $\langle w', x' \rangle = \langle w', g^- \cup d' \rangle$ will verify that the one who committed the crime will go to jail. The modal quantificational structure annotated by referents H' and H'', which is anaphoric to the complex modal base $X' = G^- + D'$ is then predicted to be true: X' denotes states that all verify that – given that a murder occurred and given what the law provides – the murderer will go to jail. And assuming that the normalcy restriction $*(w, h(X' + K'))$ will constrain the quantificational domain to a subset of "normal worlds" out of $cs(h(X' + K'))$, where a murder occured and where the conditional law defined within D' holds true,[46] the modal quantificational structure will be verified.

As it stands the relation of *context reduction* is fairly unconstrained. It does not reflect the minimality constraint which is intended to ensure that in cases of conflicting information the reduction be minimal. Due to this indeterminacy, in a case like (72), D' can in principle be chosen to denote the empty context, which is certainly not what we want.

Still, one could argue that the selection of a reduced context D' for consistent update can be left fairly unconstrained and leave it to pragmatic principles of relevance, or saliency to reduce this indeterminacy.[47] We will come back to this aspect below.

Another way – which we will explore to some extent, but finally will reject – is to further constrain the selection of the reduced context D', $D' \subseteq D$ by requiring that the reduction be *minimal*, while allowing for consistent merge of D' and G^-.

This minimality constraint is embodied in the second possibility to approach the problem of inconsistent modal bases, which we argued in Section 2.2.3 to be independently motivated by more involved examples of inconsistent modal bases that are investigated by Kratzer(1991) under the heading of "Practical Inference".

In Section 2.2.3 we defined a relation of *compatibility restricted union*,[48] which is easily redefined in the framework we have been developing so far, by defining a new relation on context referents in (73), the asymmetric relation of *compatibility restricted union* $F! + D$ of contexts (denoted by) F and D. The relation is asymmetric in that the first argument of the *merge* operator is fully preserved, while the second argument will be subject to *minimal reduction*, to allow for consistent merge with the first argument.

In the standard cases of deontic modality we take the factual (or epistemic) antecedent context F to constitute the first argument of asymmetric union, while the deontic antecedent context D will be subject to *minimal reduction*. This asymmetry is justified – at least for deontic modality – since in general common sense does not allow us to remove factive information to achieve consistency with non–factual contexts, such as desires, or

[46]See FACTICITY of * defined in Section 5.2.4.

[47]This is in fact the position we will take after having investigated the alternative approach, to impose a minimality constraint on context reduction.

[48]This term is borrowed from Kasper(1992).

juridical prescriptions, etc.[49]

The condition $X \in F \,!{+} D$ in (73a) is a shorthand for a set of conditions $X \in F{+}D', D' \subseteq D$, where D' is additionally constrained as a *minimal* reduction of D, i.e. D' is to be chosen such that for every (alternative) context $\mathbf{D}''$ that qualifies as a reduction of $e(D)$, if $e(D')$ is a proper reduction of $\mathbf{D}''$, then $e(F)$ and $\mathbf{D}''$ will be inconsistent.

Since it cannot be ensured, in general, that there will always be a unique context D' that will satisfy the minimality constraint, $F\ ! + D$ will denote a *set* of contexts, an element of which is chosen as the denotation of X. The special case of "Practical Inference", to be discussed below, is an instance where there is not a single minimal reduction of the deontic context D to allow for consistent update with the factual context F, i.e. an instance where $F\ ! + D$ will not denote a *singleton* set of contexts.

(73) a. $X \in F\ ! + D$

b. $\langle w, e\rangle \models_M X \in F\ ! + D$ iff $e(X) \in e(F)\ !+^{\bullet}\ e(D)$.

The verification condition for $X \in F\ ! + D$ in (73b) makes use of the relation $!+^{\bullet}$ defined in (74c), which applies to *denotations* $\mathbf{F}$, $\mathbf{D}$ of context referents F, D, i.e. to sets of states. The relations in (74a–b), also defined on *denotations* $\mathbf{F}, \mathbf{D}$ of context referents F, D, correspond to the DRS conditions of *reduction* $\subseteq$ and *merge* $+$ (cf. Section 3.3).

(74c) defines $\mathbf{F}\ !+^{\bullet}\mathbf{D}$ as the set of all complex contexts $\mathbf{F}\ +^{\bullet}\ \mathbf{D}'$ where $\mathbf{D}'$ is a reduction of $\mathbf{D}$ that is compatible with $\mathbf{F}$, and where there is no proper extension $\mathbf{D}''$ of $\mathbf{D}'$ that is also a reduction of $\mathbf{D}$ such that $\mathbf{D}''$ is consistent with $\mathbf{F}$.

(74) a. $\mathbf{F}' \subseteq^{\bullet} \mathbf{F}$ iff $\forall\langle w', f\rangle \in \mathbf{F}\ \exists\langle w', f'\rangle \in \mathbf{F}'$ s.th. $f' \subseteq f$.

b. $\mathbf{F} +^{\bullet} \mathbf{D} = \{\langle w', g\rangle : \exists\langle w', f\rangle \in \mathbf{F}\ \&\ \exists\langle w', d\rangle \in \mathbf{D}\ \&\ g = f \cup d\}$.

c. $\mathbf{F}\ !+^{\bullet}\mathbf{D} = \{\mathbf{F}\ +^{\bullet}\ \mathbf{D}' : \mathbf{D}' \subseteq^{\bullet} \mathbf{D}\ \ \&\ \ \mathbf{F} +^{\bullet} \mathbf{D}' \neq \emptyset\ \ \&$
$(\forall \mathbf{D}'')\ \mathbf{D}'' \subseteq^{\bullet} \mathbf{D}$ if $\mathbf{D}' \subseteq^{\bullet} \mathbf{D}''\ \&\ \ \mathbf{F}\ +^{\bullet}\ \mathbf{D}'' \neq \emptyset$, then $\mathbf{D}'' = \mathbf{D}'\}$.

In a case like (72), the typical example of the "Samaritan Paradox", where the relation $X \in F\ ! + D$ is used to deal with inconsistent modal bases F and D, $F\ ! + D$ will denote a singleton set. I.e. $e(X)$ will denote the unique element of $e(F)\ !+^{\bullet} e(D)$, $e(F) +^{\bullet} \mathbf{D}'$, for some context $\mathbf{D}'$, a minimal reducion of $e(D)$ that is consistent with $e(F)$.

Thus, in those cases where $F\ ! + D$ denotes a singleton set the relation of compatibility restricted union $X' \in F\ ! + D$ is equivalent to our previous definition of a consistent modal base in terms of context reduction (see (72)) where $X' = F\ + D'$, *provided* D' in $D' \subseteq D$ is chosen to be maximal, while consistent with F.

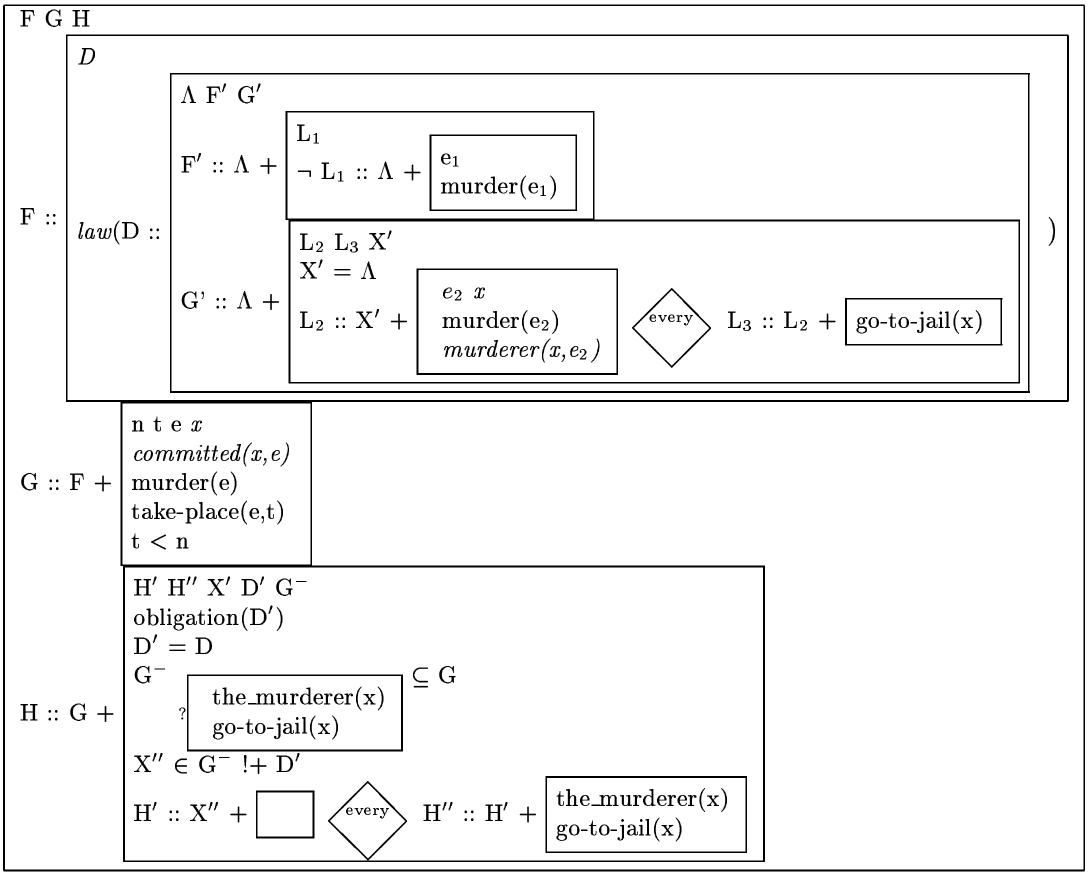
Finally, if D is consistent with the factual context F, $X' \in F\ ! + D$ is equivalent to $X' = F + D'$, with $D' = D$.

Based on this new relation of *compatibility restricted union* our example (72) now rewrites as in (75). Again we assume the relevant juridical context (69) to be presupposed. By

[49]This does of course not preclude to compute compatibility restricted union by "dropping" factual information. We quite often do that!

choosing the complex modal base X'' for the second, deontic sentence to be instantiated by a context referent that denotes one element of the compatibility restricted union of G^- and D', with $D' = D$ – and which in this case will denote a singleton set – the deontic modal quantification ranges necessarily over worlds where a murder occurs, and which obey the conditional law that is defined within D. Contrary to the analysis given in (72) the quantification cannot range over worlds determined by G^- alone (choosing D' to denote the empty set) and which would not verify the second sentence on its deontic reading.

(75) *The law provides that no murder occur, and that if a murder occurrs, the murderer will go to jail.* A murder occurred. The murderer must go to jail.



One might think that our second solution to the problem of inconsistent modal bases in terms of compatibility restricted union is largely equivalent to Kratzer's analysis of graded modality, which makes use of a (deontic) ordering source to impose a partial order on the worlds that make up the modal base, and which defines a universal (deontic) quantifier to range over the "best" of these worlds (i.e. those that satisfy as much as possible of what is prescribed by D), according to the ordering thus defined.

For the type of contexts that is illustrated above by the Samaritan Paradox these two analyses in fact yield the same results. But we already saw, in Section 2.2.3, that the analyses make different predictions for a type of example that Kratzer investigated unter the heading of "Practical Inference".

4.2.2 Practical Inference

Recall Kratzer's example of Practical Inference (see p. 40), which we modified in (76)/(77) to make the non–epistemic (deontic) reading of (77a–c) more salient. Imagine the facts are as described by the first sentence of (76): You will become popular only if you go to the pub. Mary's parents are probably not aware of these facts, since they demand that Mary go hiking, becomes popular, and doesn't go to the pub, as rendered by the second sentence of (76). Since they told her so, Mary is aware that this is what they want. But Mary also knows that the facts are as described by the first sentence. So she finds herself in a dilemma if she wants to do justice to her parents' demands.

(76) You become popular only if you go to the pub.
According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub.

According to Kratzer's analysis of deontic modality in terms of graded modality, all of the sentences in (77a–c) are verified in this context on a deontic reading, where the modal verbs are *relative to* the factual antecedent context (the first sentence) *and* the deontic context conveyed by the second sentence of (76).[50] This is because taking the deontic context conveyed by (76) to constitute the ordering source for the modal operators in (77) constrains the quantification to range over only two types of worlds where a maximum of the parents' (three) demands are realized – those where Mary goes hiking, becomes popular but goes to the pub, and others where she goes hiking and doesn't go to the pub, but doesn't become popular.[51] From this set of maximally desirable worlds it follows with *necessity* that Mary goes hiking (77a), while it is *possible* that she does or doesn't go to the pub (77b) and it is *possible* that she becomes popular (77c).

(77) In view of the facts and in order to do justice to her parents' demands,
a. Mary must go hiking.
b. Mary may (is allowed to) go to the pub.
c. Mary may (is allowed to) become popular.

In Section 2.2.3 we have argued that this analysis does not correspond to our intuitive understanding of (77b–c) if – as it is clearly intended by Kratzer – the modal *may* is to be read as non–epistemic, and relative to *both* the facts and the demands introduced by the preceding context.[52]

If *Mary may go to the pub* is really understood as *relative to* **both** *the facts and* **all** *of the parents' demands*, this sentence cannot be judged true, and neither is *Mary may become popular* if we reckon with the pragmatic implicature that is conveyed by the existential quantifier, that the corresponding universally quantified sentence (*Mary must become popular*) is not true. In the case of (77b), going to the pub (which is a necessary consequence of

[50] You can also turn the sentences in (77a–c) into first person singular, assuming them to be uttered by Mary, who considers the demands imposed on her *in view of the facts she is aware of.*

[51] Cf. Section 2.2.3, p. 40.

[52] The epistemic reading of *may* in (77b–c) is of course unproblematic: in view of only the facts and disregarding her parents' demands, it is *possible* for Mary to (not to) go to pub, to become popular, and also possible (while not necessary!) to go hiking.

(or prerequisite for) becoming popular) explicitly contradicts one of the parents' demands, and in the case of (77c), becoming popular requires going to the pub, which is again in conflict with their demands.

In Kratzer's version of the example the crucial sentences were given with the modal *could* (as opposed to *may* in (77b–c)), but still intended to be read as being dependent on the factual *and* the desire context. But – on this intended non–epistemic reading – these sentences become quite odd once we replace *could* with indicative *can*, while substitution of *should* by *must* is perfect for (78a). As for (78b), in view of both the facts and *all* of my desires it is not possible for me not to go to the pub, since this is in conflict with my desire of becoming popular, which requires that I go there. And as for (78c), in view of both the facts and *all* of my desires I cannot become popular, since this requires that I go to the pub, which is in conflict with my desire of not going there.[53]

(78) I become popular only if I go to the pub.
I want to hike in the mountains, become popular, and not go to the pub.

(In view of the facts and my desires)
a. I should/must hike in the mountains.
b. I *could/#can* not go to the pub.
c. I *could/#can* become popular.

By contrast, on a purely epistemic reading – i.e. disregarding the (conflicting) desires as indicated by the phrase *in view of the facts* in (79) – all of (79a–c) are possible in either indicative or subjunctive mood. But here the subjunctive sentences are best understood as implicitly conditional, e.g. as *I could become popular (, if I went to the pub).*

(79) I become popular only if I go to the pub.
I want to hike in the mountains, become popular, and not go to the pub.

(In view of the facts)
a. I can/could hike in the mountains.
b. I *can/could* not go to the pub.
c. I *can/could* become popular.

These observations we take as an indication that (78b–c), with subjunctive *could*, can only be interpreted as sort of counterfactually dependent on the complex antecedent context,

[53]Example (i) is a case where we feel the issue is more striking than in (78): If realizing either one of the two possible actions, helping my brother or helping my sister, is conflicting with one or the other of my deepest feelings (or desires), I cannot consistently state that *in view of the facts* it is *compatible* with these very feelings to realize one or the other of these possible actions. *Any* action I could take is conflicting with my feelings. So in our view, there is no positive answer to the questions in (i).

(i) My brother and my sister are fighting madly.
My feelings demand that I help my brother, and my feelings also demand that I help my sister.
Helping my brother requires that I hurt my sister, and helping my sister requires that I hurt my brother.
So do my feelings permit that I help my brother?
I.e. is it possible, according to all of my feelings, that I help my brother?

along the lines suggested by the following paraphrases: *(If I gave up on becoming popular,) I could (and should) not go to the pub*, and *(If I resigned myself to going to the pub,) I could (and should) become popular.* These paraphrases seem to indicate that for evaluating (78b–c) with subjunctive mood we are switching to (possibly counterfactual) contexts where our desires are *revised* in order to yield consistency with the facts, such that if we acted *according to these revised desires* we would then (with necessity !!) either become popular, or else not go to the pub.

On Kratzer's account *one and the same* bouletic or deontic context (is intended to) provide(s) the contextual basis for all the modals in (78a–c), and similarly for (77a–c) – such that the logical forms attributed to *all* of these sentences are uniformly relativized to an invariable ordering source g. In particular the oddity of (77b–c), which are predicted by the analysis of "graded modality", puts considerable doubt on this solution to the problem of inconsistent modal bases.

The oddity of indicative (non–epistemic) *can* in (78b–c), with relativization to the set of *non–revised* desires seems to indicate that once we are caught in such a deadlock, the inconsistency is resolved – not as predicted by "graded modality" – but by *hypothetical revision* of one or the other of our conflicting desires, as reflected by subjunctive mood.

We conclude that Kratzers analysis of (77)/(78) is misleading in two ways: first, the reading of (77b–c) and (78b–c) she intends to represent, where the modal verb is dependent upon both the facts and the *entire* deontic or desire context is – in our view – not available. Second, the analysis in terms of graded modality does not capture the difference in acceptability between the subjunctive and indicative versions in (78b–c).

Compatibility restricted union

In Section 2.2.3 we already suggested an analysis of modal operators with conflicting (complex) modal bases in terms of the asymmetric relation of *compatibility restricted union.* In the previous Section we have shown that carrying over this notion to our DRT analysis of relative modality accounts for the Samaritan Paradox. We will now illustrate that – to some extent[54]– it also meets our intuitions for the more involved cases of "deadlock situations" exemplified by "Practical Inference".

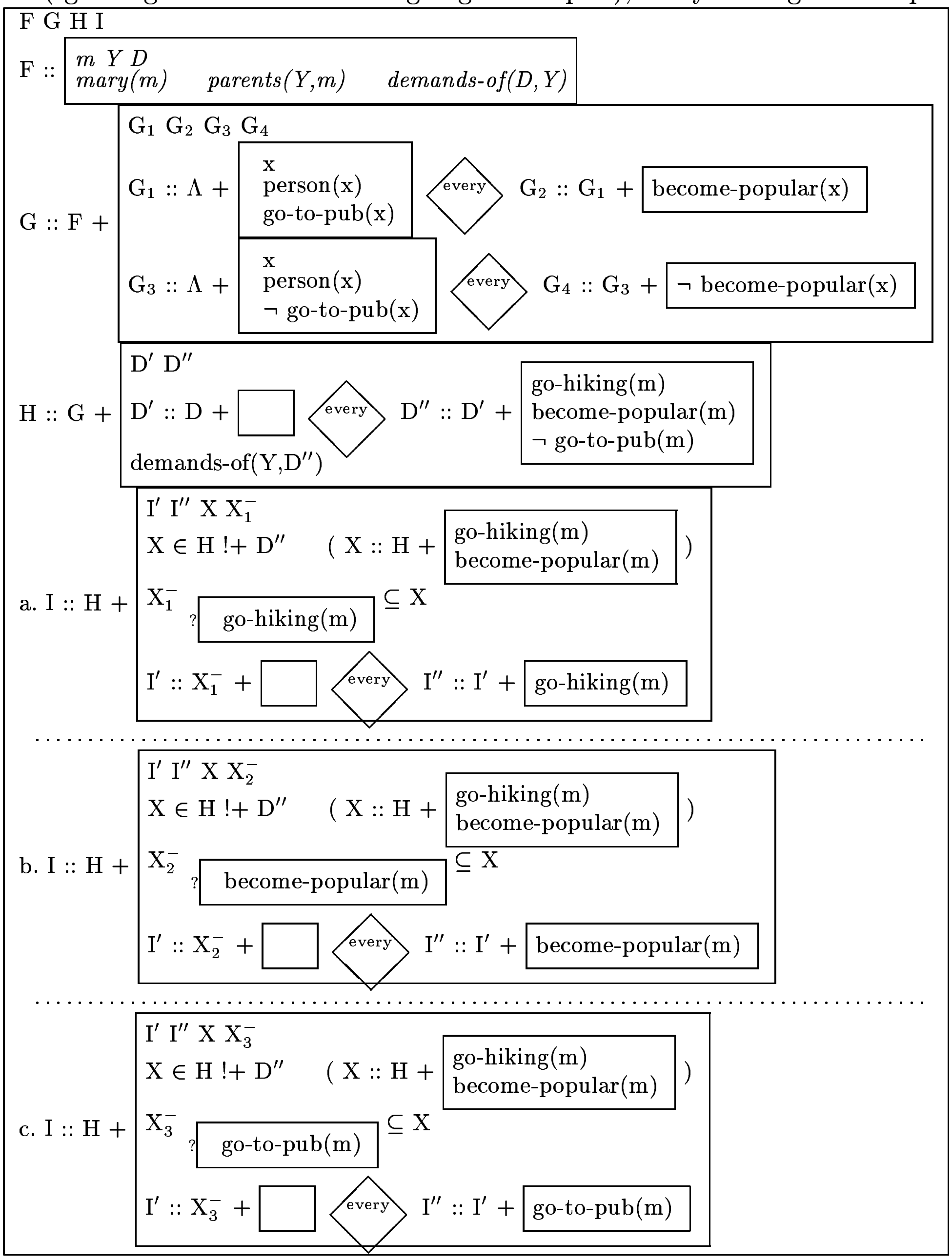
In contexts like (80) with conflicting factual and deontic contexts H and D'', for evaluation of the sentences (80a–c) we have to choose some (maximally consistent) modal base X, defined in terms of asymmetric compatibility restricted union $X \in H \,!+ D''$. There are two possible values for X: it either supports the condition **become-popular(m)**, or else the condition **not-go-to-pub(m)**. The two solutions are displayed in (80) and (81), where we state, in parantheses, the corresponding annotated DRSs $X :: K_x$.

In (80) the relation of compatibility restricted union !+ yields a context X that – besides the information provided by the factual antecedent context H – states the conditions **go-hiking(m)** and **become-popular(m)**. Relative to this complex modal base X it then follows *with necessity* that *Mary must go hiking* and *must become popular.* Further, we can derive from X that, given the facts and the demand of becoming popular *Mary must go to the pub.*

[54]There are, however, some problems to this analysis which will finally drive us to reconsider our first suggestion to account for inconsistent modal bases, where the choice of a "reduced" context $D' \subseteq D$ is determined not by the criterion of minimal reduction, but by a notion of "relevance".

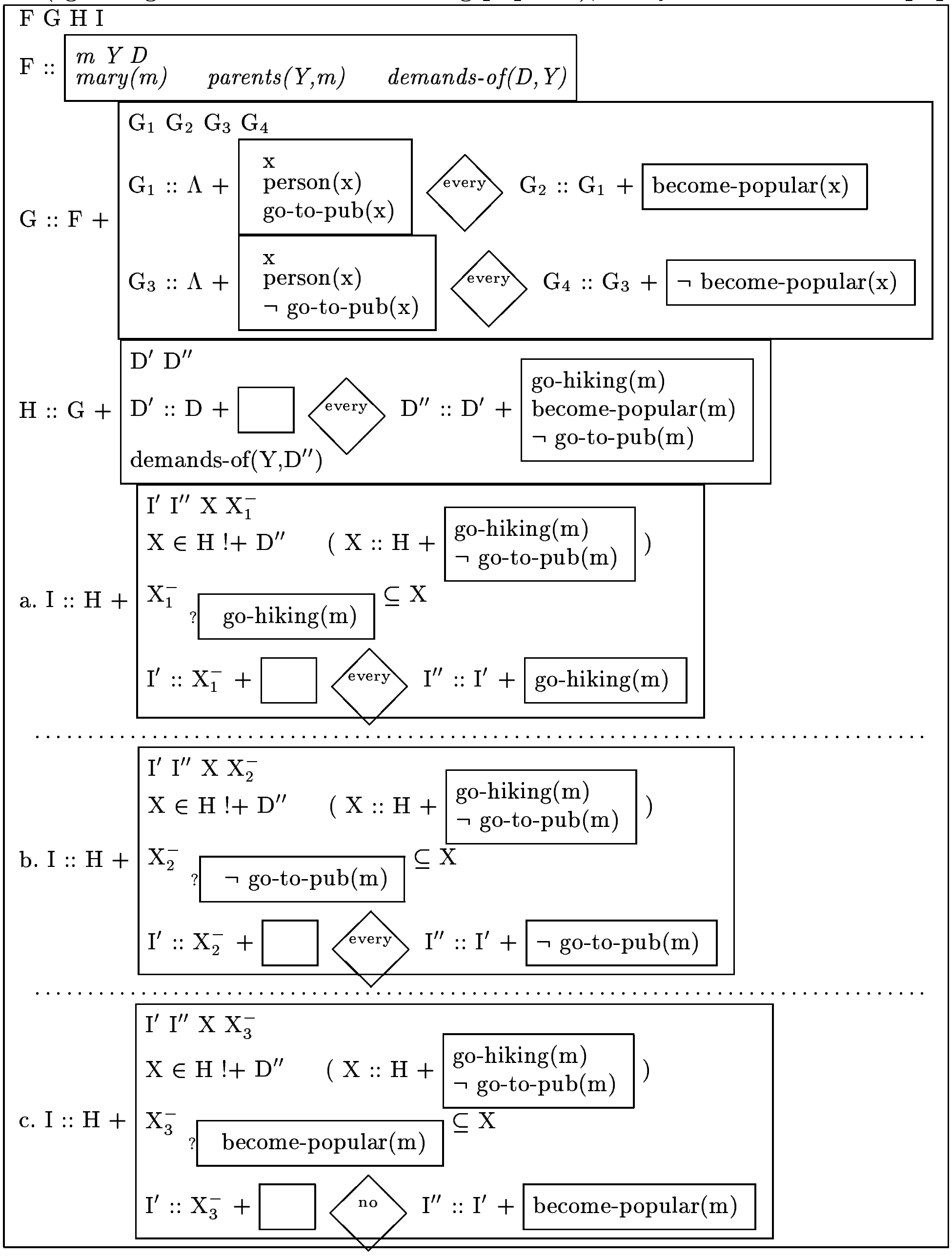
(80) You become popular only if you go to the pub. According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub. (In view of the facts and in order to do justice to her parents' demands,)

a. (Ignoring the demand of not going to the pub,) Mary must go hiking.
b. (Ignoring the demand of not going to the pub,) Mary must become popular.
c. (Ignoring the demand of not going to the pub), Mary must go to the pub.



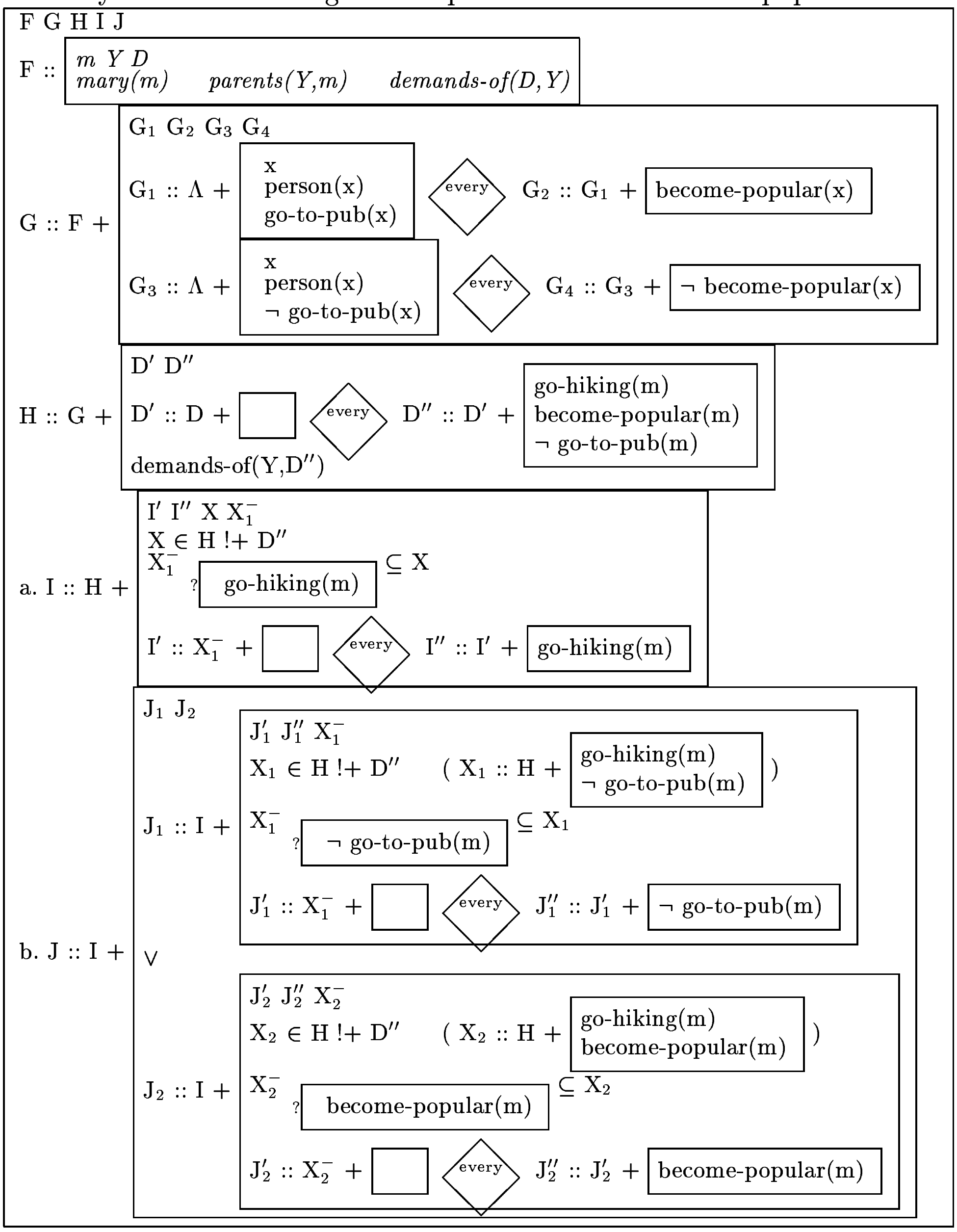
In (81) $X \in H\ !{+}D''$ is chosen to ignore the demand of Mary becoming popular. Relative to this context it follows that *Mary must go hiking* and that *Mary must not go to the pub.* Further, relative to this adjusted context X it holds that *Mary must not become popular*, since becoming popular conflicts with the demand that Mary mustn't go to the pub.

(81) You become popular only if you go to the pub. According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub. (In view of the facts and in order to do justice to her parents' demands,)
a. (Ignoring the demand of becoming popular,) Mary must go hiking.
b. (Ignoring the demand of becoming popular,) Mary must not go to the pub.
c. (Ignoring the demand of becoming popular), Mary must not become popular.



Our analysis does not allow for evaluation of the existentially quantified deontic sentences (77b–c) relative to the *entire* desire context D'', but requires these modals to be interpreted wrt. *individuated* maximally consistent complex modal bases, determined by compatibility restricted union from the factual antecedent context H and the desire context D''. But as illustrated in (80) and (81), once the underlying deontic context has been adjusted in one or the other way to yield consistency with the facts, instead of the existentially quantified (77b–c) we predict the stronger universally or negatively quantified sentences (80b–c) or (81b–c) to hold true. And we also account for (82b), where we assume that – in view of the exclusive meaning of *either ... or ...* – the modal verbs in the two disjuncts must be relativized to distinct outcomes X_1 and X_2 of $H\ !+\ D''$.

(82) You become popular only if you go to the pub. According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub. (In view of the facts and in order to do justice to her parents' demands,)
a. Mary must go hiking.
b. Mary must either not go to the pub or she must become popular.



The main objective of the above discussion was to illustrate an important difference between Kratzer's analysis of deontic modality in terms of *graded* modality and our present account in terms of *multiple relative* modality, with a single *consistent complex* modal base.

The difference emerges in cases of conflicting antecedent contexts of the type just considered, where Kratzer's analysis of graded modality leads to unintuitive results if we take seriously the notion of *relative modality.* This is evident for examples like (77) and also emerges in Kratzer's example (78), if considered with care.

In Kratzer's framework a modal operator can be evaluated relative to two inconsistent antecedent contexts, given that the inconsistency is resolved by using one of the contexts as the ordering source for the other context, which provides the modal base. In our account a *single* complex modal base is built by *merge* of the antecedent contexts, where we constrain the component contexts to be *consistent.* In case of conflicting contexts, consistency can be obtained (basically) in terms of a relation of *minimal context reduction.*

The peculiarity of the cases of "Practical Inference" is that there are two alternative ways to resolve the inconsistency by inducing *minimal* reduction (implemented in terms of compatibility restricted union). The difference between Kratzer's account and our present solution is that in these specific cases Kratzer's notion of *graded modality* leads to evaluation of the modal operator relative to a context that does not result from *minimal* reduction, but one where *two*, instead of one or the other of the two conflicting desires are "dropped".

The fact that (77b–c) are odd on a deontic reading in terms of context dependent, or *relative modality* seems to corroborate our contention that *context reduction* must always be *minimal.* In cases where complex modal bases can be built from consistent contexts F and D, reduction will be vacuous, while in cases of conflicting contexts the modal base must be built with minimal reduction of either one of the contexts, to yield consistency.

Choosing a relevant antecedent context, preserving consistency

There are, however, some crucial weaknesses of our analysis of "Practical Inference" as it stands.

First, we have not yet accounted for the necessity to switch to subjunctive *could* in (78b–c), while indicative *must* is perfectly wellformed for the hiking–case (78a).

Secondly, the maximality constraint that is built into the definition of compatibility restricted union leads to an ambiguity for the analysis of (78a) and (77a). This is most obvious in (82a), where we did not give a characterization of the reduced modal base X, as opposed to (80a) and (81a). So (82a) is ambiguous, or vague in that X can be chosen to instantiate to either one of the outcomes X_1 or X_2 of compatibility restricted union of $H'! + D''$, with X_1 as X in (80a) or X_2 as X in (81a). Yet it seems to us that – in contrast to (78b–c) – no such ambiguity is felt for (78a) when uttered in the context of (78).

Finally, note that while our analysis seemed to work well for the examples (80) and (81), it does so *only* if the bracketed conditional clauses in the respective (b) and (c) sentences are in fact realized. Once they are omitted, or not otherwise salient in the discourse, the modal sentences cannot be judged true. By contrast, the disjunctive sentence (82b) can be verified without such additional material.

Let us begin by discussing the first point. Our observation was that (78b–c), if understood as relative to both the factual and bouletic antecedent context, are odd when in indicative mood, and in this respect pattern with the deontic uses of *may* in (77b–c).[55]

We have been arguing that the subjunctive versions of (78b–c) are best interpreted relative to a *hypothetical* context where the relevant (conflicting) desire context is revised to allow for consistent update with the (otherwise identical) factual background context.[56]

Thus, subjunctive (78b–c) are interpreted along the lines of the following paraphrases: *(If I gave up on becoming popular,) I could not go to the pub* or *(If I resigned myself to going to the pub,) I could become popular.* On these readings the modal adverb is evaluated relative to epistemically accessible worlds where my desires are changed, or adjusted to be in accord with reality.[57] And of course, since there are different ways to resolve the conflict in view of the facts, both (78b) and (78c) can be true *relative to different such hypothetically revised deontic contexts.*

A preliminary analysis for (78b) that follows this line of reasoning is given in (83). The sentence is interpreted as implicitly conditional, where the corresponding universal quantifier is relative to a context referent H' that is either identical to the factual antecedent context H, or is derived from H by (proper) context reduction $H' \subseteq H$ to allow for a counterfactual interpretation.[58] The antecedent DRS of the implicit conditional structure is characterized by conditions that induce a (minimally) reduced context D_1 of D''. The embedded quantificational structure then states that – in conjunction with the otherwise unaffected factual context – it is *possible* that I become popular, given the facts and my (revised) desires D_1.

In contrast to (80)–(82) we do not make use of the relation of compatibility restricted union to ensure that the reduction $D' \subseteq D$ be minimal. As we will argue below, the appropriate choice of D' must be left to pragmatic constraints, in particular the choice of D' must respect the criterion of *relevance.*

In contrast to (80) and (81) the bracketed conditional clause in (83) can now be omitted. As we have noted in Section 4.1.4 p. 204, non–epistemic modals in subjunctive mood in general allow for accommodation of a governing epistemically based conditional structure, provided an appropriate context to fill the conditional antecedent is salient in the discourse. We can argue that in cases of "Practical Inference" the obvious need to resolve the inconsistency – in one of two possible ways – makes salient these two alternative ways. Which one it is that is actually chosen to be accommodated into the restrictor argument, is finally determined by the scope DRS of the embedded quantifier:[59] the condition **popular(i)** can only be verified relative to $I'^{-} + D_1$ if D_1 does not contain the condition ¬ **go-to-pub(i)**.[60]

[55]Recall also the point we made in Section 2.2.3 where we confronted (78b–c) with (i). If (i) is uttered in the context (78), where I do not take any stand on whether I like to go dancing or not, (i) is wellformed and true if interpreted relative to both the facts and my desires. But I cannot reason in a similar way for (78b–c) with indicative *can.*

(i) I *can* go dancing.

[56]The same holds true for alternatives to (77b–c), with *could* replacing deontic *may.*

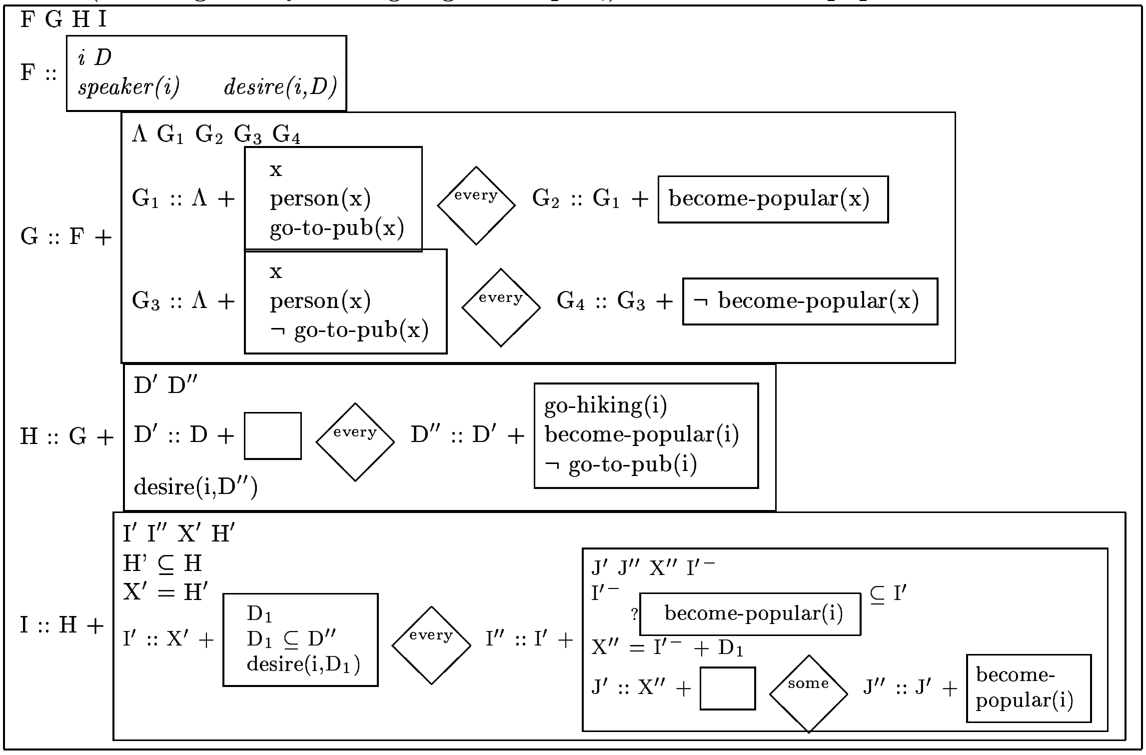
[57]These worlds might be conceived of as counterfactual, by assuming the deontic context were different from what it acually is, or else as noncounterfactual, by assuming that somehow the deontic context will *change* in the future, to meet with the facts.

[58]Since we have not yet confronted the analysis of counterfactual modality, we can only posit the corresponding details that will be introduced and discussed in Section 4.3 and Chapter 5.

[59]See Gabbay(1972) and Section 5.1.2, and especially Section 4.3.3.

[60]There is also the question why – in case the conditionalization is not explicit – the sentence is existentially

(83) You become popular only if you go to the pub.
I want to go hiking, become popular, and not go to the pub.
(In view of the facts and my desires)
(If I resigned myself to going to the pub,) I *could* become popular.



It should be obvious that an analysis along these lines accounts for the first problem raised above, the contrast between the indicative and subjunctive versions of (78b–c): As we have

quantified, since on the analysis given in (83) a corresponding universally quantified sentence is predicted to be true, such that the speaker should choose the stronger, universally quantified sentence. But neither (ia) nor (ib) seem appropriate.

(i) a. I should become popular.
b. I would have to become popular.

But note that, by contrast, the corresponding universally quantified reading is available with overt conditionalization in (iia–b). This we take as an indication that in case the sentence is overtly non–restricted, as we assumed for (83), the pragmatic function is to *determine* some appropriate (minimally) revised deontic context that allows for realization of one of the actions *in correspondance* with the facts. I.e. in contexts like (83), without overt conditionalization, the point of the utterance is to "find a way" or "raise a possibility" for (minimal) revision of the conflicting demands to meet the facts.

For the overtly conditionalized sentences in (ii) the picture is a bit different. Here, by explicitly settling one or the other of the alternatives, the objective is not so much to hint at a possible way of resolving the inconsistency, but rather to state what follows from one or the other of the possible options for revision.

(ii) a. If I resigned myself to going to the pub, I *could (would be able to)* and *should (would have to)* become popular.
b. If Mary ignored the demand of not going to the pub, she *could (would be able to)* and *should (would have to)* become popular.

Finally, in (ii) we see that in these contexts the subjunctive modal *could* is naturally substituted by *would be able to*, which patterns the structure of the complex (embedding) modal construction in the respresentation (83).

argued, non–epistemic non–restricted modals do in general only allow for accommodation of a governing epistemically based quantifier if in subjunctive mood. Therefore, an analysis of indicative (78b–c) corresponding to (83) is precluded.

But do we also account for the oddity of (77b–c) and the indicative variants in (78b–c) if they are analyzed in terms of a single, i.e. non–embedded non–epistemic modal quantifier? In (80) and (81) this was predicted by the analysis of conflicting modal bases in terms of compatibility restricted union.

As we pointed out above, the analysis of (80) and (81) in terms of the relation of compatibility restricted union is *only* correct if the modal sentences are overtly conditionalized, i.e. explicitly settle one or the other possibility of resolving the conflict. Therefore, especially in view of the above results (see in particular footnote 60), we have to reject the analysis in terms of compatibility restricted union.

Instead we will return to our original proposal, to define context revision in case of inconsistent antecedent contexts by use of the fairly unconstrained relation $\subseteq$ of context reduction, and leave it to pragmatic restrictions to ensure that the reduced context $D' \subseteq D$ be *contextually relevant.*

We will now show that this final solution will not only account for the oddity of examples (77b–c) and indicative (78b–c),[61] but also for the second problem raised above, the unwarranted ambiguity of the universally quantified (77a) and (78a), which was predicted by the analysis in terms of compatibility restricted union (see above p. 224).

Let us begin with the latter aspect: as noted above, we can truthfully utter, in (78), that *I must go hiking*, in the non–epistemic (bouletic) reading, i.e. relative not only to the facts, but to my desires in view of the facts. If the selection of a consistent *complex* modal base were to obey the maximality constraint imposed by compatibility restricted union, two alternative contexts X_1 and X_2 could be chosen, with equal right, to provide the modal base (cf. X in (80) vs. (81)). But of course there is no such ambiguity involved in the interpretation of this sentence.

The problem is closely related to the phenomenon of *vagueness* of indicative and counterfactual conditionals. The truth of a conditional sentence crucially depends upon the particular choice of (a subset of) the set of accessible worlds where the antecendent holds true. If all epistemically accessible worlds were to be taken into account, hardly any (universally quantified) conditional sentence could be judged true.

The pervasive phenomenon of *vagueness* involved in the selection of accessible worlds was discussed by Lewis, who chose the concept of *(maximal) overall similarity* to constrain the domain of quantification. The fact that the criterion of (maximal) overall similarity is notoriously vague was considered by Lewis as a pro: due to its inherent vagueness the concept of overall similarity was considered most appropriate to account for the vagueness of conditionals.

Yet, both the criterion of similarity and the maximality constraint have been argued to be too strong.[62] In Section 5.1.2 we will argue that besides a notion of *normalcy*, in many cases the set of worlds that constitutes the quantificational domain is strongly determined by the notion of *relevance*, determined by the particular utterance context, and which is of

[61] Note that the analysis we have given in (83) for the wellformed subjunctive versions (78b–c) already dispensed with the notion of compatibility restricted union

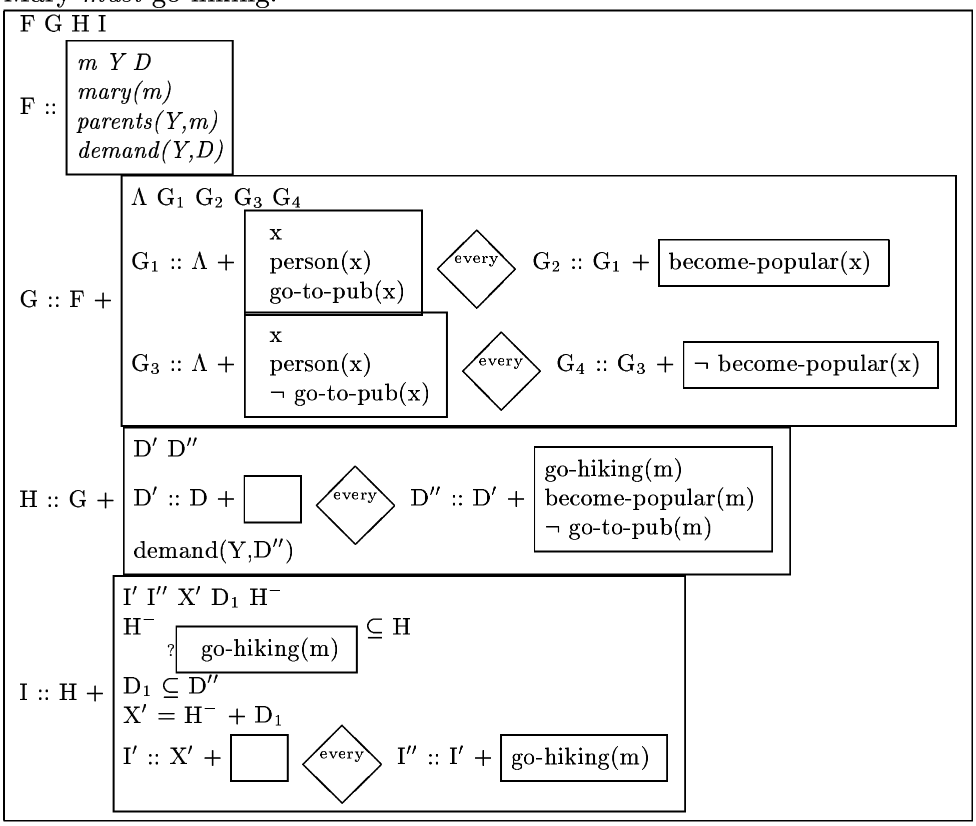
[62] See our discussion in Section 2.2.2, and in particular Sections 4.3.1 and 5.1.2.

course at least as vague as the notion of similarity.

Our point is that the choice of the (reduced) deontic antecedent context to contribute to the complex modal base for the deontic sentence (77a) and the non–epistemic interpretation of (78a) is also subject to pragmatic criteria of *relevance*. We will first illustrate this intuition by discussion of (84) and (85), and then try to give a formal characterization for the selection of an appropriate (relevant) complex modal base for deontic modality, relative to (possibly conflicting) factual and deontic antecedent contexts.

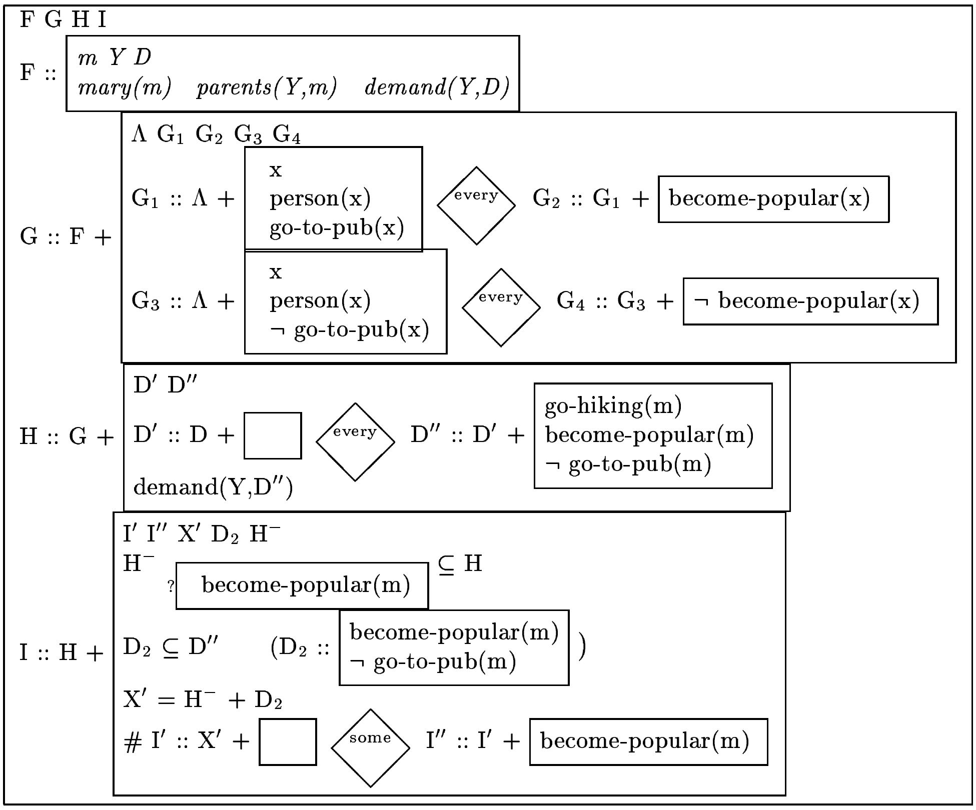
For the examples at hand it is most natural to assume that for evaluation of (77a) the conflicting demands of *becoming popular* and *not going to the pub*, given that they are in no way dependent on or interfering with the issue of *hiking*, are simply not *relevant* – and therefore ignored – for the issue of whether Mary must go hiking, such that there will be *one* single reduced context D_1, which only contains the condition **go–hiking(i)**, that is chosen to yield a consistent complex modal base $X' = H^- + D_1$ for the universally quantified deontic modal *must*. This analysis is given in (84), where we make use of the relation $\subseteq$ for selection of the reduced context D_1, as we already did in (83).

(84) You become popular only if you go to the pub.
According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub.
(In view of the facts and in order to do justice to her parents' demands,)
Mary *must* go hiking.



By contrast, for evaluation of the *indicative* versions of (78b–c) – and similarly for (77b–c) –, given the conditional dependence of **becoming-popular** upon **going-to-pub**, the demand of *not going to the pub* is not irrelevant for the issue of *becoming popular*, and vice versa, and therefore the reduced context $D_2 \subseteq D$ cannot be chosen to ignore, or "drop" one or the other of these two conflicting demands. Verification of the existentially quantified condition for *may*, relative to the complex modal base $X' = H^- + D_2$, with D_2 as characterized in parantheses, is therefore not possible, which we indicate by #.

(85) You become popular only if you go to the pub.
According to her parents' demands, Mary must go hiking, she must become popular, and she must not go to the pub.
(In view of the facts and in order to do justice to her parents' demands,)
Mary *may* become popular.



So constraining the selection of a *reduced* context D' in terms of the notion of *relevance* will account for the problematic cases of "Practical Inference", and of course it also carries over to the classical case of inconsistent modal bases, the Samaritan Paradox. In a context where a murder occurs, the conflicting juridical prescription that no murder may occur is in a certain way irrelevant: the murder cannot be undone. What *is* relevant, by contrast, is what the law provides for cases where the first law is violated. Thus, the conditional law that in case of a murder the murderer must go to jail will of course be relevant to judge the issue of what is demanded by the law in the actual murder case under investigation. Thus, for our murder example we assume the original representation in (72), where D' is chosen as a *relevant* reduced context.

So in sum, having argued that the oddity of the problematic examples (77) and (78) can be accounted for through use of the pragmatic notion of *relevance* to constrain the selection of a particular *reduced* deontic antecedent context, we can finally dispense with the minimality constraint on context revision that motivated the definition of compatibility restricted union. Instead, we will uniformly make use of the relation of *context reduction* $\subseteq$ not only to deal with inconsistent modal bases in contexts of non–epistemic (deontic) modality, but also – as can be seen from the representation (83) for subjunctive *could* – to deal with the selection of a (reduced) factual modal base for the analysis of counterfactual conditionals, to which we will turn shortly.

How to determine an appropriate (reduced) context D' for deontic modality

The previous discussion brought out that a *minimality* constraint on the selection of a reduced modal base D' of D to yield a consistent complex modal base – implemented in terms of the relation of compatibility restricted union – is too strong for the more involved cases of Practical Inference, which we illustrated by (80)/(81).[63] Instead, we came back to our original proposal, to define a consistent complex modal base $F + D'$ from conflicting factual (F) and deontic (D) contexts, where the selection of a *reduced* context $D' \subseteq D$ is quite undetermined, and left to be constrained by a pragmatic notion of *relevance.*

We will now try to sketch a slightly more formal characterization for the selection of an appropriate *relevant* reduced context $D' \subseteq D$, to build a complex modal base $F + D'$ for the deontic modal operator[64] in cases of conflicting background contexts F and D.[65]

The two cases we have been considering above are distinct in that in the case of the "Samaritan Paradox" there is one single condition defined by D that is sufficient to induce inconsistency with the factual context F: in (72) this was the juridical demand that *no murder occurs.* By contrast, in the case of "Practical Inference" the inconsistency between the deontic/bouletic context D and the factual background context F is not induced by a *single* condition from within D, but only if *both* the desire of becoming popular *and* the one of not going to the pub are *jointly* considered "in light of the facts F".

In order to determine a *relevant* reduced context D' of D, we have to compute the following steps:

Especially in view of the case of Practical Inference, we must first identify a minimal subset of conditions defined within D that are in conflict with F. We do this, in (86), by choosing a context $D_1 \subseteq D$ s.th. D_1 is *inconsistent* with F *and* such that for any proper reduction X of D_1 ($X \subset D_1$ to be defined appropriately) it is the case that X is again *consistent* with F.

We then construct, in (87), a set $D_1^{-(F)}$ of contexts Y that are reductions of D_1, and which are again *compatible* with F. Finally, then, we define a set D' as in (88), which defines different possibilities to build a complex consistent modal base relative to the conflicting contexts F and D: Each possibility, i.e. context within D', is defined by, first, eliminating

[63] Similarly, Kratzer's analysis in terms of graded modality, which also embodies a maximality constraint, was argued to be problematic for these cases, yet in different respects. See Section 2.2.3 and p. 218 above.

[64] We ignore, for the moment, the additional reduction F' of F ($F' \;_{?K''}\!\subseteq F$), K'' the scope DRS) to avoid "trivial" deontic sentences.

[65] We essentially follow a proposal by Hans Kamp.
The formal characterization we state below is not meant to give a general characterization of the notion of *relevance*; nevertheless it captures the right results for the specific cases under discussion.

the conflicing information D_1 from D ($D - D_1$ to be defined appropriately), and secondly, by extending this reduced context $D - D_1$ with one of the contexts $D_1' \in D_1^{-(F)}$.

(86) $D_1 \subseteq D$ and $D_1 + F$ is inconsistent and $(\forall X : X \subset D_1)$: $X + F$ is consistent.

(87) $D_1^{-(F)} = \{\ Y : Y \subseteq D_1$ and $Y + F$ is consistent$\}$.

(88) $D' = \bigcup\{(D - D_1) + D_1'\}_{D_1' \in D_1^{-(F)}}$.

For our Samaritan Paradox example (75) this yields the following result, where we considerably simplify things by using abbreviatory terms for DRSs that characterize the context referents F and D: according to (86) D_1 is the minimal reduced context of D that is inconsistent with F. The only proper reduction of D_1 that is consistent with F is the empty set. According to (88) D' is then defined to contain a single reduced context, which states the conditional law that in case of a murder the murderer goes to jail.

(89) $F = \{$ murder$\}$, $D = \{\ \neg$ murder, murder $\rightarrow$ jail$\}$.
$D_1 = \{\ \neg$ murder$\}$
$D_1^{-(F)} = \{\ \emptyset\}$
$D' = \{\ \{$ murder $\rightarrow$ jail$\}\}$

For the case of Practical Inference, the minimal reduced context D_1 of D that is inconsistent with F contains both the condition of becoming popular and of not going to the pub. Further reduction of the context characterized in D_1 yields alternative contexts within $D_1^{-(F)}$ that are again consistent with F. D' is then defined to consist of two alternative desire contexts, one for going hiking and becoming popular, the other for going hiking and not going to the pub.

(90) $F = \{$ pop $\leftrightarrow$ pub$\}$, D $= \{$ hiking, pop, $\neg$ pub$\}$.
$D_1 = \{$ pop, $\neg$ pub$\}$
$D_1^{-(F)} = \{\ \{$ pop$\}$, $\{\ \neg$ pub$\}\}$
$D' = \{\ \{$ hiking, pop$\}$, $\{$ hiking, $\neg$ pub$\}\}$

The evaluation of a deontic modal operator can then be defined, roughly, as in (91), such that *must* K'' is true relative to F and D iff $(\forall D'' \in D')$ K'' is verified by every state denoted by $F + D''$, while for *may* K'' we require that for every such D'' K'' is verified by *some* state denoted by $F + D''$.[66]

[66]Alternatively to the analysis of subjunctive *could* we have given in (83) this construction allows us to define non–epistemic *could* as in (i), such that *could* K'' is true relative to F and D iff $(\exists D'' \in D')$ s.th. K'' is verified by some state in the denotation of $F + D''$.

(i) *could* K'' is true relative to F and D iff
$(\exists D'' \in D')$ s.th. K'' is verified by *some* state in the denotation of $F + D''$.

(91) a. *must* K'' is true relative to F and D iff
$(\forall D'' \in D')$ K'' is verified by *every* state denoted by $F + D''$.

b. *may* K'' is true relative to F and D iff
$(\forall D'' \in D')$ K'' is verified by *some* state denoted by $F + D''$.

An alternative definition that is more in line with our specific analysis of modally quantified structures is given in (92).

(92) a. *must* K'' is true relative to F and D iff
K'' is verified by *every* state denoted by $F + {}^{\vee}D''$,
where ${}^{\vee}D''$ denotes the set of states $\bigcup_{D'' \in D'} [\![D'']\!]$.

b. *may* K'' is true relative to F and D iff
K'' is verified by *some* state denoted by $F + {}^{\vee}D''$,
where ${}^{\vee}D''$ denotes the set of states $\bigcup_{D'' \in D'} [\![D'']\!]$.

To conclude this Section, we briefly summarize some important results of this first discussion of *inconsistent modal bases*, which raised an important objection against Kratzer's analysis of *graded* modality to account for inconsistent contextual backgrounds in contexts of non–epistemic modality.

First, we have argued that Kratzer is mistaken about the interpretation of (78b–c), which was made plain by the parallel, but more intelligible example (77), which brought out that the intended reading is in fact not available. Second, Kratzer's analysis does not account for the difference in acceptability of the indicative and subjunctive versions of (78b–c).[67] We then illustrated that an alternative analysis in terms of compatibility restricted union – which also incorporates a maximality constraint, yet applied to "individuated" ways of resolving the inconsistency – is able to account for the first, but not the second of these problems, and is confronted with various other problems (spurious ambiguities, etc.). We finally stated an analysis that does not suffer from these various shortcomings, where we make use of the notion of *relevance* to constrain the selection of a reduced deontic context in order to define a consistent complex modal base. It will be one of our objectives, in the following Section, to provide evidence that also for the analysis of counterfactual conditionals we can dispense with the notion of *graded modality.*

4.3 Inconsistent modal bases II: Counterfactual modality

In our discussion of subjunctive *could* in cases of "Practical Inference" we already touched on the aspect of counterfactuality, and we will now outline the basic ingredients of our analysis of counterfactual modality.

In the spirit of the previous discussion the analysis differs from Kratzer's (and with it Roberts'(1989) and Geurts'(1995)) analysis in that it does not make use of the notion of

[67] Recall that Kratzer does not advocate a complex (embedded) analysis of overtly (or in some cases implicitly) *restricted* non–epistemic modals (i).

(i) If your parents didn't insist on your becoming popular, you could/would be allowed to not go to the pub.

graded modality. Instead, counterfactual modality will be analyzed in terms of the notion of *relative modality*, where the modal base is gained from the conflicting factual or epistemic antecedent context in terms of *context reduction*. By this move we are able to overcome some weaknesses of Roberts' and Geurts' reconstructions of Kratzer's theory in the framework of DRT (see Section 2.3.2). Finally we will extend our analysis of modal subordination to counterfactual contexts, an important aspect that is not fully accounted for in Geurts(1995).

In Chapter 5 we will address the problem of the *vagueness* and *variability* of (indicative and counterfactual) conditionals. We will then be able to show that the analysis accounts for the phenomenon of conditional variability, discussed for counterfactuals by Lewis(1973), and which we argued in Section 2.2.2 not to have received a satisfying treatment in his analysis in terms of a system of spheres.

4.3.1 Vagueness and variability of counterfactual and indicative conditionals

In Section 2.2.2 we have argued that *both* indicative and counterfactual conditionals are inherently *vague* and *variably strict*. (93), uttered at the very moment where Nixon has to make his decision, is vague in that there might well be worlds where e.g. the consequences of a nuclear holocaust, ensuing from his possible action, are removed within a second. Such worlds, although epistemically accessible, are in general not considered to make the indicative conditional false. And, of course, indicative conditionals can be increasingly strict, with conflicting consequents, in the same way as counterfactual conditionals (94).

If this is so, then – in light of the efforts made by numerous authors to cope with the vagueness and variability of counterfactuals (see especially Lewis(1973), and Nute(1986) for an overview) – our present analysis of indicative *if*–conditionals seems incredibly simplistic.

(93) If Nixon presses the button, there will be a nuclear holocaust.

(94) If Otto comes, it will be a lively party;
but if *both* Otto and Anna come, it will be a dreary party;
but if Waldo comes *as well*, the party will be lively.

But perhaps it is not. When reviewing Lewis's theory of counterfactuals we argued against the interpretation of (counterfactual) conditionals in a *system* of spheres of *comparative similarity of worlds*. First, providing for a *set* of accessibility relations for sequences of conditionals such as (94) licenses unwarranted inferences, such as: *Therefore, if Otto comes, it will be a lively party*. We argued that it seems more adequate to account for such sequences by choosing, for each conditional sentence, a new *single* sphere of accessibility, to be determined by the preceding, dynamically extended discourse.

Moreover, it seemed that the criterion of "maximal overall similarity" for choosing some particular sphere of accessibility is rather unintuitive, and leads to unwelcome predictions. Two examples, cited from Nute(1986), may suffice to illustrate the point.

(95) is placed into the following context: "Suppose [...] that my lawn is just slightly too short to come into contact with the blades of my lawnmower. Thus my lawnmower will not cut the grass at present. Suppose further that the engine on my lawnmower is so weak that it will only cut about a quarter of an inch of grass. If the height of the grass is more than a quarter of an inch greater than the blade height, the mower will stall." Nute(1986:407).

(95) If the grass were higher, the mower would cut it. Nute(1986:407)

On a "minimal change theory" (95) must come out true, since the worlds where the grass is no more than a quarter of an inch higher than the blades are more similar to the actual world than those where it is more than a quarter of an inch higher. Yet, given the antecedent context that introduced (95), "[i]f someone were to assert [(95)], we would likely object, 'Not if the grass were much higher'. This shows that we are inclined to consider changes which are more than minimally small in our evaluation of conditionals." (ibid p.408).

The example illustrates that the selection of accessible worlds to verify the conditional's antecedent is not so much determined by degrees of similarity, but rather depends on the range of possibilities that is made salient in the discourse.

In Lewis(1979) a more refined notion of "overall similarity" was defined, where two worlds are classified to be similar to a high degree if they maximize spatio–temporal overlap (see Section 2.2.2). Yet, it has been pointed out that even this more refined notion of "similarity" does not in general give us the right result.[68] If those worlds classify as maximally similar that display maximal spatio–temporal overlap with the actual world, for (96), given that I left my coat in the bar yesterday, if it had been taken, the theory predicts it to have been taken at the latest time possible. Yet, "experience teaches that unguarded objects tend to disappear earlier rather than later." Nute(1986:421).

(96) I left my coat in the bar yesterday. If it had been taken, it would have been taken today (rather than yesterday). Nute(1986:421)

In light of these examples, and also if we recall sequences of variably strict conditionals (94), the criteria for the selection of the "appropriate" sphere of accessibility for conditionals do not seem to be determined by degrees of similarity. Rather, what is at stake is some pragmatically determined choice of contexts, or sets of worlds *taken into account in a particular context.*

Especially for (94) it is obvious that more and more *specific* contexts are taken into account, which may simply be grounded in the speaker continuously picturing to herself what the party could be like, depending on which people will show up. And for (95), given that the immediate antecedent context explicitly introduces the information that the grass should not be too high, for the mower will then not cut it any more, it is very likely that we will in fact *take into account* those possible worlds where the height of the grass is higher than a quarter of an inch, and which will falsify the conditional.

Finally, for (96) it is obvious that the set of worlds taken into account for the evaluation of the counterfactual has nothing to do with aspects of similarity, but rather is chosen to correspond as much as possible to *the normal course of events.*

So, why not admit what e.g. Bowie(1979) has concluded, after reviewing various alternatives for specifying an appropriate similarity relation for ordinary counterfactuals, namely that it might be the case that "while there is no single notion of similarity which gives us a uniform analysis of counterfactuals, that there is a range of notions of similarity such that (a) each counterfactual is correctly analysed by one notion of similarity in this range, and (b) the context of assertion indicates which in this range is the intended notion of similarity? [...] Could it be [...] that the context of assertion can be called upon to indicate the

[68]It won't do for (95) either.

appropriate notion of similarity?" (Bowie(1979:493)).

If the choice from varying "notions of similarity" is in fact determined by the context of assertion, why not dispense with this slippery notion of "overall similarity" altogether and simply make the "choice of the appropriate sphere of accessibility" context dependent?

If we take such a view of conditional vagueness – that it is grounded in a pragmatically determined choice of an appropriate "sphere of accessibility" – we also get a rather simple solution for the otherwise highly problematic example (97) of Tichy(1976), which is at odds with any theory of counterfactuals that is based on a notion of (maximal) similarity.

The example is this:[69] There is a man, of whom you are informed that he always wears a hat if it is raining, but who sometimes does and sometimes does not wear it if it is not raining. The story tells us that it is raining, so that he in fact has his hat on. The question is now whether the counterfactual (97), uttered in this context, comes out true, or not.

According to our intuitive understanding, it cannot be judged true. But on *any* theory building on maximal similarity it will be validated. Given that the factual context settles that the man wears his hat, this will also hold true in any maximally similar alternative world where it is not raining. It then follows that he has his hat on in any such situation.

(97) If it hadn't been raining, he would have had his hat on.

One explanation of what intuitively goes wrong with this type of examples is that when considering a counterfactual situation $\neg\psi$, we have to "retract" from the factual antecedent context not only the factual information ψ that is explicitly overriden by the counterfactual assumption, but in addition we have to retract all factual information ϕ that *conditionally*, or *counterfactually* depends on ψ. In the example at hand, the contextual background provides the conditional: $r \Box h$ (and also two *might*–conditionals: $\neg r \Diamond h$ and $\neg r \Diamond \neg h$). So if – in order to update with the counterfactual assumption $\neg r$ – r is retracted from the factual context, according to this hypothesis, also h, which is conditionally dependent on r, must be defeated for the evaluation of the counterfactual antecedent. Since the counterfactual then quantifies over worlds where it doesn't rain and where it is not settled that the man wears his hat, (97) will not come out true, as desired.

Similar cases are discussed in Ginsberg(1986), where interesting connections are drawn between counterfactual reasoning and planning. To illustrate the problem in selecting "maximally similar alternative worlds" he describes a scenario consisting of the facts: b: *I have a boat*, $\neg o$: *I do not have oars*, $\neg r$: *I cannot row across the river*, and $\neg f$: *I cannot fly across the river*. There is, in addition, the rule of inference $b \wedge o \rightarrow r$: *If you have a boat and some oars, you can row across the river*. In order to evaluate $o > r$: *If I had some oars, I could row across the river*, maximally similar possible worlds are computed by removing from the set of facts S enough facts to allow for consistent update with the counterfactual antecedent o. If the selection of such maximally similar worlds were only subject to a maximality constraint wrt. the number of facts in S that remain unchanged,[70] given that $\neg r$ and the inference rule $b \wedge o \rightarrow r$ are in S, one of the three maximally similar worlds results from removing (along with $\neg o$) the rule of inference $b \wedge o \rightarrow r$ from S, which however is unwarranted. Another one is obtained by removing $\neg o$ along with b from S, which

[69] We are following here the presentation in Morreau(1992:28ff).

[70] The set of maximally similar p–worlds is defined as follows: (Ginsberg(1986:44))
$W(p, S) \equiv \{T \subseteq S \mid T \not\models \neg p \text{ and } T \subset U \subseteq S \Rightarrow U \models \neg p\}$

corresponds to a reasoning to be paraphrased by "Even if I had oars, I could not cross the river if I didn't have the boat anymore (e.g. because I made the oars from the wood of the boat)". Only the third possible world removes $\neg r$ along with $\neg o$, and this is the only one of these maximally similar worlds where the counterfactual is intuitively judged true.

Again, we will suggest, in Section 5.1.2, that the problem can be avoided if we constrain the selection of counterfactual worlds in the quantificational domain to result from the factual context, by retracting all of the issues (i.e. the corresponding positive or negative facts) that are (partly) conditionally dependent on the counterfactual antecedent.

Although we have to postpone the detailed discussion of these problems to Section 5.1.2, we can conclude from the above discussion that for the analysis of counterfactuals we have to account for three aspects of their meaning, which are to be clearly distinguished:

For one, there is the – most prominent – aspect of counterfactuality: although the counterfactual hypothetical context is in many ways dependent upon the preceding factual context, and therefore cannot but be evaluated *relative to* this context, its antecedent is not *fully* compatible with the factual context. In our framework of *relative modality*, this necessitates selection of a reduced modal base that is dependent on the factual context, yet allows for consistent update with the counterfactual antecedent.

We have also seen that vagueness and variability are characteristic of, but not restricted to counterfactual conditionals. We will therefore try to account for these latter aspects in a uniform way for indicative and counterfactual conditionals. As we have argued, the vagueness and variability of conditionals cannot be captured in terms of the similarity criterion. We have argued above that the selection of the conditional's quantificational domain is – to some extent – determined by pragmatic factors such as *salience* or *relevance*, and we will further argue, in Section 5.2.1, that the quantification is further constrained in terms of a context dependent *normalcy selection function*, as we have been assuming all along.

In Sections 4.3.2 to 4.3.4 we will only be concerned with the first of these aspects, *counterfactuality*, which calls for a solution to establish – in general from the factual antecedent context – a modal base that allows for consistent update with the counterfactual antecedent. The aspects of vagueness and variability will then be considered, for both indicative and counterfactual modality, in Chapter 5.

Thus, our analysis is – by and large – in accordance with the *Ramsey Rule* for the evaluation of conditionals,[71] which gives indicative and counterfactual conditionals a uniform semantic analysis, modulo the second step (below), which applies vacuously to indicative conditionals, where the problem of inconsistency does not arise.[72]

> [...] first, add the antecedent (hypothetically) to your stock of beliefs; second, make whatever adjustments are required to maintain consistency (without modifying the hypothetical belief in the antecedent); finally, consider whether or not the consequent is then true. Stalnaker(1968:44)

[71]Yet, we do not commit ourselves to a necessarily epistemic interpretation of conditionals: the modal base may or may not be *relative to* a belief context.

[72]There has been an objection against the *Ramsey Test*, brought up by Stalnaker(1984:105). One prediction of the Ramsey test is that if one believes in the truth of a conditional, then if the belief context is updated with the conditional antecedent, one should believe in the truth of the consequent. This prediction is questioned in light of the following example:

4.3.2 Counterfactual conditionals: Avoiding inconsistencies

An important distinguishing feature between *indicative* and *subjunctive* conditionals is that there is a strong implicature that the situation described by the antecedent of a *subjunctive* conditional is not compatible with the preceding factual context, while an appropriate use of *indicative* conditionals is bound to contexts where the conditional antecedent is compatible with the factive antecedent context.

According to Stalnaker(1976) the "normal expectation" for a conditional sentence is that the world(s) to verify the conditional's antecedent must be selected from within the *context set*. This will only be possible if the antecedent is *compatible* with the information conveyed by the context. If the worlds to verify the antecedent should reach *outside* the context set, this has to be indicated by subjunctive mood. So "[it] is appropriate to make an indicative conditional statement only in a context which is compatible with the antecedent", while "counterfactual conditionals must be expressed in the subjunctive" (Stalnaker(1976:201)).

In the following we will first develop an analysis of subjunctive *counterfactual* conditionals, extend it to counterfactual *deontic* conditionals, and finally investigate their potential to engage in modal subordination.

The defining characteristic of a *counterfactual* conditional is the incompatibility of the conditional antecedent with the factual context.[73] This incompatibility can either be explicit, as in (98a–b), or else can be deduced from the implicature carried by conditionals in subjunctive mood, as in (98c).

(98) a. Max didn't attend the conference. If he had done so, he'd have learnt interesting things.

b. Max didn't attend the conference. If he had heard the first talk, he'd have learnt interesting things.

c. If Max had been at this conference, he'd have learnt interesting things.

> Suppose I accept that if Hitler had decided to invade England in 1940, Germany would have won the war. Then suppose *I discover, to my surprise, that Hitler did in fact decide to invade England in 1940* (although he never carried out his plan). Am I now disposed to accept that Germany won the war? No, instead I will give up my belief in the conditional. In this case, my rejection of the antecedent was an essential presupposition of my acceptance of the counterfactual, and so gives me reason to give up the counterfactual rather than to accept its consequent, when I learn that the antecedent is true. (italics added)

We tend to think that this is not in fact a principled argument against the *Ramsey Test* analysis of indicative and counterfactual conditionals, in particular if we focus on its *context dependent* aspect: Note that in the example above the two distinct judgements for the truth of the counterfactual – first belief in but then rejection of the counterfactual – are dependent on *distinct* belief contexts: the counterfactual $A > B$ is first evaluated relative to an epistemic state B_F where we believe that $\neg A$. We certainly also know that $\neg B$ (Germany did not win the war), such that we may well believe in the truth of $A > B$. But then we learn that A, which necessitates revision of B_F to B_F* where A holds true. But we will certainly still believe that $\neg B$, and not be inclined to drop or revise this assumption. Thus, the counterfactual $A > B$ is, relative to this revised belief context B_F* not a counterfactual any more, and thus leads to an inconsistency, if we follow Stalnaker's assumption that the set of worlds to be quantified over must be chosen from the context set if compatible with the conditional antecedent. Thus, updating B_F* with A cannot support that B and this is why we have to reject belief in $A > B$, on the basis of our new, adjusted belief context B_F*.

For this argument we benefitted from a suggestion by Hans Kamp.

[73]On this view, subjunctive conditionals with true antecedents are not considered as counterfactuals.

In Section 3.4 we have already discussed cases similar to (98a–b), where sentential negation in the antecedent context introduces a context referent, representing "counterfactual states", that provides an appropriate antecedent context for the counterfactual conditional. Anaphoric and presuppositional expressions introduced within the antecedent and scope DRS of the counterfactual can then be bound to accessible referents introduced either by the negated antecedent context, or else by the factual antecedent context the negated sentence is dependent on. In (98a), e.g., the VP–anaphor *so* can be anaphorically bound to the event of attending the conference, while the pronominal *he* can be bound to the referent for *Max*, which is to be accommodated within the non–negated factual antecedent context.

Counterfactual conditionals that are not stated *relative to* an overtly introduced negated context, as e.g. (98c), are nevertheless contextually dependent on the factual context.

First, presuppositions triggered within the counterfactual's antecedent or scope are often to be bound or accommodated within the factual antecedent context.

E.g. the presupposition triggered by the definite description *this conference* in (98c) is to be bound or accommodated within the factual context. Also, (99a) presupposes that in the actual world I am smoking and that I am not a chocolate maniac. In (99b) *he* and *they* anaphorically refer to the referents introduced for *Max* and the group consisting of Max and his daughter, respectively.

One could argue that presuppositions are not projected from the counterfactual antecedent, but rather indirectly by accommodation of its negation within the factual context, from which they can escape/project. But we cannot argue in the same way for presuppositions triggered within the counterfactual's scope and which are not bound within the antecedent.

(99) a. If I stopped smoking, I would immediately become a chocolate maniac.

b. Max bought a bike for his daughter. If he had more time, they would often go for nice trips.

Secondly, as noted in Section 2.3.2 in connection with (100), dependence on the factual context is indispensible if we want to derive the proper truth conditions for counterfactuals. That Max – had he bought a car – would have been free from paying taxes can only be derived if the information provided by the factual antecedent context is retained within the counterfactual context induced by the conditional's antecedent.

(100) Max is a disabled person. If he had bought a car, he wouldn't have had to pay taxes.

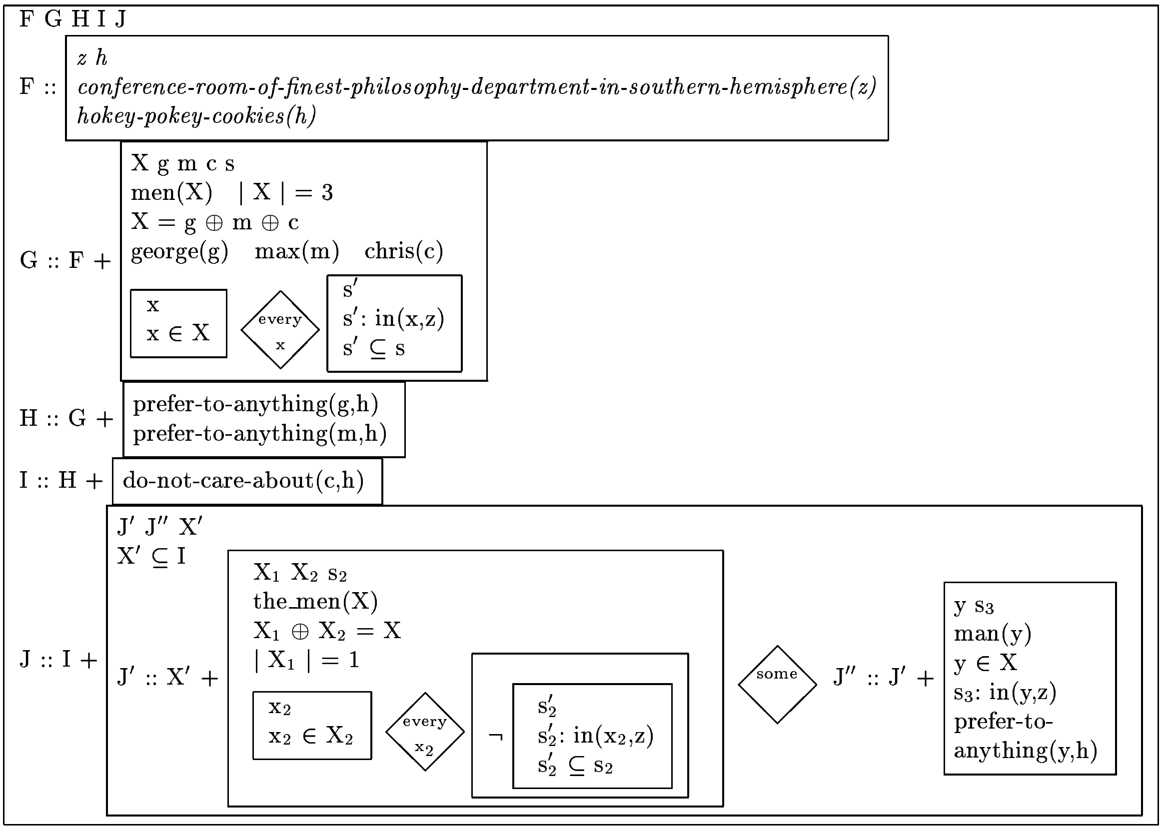
Given our analysis of deontic modals with conflicting factual and deontic antecedent contexts in Section 4.2 it is evident how we will proceed. A counterfactual conditional will be represented to be contextually dependent on its factual antecedent context F by characterizing its modal base X' as a *reduction* of F: $X' \subseteq F$. Which particular reduction X' of F is to be chosen is dependent on (at least) two factors: X' must allow for consistent update with the antecedent DRS K', but at the same time X' must retain *relevant* information from within F, *relevant* to the "issues" K' and K''.

As an example consider (101), borrowed from Kratzer(1979:123).[74] The factual context introduces some determined room z in a particular philosophy department (to be determined by world knowledge), where we find a group X consisting of three men, *George*, *Max*, and *Chris* ($X = g \oplus m \oplus c$), of whom only c does not prefer hokey–pokey–cookies to everything else in the world. The counterfactual (101a–b) is interpreted as dependent on the factual context I by characterizing its modal base X' as a *reduction* of I. The choice of X' will – inter alia – be constrained by the counterfactual antecedent, which describes a situation where *all but one of the men* are not in the room.[75]

(101) In the conference-room of the finest philosophy department in the Southern Hemisphere, there are exactly three men, George, Max and Chris. George and Max prefer hokey-pokey-cookies to anything else in the world. Chris does not care about hokey-pokey-cookies at all.

a. If all but one of the men were not in the room, there *would* still be one man in the room who prefers hokey-pokey-cookies to anything else in the world.

b. If all but one of the men were not in the room, there *could* still be one man in the room who prefers hokey-pokey-cookies to anything else in the world.



[74]We have chosen this particular example in order to illustrate that the analysis accounts for cases where there exist different ways of resolving the inconsistency between the factual context and the counterfactual antecedent. We modified it somewhat, such that it only allows for a counterfactual interpretation.

[75]We give a rather ad hoc representation for *all but one of the men were not in the room.* Also, since we do not represent the meaning of *exactly*, we constrain y in the scope DRS of the conditional to be a member of the group X of three men that are in the room.

Given the factual context I, the update of X' with the conditional's antecedent DRS K' will only succeed if X' is chosen in such a way that the conflicting information that all of the three men are in the room is *undone*. So the context X' will result from I by removing all assignments that verify this conflicting factual information.[76] Updating X' with the antecedent DRS will then map the group X_2 of two men out of X to either $m \oplus g$, $m \oplus c$, or $c \oplus g$, such that for each x_2 out of X_2 it is the case that x_2 is *not* in the room.

Provided that X' still supports the assignment to X, as well as the conditions that sketch the attitudes of George, Max and Chris to hokey–pokey–cookies, the universally quantified counterfactual (101a) does not come out true: there is one instantiation for y that maps it to a person that does not prefer them over anything in the world. And under the same proviso the existentially quantified counterfactual (101b) can be verified.

The analysis also accounts for exceptions to the Law of conditional excluded middle, discussed by Lewis(1973) (see Section 2.2.2). In (102) the counterfactual is relative to the *reduced* factual antecedent context $X' \subseteq G$, to be chosen such that Bizet and Verdi can be consistently assumed to be compatriots. There are two alternative ways to resolve this inconsistency: X' can be chosen to denote both states $\langle w', x'_1 \rangle$ that support **french(b)** but do not settle Verdi's nationality, and others, $\langle w'', x'_2 \rangle$ that support **italian(v)**, but do not settle information about Bizet's nationality. X' can then be updated with the antecedent DRS, which constrains the quantification to range over states that either support that Bizet is Italian or else that he is French.[77]

Since we didn't impose a minimality constraint on context reduction to ensure that the modal base X' of the counterfactual retain as much information as possible from the factual context G, it is not precluded that X' could be chosen to denote states $\langle w''', x'_3 \rangle$ where the nationality of both Bizet and Verdi is unsettled. Yet, on the assumption that the *relevance* criterion settles that what is at issue is a counterfactual context where Bizet and Verdi are French or Italian compatriots, this precludes the denotation of X' from including states in which the nationality of neither Bizet nor Verdi is retained. X' will then not support the truth of e.g. *If Bizet and Verdi had been compatriots, Bizet could have been German.*[78]

(102) Bizet was French and Verdi was Italian. If Bizet and Verdi had been compatriots, Bizet would or would not have been Italian.

F G H

F :: $\boxed{b\ v \quad \mathit{Bizet(b)}\ \ \mathit{Verdi(v)}}$

G :: F + $\boxed{\text{french(b)}\ \ \text{italian(v)}}$

H :: G + $\boxed{\text{G}'\ \text{G}''\ \text{X}' \quad \text{X}' \subseteq \text{G} \quad \text{G}' :: \text{X}' + \boxed{\text{compatriots(b,v)}}}$ ⟨every⟩ G″ :: G′ + $\boxed{\text{G}''_1\ \text{G}''_2 \quad \text{G}''_1 :: \text{G}' + \boxed{\text{italian(b)}} \quad \vee\ \text{G}''_2 :: \text{G}' + \boxed{\neg\ \text{italian(b)}}}$

[76]The assignment that matters here is the assignment for the situation variable s, which provides situations s', $s' \subseteq s$, where some $x \in X$ is in z.

[77]Disjunction is represented by disjunctive updates of G' with either one of the disjuncts. See Section 3.5.

[78]The formal characterization of a *relevant* reduced context in (86)–(88) above can also be applied to the present case, to determine a *relevant* reduced context X' in view of the conflicting factual context G and counterfactual antecedent K': X_1 is the minimal reduced context of G that is inconsistent with K' and such that every proper reduction of X_1 is again consistent with K'. $X_1^{-(K')}$ is the set of contexts that are reductions of X_1 and which are consistent with K'. Finally, X' is defined as in (88), as the set of alternative maximally consistent contexts that determine a *relevant* reduced modal base for the counterfactual's modal operator (see (92)).

$X_1 = \{\text{french(b), italian(v)}\}$ $\quad X_1^{-(K')} = \{\ \{\text{french(b)}\}, \{\ \text{italian(v)}\}\ \}$ $\quad X' = \{\ \{\text{french(b)}\}, \{\ \text{italian(v)}\}\ \}$

As it stands the analysis accounts for explicitly counterfactual conditionals, where the conditional's antecedent DRS is inconsistent with or conflicting with the information stated in the factual antecedent context F. In these cases the consistency constraint on updates constrains the modal base $X' \subseteq F$ to be chosen to either (i) properly "reduce" the assignments f in states $\langle w', f\rangle$ in the denotation $e(F)$ to assignments $x' \subset f$, such that X' will denote a set of states $\langle w', x'\rangle$ where the cardinality of $e(X')$ is greater than the cardinality of $e(F)$ (or alternatively, the set of worlds determined by the denotation of F, $cs(e(F))$ is a subset of the one determined by X': $cs(e(F)) \subset cs(e(X')))$ (as e.g. in (101)), or else (ii) retain the assignments f ($x' = f$), but nevertheless constrain X' to denote a proper subset of the context set determined by F: $cs(e(F)) \subset cs(e(X'))$ (as e.g. in (102)).[79]

Thus, consistent update with the *counterfactual* antecedent only succeeds if the modal base X' denotes a set of (states pertaining to) worlds that are a superset of those determined by the factual antecedent context F. For counterfactual conditionals we could therefore strengthen the relation of *context reduction* to a relation $X' \subset F$, where $cs(e(F)) \subset cs(e(X'))$.

Now, what about cases like (103) where either, as in (103a), the antecedent DRS is not by itself incompatible with the factual antecedent context, or else there is no discourse information available about the factual background context, as in (103b)?

(103) a. Fred has a collection of chopsticks. If he had gone to China, he would have bought lots of them.

b. If Fred had gone to China, he would have bought chopsticks.

As noted above, such uses of subjunctive conditionals come with a strong pragmatic implicature that the conditional is counterfactual. But this is not necessarily so. There are famous counterexamples, like Stalnaker's (104a). Further, Kratzer(1979) considers cases like (104b) where in the factual antecedent context for (104b) it is an open question whether Caligula is (still) alive or has been murdered. Yet, the examples (104a–b) are subject to quite specific contextual restrictions, which could lead us to conclude that they are in fact to be understood as counterfactual relative to an attitudinal context of the speaker (belief, expectations, etc.).

But still, there are examples like (104c) where the subjunctive modal is – preferably – understood as non–counterfactual, with a strong suggestive meaning component. I.e. in this type of examples the use of subjunctive mood goes along with a specific pragmatic purpose. We will set these cases apart from our present investigations.

(104) a. If the butler had done it, we would have found just the clues which we in fact found. Stalnaker(1976:200,201)

b. If Caligula were dead now, I would get promoted. Kratzer(1979:134)

c. You could go to Paris.

[79] Recall the definition of cs: For $\mathbf{X}$ a set of sates, $cs(\mathbf{X}) = \{w' : (\exists x')\langle w', x\rangle \in \mathbf{X}\}$.

In view of these observations we will, for the *semantic* representation of *subjunctive* conditionals uniformly make use of the relation of *weak context reduction* $\subseteq$ in order to establish the anaphoric modal base X' as being *relative to* a (factual) antecedent context F. This leaves room for the application of pragmatic implicatures to induce a counterfactual interpretation in cases like (103), but nevertheless allows for non–counterfactual readings in cases such as (104).

By contrast, for *indicative* conditionals the semantic representation will define the modal base X' to be *identical* to the antecedent context F, which enforces a non–counterfactual interpretation.

This is settled in (105), where the particular rule for establishing the anaphoric modal base X' is dependent on sentence mood. In sum these conditions reflect the pragmatic conditions for the use of subjunctive and indicative conditionals in Stalnaker(1976): For indicative conditionals the quantification is constrained to range over worlds from within the context set (here the antecedent context F), while the subjunctive conditional may induce quantification over a set of worlds from within or outside the context set.

(105) A conditional or non–restricted modal sentence S uniformly introduces, into the local DRS K_i, a condition

$$\mathrm{G}' :: \mathrm{X}' + \boxed{K'} \;\; \langle \mathrm{Q} \rangle \;\; \mathrm{G}'' :: \mathrm{G}' + \boxed{K''}$$

Let F be an accessible context referent that is chosen as the antecedent referent for the anaphoric modal base X'.

a. If S is in *indicative* mood, the condition $X' = F$ is introduced into K_i.

b. If S is in *subjunctive* mood, the condition $X' \subseteq F$ is introduced into K_i.

The semantic constraints defined in (105) are in accordance with the constraints on sentence mood established in Section 3.4, where we stated that *indicative* modals are constrained to induce quantification over a set of (states pertaining to) worlds that includes the "world of evaluation".

4.3.3 Non–epistemic modality in counterfactual contexts

Non–epistemically modalized conditionals

Given the results of the previous Section it will not come as a surprise that the analysis of *indicative* non–epistemic (deontic) conditionals we developed in Section 4.1.4 carries over straightforwardly to *subjunctive* deontic conditionals.

For subjunctive deontic conditionals we observe the same range of varied quantificational forces (106) that is characteristic of the corresponding indicative conditionals, and which led us to assume that the non–epistemic (deontic) modal operator is *always* embedded within the scope of the epistemically based conditional.[80]

[80] In contrast to their corresponding indicative versions there are no variants of (106a–b) that involve *must* or *may*. The reason is that these modals do not have subjunctive forms. So, as in the overtly embedded cases (106c–f) the predicates *have to* and *be allowed* are used instead. Subjunctive marking is done throughout by *would*, the subjunctive verb form of *will*.

(106) a. If Max stayed with G., he (*necessarily*) would **have to** walk the dog.

b. If Max stayed with G., he (*necessarily*) would **be allowed** to walk the dog.

c. If Max stayed with G., he *possibly* would **have to** walk the dog.

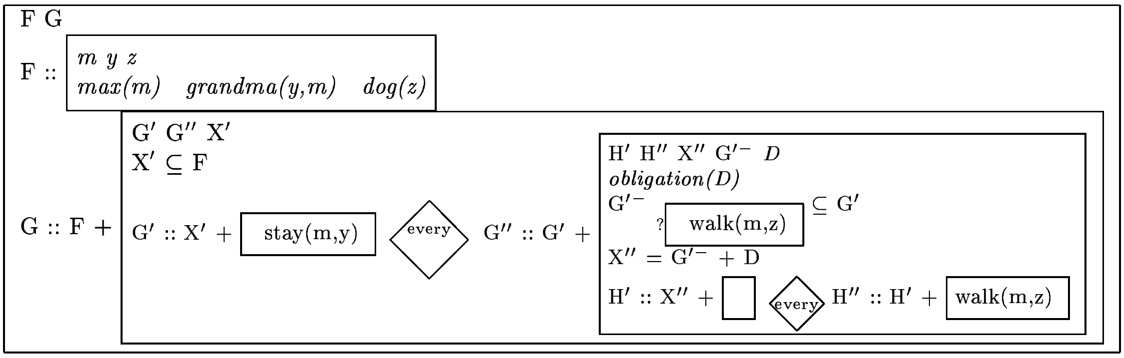
d. If Max stayed with G., he *possibly* would **be allowed** to walk the dog.

e. If Max stayed with G., he *probably* would **have to** walk the dog.

f. If Max stayed with G., he *probably* would **be allowed** to walk the dog.

So (106a) will be represented as in (107), which differs from the representation of its indicative counterpart only in that the modal base X' is obtained from the antecedent context F in terms of the relation of *context reduction* $X' \subseteq F$.

(107) If Max had stayed with Grandma, he would have had to walk the dog.

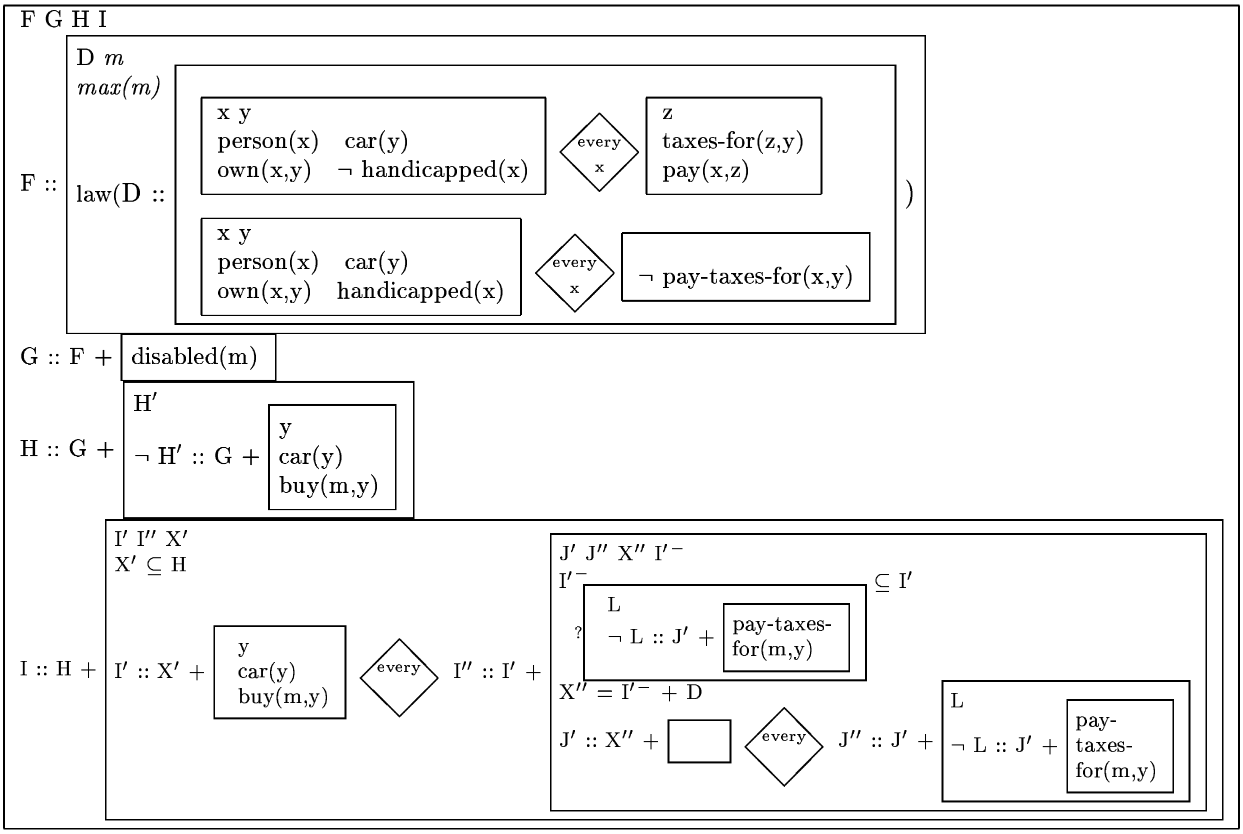


Also, relativization of the governing counterfactual conditional structure to a reduced modal base X' gives us the right predictions in cases like (108), discussed in Sections 2.2.3 and 2.3.2, where the factual antecedent context states information that is crucial for determining the application of conditional laws that pertain to the deontic context referred to by the embedded modal quantification.

Again we take the statements in (108a) to define the relevant juridical context for the interpretation of the deontic modal expression *have to* in (108b). The counterfactual deontic conditional in (108b) is stated *relative to* a context H where Max is a disabled person and doesn't own a car. In order to allow for consistent update with the conflicting antecedent DRS, *context reduction* must apply non–vacuously. Since Max's being handicapped is relevant for the issue of whether he will have to pay taxes in case he buys a car, the reduced modal base X' will still support that he is handicapped. The quantification therefore ranges over worlds that are *normal* relative to such a context. The embedded deontic quantification is – as usual – dependent on the context referent that annotates the conditional's antecedent – and which, given the choice of X', represents a context where Max is handicapped and owns a car – in conjunction with the juridical context D that is introduced within the factual background context. Since this complex modal base will only denote states where Max is handicapped, it is predicted that – if everything holds that is normally the case in such a context – Max will not have to pay taxes for the car (see Sections 4.1.4 and 4.1.5).

(108) a. Every holder of a car who is not handicapped pays taxes for the car.
Every holder of a car who is handicapped does not pay taxes for the car.

b. Max is a disabled person. He didn't buy a car. If he had bought a car, he would not have had to pay taxes.



So, as predicted by our "embedded" analysis of deontic conditionals, the representations for indicative vs. subjunctive *deontic* conditionals do only differ in their (epistemic) conditional meaning component, while being entirely parallel wrt. their deontic meaning.

Nonrestricted non–epistemic modality

In Section 4.1.3 we have represented *indicative* deontic sentences like (109a) in terms of a non–embedded modal quantifier that is relativized to a complex modal base consisting of the factual antecedent context and a deontic background context *D*, which is defined within the factual antecedent context via some intensional predicate, like *obligation*, or *law*. In other words, the deontic accessibility relation that is defined by these predicates is grounded in the factual context. For the corresponding subjunctive sentence (109b) we will assume accommodation of an embedding epistemically based conditional stucture, and – with it – an implicit antecedent clause. The embedded non–epistemic modal is then dependent on a deontic context that is grounded in a non–factual (hypothetical or counterfactual) context. As discussed in 4.1.4 the deontic context may therefore differ from what is prescribed within the factual context.

(109) a. Peter must pass the test.

b. Peter would have to pass the test.

A similar analysis is found in Kasper(1992), where it is argued that the distinct semantic properties of *epistemic* non–restricted subjunctive (110) vs. indicative (111) sentences ("simple subjunctives" vs. "simple indicatives") are best accounted for if the simple subjunctive is analyzed as a counterfactual conditional with accommodation of an antecedent clause stating the "preconditions for the possibility of the consequent to be true" (ibid, p.310).

> We may assume that the use of simple subjunctives and simple indicatives is complementary in the sense that simple subjunctives require non–fulfilment of such preconditions, which are usually taken for granted in using simple indicatives, and interpret simple subjunctives then as counterfactual assertions about what would have been the case if these preconditions had been fulfilled. ...in the case of unnegated simple indicatives these preconditions are necessary conditions for their truth. If they are not fulfilled, the simple indicative is false. The corresponding simple subjunctive then presupposes the falsity of the simple indicative just because the simple subjunctive presupposes the falsity of those necessary preconditions. In the case of negated simple subjunctives, on the other hand, the fact that the preconditions are not satisfied is compatible with the truth of the simple indicative. Since the falsity of this (negated) simple indicative now would require these preconditions to be satisfied (by the rules of *contraposition* and *double negation*), the simple indicative must be true if the simple subjunctive presupposes that the preconditions are not fulfilled. Kasper(1992:312)

(110) a. Your brother Peter would have failed the test.
If Peter had undergone the test, he would have failed.
Peter didn't undergo the test.

b. Your brother Peter wouldn't have failed the test.
If Peter had undergone the test, he wouldn't have failed.
Peter didn't undergo the test.

(111) a. Your brother Peter failed the test.
Peter did undergo the test.

b. Your brother Peter didn't fail the test.

Let us check, on the basis of these insights, whether accommodation of such necessary preconditions can be assumed for *deontically modalized* "simple subjunctives" like (109b).

Peter undergoing the test is a necessary precondition for him to *pass the test*, but not for *being obliged to/ having to pass the test.* On the other hand, *intending to get a driver's license, or being in need of a driver's licence* can (in general) count as a necessary precondition for *being obliged to pass the driving test.* Consider then (112), which can be paraphrased as in (112ii), but not as in (112i).

(112) Peter would have had to pass the test.
i. ≠ *If Peter had undergone the test*, he would have had to pass.
ii. *If Peter had intended to get/ would have been in need of the driver's licence*, he would have had to pass the test.

Also, for the indicative counterpart of (112) we can take the preconditions stated in the restrictive clause in (112ii) to be fulfilled if (113) holds true.

(113) Peter must pass the driving test.
Peter intends to get/ is in need of the driver's licence.

These results support our analysis of non–epistemic (deontic) modality in two ways: First, the asymmetry between non–restricted "simple indicatives" and implicitly restricted "simple subjunctives" that is noticed and explained in Kasper(1992) could be shown to carry over to non–epistemically modalized simple sentences. This is in accordance with the analysis of *indicative* non–conditional vs. implicitly conditional *subjunctive* non–restricted deontic sentences outlined in Sections 4.1.3 and 4.1.4.[81]

More importantly, the contrast between the implicit restriction arguments in (i) and (ii) of (112) can only be accounted for if the non–epistemic modal operator is evaluated *within* the scope of the higher, epistemically based modal operator.

Finally, these results do also support our analysis of "Practical Inference", in particular of (114b–c) in their non–epistemic reading, i.e. as being dependent on the *entire* desire context in view of the facts.

(114) I will become popular only if I go to the pub.
I want to go hiking, become popular, and not go to the pub.
b. I could not go to the pub.
c. I could become popular. Kratzer(1991:648)

As we have argued, *in this reading* substitution of *could* with indicative *can* is not possible. This is predicted if the indicative non–restricted sentence does not induce accommodation of a (governing) restricted conditional structure, such that the modal is dependent upon the entire (or more correctly: the reduced, but *relevant*) desire context, which is inconsistent with the facts. As we have argued in Section 4.2.2, the only way to get at the intended non–epistemic interpretation of the subjunctives (114b–c) is by accommodation of a governing, implicitly restricted counterfactual conditional, with accommodation of a "revised desire context" in the antecedent clause: *If I resigned myself to going to the pub, I could become popular.* or *If I did without becoming popular, I could not go to the pub.*[82] This

[81] But see Section 4.1.5, where we have seen that in modal subordination contexts *indicative* non–restricted deontic sentences also allow for accommodation of a governing modal quantificational structure, if the context provides an accessible context referent, representing an (epistemically based) modal context, and which can be chosen as an antecedent for the anaphoric modal base of the accommodated governing epistemic modal quantifier.

[82] As we have noticed, this reading is rather hard to get *without* an overt restrictive clause, but I think not impossible in some appropriate contextual setting, where e.g. I myself or someone else half–ways convinced me to overcome my resistance against pubs. In such a discussion I could easily say: *Well, of course I could become popular*, with the (understood) implicit restriction that this requires revision of my desires.

line of reasoning is now supported by Kasper's analysis of "simple subjunctive sentences" as inducing accommodation of an antecedent clause that states "necessary preconditions for the possibility of the counterfactual's scope to come true". In the kind of "deadlock"–situation described by (114) revision of the underlying set of desires is certainly a necessary precondition for being able to act in full accordance with my (then revised) desires.

4.3.4 Modal subordination in counterfactual contexts

Modal subordination with non–restricted "simple" subjunctive sentences

In the previous Section we adopted Kasper's insight about the analysis of simple subjunctives as implicitly restricted counterfactual conditionals: the conditions to be accommodated in the antecedent clause are characterized as "preconditions for the possibility of the consequent to be true" (Kasper(1992:310)).

Is this analysis consistent with further data we find with non–restricted subjunctive sentences, now tied to modal subordination contexts?

Kasper's accommodation–of–preconditions–analysis predicts that in (115a) the implicit restriction argument of the second sentence cannot be established simply by construing the subjunctive sentence as *relative to* the context set up by the first sentence, as indicated by (115b): The antecedent context does not state necessary preconditions for the truth of the nuclear scope of the putatively subordinated conditional. So, while the (implicitly restricted) sentence may well be interpreted as *relative to* the context conveyed by the first sentence – the fact is that Peter would have passed the exam that John failed! –, *accommodation* of the necessary preconditions for the truth of the subjunctive sentence must occur, as in (115c).

By contrast, in (116) the first sentence states the necessary preconditions for John to fail the test. In principle, then, it provides an appropriate antecedent context to establish the implicit restriction argument, or modal base, for the subsequent subjunctive sentence. Still, the sequence is odd. In this case the oddity is due to the pragmatic restrictions on sentence mood. Subjunctive modals carry a strong presupposition that they are to be assigned a counterfactual reading, such that the quantification must range over worlds that lie outside the "context set".[83]

(115) a. John failed the exam. Peter would have passed.

b. John failed the exam. # *If John had failed the exam,* Peter would have passed.

c. John failed the exam. *If Peter had undergone the exam,* Peter would have passed.

(116) a. John presented himself for the driving test. #? He would have failed.

b. John presented himself for the driving test #? *If John had presented himself for the driving test,* he would have failed.

[83]Note that (i) is in accordance with this explanation. Here the postposed conditional clause explicitly states (additional) conditions that may constrain the quantification to range over counterfactual worlds.

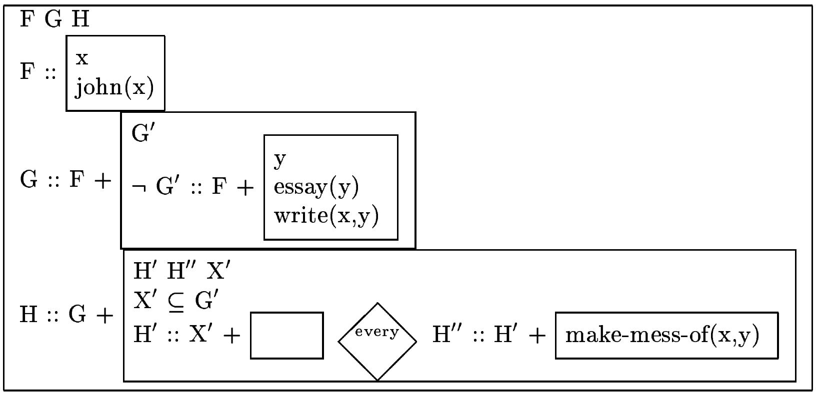
(i) John presented himself for the test. He would have failed if he had not slept enough.

The picture is different for negated antecedent contexts. Here the implicit restriction of a subsequent "simple subjunctive" can be induced by way of modal subordination.

In (117a), which parallels example (117b) discussed by, but not successfully accounted for in Geurts(1995), this is indicated by the pronominal *it* being interpreted as anaphoric to *an essay.* As we have shown in Section 3.4, the modal base for the subjunctive modal can be represented as being anaphoric to the context referent G' that annotates the negated update condition within the factual antecedent context. And – as predicted by Kasper's theory – since writing an essay qualifies as a necessary precondition for making a mess of it, anaphoric reference of X' to G' establishes an appropriate restriction for the "simple subjunctive" sentence in (117a). In these cases, context reduction will of course be vacuous, since the antecedent context G' does not induce any inconsistency. Moreover, this time the analysis is compatible with the pragmatic constraints on sentence mood: the subjunctive modal quantifies over worlds that reach outside the context set (in our terminology: none of the states quantified over contains a world parameter that is identical to the world of evaluation).

This explanation for (117a) carries over to (117b): buying a microwave oven results in having it, so the preconditions for the truth of (the scope argument of) the second sentence are in fact provided by anaphoric reference to the context referent that represents the negated antecedent context.

(117) a. John didn't write an essay. He would have made a mess of it.



b. Peter didn't buy a microwave oven. He wouldn't know what to do with it.

So we find that our analysis of modally subordinated "simple", or non–restricted subjunctive sentences in contexts like (117), as involving modal subordination relative to the negated factual antecedent context is compatible with the general analysis of simple subjunctives given in Kasper(1992). While in the more general cases, as e.g. (115a), the implicit restriction argument to provide the "necessary preconditions for the truth of the consequent" must be induced by way of *accommodation*, in contexts like (117), where such conditions are explicitly stated by the negated antecedent context, this (implicit) restriction can be induced by way of modal subordination.

Before we turn to modal subordination with counterfactual conditionals we want to examine some examples brought up by Corblin(1994a,Corblinb), to substantiate this analysis.

Corblin gives an analysis of modal subordination by resorting to a notion of *relativization*, which is roughly equivalent to accommodation in Roberts' account, and which is guided by pragmatic constraints, such as discourse relations, or discourse coherence.

Subjunctive mood is characterized as "le mode du cas contraire" (the mood of 'the other case'), to account for examples such as (118a–b).[84] *Relativization au cas contraire* is obtained by accommodation of the negation of the antecedent phrase into the (empty) restrictor of the subordinated subjunctive sentence.

(118) a. Jean n'a pas de voiture. Je l'aurais vue. Corblin(1994b:13)
'John doesn't own a car. I would have seen it.'

b. Jean a reçu la lettre. Il m'aurait prévenu (*sinon*). Corblin(1994b:12)
'John got the letter. He would have told me (*if not*).'

For the cases of type (118a) this analysis is more or less equivalent to our account – pending, of course, the crucial difference between an accommodation vs. an anaphoric account of modal subordination –, where in our framework the negation of the first (negated) sentence can be accessed in terms of anaphoric reference to the context referent that annotates the negated subDRS. For (118b), however, the predictions are different. Corblin's modal subordination analysis allows for accommodation of the negation $\neg$ P_1 of the antecedent sentence into the restrictive clause of the subordinated modal sentence, while this is not possible on our analysis. As noticed above, the context referent that represents the preceding factual context cannot be chosen as an antecedent for the anaphoric modal base, given that the sentence is subjunctive. The pragmatic constraints on sentence mood require the quantification to range over a set of counterfactual states, i.e. states that are not tied to the world of evaluation. Given that the antecedent context is factual, this constraint will be violated on a subordinated reading of (118b).

The contrast is illustrated by (119a–b) below, again borrowed from Corblin(1994a:16).[85]

(119) a. Mary didn't give the name of the witness.
(*If she had done so/ Otherwise*) They would have killed him.

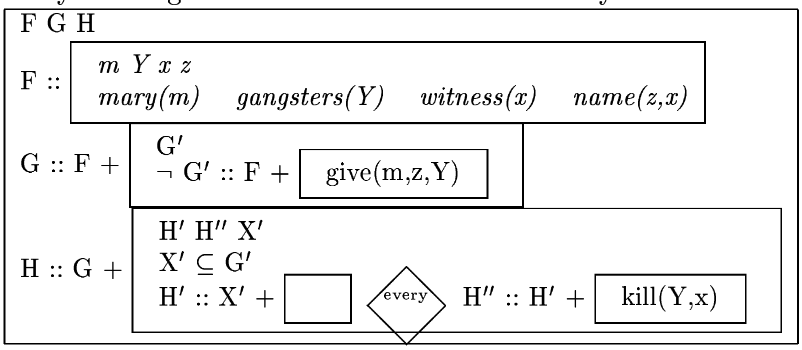
b. Mary gave the name of the witness.
(*If she hadn't done so/ Otherwise*) They would have killed her.

In (120) anaphoric reference to G' is possible for a counterfactual interpretation of the second sentence since negation qualifies the annotating context referent as non–factual, thereby satisfying the constraints on sentence mood. And – by the way – this analysis suggests that giving the witness' name to the gangsters qualifies as a necessary precondition for him to be killed by them.

[84] As will be discussed momentarily, we do not share the intuition that (118a–b) are equally wellformed. While (118a) is fine without additional material, such as *dans le cas contraire/sinon* (otherwise), (118b) is considerably harder to get without *sinon*.

[85] Again, we feel a clear difference of 'markedness' between these examples.

(120) Mary didn't give the name of the witness. They would have killed him.



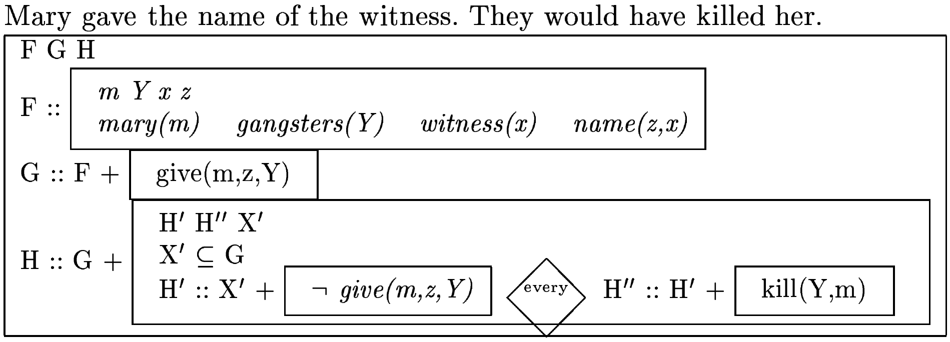
In (121), by contrast, the modal base of the "simple" subjunctive sentence can only be chosen as a *reduced* context $X' \subseteq G$. And of course this reduction might be such that the information stated by the first sentence is "undone", such that X' comes down to the background context F. But this choice is confronted with two problems:

(i) The world parameters of the states in the denotation of H will *all* figure within states denoted by F, since H results from (subsequent) update of F. If the antecedent DRS is empty, as it should be if the bracketed material is omitted, this is necessarily at odds with our constraints on sentence mood: the modal quantification will range over a set of states $\langle w', h' \rangle$ (or $\langle w', f \rangle$), such that there is a state $\langle w, h' \rangle$ that is tied to the world of evaluation w.

(ii) The content conveyed by F – there being Mary, a witness with a certain name and a group of gangsters – does not by itself qualify as a necessary precondition for the gangsters to kill Mary. Such necessary conditions can only be supplied by additional *accommodation* of a condition ¬ *give(m,z,Y)* into the restrictor DRS of the subordinated modal sentence.[86] But not only will this require some world knowledge and inferencing, it will involve *accommodation* of material that is not by itself conveyed by the overt discourse in (121) (as opposed to the bracketed material in (119b)). In this respect, the representation (121) differs crucially from (120), where no additional material has to be accommodated.

Once the condition ¬ *give(m,z,Y)* is accommodated into the restrictor DRS, the quantification will be constrained to range over states that are not tied to the world(s) of evaluation, where Mary *did* give the name. This predicts that (121) is in fact acceptable on our analysis, yet under the proviso that it involves *accommodation* of appropriate conditions – which can be argued to account for our intuition that (121) is somewhat harder to process than (120).

(121) Mary gave the name of the witness. They would have killed her.



[86]A necessary precondition for Mary being killed by gangsters could well be that Mary is alive. But accommodation of this condition would not satisfy the pragmatic constraints for subjunctive mood.

One could object that we made use of *accommodation* of necessary preconditions also for the general cases of "simple subjunctives" without predicting these sentences to be in any way hard(er) to process. But note that it is quite difficult to make sense of such non–restricted subjunctive sentences if the linguistic or nonlinguistic context does not provide for appropriate material to be accommodated. Cases in point are (122a–b).

(122) a. Peter would get a letter.

b. Peter would have passed.

So our prediction is that in cases where the content of the simple subjunctive sentence by itself, or else the linguistic context does not immediately suggest appropriate conditions for accommodation, sequences of the type (121) are considerably harder to interpret than those of type (120). According to our intuition the contrast in (123) supports this view.

(123) a. John didn't get a letter. He would have told me.

b. John got a letter. ?? He would have told me.

To conclude, our analysis does not exclude that examples of type (121) are processed, by making use of mechanisms other than modal subordination, such as *accommodation* of material salient in the discourse, or based on inferences and world knowledge. It rather predicts a difference between these types of examples as opposed to cases like (122) and (123b), where the material to be accommodated is not easily available.[87]

Modal subordination with (counterfactual) subjunctive conditionals

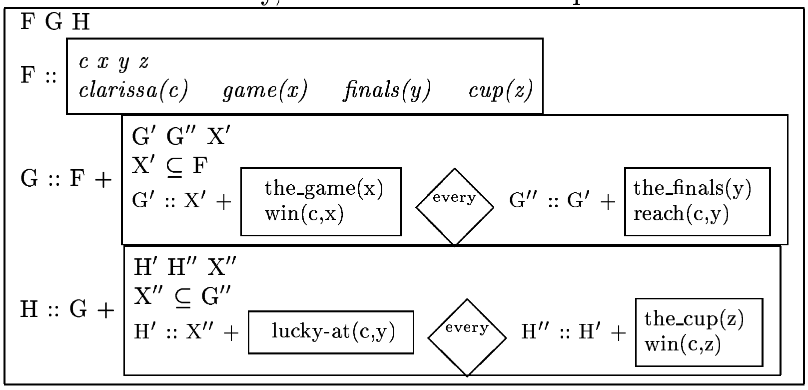
Given the close parallelism between indicative and subjunctive conditionals there is not much left to say here about modal subordination with *subjunctive* conditionals.

The only distinctive feature is the different way of establishing the anaphoric relation between the modal base X' and an appropriate antecedent context, where for subjunctive conditionals we use the relation of *context reduction* instead of an equation condition.

In (124) the first subjunctive conditional establishes a (preferably counterfactual) modal context where Clarissa has won the game in question and therefore reaches the finals. The interesting case is the modally subordinated subjunctive conditional, which is best understood as an extension of the non–factual context introduced by the preceding conditional. The construction principle stated in (105) characterizes the modal base X'' as a *reduction* of the antecedent context G''. In this case, since the antecedent of the second conditional does not *conflict* with the context established by the scope of the first conditional, reduction will be vacuous, exactly as in cases of modal subordination relative to negated contexts (see (120) above). Nevertheless the pragmatic constraint for *subjunctive mood* is satisfied.

[87]In Corblin's accommodation, or *relativization* analysis this difference can only be accounted for by positing differences as regards the type or availability of rhetorical relations to constrain relativization (although he does not posit such differences for the contrastive pair (119)). But in our view it is just the availability of a (regular) modal subordination analysis in the (a) example that helps to *establish* a rhetorical relation (of *explanation*), while Corblin's account presupposes some such rhetorical relation to be given in order to guide, or constrain the accommodation mechanism.

(124) If Clarissa had won the game, she would have reached the finals.
If she had been lucky, she'd have won the cup.



What about examples where the antecedent of the second subjunctive conditional is conflicting with the scope argument of the preceding (subjunctive) conditional, as in (125)?

(125) If Clarissa had won the game, she would have been happy.
If she hadn't (been happy), I'd have been rather surprised.

This type of example is a challenge for an analysis of modal subordination in terms of anaphoric reference if the accessibility restrictions for anaphoric binding are *only* defined in *semantic* terms (see Section 3.3 where we gave a syntactic and a semantic definition). Due to the VP–anaphor (ellipsis), the second sentence must be understood as subordinated to the scope of the first conditional, annotated by, say, G''. Clearly the antecedent DRS of the subordinated subjunctive conditional is not compatible with G'', so the modal base X'' must be assumed to result from non–vacuous *context reduction* of G'', which will "retract" the condition and the state referent that represent that Clarissa is happy. However, this referent and condition must be defined by states within the denotation of X'' in order to allow for anaphoric binding of the VP–anaphor in the restrictor argument of the subordinated modal. So if accessibility is defined in terms of *semantic* as opposed to *syntactic* notions, the analysis does not allow for a modal subordination reading of (125).

But closer inspection of the parallel example (126a), involving an individual type anaphor *it*, brings out that such sequences are not as good as one might expect. Again this differs for *one*–anaphora in (126b), which must be assumed to anaphorically refer to a discourse entity of type property ($\lambda x.new\_racket(x)$).

Finally, the same contrast can be observed in non–modal examples involving negation (127). Since we do not want material from within the scope of negation to be accessible from a non–subordinated sentence (127a), we choose to set apart accessibility constraints for individual–type vs. property–type and VP–anaphora. If we constrain anaphoric binding to be subject to only the semantic or else both the semantic and the syntactic notion of accessibility, our analysis allows for anaphoric binding only of individual–type anaphors.

(126) If Clarissa had won the game, she'd have bought a new racket.
a. # If she hadn't bought it, I'd have been rather surprised.
b. If she hadn't bought one, I'd have been rather surprised.

(127) Clarissa didn't buy a new racket. a. # She doesn't need it.
b. She doesn't need one.

4.3.5 Summary of Chapter 4

In this Chapter we have developed a DRT analysis for various types of modal constructions – *if*–conditionals and non–restricted modal sentences – which accounts for their inherent context dependent nature. We started out from Kratzer's analysis of *relative modality*, which was extended to account for a special instance of *relative modality*, modal subordination, to give a *uniform* analysis of "generalized" context dependence in modal constructions.

In this respect the analysis differs from Roberts' (and to some extent Geurts') account, where relative modality and modal subordination are accounted for by distinct formal concepts (see Section 2.3.2). Also, we have argued that both Roberts' and Geurts' reconstructions of Kratzer's theory of *relative modality* within the framework of DRT fall short of the main ingredients of Kratzer's insights in that they do not represent, at the level of the DRS, the modal base and/or ordering source for the various types of modal constructions.

So one of the objectives of the present Chapter was to develop a "unified" analysis of modal constructions in DRT which captures both relative modality and modal subordination, while making use of genuinely DR–theoretic concepts.

Besides this overall objective, we believe to have provided an improved analysis of *if*–conditionals which host non–epistemic modal verbs such as *must*, *may*, *be allowed*, etc. Not only did we reject Kratzer's and Lewis' view, which holds that the *if*–clause acts as a restrictor of a *single* deontic (or other non–epistemic) operator, and instead represented conditional deontic sentences throughout as involving an embedded deontic quantification. We also rejected Kratzer's analysis of non–epistemic modality in terms of "graded modality". We have shown that it is not necessary to treat non–epistemic modality in terms of an ordering source, which imposes a partial order on the worlds to make up the modal base. By contrast, the discussion of the notorious deadlock–examples, "Practical Inference", brought out that an analysis in terms of graded modality leads to counterintuitive results.

Neither do we need this concept to account for truly graded modal quantifiers like *probably, unlikely*, etc., given that our analysis makes use of generalized quantification, which is easily adapted to these graded modal (ad)verbs, by enrichment with probabilistic notions.

We have considered various constructions involving graded modality and negation in modal subordination contexts, where we established some pragmatic constraints on sentence mood in modal constructions.

Thus, instead of resorting to the notion of an ordering source for *both* truly "graded" modality and modal constructions involving inconsistent modal bases, our analysis clearly distinguishes between these different phenomena: graded modals are captured in terms of generalized quantification, while inconsistencies arising in counterfactual and non–epistemic modal constructions are accounted for in terms of a relation of *context reduction*.

As our discussion of "Practical Inference" brought out, in the case of non–epistemic modality a minimality constraint on context reduction is mistaken. We have also argued, in passing, that a minimality constraint is too strong for counterfactual modality. However, we didn't yet provide any other criterion to determine, or constrain the operation of context reduction, unless leaving it to pragmatics to determine some *relevant* reduced context to allow for consistent update with conflicting information.

The aim of the following Chapter is to try to get at a better understanding of this, as well as related problems, in particular the aspects of *conditional vagueness* and *variability*.

5 Vagueness and variability of subjunctive and indicative conditionals

5.1 Vagueness of non–restricted and conditional modality

5.1.1 Vagueness vs. variability of non–restricted and conditional modality

To recapitulate, any theory of conditionals must account for what Lewis called the "vagueness" of counterfactuals:[1] we consider (1) as true, although there are quite eccentric, yet epistemically accessible worlds where kangaroos losing their tail walk around on crutches, or else immediately develop longer front paws for balance, so that they don't fall over. In Lewis'(1973) analysis the selection of the set of possible worlds to constitute the quantificational domain for the conditional is determined by the criterion of (maximal) "overall similarity": only those worlds that are maximally similar to the actual world are considered when evaluating the truth of the conditional. As discussed in Section 2.2.2 his analysis is still more involved, by evaluation of counterfactuals relative to a *system* of spheres of comparative similarity, to account for what he calls *counterfactual variability*, illustrated in (2): the problem is known as the nonmonotonicity property of conditionals: while for strict implication it holds that if $\phi \Rightarrow \psi$ is true, then so is $\phi \wedge \chi \Rightarrow \psi$, for any χ consistent with ϕ, monotonicity does not hold for conditional sentences in natural language. This is most obvious in the famous example *If there is sugar in my coffee, it will taste good. If there is sugar and diesel–oil in my coffee, it will not taste good.* – and this is also the underlying structure of (2), where the antecedent of the second conditional – by modal subordination – is to be read as *If kangaroos had no tails but could walk around on crutches.*

(1) If kangaroos had no tails, they would topple over.

(2) If kangaroos had no tails, they would topple over.
But if they could walk around on crutches, they would not.

We have chosen example (2) to make plain the close relationship between the two phenomena of vagueness and variability, which in our view are not just related, but essentially just two sides of the same coin, viz. two manifestations of the same underlying characteristic: while we recognize the nonmonotonicity of the conditional (1) once we imagine, or take into account some more eccentric epistemic alternatives, these considerations are made fully explicit in a succession of more and more strict conditionals, as in (2). And in fact, Lewis captured this intuition, that vagueness and variability are essentially based upon a unique underlying property, by evaluation of counterfactuals within a single *system* of spheres of "overall similarity", to be structured in such a way as to make true counterfactuals of varying degrees of strictness.

Yet, these two sides of a coin are different, even if sides of one and the same coin.

[1] Lewis was only concerned with counterfactuals, but of course the phenomenon carries over to indicative and non–counterfactual subjunctive conditionals. See Section 2.2.2.

In Section 2.2.2 we have provided arguments to show that a sphere system is not appropriate to account for sequences of variably strict conditionals. If we can truthfully assert (3), this does not enable us to continue the sequence by asserting (or concluding) that *if Otto comes, it will be a lively party.* This is not explained by Lewis' analysis.

(3) If Otto comes, it will be a lively party;
but if both Otto and Anna come, it will be a dreary party;
but if Waldo comes as well, the party will be lively.

Moreover, we have argued that examples such as (4a), brought up to manifest the non–transitivity of conditionals – which is just another property that follows from their non-monotonicity –, do not go through in most cases: As discussed, according to our intuition, nothing is wrong about concluding, from the premises in (4a), that *if Otto had gone, then Waldo would have gone.* No one whose information state is limited to the premises in (4a) will do otherwise. Only on the basis of very specific contextual assumptions, viz. that Waldo tends to avoid Anna if Otto is around, this reasoning does not go through. But this is only to be expected. Since if we adopt this information as an additional premise, as we did in (4b), we cannot maintain the conditional *If Anna had gone, Waldo would have gone* as a true premise, and therefore the conclusion that *if Otto had gone, then Waldo would have gone* in fact cannot be derived.

So first of all, it is misleading to hold, as Lewis does, that (4a) is invalid. Rather – this is the central point of the nonmonotonic perspective – (4a) should be regarded as valid *relative to the context established by the premises.* Secondly, Lewis' fallacy–argument, viz. that transitivity doesn't hold for (4a), is not a case in point: it doesn't correspond to the particular context he evokes in order to show that the conclusion cannot be drawn: once the premises are adjusted, as in (4b), to correctly represent the specific contextual background assumptions that make the conclusion fail, the conclusion cannot, in fact, be drawn.

(4) a. If Otto had gone to the party, then Anna would have gone.
If Anna had gone, then Waldo would have gone.
$\vdash$ If Otto had gone, then Waldo would have gone. Lewis(1973:32)

b. If Anna goes out with Otto, Waldo avoids her.
If Otto had gone to the party, then Anna would have gone.
If Anna had gone, but not Otto, then Waldo would have gone.
$\nvdash$ If Otto had gone, then Waldo would have gone.

So it seems that the two sides of the coin that is the vague conditional – and which in Lewis' analysis are captured *uniformly* by use of a sphere system – differ with regard to *contextual dynamics.* While a single conditional such as (1) can be interpreted without particular contextual assumptions, or else relative to some salient contextual background context, examples such as (3) and (4) constitute, on their own, a *dynamically changing* context. By assertion of the first conditional in (4b) the context is changed, and *If Anna had gone, then Waldo would have gone* is no longer true *relative to the new, dynamically extended context.* It is this aspect of contextual dynamics that cannot be captured appropriately if conditionals are interpreted relative to a *system of spheres*, which can be understood to correspond to a *set*, or *family* of accessibility functions, each one appropriate for a particular contextual background setting, but – misleadingly – available throughout for any conditional in any context.

So we conclude that we are better off if *any* conditional – be it a single conditional in a "null" context, or any single conditional in a sequence of conditionals – is interpreted relative to a *local* context: some presupposed more or less "null" context in the first case, or the context updated by evaluation of a (sequence of) preceding conditional(s) in the second case. The selection of the set of possible worlds to quantify over must then be governed by an accessibility function that is determined by the *local* context.

The aim of the following Sections is to provide an analysis of conditional vagueness and variability that is based upon the semantics and logical form of conditionals and non–restricted modals that we developed in the previous Sections, and which implements this particular view of their *local* contextual dependence.

To this end we must investigate the notion of *conditional vagueness*, which we argued is not a matter of "similarity", but tied to the notion of *normalcy* together with further kinds of constraints to determine the choice of a (possibly) *reduced* antecedent context for modal quantification: besides the pragmatic criterion of *relevance* we will investigate the semantic notion of *historical necessity.*

Based on such a conception of what is the "coin" – viz. the vague conditional, to be analyzed in terms of *relativization* to a set of accessible *normal* worlds –, in conjunction with a *dynamic view* of context dependence the two related, but different sides of it, discussed by way of (1) and (2)–(4), should fall out naturally.

Before we turn, in Section 5.1.2, to a more elaborate discussion of what are the underlying features of (conditional) vagueness, we want to raise the issue of the vagueness of non–restricted modals. We will defend the claim – implicit in our analysis – that vagueness is not restricted to indicative and subjunctive conditionals, but is an equally pervasive characteristic of epistemically based non–restricted modals. Yet, it will turn out that there is a principled difference between conditional and non–restricted modality, which is the dynamic aspect of "variability". This difference is predicted by the view of (conditional) vagueness and variability that we sketched above.

Vagueness and non–variability of non–restricted modals

Our claim is that not only conditionals, but also non–restricted modal sentences – of varying modal forces and both in indicative and subjunctive mood, as illustrated in (5) – are essentially vague. Whether the same claim can be made for non–epistemic modals of the type we have considered in Sections 4.1.2 to 4.1.5 is a more intricate question, so we will first deal with the simpler cases in (5) and finally come to discuss the examples in (6).

(5) a. Clarissa will (certainly/necessarily) win the race.

b. John must have/certainly has landed by now.

c. A thief might/could break in.

d. John (certainly) would have passed the exam.

(6) a. John must take piano lessons every week.

b. You must leave now.

c. You may leave now.

At first sight it is not so evident that e.g. (5a), if uttered sincerely and on the basis of the speaker's beliefs and evidence, should be vague. Yet, we can see by way of (7) that it is perfectly possible, in a single context and on the basis of an unchanged belief context, to consider a possible situation – consistent with the speaker's beliefs, but *not taken into account* when uttering the first sentence – that makes the conclusion fail.

(7) Clarissa will certainly win the race.
But/Only *if John happens to be one of the competitors*, she will not.

Here we observe the same pattern that we found, for conditionals, to be grounded on vagueness: if the set of epistemically accessible worlds is constrained by additional, context dependent criteria such as relevance and normality (or similarity), it is possible that relative to a dynamically extended context the (context dependent) criteria of relevance, etc. determine a selection of accessible worlds, for evaluation of the subsequent, modally subordinated sentence, that supports the negation of the previous sentence's scope argument.

That this principle applies to non–restricted modals may also be illustrated by an example involving two speakers, Peter and Fred, who have identical beliefs about the relevant situation, say the condition of Clarissa's horse, the difficulty of the course, etc., while both are only partially, but identically informed about the other competitors. Yet, they may very well differ in opinion about the truth of (5a). And the reason may be that e.g. Peter, when uttering the sentence in (8), does *not* take into account the possibility that John, Clarissa's strongest rival, will show up, while Fred, being a more sceptical person, reckons with such a possibility, and so objects to Peter's claim:

(8) Peter: Clarissa will win the race.
Fred: Well, she might not. If John participates, she'll have a hard time.

Yet, there is a principled difference between conditional and non–restricted modality: while in both cases the selection of the "normal" worlds to constitute the quantificational domain may vary with context, the *way* in which the context determines this variation is radically different. This is obvious from the way we set up our examples (7) and (8).

In (7) the quantificational domain of the non–restricted modal must be assumed to be pragmatically determined. A *change* of this quantificational domain can only come about, in the second sentence, by use of a subsequent *restricted*, conditional sentence. Its antecedent imposes additional constraints upon the set of worlds that are to constitute the modal's domain argument. If these conditions have not been taken into account for evaluation of the first sentence – it is reasonable to assume that they haven't, since otherwise there would be no point in uttering the second sentence anyway –, this additional condition may induce some critical *change* in the determination of the quantificational domain, which may lead to a change in the truth of the consequent.

With non–restricted modals similar changes to the underlying modal base can only arise if, as in (9), the pragmatic context strongly supports the assumption that either the speaker is still weighing eventualities, and makes up his mind about the evidence (i.e. the quantificational domain) to support his claim, or else gains further, conflicting evidence, as e.g. by just observing that Clarissa's horse is falling behind. Another source for variability with non–restricted modals is a set–up as in (8), where we can safely assume that two different speakers, even if they happen to have identical beliefs, may be guided by different criteria for selection of the quantificational domain to support their respective claims.

(9) Clarissa will certainly win the race.
Hmm, ... well, she also might not.

Thus, as the additional examples in (10)–(12) should illustrate, we can safely assume non–restricted modal sentences to be vague – i.e. subject to a normalcy restriction – in general, as are restricted, conditional sentences, but must conclude that they do not easily allow for variability. Changes in the underlying quantificational domains are most naturally induced by *restricted, conditionalized* modal sentences. This will be accounted for by our analysis of conditional variability.

(10) John certainly has landed by now.
But/Only *if there's fog and the plane is somewhere in the queue*, we'll have to wait some more time.

(11) A thief could break in.
But *if the dog is in the garden*, no thief will take the risk.

(12) John certainly would have passed the exam.
But/Only *if he hadn't slept enough the night before*, he would have failed.

Up to now we have only considered non–restricted modals that could be interpreted as being based upon an epistemic or factual backgound context. What about the cases in (6), which are intended to be read as depending on a deontic context?

As for (6a), an extended context such as (13) could be taken to indicate that deontic modal quantification can come with varying degrees of strictness. But on closer inspection it seems that in the second sentence it is not the *deontic* context that is subject to variability, but rather the *epistemic background* that jointly with the deontic context constitutes the complex modal base for the deontic modal: the quantifier *every week* in the first sentence must, in retrospect, be assumed to be restricted to the "prototypical", or "normal" weeks, weeks that are not vacation–weeks, while the second sentence focusses on those exceptional cases about which the underlying "law" must be assumed to be precise: the law is that on those occations John is "freed" from this burden. It will turn out that this is predicted by our analysis of deontic modality, which allows for *conditional* obligation. Since on our analysis the deontic operator is embedded within the epistemically based *if*–conditional, and relativized to the hypothetical epistemic context introduced by the conditional antecedent – in conjunction with the *unchanged* (conditionalized) deontic context – this combined context will in fact license the existential deontic quantification in (13).[2]

[2]See Section 4.1.3 for normalcy restriction in deontic modal quantification.

(13) John must take piano lessons every week.
But if he's on vacation, he may drop his lesson.

On the other hand, while a sequence such as (14) is possible, it seems to us that it differs from (9) in that it necessitates a *revision* of the underlying deontic context, while in (9) – on the reading that does not presuppose new information to have changed the underlying belief context – the qualification was possible in terms of the selection of a different subset of worlds from the *unchanged* belief context. A corresponding interpretation of (14), with the deontic context kept constant, does not seem to be possible.

(14) You must leave.
Hmm, ... well, you may stay.

So we take it that – while the following examples at first sight seem to suggest that non–epistemic modals are subject to vagueness in the same way as epistemically based modals – the epistemic and non–epistemic cases must be clearly distinguished. The deontic modal bases in (15)–(16) are clear–cut: e.g. in a hotel it is the law that you may only stay if there is a room free. So the first sentence, if implicitly constrained to the most obvious epistemic alternatives where the future is such that all rooms are and remain taken, if follows that you must leave, while if taking into account some more improbable epistemically accessible worlds where by good luck some room gets free, *based on the same rule*, you then may stay.

(15) You must leave tomorrow.
But/Only if I can find you another room, you may stay another week.

Similar observations apply to the qualification in (16a): assume the underlying deontic rule to be such that in order for you to be able to work efficiently, every source of disturbance must be eliminated. Given a situation where your brother is noisy, you may, after having asserted the first sentence on the basis of the given facts and the consideration of only those probable epistemic alternatives where he goes on being noisy, sincerely continue with (16a), thereby invoking the very same deontic rule, but now with relativization to those more improbable epistemic possibilites where your brother turns quiet, such that you'll be able to work.

In our view, (16b) is different in this respect: here it seems that the deontic rule is *weakened*, i.e. we must in fact assume a *revision* of the underlying deontic context, where the speaker resigns to work under less–than–ideal conditions, and so modifies the deontic rules. Still we believe that this is different from the typical pattern we observed for variability in epistemic modal contexts. While (7) and (9) can be interpreted as being based upon an *unchanged* belief context, yet by selection of different subsets of epistemically accessible worlds consistent with this unchanged belief context, (16b) patterns with (14), where we are forced to presuppose a *change* in the underlying deontic context.

(16) You must leave now.
a. But/Only if you keep quiet, you may stay.
b. But if you ask nicely, you may stay.

In sum, these observations are in accordance with the particular representation we assigned to deontic modal constructions in Section 4.1. Having characterized deontic modals as (i) being dependent upon a *complex* modal base, consisting of an epistemic and a deontic background context, and (ii) as possibly involving *conditional* structures within the deontic background context, we will be able to account for the apparent variability observed in (13), (15) and (16a), in terms of the normalcy restriction for the selection of epistemically accessible worlds, without having to admit "variability" in the selection of deontically accessible worlds, which is in conflict with (14) and (16b).

Once we have spelled out, in detail, how we will account for (epistemically based) vagueness and variability in our DRT framework, we will return to the analysis of these cases of *apparent* vagueness and variability with non–epistemic modality.

5.1.2 Vagueness of non–restricted and conditional epistemic modality

Having argued that conditional variability is essentially based upon the inherent vagueness of conditionals, yet going along with the additional "side effect" of a dynamically changing context, we will, in this Section, first examine the *vagueness* of conditionals and (epistemic) non–restricted modals, and reflect upon *variability* once we have clarified what is, on our view, the notion that best characterizes the underlying property of the vagueness, or nonmonotonicity of conditional and non–restricted epistemic modality.

A matter of (maximal) similarity?

At various points we have questioned the appropriateness of reducing the vagueness of conditionals to the concept of "overall similarity". Here we just take up some of the arguments raised in Sections 2.2.2 and 4.3.1.

Example (15), repeated as (17), is illustrative in this respect:

(17) If Otto comes, it will be a lively party;
but if both Otto and Anna come, it will be a dreary party;
but if Waldo comes as well, the party will be lively.

If we interpret each one of the conditionals relative to the *local* context induced by the preceding conditional(s), it is more than obvious that an accessibility relation that is based on the notion of *similarity* cannot be appropriate: on Lewis' analysis, for the first sentence, uttered relative to a "null" context, the *most similar worlds* where Otto comes to the party will be determined as those where Otto is coming, but not Anna and Waldo. For interpretation of the second conditional we have to choose a different set of *maximally similar worlds* where Otto and Anna will come, but not Waldo. In which ways might these latter worlds be *less similar* to the actual world than the former? In our view, there is no conceivable reason for assuming *differences in similarity* between these two sets of possible worlds. Rather, they cannot but be grounded on *differences in salience*, or *relevance* of the corresponding possible situations, together with an expectation as to what is *the normal course of events* in each of these (specifically relevant, or) salient situations. Let us briefly illustrate this contention by going through the example.

The example is best understood as a continuous reflection upon what the party could be like, depending on which people will show up. The situations contemplated, introduced by the antecedent clauses, can be considered as being dependent on what in the particular (local) context is a *salient*, or *relevant* situation: Perhaps the speaker is *expecting* Otto to come, and continuously reflects upon the possible appearances of additional people, which might be *relevant* for judging the success of a party where Otto shows up.

Thus, if the first conditional is truly asserted in such a context, it is naturally interpreted as involving a notion of *normality*: If Otto comes, *and the course of events will develop as one expects it to develop normally in such a situation*, (given what we know about Otto and his habits), the party will be lively: Otto is a nice person, and people tend to like him. The second conditional, if truly asserted relative to this local context, now considers (relevant) situations where Otto and Anna join the party, and where the situation does *not* evolve as it normally does when Otto shows up: what the conditional states is that *in the normal course of events where Otto and Anna meet on a party*, there'll be some trouble. Maybe Anna doesn't like Otto, and will start a quarrel. As a kind of afterthought, we must conclude that the appearance of Anna at the party hasn't been reckoned with when evaluating the first conditional – this is also supported by the use of *but*: maybe it is rather unlikely that Anna will join the party, or maybe we were just taking into account possible situations where people behave in the manner expected at parties – communicative and peaceful –, while Anna normally does not fit this pattern. Finally, the third conditional, contextually dependent on the first and second conditional, must be interpreted as stating that in all possible situations where Otto, Anna *and Waldo* come, *if things develop as is normal in such a situation*, the party will be lively: maybe normal situations of *this* type are such that Waldo is talking to Anna most of the time, such that no conflict is likely to arise between Otto and Anna. And again we must conclude that this additional factor of Waldo entering the game hasn't been reckoned with when asserting the second conditional.

The above – highly informal – characterization of what goes on in such sequences of variably strict conditionals seems to corroborate that it is quite odd to distinguish, on the basis of the notion of *similarity* of possible worlds, between situations where Otto and Anna show up, but not Waldo as being more *similar* to the actual world than those where all three of them join the party. Instead, we argue that the selection of these different antecedents is grounded on notions such as *relevance*, or *salience*, and take the evaluation of these conditionals to be further restricted to situations that evolve according to *what is considered to correspond to the normal course of events in such situations*.[3]

Recall also the various arguments brought up against Lewis' conception of "overall similarity" of worlds, refined in Lewis(1979) to account for the vagueness of conditionals such as (18), where the "most similar" worlds that verify the counterfactual's consequent, on any intuitive understanding of the term *similarity of worlds*, must in fact be understood to be much more *dissimilar* from the actual world (where no nuclear holocaust occurred) than those more *far–fetched* worlds, where e.g. a miracle takes place that undoes any effect caused by the nuclear weapons.

(18) If Nixon had pressed the button, there would have been a nuclear holocaust.

[3]In Section 5.2 we will see that grounding the evaluation of conditionals on concepts such as *salience*, or *relevance* of possible situations, in conjunction with the concept of a *normal course of events* associated with particular types of situations, allows for a more natural interpretation of *variably strict* conditionals.

Some of these objections are discussed by Nute(1986). Example (19) was brought up in order to demonstrate that the particular conditions that Lewis(1979) imposed upon the criterion of "overall similarity", in particular that it is of high importance "to maximize the spatio–temporal region throughout which perfect match of particular facts prevails" (Lewis(1979:472)), is not suited to account for the natural interpretation of many counterfactuals in ordinary discourse. If the evaluation of the conditional is restricted to those worlds that maximize spatio–temporal overlap with the actual world, the truth of (19) implicates that the coat would have been taken today, rather than yesterday – contrary to anybody's experience that "unguarded objects tend to disappear earlier rather than later." (Nute(1986:421)). Again, the example supports an alternative analysis that restricts the quantificational domain not to (maximally) *similar* worlds, but to worlds where – along with the antecedent clause – everything holds *which corresponds to the normal course of events* in the type of situation described by the antecedent clause.

(19) I had left my coat in the bar yesterday, it would have been taken. Nute(1986:421)

Example (20) is also a problematic case for the (maximal) similarity approach: if – as is natural – the worlds where the grass has grown only a little higher than it actually is are considered to be *more similar* to the actual world than those where it has grown very much higher, such that a normal mower will not manage to cut it, (20) should invariably be considered true. Now, take it to be uttered by a person that is known to dislike working in the garden, who tends to put off this burden from week to week, and who finds himself very often in this miserable situation where the grass has grown much too high to be cut by his little mower. In such a situation we will most likely object: *No. If the grass were higher, the mower wouldn't cut it. It would have grown too much.* That is, although the same criteria of comparative similarity must be assumed to hold as to the height of the grass, we do not, in such a context, evaluate the conditional relative to the set of worlds where the grass is minimally higher than it actually is, but relative to a *contextually salient* set of worlds, which involve often experienced situations where the grass has grown much too high, and where it is then *normally* the case that the mower will not manage to cut it.

(20) If the grass were higher, the mower would cut it. Nute(1986:407)

Another type of example where the selection of the quantificational domain and, with it, the truth of a conditional is heavily dependent upon the particular contextual setting is (21a–b). Here both counterfactuals are introduced by the same antecedent clause, while their consequents are incompatible. The reason is that the set of worlds quantified over is different for these two counterfactuals, and this difference is highly dependent upon the particular contextual background involved: If you are interested in investigating which kind of (modern) weapons *a general as cruel and ingenious as Caesar* would have used if he had been involved in the Vietnam war, you will consider worlds where Caesar is placed within the recent past and has knowledge about modern weapons, and certainly evaluate (21a) as being true, while if you are investigating which kind of weapons Caesar, *as a general of the ancient world*, would have used if placed within the time of the Vietnam war, you will take into account only those possible worlds where he has knowledge only of ancient weapons, such that (21b) will come out true. Again it is questionable whether a notion of "overall similarity" is appropriate to account for such highly pragmatic conditions that determine the selection of the set of accessible worlds. It seems more promising to resort to a notion of contextually determined *salience* or *relevance* of particular contexts, or sets of worlds, to constitute the conditional's quantificational domain, a notion that easily admits for apparently contradictory examples such as (21).

(21) a. If Caesar had been in Vietnam, he would only have used nuclear weapons.

b. If Caesar had been in Vietnam, he would only have used catapults.

Besides these objections to the (maximal) similarity account for the analysis of conditional vagueness, there are also objections, raised by Morreau(1993), to Lewis' counterfactual analysis of cause in Lewis(1973b)). The analysis roughly is this: "in the case of particular events c and e which have occurred, [...] e "depends causally" on c just in case e would not have occurred had c not occurred. And an actual event c is a cause of an actual event e if there is a chain of actual events, each causally dependent on its predecessor, of which the first is c, and the last e." Morreau(1993:376).

The main problem is again the criterion of maximal similarity, which leads to counterintuitive results in certain cases of causation. Morreau brings up the example of a dinosaur, who stops to drink for a few minutes. During this time, it is hit by a meteorite and dies. Had it not stopped in order to drink, it would not have been hit by the meteorite. So the counterfactual analysis of causation predicts that the dinosaur's stopping to drink was a cause of its death. Another problem are "epiphenomena" of causes.[4] "An epiphenomenon occurs before the effect but is not its cause; instead, it is itself a second effect of a third event which is the cause." Since the counterfactual analysis is based on the criterion of maximal similarity, epiphenomena of a cause that has the effect e are invariably analyzed as causes for e.

Since we will not be concerned with the concept of causation, we will not go any further into this subject. Mention was made only for the sake of completeness.

An illustrative example of the maximal similarity approach

As an example of a theory of counterfactuals that is built upon Lewis' analysis we want to discuss in some detail the work of Ginsberg(1986), which is situated in the domain of Artificial Intelligence. The reason for discussing this theory is that this "reconstruction" of the Lewis approach within an implementational framework is quite explicit in trying to "sharpen" the criterion of similarity, and thus clearly shows that the notion of similarity has to be broken down into quite distinct criteria, which, in our view, are only remotely related to an intuitive notion of similarity.

Ginsberg focusses on the importance of counterfactual reasoning in the domains of planning and error diagnosis. Based on Lewis' analysis of counterfactuals he develops a "new,

[4]Hans Kamp observes that we may well consider the dinosaur's stopping to drink as *a* cause of its death, while not as *the* cause. Thus, given that Lewis's definition (see citation from Morreau) involves the notion of *a* cause, the objection seems to be pointless.

albeit equivalent, description of counterfactual implication in terms applicable to a simple predicate calculus style database" (Ginsberg(1986:77)), where his main interest is tied to "the database update problem—the determination of the validity of a given counterfactual given a conventional predicate calculus knowledge base." (Ginsberg(1986:37)). The subject of counterfactual, or nonmonotonic reasoning is only addressed as a minor issue.

We will not go into too much detail of this analysis and its implementation issues. Rather, we will review the various "measures of the similarity ... between possible descriptions of the world" that he formalizes in order to present "a sharper definition of [the notion of "similarity"]" (Ginsberg(1986:42)). Namely, three measures of (comparative) similarity of worlds – viz. between descriptions consisting of collections of facts which hold in the worlds compared – are distinguished: "These three measures now correspond loosely to the number of propositions whose truth values change between two such descriptions, to the extent to which the truth values change, and in some informal way to the importance of the propositions whose truth values are modified." (Ginsberg(1986:42)).

The first of these notions of similarity is syntactic: it implements the idea that any set of statements T that makes up the description of a possible world, and which results from a description S by removing some subset R of statements contained in S, will be more similar to S than any set of statements T' resulting from S by removing a subset of statements R', where R is a subset of R'. Briefly: T is more similar to S than T' iff more of the statements in S are preserved in T than there are in T'.

This notion is directly built into the notion of "most similar alternative worlds compatible with the counterfactual antecedent" in (22): it involves the computation of the maximally similar alternative descriptions $T \subseteq S$ that are consistent with the counterfactual premise p, and do not involve "gratuitous" changes to S. I.e. the subsets T should be maximal, while consistent with the counterfactual premise.

(22) $W(p, S) \equiv \{T \subseteq S \mid T \not\models \neg p \text{ and } T \subset U \subseteq S \Rightarrow U \models \neg p\}$ Ginsberg(1986:44)

Truth of a counterfactual is then defined by (23):

(23) $p > q$ is true in a world S iff for every $T \in W(p, S),\ T \cup \{p\} \models q$ Ginsberg(1986:44)

Ginsberg gives an example where the actual world S is described by the four facts and one implication in (24), namely you have a boat (b), but no oars ($\neg o$), you can row if you have both boat and oars ($b \wedge o \rightarrow r$), and you cannot row ($\neg r$) nor fly ($\neg f$). If only based on the syntactic notion of similarity underlying (22), $W(o, S)$ yields three maximal subsets T_1 – T_3, where, however, only T_3 verifies the counterfactual *if you had oars, you could row.*

(24) $S = \{b, \neg o, \neg r, \neg f, b \wedge o \rightarrow r\}$ Ginsberg(1986:44,45)
$W(o, S) = \{T_1, T_2, T_3\}$

a. $T_1 = \{b, \neg r, \neg f\}$

b. $T_2 = \{\neg r, \neg f, b \wedge o \rightarrow r\}$

c. $T_3 = \{b, \neg f, b \wedge o \rightarrow r\}$

While "syntactically similar", the descriptions T_1 and T_2 do not correspond to an intuitive notion of "similarity": T_1 is a minimal reduction of S where (along with $\neg o$) the implication $b \wedge o \rightarrow r$ is removed, which however should intuitively be assumed to hold true in the most "similar" alternative worlds; and T_2 results from S by removing the assumption b, that you have a boat, which corresponds to a world where in order to have oars, you destroy the boat. Again, this should not be considered as a "maximally similar world".

In order to implement a more refined notion of maximal similarity, a third[5] notion of similarity is defined, which is "context dependent". It determines the relative weight of alternative propositions that may be "dropped" in order to obtain consistency with the counterfactual premise. Such relative weight, or importance, cannot be determined independently of the specific domain, or context of the counterfactual statement.

E.g. in the above scenario it is natural to assume that dropping the assumption that we have a boat results in a world more exceptional or dissimilar from the actual world than the one we end up with if we drop the assumption that we cannot row. The reason for this assumption is essentially pragmatic: if e.g. we intend to cross a river by boat, we easily abandon the assumption that we cannot row. This is just what we must be able to do in order to cross the river. By contrast, we should not abandon having a boat in exchange for having oars, since this still leaves us unable to row, given the implication $b \wedge o \rightarrow r$ (which should in fact be a biconditional). Such relative weights, or preferences for (not) dropping particular assumptions are encoded in terms of a partial order induced on the subsets of S, and which is assumed to extend the partial order corresponding to set inclusion as defined by (22). Thus, in order to impose the preferences just discussed, this partial order is extended by the following constraint: $W - \{b\} < W - \{\neg r\}$.

Further, in order to exclude T_1 from $W(o, S)$ in (24), Ginsberg introduces a "badworld" predicate B, defined on the powerset of S, which is used to exclude the set of propositions it applies to from the extension of $W(p, S)$ (see (25)). Thus, by assuming $B(S - \{b \wedge o \rightarrow r\})$ for the scenario (24), and given the refined definition of a "*possible world for p in S*" in (25), $W(o, S)$ will only yield a single maximal subset of S, namely T_3 in (24c).

(25) $W(p, S) \equiv \{T \subseteq S \mid T \not\models \neg p, \neg B(T) \text{ and } T < U \subseteq S \Rightarrow U \models \neg p \text{ or } B(U)\}$
Ginsberg(1986:46)

It is evident that (i) the notion of "overall similarity" of the Lewis approach has been broken down into two inhomogeneous notions of similarity, one "syntactic", the other "domain-dependent", and (ii) use has been made of a special "badworld predicate", which by brute force "eliminates" unwarranted world descriptions from $W(p, S)$, instead of characterizing such world descriptions as rather "dissimilar" from the actual world in terms of the ordering relation $<$.

As for (i), it seems to us that the syntactic notion of "similarity" can alternatively be viewed as a constraint on "minimal reduction" to allow for consistent update with the counterfactual premise.[6] I.e. the maximality condition imposed by (22) could alternatively

[5]We will not discuss the second similarity notion, which is dependent upon a framework of multi–valued logic. But it should be noted that – despite appearance – this similarity measure is not, as far as I can see, intended to account for degrees of similarity such as e.g. minimal differences in height, as in the mower example: *If the grass were higher, the mower would cut it.*

[6]This is even suggested by the informal description of, or motivation for (22):

be characterized as a constraint on "minimal revision", or "maximal preservation" of the information described by S, without resorting to the concept of similarity.

As for the domain–dependent notion of similarity, it is certainly most appropriate to account for the context–dependent nature of the notion of similarity, even if, as hinted at in footnote 5, it does not capture aspects of similarity that rely upon different degrees along a certain scale (as e.g. length, weight, etc.). Yet, on closer inspection of example (24) it turns out that the use that is made of the domain–dependent similarity notion is not quite appropriate, and secondly, that what is genuinely to be understood to be tied to the notion of "similarity of worlds", is *not* captured in terms of either "syntactic", or "domain–dependent" similarity, but rather in terms of the special badworld predicate.

Let us first discuss the latter point. In order to exclude T_1 in (24) from the extension of $W(o,S)$, T_1 is defined as a "bad world" by the constraint $B(S - \{b \wedge o \rightarrow r\})$. In our view, rather than to resort to a special mechanism, the badworld predicate, it seems much more natural to conceive of this constraint as a genuine similarity criterion: a world where it does *not* hold that *if you have a boat and oars, you can row* cannot be considered as reasonably similar to our actual world, where this implication is recognized to hold true. Dropping this conditional fact either comes down to violation of fundamental laws holding in this world, or else it requires the assumption of special circumstances that prevent the implication from going through. Thus, in our view, the removal of such implicative conditions should be constrained to take us to rather "dissimilar" worlds in terms of the domain–dependent notion of similarity. This would then also account for the fact that in specific contexts of use it may in fact be possible, or necessary to drop such implicative conditions, as e.g. where the counterfactual antecedent is tied to rather eccentric, dissimilar worlds, where we cannot assume the condition to hold: a case in point is: *If water had a density equal to the density of the air and I had oars, I could not row*, where *row* is to be understood in the sense of *moving forward by rowing.*

As for the first objection raised above, the use of the domain–dependent similarity notion to exclude the subset T_2 in (24) from the extension of $W(o,S)$, we must first briefly address a problem that has not yet been mentioned. Ginsberg discusses an example that is structurally equivalent to the Tichy–example of the man with the hat (see Section 4.3.1). Suppose S contains propositions a, b, and $a \rightarrow b$, for *Socrates is human*, *Socrates is mortal*, and *If Socrates is human, he is mortal.* If we were to evaluate the counterfactual $\neg a > b$, every maximal subset $T_i \in W(\neg a, S)$ would contain the condition b and therefore $W(\neg a, S)$ validates the counterfactual *If Socrates were not human, he would (still) be mortal.*

Ginsberg argues convincingly that such cases are best handled by resorting to the closure $cl(S)$ of S, but where it "should be record[ed] that the inclusion of b is a consequence of the rule of inference $a \rightarrow b$, so that if a or $a \rightarrow b$ is removed, b should go as well. Somehow we need to include truth maintenance information ... in our counterfactual construction." (Ginsberg(1986:48)). Ginsberg refers to Doyle(1979) as a representative example of a "reason" maintenance system. "What a truth maintenance system does is to record the *reason* for a fact's being true; if the reason disappears, the fact goes with it." (Ginsberg(1986:67)).

The idea that S' *not involve gratuitous changes* to S now corresponds to S' being maximal subject to the constraint that $\neg p$ not be a consequence of it.(Ginsberg(1986:43),italics added)

Now, if some system of "reason maintenance" is used to record (conditional)[7] dependencies between facts contained in a world description, then the principle mentioned by Ginsberg – requiring that facts that (conditionally) depend on a proposition that is removed from S for counterfactual reasoning should be removed as well – should certainly extend to cases of the type considered in example (24): Here, given the implication[8] $b \wedge o \rightarrow r$ and the assumption of b and $\neg o$ in S, the proposition $\neg r$ is *partly* conditionally dependent upon the information $\neg o$. Thus, if $\neg o$ is removed from S for processing the counterfactual $o > r$, we also have to remove any proposition that (partly) conditionally depends on $\neg o$, and therefore must remove $\neg r$ along with $\neg o$. But *if* we do so – and this is the point we in fact wanted to raise – then the statement about comparative (domain–dependent) similarity, $W - \{b\} < W - \{\neg r\}$, which we claimed above not to be used appropriately in (24), is in fact superfluous, as is the badworld predicate $B(S - \{b \wedge o \rightarrow r\})$: both T_1 and T_2 in (26), where – besides $\neg o$ and $\neg r$ – the proposition b, or the implication $b \wedge o \rightarrow r$ is removed, are not *maximal*. In a way *there is no point* in removing these assumptions from the actual world description S: the counterfactual assumption o can consistently be added to the unique maximal subset T_3 that results from S by observing the principle that, on removing a fact a from S (for counterfactual reasoning!), we must remove every piece of information b that (partly) conditionally depends on a.[9]

(26) $S = \{b, \neg o, \neg r, \neg f, b \wedge o \rightarrow r\}$
$W(o, S) = \{T_3\}$

a. $T_1 = \{b, \neg f\}$ — not maximal

b. $T_2 = \{\neg f, b \wedge o \rightarrow r\}$ — not maximal

c. $T_3 = \{b, \neg f, b \wedge o \rightarrow r\}$ — maximal

[7]We think it would be more appropriate to represent the implications in question as conditionals, and consequently often switch to the term "conditionally dependent".

[8]In fact, in order for our argument to go through, the implication has to be replaced by the biconditional $b \wedge o \leftrightarrow r$, which I think is correct for the example at hand.

[9]Just for sake of clarity, reconsider the Tichy–example (i), where the evaluation of the counterfactual $\neg r > h$ is subject to the principle just sketched: in (i), where h is conditionally dependent on r, h is removed from $W(\neg r, S)$, such that the counterfactual cannot be validated.

(i) There is a man who is famous for his strict hat–wearing habits: He always wears his hat if it is raining, while he either does or doesn't wear it if it is not raining. Today it is raining, and as you can see, he's wearing his hat right now. Would he be wearing his hat if it weren't raining?
$S = \{r \rightarrow h, \neg r \rightarrow (h \vee \neg h), r, h\}$
$W(\neg r, S) = \{T_1\}$, where $T_1 = \{r \rightarrow h, \neg r \rightarrow (h \vee \neg h)\}$.
Thus, $T_1 \cup \{\neg r\} \not\models h$, while $T_1 \cup \{\neg r\} \models h \vee \neg h$.

(ii) reverses the original Tichy–example. Given that in the modified scenario h is not conditionally dependent on r, h is not retracted from S and the counterfactual is validated by T_1.

(ii) There is another man, who is also famous for his strict hat–wearing habits: He always wears his hat if it is *not* raining, while he either does or doesn't wear it if it *is* raining. Today it is raining, and as you can see, he's wearing his hat right now. Would he be wearing his hat if it weren't raining?
$S = \{r \rightarrow (h \vee \neg h), \neg r \rightarrow h, r, h\}$
$W(\neg r, S) = \{T_1\}$, where $T_1 = \{r \rightarrow (h \vee \neg h), \neg r \rightarrow h, h\}$. Thus, $T_1 \cup \{\neg r\} \models h$.

Let us sum up what we consider to be the main results of this discussion, in light of our present concern, which is to decide whether the vagueness of conditionals is appropriately analyzed as based on the concept of (maximal) similarity.

(i) We first observed that Ginsberg's notion of "syntactic similarity" defined in (22) can be conceived of in terms of "minimal reduction" of the set of propositions S describing the actual world, to allow for consistent update (or union) with the counterfactual antecedent. It turned out that "syntactic" similarity (22) does *not* correspond to an intuitive notion of "similarity".

(ii) Second, while we consider the notion of "domain–dependent similarity" to be well motivated in principle, we have argued that the use that has been made of this domain–dependent notion of similarity in order to account for the particular example reviewed is misleading in two ways: first, a case that we consider to be a genuine case of domain–dependent similarity[10] – to preclude implicative conditions from being dropped – was handled by resorting to the special "badworld predicate";[11] and secondly, it turned out that once we assume an additional mechanism of "reason maintenance", and adopt the principle that, if retracting a proposition p from S to allow for consistent assumption of the counterfactual premise $\neg p$, we must retract, along with p, any proposition q that (partly) conditionally depends on p, the particular use that in the example has been made of both the badworld predicate and domain–dependent similarity constraints is in fact superfluous.

(iii) Finally, the mechanism of "reason maintenance", in conjunction with a principle determining the retraction of conditionally dependent propositions was argued to be needed – independently from the different notions of similarity – to account for the Tichy–examples and structurally equivalent cases, as e.g. (24).

These observations do, in our view, put some doubt upon the naturalness of the concept of "overall similarity" for the analysis of conditional vagueness: Not only is the concept of similarity broken down into non–homogeneous secondary notions of similarity, along with a rather special notion of "bad worlds" and a mechanism of "reason maintenance". But in particular we have seen that if some such mechanism is adopted to account for the Tichy-examples, at least for the cases considered we could do without both context–dependent similarity and the badworld predicate. Now, if the similarity account of counterfactuals were right, it should be possible to reduce this principle governing the retraction of conditionally dependent propositions to some (abstract) notion of similarity. Yet, it is well–known that this is not so easy. Recall our discussion in Section 4.3.1, which showed that the Tichy–cases are in fact the hardest challenge for the similarity account.

What might be the "deeper" concept underlying the principle that requires information to be retracted from the set S if it conditionally depends upon the negation of the counterfactual antecedent? On a conception of the (indicative or counterfactual) conditional $p > q$ as a *test*, i.e. a test for the truth of q under the (possibly counterfactual) assumption that p, – which is explicitly pursued by Veltman(1990), and which is implicit in the Ramsey rule and its elaboration in Stalnaker(1968) – then it is rather evident that, being interested in the truth of the proposition q under the *counterfactual* assumption that p, and if the truth of q or its negation is (partly) conditionally dependent upon some proposition r, it is

[10]... or "normality" – see below...

[11]By generally excluding such world descriptions from the extension of $W(p, S)$ there is no way to account for examples like *If water had a density equal to the density of the air and I had oars, I could not row across the river.* Again this kind of example calls for an analysis in terms of "reason maintenance".

necessary, if we retract from S any proposition v that implies r in order to update with the counterfactual antecedent p, we have to retract r, along with q or $\neg q$, as well. So if $\neg p \rightarrow v$, and $v \rightarrow q$ or $v \rightarrow \neg q$, when retracting $\neg p$ from S to update with the counterfactual antecedent p, we have to retract v and $q/\neg q$ if they are assumed as facts in S. If this were not the case, i.e. if the "reasons" for assuming q or $\neg q$ were to be retained in the set of selected "worlds" $W(p, S)$ out of S, there would be no point at all in doing the counterfactual test for the truth of q on the assumption of p!

On the basis of this explanation, the "deeper" reason underlying the principle to retract information that is conditionally dependent upon the negation of the counterfactual assumption is essentially pragmatic. It seems reasonable that the pragmatic preconditions for performing a *conditional test* on the truth of q under the counterfactual assumption that p are such that the set of worlds that provide the basis for the test do not yet *settle* the case, and – what is even more serious – settle it on the basis of the information that $\neg p$. Thus, before performing an update of this set with the condition p, any "reason" to assume either q or $\neg q$ that is dependent upon $\neg p$ must have been eliminated.

This view is in fact compatible with Veltman's pragmatic conditions on (indicative) conditionals, which – besides the indeterminateness of the truth of the conditional antecedent in the indicative case – requires the truth of the consequent not to be settled in the set of worlds that provide the basis for the conditional test (see Veltman(1990)).

We may even draw some connections to a theory of conditionals in Gabbay(1972),[12] which, contrary to the maximal similarity theories, defines the selection function for a conditional $\phi > \psi$ to depend not only upon the content conveyed by ϕ, but in terms of the content of both ϕ and ψ: Let us just cite what Nute(1986:410) tells us about this analysis:

> "A conditional $\phi > \psi$ is true at i [in a model $\langle I, g, [\![\ ]\!]\rangle$] just in case $g(\phi, \psi, i) \subseteq [\phi \rightarrow \psi]$. [...] When we evaluate $\phi > \psi$, we are not concerned to preserve as much as we can of the actual world in entertaining ϕ; instead we are concerned to preserve ony those features of the actual world which are relevant to the truth of ψ, or perhaps to the effect ϕ would have on the truth of ψ. In actual practice the kind of similarity which is required is supposed by Gabbay to be determined by ϕ, by ψ, and also by general knowledge and particular circumstances which hold in i at the time when the conditional is uttered. What this involves is left vague, but it is no more vague than the notions of similarity assumed in earlier theories." Nute(1986:410)

If we acknowledge the impact of pragmatic conditions upon the selection of worlds for the evaluation of a conditional, such as those preconditions for a "conditional test" just mentioned, a ternary selection function $g(\phi, \psi, i)$ as in Gabbay's theory is fully appropriate to state the corresponding restrictions in terms of the conditional's antecedent *and* consequent.

To conclude, our discussion of Ginsberg's account of counterfactuals – which may be considered as a digression, or elaboration of the arguments raised in the beginning of this Section – strengthens our contention that a theory of counterfactuals that is built upon the notion of maximal similarity is forced to resort to different, non–homogeneous notions of "similarity", which cannot be considered as rendering any intuitive conception of the notion of similarity.

[12] We only have indirect access to this theory via Nute(1986).

By contrast, the discussion provides further support for our hypothesis, guided by the observations made in the beginning of this Section, that the analysis of both indicative and counterfactual conditionals is to be based on the selection of a set of accessible worlds which is determined by at least two distinct notions: (i) contextually determined *relevance* or *salience*, and (ii) the notion of contextually determined *normalcy*: In particular, the preservation of implicative conditions in the set of selected worlds, instead of being captured in terms of a "badworld predicate", has been argued to be better accounted for by a domain–dependent notion of "similarity" – or rather a context dependent notion of *normalcy*. Also, we sketched an account of the notorious Tichy–examples which is inspired by Ginsberg's notion of "reason maintenance" and which we argued to be grounded on a *pragmatic* principle that derives from the pragmatic function of conditionals as *tests*. This is in accordance with the general assumption that for evaluation of a conditional the set of worlds in the quantificational domain is constrained to be pragmatically *relevant*.

Finally note that the syntactic similarity notion in Ginsberg's analysis is equivalent to a mechanism of (minimal) reduction to allow for consistent update with the counterfactual antecedent. This is closely analogous to the relation of *(minimal) context reduction* that we used for the analysis of counterfactual conditionals in Section 4.3.2.

Given these observations, our overall objective is to devise an analysis of conditionals that is based on the notions of contextually determined *relevance* and *normalcy*, and that makes use, for counterfactual conditionals, of the relation of *context reduction*.

But before we can turn to our own analysis, we have to review one further criterion of Lewis' notion of "overall similarity", which is tied to the concept of "historical necessity" discussed by Kamp(1978), and which is crucial for what Lewis(1979) discussed under the heading of the *asymmetry of counterfactual dependence*. In the next Section we will review Lewis' arguments against what he called the "analysis–by–fiat" of the asymmetry of counterfactual dependence, which led him to assume, instead, specific criteria to determine comparative "overall similarity of worlds".[13] We will argue that the arguments Lewis brought up against the "analysis–by–fiat" can – at least partly – be refuted. So we will instead propose an analysis along the lines of the *analysis–by–fiat*, which accounts for the asymmetry of counterfactual conditionals not in terms of some more or less unmotivated restriction of the vague notion of "similarity", but rather by building into the analysis the concept of *historical necessity*.

So, finally, in our analysis of conditionals the selection of epistemically accessible worlds will be governed by three criteria: (i) contextually determined *relevance*, (ii) contextually determined *normalcy*, and (iii) the notion of *historical necessity*, to constrain the relation of context reduction for counterfactual conditionals. While it would in principle be possible to build the notion of *historical necessity* into the formal definition of *normalcy*, the distinction between these notions will finally prove advantagous to account for the contrast between the *vagueness* of conditionals due to the normalcy–restriction on the one hand, and the *clear–cut* asymmetry of counterfactual dependence on the other.

5.1.3 The asymmetry of counterfactual dependence

It is high time to elucidate the notion of the "asymmetry of counterfactual dependence". To this end, we just refer to Lewis' own rendering:

[13]See our first discussion in Section 2.2.2, p. 26.

> The way the future is depends counterfactually on the way the present is. If the present were different, the future would be different; and there are counterfactual conditionals, [...] , that tell us a good deal about how the future would be different if the present were different in various ways. Likewise the present depends counterfactually on the past, and in general the way things are later depends on the way things were earlier.
>
> Not so in reverse. Seldom, if ever, can we find a clearly true counterfactual about how the past would be different if the present were somehow different. Such a counterfactual, unless clearly false, normally is not clear one way or the other. It is at best doubtful whether the past depends counterfactually on the present, whether the present depends counterfactually on the future, and in general whether the way things are earlier depends on the way things will be later.
>
> Often, indeed, we seem to reason in a way that takes it for granted that the past is counterfactually independent of the present: that is, that even if the present were different, the past would be just as it actually is. [...] More generally, in reasoning from a counterfactual supposition about any time, we ordinarily assume that facts about earlier times are counterfactually independent of the supposition and so may freely be used as auxiliary premises. Lewis(1979:455)

Following Lewis, this general picture, that the past is counterfactually independent of the present, even carries over to so–called backtracking arguments. The example is this:[14] "Jim and Jack quarreled yesterday. We conclude that if Jim asked Jack for help today, Jack would not help him." Now some further reflection comes in: "Jim is a prideful fellow. He never would ask for help after such a quarrel." So, can we reason that *if he asked Jack for help today, there would not have been a quarrel yesterday*?

Lewis argues that – under normal conditions[15] – "backtracking arguments" like (27i) are defeated by the asymmetry of counterfactual dependence. We can only accept (27ii), where the consequent is embedded within the scope of an additional modal *have to.* According to Lewis, this "syntactic peculiarity" serves as an indication that the "standard resolution of vagueness" – which observes the asymmetry of counterfactual dependence – is ignored. "Only under the standard resolution [of vagueness] do we have the clear–cut asymmetry of counterfactual dependence that interests me" (Lewis(1979:458)). That is, in general "the vagueness of counterfactuals [is resolved] in such a way that counterfactual dependence is asymmetric (except perhaps in cases of time travel or the like)." (ibid)

(27) Jim and Jack had a quarrel yesterday. If Jim asked Jack for help today, Jack would not help him. But Jim is a prideful fellow.
  (i) # So if he asked Jack for help today, there would have been no quarrel yesterday.
  (ii) So if he asked Jack for help today, there would *have to* have been no quarrel yesterday.

So Lewis' claim is that "counterfactual asymmetry" is restricted to contexts with "standard" resolution of vagueness. "Subject to these needed qualifications, what I claim is as follows. Consider those counterfactuals of the form "If it were that A, then it would be that C" in which the supposition A is indeed false, and in which A and C are entirely about

[14]The example is attributed to Downing(1959).

[15]See below for exceptions.

the states of affairs at two times t_A and t_C respectively. Many such counterfactuals are true in which C also is false, and in which t_C is later than t_A. These are counterfactuals that say how the way things are later depends on the way things were earlier. But if t_C is earlier than t_A, then such counterfactuals are true if and only if C is true. These are the counterfactuals that tell us how the way things are earlier does not depend on the way things will be later." Lewis(1979:458).

Lewis opposes two different analyses of counterfactuals that respect their asymmetric behaviour. Analysis 1 is called the *analysis–by–fiat*, where the asymmetry is directly built into the semantic analysis of counterfactuals:

(28) *Analysis 1*:
Consider a counterfactual "If it were that A, then it would be that C" where A is entirely about affairs in a stretch of time t_A. Consider all those possible worlds w such that:
(1) A is true at w;
(2) w is exactly like our actual world at all times before a transition period beginning shortly before t_A;
(3) w conforms to the actual laws of nature at all times after t_A; and
(4) during t_A and the preceding transition period, w differs no more from our actual world than it must to permit A to hold.
The counterfactual is true if and only if C holds at every such world w. Lewis(1979:462)

Analysis 1 works fine for most counterfactuals that arise in everyday life. Now, Lewis argues, there are two problems with it. First, there are counterfactuals where the antecedent clause is not about a particular time t, such as the ones in (29).

(29) a. If kangaroos had no tails ...

b. If gravity went by the inverse cube of distance ...

c. If Collett had ever designed a Pacific ... Lewis(1979:464)

Second, analysis 1 is claimed to be too strong in that it does not allow for special contexts with "non–standard resolution of vagueness", where the asymmetry of counterfactuals breaks down. Here Lewis mentions conditions as e.g. "in a time machine, or at the edge of a black hole, or before the Big Bang, of after the Heat Death, or at a possible world consisting of one solitary atom in the void." (Lewis(1979:458)). According to Lewis, such contexts could allow for exceptions to the asymmetry of counterfactual conditionals.

In light of these objections, Lewis opts for the second, more general analysis of counterfactuals, where the asymmetry is built into the notion of comparative similarity, and where – due to the vagueness of the similarity criterion – special cases, where the asymmetry breaks down, can be accounted for by "non–standard resolution of vagueness":

(30) *Analysis 2*:
A counterfactual "If it were that A, then it would be that C" is (non–vacuously) true if and only if some (accessible) world where both A and C are true is more similar to our actual world, overall, than is any world where A is true but C is false. Lewis(1979:465)

In this analysis the burden of how to account for counterfactual asymmetry is shifted to the criterion of overall similarity, which in (31) is defined to cover the range from standard to non–standard resolution of vagueness (see our discussion in Section 2.2.2). But, as Lewis observes, the asymmetry of counterfactual dependence is not built into the similarity criterion as such. In the example of Nixon pressing the button, we could well consider, when determining overall similarity of worlds, a world w' where he presses the button, and where a *small* miracle occurs that permits perfect convergence with the actual world w_0, where Nixon didn't press the button and no nuclear holocaust occured. According to the similarity criterion, such a world would falsify the counterfactual *if Nixon had pressed the button, there would have been a nuclear holocaust.* Yet, given the temporal and causal structure of our world, there are no such worlds to consider, where a *small* miracle allows convergence of a world w', where Nixon presses the button, to the world w_0 where no holocaust occurs: "Divergence from a world such as w_0 is easier than perfect convergence to it. Either takes a miracle [...], but convergence takes very much more of a miracle." (Lewis(1979:473)). So, it is the temporal and causal structure of our world that – in conjunction with the similarity criteria in (31) – determines the asymmetry of counterfactual dependence.

(31) (1) It is of the first importance to avoid big, widespread, diverse violations of law.
(2) It is of the second importance to maximize the spatio–temporal region throughout which perfect match of particular fact prevails.
(3) It is of the third importance to avoid even small, localized, simple violations of law.
(4) It is of little or no importance to secure approximate similarity of particular fact, even in matters that concern us greatly. (L79:472)

According to Lewis, analysis 2 is more general than analysis 1, in that it not only accounts for the counterfactual asymmetry in contexts where the "standard resolution of vagueness" applies. It also allows, in special circumstances, for "non–standard resolution of vagueness", to allow for particular cases of "backtracking counterfactuals".

There are various objections that one might raise against Lewis' contention that the similarity account of counterfactuals, analysis 2, is to be preferred over the *analysis–by–fiat.*

First, one of the arguments raised against analysis 1 is in our view not convincing: Even though examples like (29) do not come with a definite specification of the antecedent's temporal location, we will argue below that (a variant of) analysis 1 should be able to account for such cases, in full analogy with conditionals that host a definite temporal specification in the antecedent clause. Moreover, we will argue that the vagueness of counterfactuals, which on analysis 2 is tied to the similarity criterion, does not pattern with the characteristic of counterfactual asymmetry, which is a rather clear–cut property of even those counterfactuals that demand application of very low standards of "overall similarity".

Second, it is certainly true that analysis 1 is too strong once we take into account worlds that exhibit a time structure that differs significantly from the temporal and causal laws that govern our own world. So at first sight analysis 2 seems to be more appropriate, given that "it does little to predict the truth values of particular counterfactuals in particular contexts. ... Analysis 2 is only a skeleton. It must be fleshed out with an account of the appropriate similarity relation, and this will differ from context to context." (Lewis(1979:465)).

But below we will discuss examples where counterfactuals are to be interpreted relative to worlds that exhibit quite eccentric temporal and causal structures, and which show that we can tell next to nothing about the truth of counterfactuals in such worlds. Such examples raise philosophical problems and questions which I do not dare to touch. But I would like to raise the question whether – given that we can tell next to nothing about the truth or falsity of counterfactuals in such worlds – a theory of counterfactuals should be designed to apply to such contexts in the first place, and whether – in consequence – we must take Lewis' objections against analysis 1 to be as "damaging" as he appears to think they are. At least from the standpoint of practical applications, such as reasoning systems in Artificial Intelligence, it seems to be a viable solution – if perhaps not a philosophically sound one – to restrict the range of application of a theory of counterfactuals to epistemically accessible worlds where we find the same temporal and causal structures that we assume to hold in our actual world.

But let us now consider these points in turn.

Examples like (29) can be accounted for by analysis 1 if we allow for indeterminateness in the resolution of the temporal parameter t_A that determines the temporal location of the state of affairs described by the counterfactual antecedent. Once we allow for this range of variation we even get a better explanation for the fact that despite their indeterminateness of temporal location, these counterfactuals preserve their clear–cut characteristic of counterfactual asymmetry. This is exemplified by (32). According to our intuition (32a) can only be understood in a way such that evolution would diverge from the path it actually followed, starting from the period of time shortly before kangaroos came to have no tails – by whatever reason. An interpretation such that evolution would have gone differently *before* kangaroos happened to have no tails can, in our view, only be obtained for (32b), where we have again the "syntactic peculiarity" of an embedded modal expression.

Thus, although for (32) we must apply rather weak standards of similarity, the example still displays all marks of clear–cut counterfactual asymmetry. This is at least surprising on Lewis' analysis, where counterfactual asymmetry is built into the similarity criterion, which is by definition infected with vagueness. Once we are forced to take into account worlds that differ significantly from the actual world, the standards of similarity are quite low, such that we could well be confronted with a case of "nonstandard resolution of vagueness", where the asymmetry of counterfactual dependence does not hold.

(32) a. If kangaroos had no tails, evolution would have gone a different way.

b. If kangaroos had no tails, evolution would have *had* to go a different way.

Thus, instead of weakening the *analysis–by–fiat*, we take example (32) to put considerable doubt on analysis 2: In contexts where the antecedent requires the application of very low standards of similarity it is quite unexpected, by analysis 2, why similarity wrt. some particular facts, namely the preservation of maximal spatio–temporal overlap with the actual world, should be so important. Given that similarity is a "highly volatile matter", we would expect the asymmetry of counterfactuals to get more and more affected, along with increasingly lower standards of similarity imposed by "far–fetched" situations induced by the antecedent clause.

Moreover, once we acknowledge that even for counterfactuals with definite temporal adverbs like (27) the temporal location is not fully resolved, analysis 1 can be understood to allow for a contextually determined selection of a temporal variable t_A, where it is often the counterfactual consequent that imposes constraints on the temporal location of t_A – due to the hard–wired asymmetry of counterfactuals. Thus only by analysis 1, which requires the point of "divergence" for the choice of accessible counterfactual worlds to be located shortly before the temporal location t_A of the antecedent clause, is it possible to account for the clear interpretational difference between (32a–b).

So we are left with Lewis' second objection against analysis 1, that for evaluation of a counterfactual we might have to access possible worlds exhibiting a time structure that differs from the one that governs our actual world. But if we aim at a theory of counterfactuals that carries over to worlds with different time structures, we first have to inspect our intuitions about whether it is possible, at all, to judge the truth of counterfactuals in such unfamiliar possible worlds. All of our examples are taken from Lightman(1993), a novel about *Einstein's dreams.*

> 22 May 1905
>
> Dawn. A salmon fog floats through the city, carried on the breath of the river. [...] As the city melts through fog and the night, one sees a strange sight. Here an old bridge is half–finished. There, a house has been removed from its foundations. Here, a street veers east for no obvious reason. There, a bank sits in the middle of the grocery market. [...] A man walks briskly toward the Bundeshaus, stops suddenly, puts his hands to his head, shouts excitedly, turns, and hurries in the opposite direction.
>
> This is a world of changed plans, of sudden opportunities, of unexpected visions. For in this world, time flows not evenly but fitfully and, as a consequence, people receive fitful glimpses of the future.
>
> When a mother receives a sudden vision of where her son will live, she moves her house to be near him. When a builder sees the place of commerce in the future, he twists his road in that direction. When a child briefly glimpses herself as a florist, she decides not to attend university. When a young man gets a vision of the woman he will marry, he waits for her. When a solicitor catches sight of himself in the robes of a judge in Zürich, he abandons his job in Berne. Indeed, what sense is there in continuing the present when one has seen the future?
>
> For those who have had their vision, this is a world of guaranteed success. Few projects are started that do not advance a career. Few trips are taken that do not lead to the city of destiny. Few friends are made who will not be friends in the future. Few passions are wasted.
>
> For those who have not had their vision, this is a world of inactive suspense. How can one enroll in university without knowing one's future occupation? How can one set up an apothecary on Marktgasse when a similar shop might do better on Spitalgasse? How can one make love to a man when he may not remain faithful? Such people sleep most of the day and wait for their vision to come.
>
> Thus, in this world of brief scenes from the future, few risks are taken. Those who have seen the future do not need to take risks, and those who have not yet seen the future wait for their vision without taking risks.
>
> Some few who have witnessed the future do all they can to refute it. A man goes to tend the museum gardens in Neuchâtel after he has seen himself a barrister in Lucerne. A youth embarks on a vigorous sailing voyage with his father after a vision that his father will die soon of heart trouble. A young woman allows herself to fall in love with one man even though she has seen that she will marry another. Such people stand on their balconies at twilight and shout that the future can be changed, that thousands of futures are possible. In time, the gardener in Neuchâtel gets tired of his low wages, becomes a barrister in Lucerne. The father dies of his heart, and his son hates himself for not forcing his father to keep his bed. The young woman is deserted by her lover, marries a man who will let her have solitude with her pain.
>
> Who would fare better in this world of fitful time? Those who have seen the future and live

> only one life? Or those who have not seen the future and wait to live life? Or those who deny the future and live two lives? Lightman(1993:85–89)

Einstein's dream of 22 May 1905 pictures a world where it seems quite natural to have backtracking conditionals. If concerned with one of those humans who had visions about their future, and who chose to live only one life, backtracking conditionals such as (33) should, we feel, be perfectly natural. But if concerned with people that did not have such visions, or those that have visions, but do all they can to refute them, they should fail. Analysis 2 would have to resort to different criteria of overall similarity – depending on these preconditions – to account for the possibility or impossibility of backtracking conditionals.

(33) a. If this woman had been faithful to me in my old days, I would have married her.

b. If I had succeeded on my thesis, I would have worked on it.

The next dream we cite in order to put some doubt on whether we can *always* judge the truth or falsity of a (counterfactual) conditional in worlds with unfamiliar time structures.

> 16 April 1905
>
> In this world, time is like a flow of water, occasionally displaced by a bit of debris, a passing breeze. Now and then, some cosmic disturbance will cause a rivulet of time to turn away from the mainstream, to make connection backstream. When this happens, birds, soil, people caught in the branching tributary find themselves suddenly carried to the past.
>
> Persons who have been transported back in time are easy to identify. They wear dark, indistinct clothing and walk on their toes, trying not to make a single sound, trying not to bend a single blade of grass. For they fear that any change they make in the past could have drastic consequences for the future.
>
> Just now, for example, such a person is crouching in the shadows of the arcade, at no. 19 Kramgasse. [. . .] She huddles in a corner, then quickly creeps across the street and cowers in another darkened spot, at no. 22. She is terrified that she will kick up dust, just as a Peter Klausen is making his way to the apothecary on Spitalgasse this afternoon of 16 April 1905. Klausen is something of a dandy and hates to have his clothes sullied. If dust messes his clothes, he will stop and painstakingly brush them off, regardless of waiting appointments. If Klausen is sufficiently delayed, he may not buy the ointment for his wife, who has been complaining of leg aches for weeks. In that case, Klausen's wife, in a bad humor, may decide not to make the trip to Lake Geneva. And if she does not go to Lake Geneva on 23 June 1905, she will not meet a Catherine d'Épinay walking on the jetty of the east shore and will not introduce Mlle. d'Épinay to her son Richard. In turn, Richard and Catherine will not marry on 17 December 1908, will not give birth to Friedrich on 8 July 1912. Friedrich Klausen will not be father to Hans Klausen on 22 August 1938, and without Hans Klausen the European Union of 1979 will never occur.
>
> The woman from the future, thrust without warning into this time and this place and now attempting to be invisible in her darkened spot at no. 22 Kramgasse, knows the Klausen story and a thousand other stories waiting to unfold, dependent on the births of children, the movement of people in the streets, the songs of birds at certain moments, the precise position of chairs, the wind. She crouches in the shadows and does not return the stares of people. She crouches and waits for the stream of time to carry her back to her own time.
>
> When a traveler from the future must talk, he does not talk but whimpers. He whispers tortured sounds. He is agonized. For if he makes the slightest alteration in anything, he may destroy the future. [. . .] He is an exile of time. Lightman(1993:13–17)

Although in this world both indicative and subjunctive conditionals seem to work exactly as they do in our own world (see the sequence of conditionals about the "Klausen story"), there are others where our intuitions about their truth or falsity seem to vanish. Suppose the woman in Einstein's dream is the daughter of Hans Klausen. Are (34a–b) true or false?

(34) a. If the woman kicked up dust, she would kick up dust.

b. If she kicked up dust and sullied Klausen's clothes, she would not kick up dust.

But things can become even more complicated:

> 3 MAY 1905
>
> Consider a world in which cause and effect are erratic. Sometimes the first precedes the second, sometimes the second the first. Or perhaps cause lies forever in the past while effect in the future, but future and past are entwined.
>
> On the terrace of the Bundesterrasse is a striking view: the river Aare below and the Bernese Alps above. A man stands there just now, absently emptying his pockets and weeping. Without reason, his friends have abandoned him. No one calls any more, no one meets him for supper or beer at the tavern, no one invites him to their home. For twenty years he has been the ideal friend to his friends, generous, interested, soft–spoken, affectionate. What could have happened? A week from this moment on the terrace, the same man begins acting the goat, insulting everyone, wearing smelly clothes, stingy with money, allowing no one to come to his apartment on Laupenstrasse. Which was cause and which effect, which future and which past?
>
> In Zürich, strict laws have recently been approved by the Council. Pistols may not be sold to the public. Banks and trading houses must be audited. All visitors, whether entering Zürich by boat on the river Limmat or by rail on the Selnau line, must be searched for contraband. The civil military is doubled. One month after the crack–down, Zürich is ripped by the worst crimes in its history. In daylight, people are murdered in the Weinplatz, paintings are stolen from the Kunsthaus, liquor is drunk in the pews of the Münsterhof. Are these criminal acts not misplaced in time? Or perhaps the new laws were action rather than reaction? [...]
>
> In this acausal world, scientists are helpless. Their predictions become postdictions. Their equations become justifications, their logic, illogic. Scientists turn reckless and mutter like gamblers who cannot stop betting. Scientists are buffoons, not because they are rational but because the cosmos is irrational. Or perhaps it is not because the cosmos is irrational but because they are rational. Who can say which, in an acausal world? [...]
>
> Most people have learned how to live in the moment. The argument goes that if the past has uncertain effect on the present, there is no need to dwell on the past. And if the present has little effect on the future, present actions need not be weighed for their consequence. Rather, each act is an island in time, to be judged on its own. Families comfort a dying oncle not because of a likely inheritance, but because he is loved at that moment. [...] Clerks trampled by their bosses fight back at each insult, with no fear for their future. It is a world of impluse. It is a world of sincerity. [...] Lightman(1993:38–42)

While it is quite obvious that in this world we shouldn't expect asymmetric dependence of counterfactuals on time, neither on the past nor on the future, we must ask ourselves how we could judge the truth of any counterfactual in such an acausal world. If no predictions are possible, based on causal laws and evidences, no counterfactual can be judged true or false, unless by "postdiction" and hence by complete knowledge of contingent facts in every accessible possible world. Without such complete knowledge the conditionals in (35) cannot be judged true or false.

(35) a. If the new laws hadn't been introduced, those crimes would not have happened.

b. If those crimes had not happened, the new laws would not have been introduced.

There are numerous other possible worlds with eccentric time structures and causal laws. We have reviewed some of those created by Lightman(1993), in order to question the impact of such scenarios on our judgement whether some particular analysis of counterfactuals is adequate. In our view, our intuitions about which counterfactuals are true or false in such worlds is restricted. Often it seems that counterfactuals work more or less the same way they do in our world. But on closer inspection, we begin to have doubts: in a world with looping time structure, where every day repeats over and over, is there any counterfactual world where any event of this day is different? And, if so, which laws would prevail in such a counterfactual world? Would the counterfactual events also be repeated over and over every day? Which laws would prevail in such a world of repetition? Is it governed by laws that undo every memory and trace of the evolutions that start anew every day? Or does a human in such a world remember he has lived through this day before, (and before that, and ...)? But then, how come he does not gain any insights from the same mistakes he has made over and over in the very same situations and acts in a different way one fine day? It is difficult to judge the truth of any counterfactual in such a world, while being fully aware of the stangeness that must characterize the laws prevailing in such a world.

So we doubt that we can have reliable intuitions about the truth of counterfactuals if evaluated relative to worlds with unfamiliar temporal and causal laws, and choose to restrict our attention to the analysis of counterfactuals where we do *only* consider possible worlds that are characterized by the same time structure and the same causal laws that (we take to) govern our actual world, and which undoubtlessly determine our intuitions about what is a possible meaning of a counterfactual conditional. This view may be by far too narrow from a philosophical standpoint. But, as noted above, there are numerous applications of counterfactual reasoning, as e.g. in Artificial Intelligence, that do not necessitate such a broad philosophical view, but rather an account of the asymmetry of counterfactual dependence that is deterministic for worlds such as *ours*.

5.1.4 The asymmetry of counterfactual dependence in DRT

Once we choose to ignore exceptional worlds with unfamiliar causal and temporal structures for our analysis of (counterfactual) conditionals, we can fully rely on the particular temporal and causal structure that governs our actual world, and which determines the asymmetric dependence of counterfactuals on the past. Thus restricted, we can choose an analysis along the lines of the *analysis–by–fiat*, which directly builds in the asymmetry of counterfactual dependence.

But it seems preferable to go one step further and ground the analysis of asymmetric counterfactual dependence in the properties of the particular temporal structure that governs our world. It was already observed by Lewis that it is in fact not the similarity criterion (2) that ensures the asymmetric behaviour of counterfactuals in analysis 2. And in much the same way condition (2) of analysis 1 can only be considered as a reflex of a "deeper" concept that determines the asymmetry of counterfactual dependence on time. In our view, it is the concept of *Historical Necessity*, discussed in Kamp(1978) and Thomason(1984), that lies at the heart of this phenomenon.

The asymmetry of counterfactual dependence and historical necessity

Kamp illustrates the notion of *historical necessity* by way of a game, which can be played two ways:

> Consider the following game – I will call it GOF. GOF is played by two players, A and D. It goes as follows. On his first and only move A makes an assertion, of his own choice, about the immediate future – to be precise about the period from one to two minutes after his utterance. D has to reply by saying whether this assertion is correct or not. He has to reply within one minute.
>
> Suppose you are asked to play this game and you may decide whether to play as A or as D. It is pretty clear which side you should choose. For if A is not a complete idiot D doesn't have a chance in this game. All A has to do is to pick a sentence which he is in a position to make true or false. For example he can stick to the sentence 'Between one and two minutes from now I will say 'Booh' '. If D then says 'No' A waits until one minute has passed at which time he says 'Booh'; if D says 'Yes' A keeps his mouth shut. Not a very amusing game, – certainly not for D; and, unless the stakes are significant, not really for A either.
>
> The only reason I mention it is in order to contrast it with another game, GOP, which is superficially similar to GOF, yet works out quite differently in practice. GOP is also played between two players A and D and also involves only two moves. The difference with GOF is that now A is to make an assertion about the period between one and two minutes before his utterance. Here it is not quite so obvious which side you should prefer. You might argue: If I am D then, even if I know nothing that is relevant to the truth value of the sentence which A has picked, I still have a 50% chance of winning, by mere guessing. And with a bit of luck A may now and then choose a sentence the truth value of which I can guess with a somewhat better chance of being right. Kamp(1978:1–2)

The explanation of why GOF and GOP work differently is obvious: "in GOF A can choose sentences which he still has the power to "make" true or false after D has made his countermove." (Kamp(1978:2)). The difference between the sentences A may choose in GOF or GOP is only restricted by tense: in GOF the sentences are about the future, while in GOP they are about the past. Now, a sentence that is about the past is "invariably 'settled' – whether it is to be true or false is no longer within anybody's power. On the other hand any proposition one asserts by uttering a sentence of the first type need not be settled at the time of assertion, and among those who are still in a position to influence its eventual truth or falsehood the utterer himself may occupy a central position. [...] I shall call a sentence S (historically) necessary, or determinately true, at a given time t if the truth of what S says is immune to the influence of chance events as well as to that of agents, at all times after t. I shall represent determinateness by means of a 1–place sentential operator D: Ds is to mean 's is determinately true'." (Kamp(1978:4)).

As the discussion of GOP brought out, "all sentences about the past have the property that if the sentence s itself is true at t then Ds must also be true at t. [...] for certain other sentences, viz. sentences about the future, this implication is in general not valid." (Kamp(1978:5)).[16]

[16] This rests, of course, on the assumption that there is no complete determinism in this world. The discussion of this question is highly philosophical and far beyond our concerns and capacities, and hence

The operator D is defined by extension of a propositional language $L(P, F)$, itself an ordinary propositional language enriched by the tense operators F and P of Prior(1967). The model for $L(P, F)$ is given by a structure $\langle \mathcal{T}, M \rangle$, M an ordinary model for a propositional language, and $\mathcal{T}$ a linearly ordered temporal structure $\langle T, < \rangle$, where T a nonempty set of moments of time, and $<$ a linear ordering on T.[17]

In order to define the operator D in an extended language $L(P, F, D)$, the model must be refined such that not only it represents the complete history of a particular world, e.g. the actual world, from the beginning of time to the end, but – in order to represent that at any stage of this history the future is *open* – "besides the way in which the history in fact continues after t there will be other alternative continuations, in which certain propositions (which are not yet determined at t) receive a truth value opposite to that which they have in the actual future. Moreover, it is reasonable to assume that in any such alternative course of events w the future could again be open at times t'' subsequent to t, so that we must also countenance alternative continuations of w after $t'[']$ which differ from the way w itself develops after that time." (Kamp(1978:17)).

This conception is implemented by treating those alternative futures, open at a time t, as complete worlds, running from the beginning of time till its end. This requires that each world w that represents one of the alternative futures for w_0 coincides with w_0 at each past time t' up to t. "We thus come to the view that a model for $L(P, F, D)$ is to specify the development through time of a bundle of worlds. Any two worlds w and w' in the bundle may coincide up to a certain point in time, which means intuitively that, up to that time, w and w' really are one and the same world. [...] This last relationship, i.e. that of coinciding at least up to a certain time, we shall symbolize as: $\approx$. Thus $w \approx_{t'} w'$ is to mean that w and w' coincide at least up to t'." (Kamp(1978:18)). With this in place, D is defined as:

(36) Dψ is true in w at t iff ψ is true at t in all w' such that $w \approx_t w'$. Kamp(1978:18)

The model for $L(P, F, D)$ is defined in such a way that a well–foundedness constraint ensures, for all worlds w and w' that coincide up to some time t ($w \approx_t w'$), that they coincide in every particular fact q_i holding at all times $t' \leq t$.

A <u>model for $L(P, F, D)$</u> is [a] quadruple $\langle W, \mathcal{T}, \approx, A \rangle$, where

i) W is a notempty set (of "worlds");

ii) $\mathcal{T}$ is a function from W to linear time structures; we write $\mathcal{T}_w$ for $\mathcal{T}(w)$ and will assume $\mathcal{T}_w = \langle T_w, <_w \rangle$; we let $T = \bigcup_{w \in W} T_w$

iii) $\approx$ is a 3–place relation $\subseteq W^2 \otimes T$; we write $w \approx_t w'$ instead of $\approx (w, w', t)$; for fixed t $\approx_t$ is an equivalence relation. Moreover, if $w \approx_t w'$, then $t \in T_w \cap T_{w'}$ and the initial segments of $\mathcal{T}_w$ and $\mathcal{T}_{w'}$ which end with t coincide. Finally, if $w \approx_t w'$ and $t' <_w t$ then $w \approx_{t'} w'$.

iv) A assigns to each q_i, each $w \in W$ and each $t \in T_w$ a truth value. A model $M = \langle W, \mathcal{T}, \approx, A \rangle$ is <u>well–founded</u> if for all w, w', t, q_i, if $w \approx_t w'$ then $A(q_i, w, t) = A(q_i, w', t)$ Kamp(1978:24f)

we go along with this assumption without justification. See Kamp(1978) for arguments in favour of non–determinism.

[17]Kamp restricts his attention to densely ordered time structures.

While the objective in Kamp(1978) is the study of the logic of the operator D in interaction with the other temporal operators, F and P, we will restrict our attention to how to implement this notion of *historical necessity* into our DRT–framework, and how to make use of it to account for the asymmetry of counterfactual dependence observed by Lewis.

To this end, we have to enrich our model M, defined in Section 3.3, by temporal structure. We closely follow Kamp&Reyle(1993), who define an extensional model M for the temporal fragment of DRT (see Kamp&Reyle(1993: Ch.5.6)). The model is enriched, not only by a linearly ordered *instant structure* $\mathcal{T} = \langle T, < \rangle$ (with T a set of instants, and $<$ a linear order), but also by an *eventuality structure* $\mathcal{EV} = \langle EV, <, \bigcirc, E \rangle$ (EV a set of eventualities, E a set of events $E \subseteq EV$, and $<$, $\bigcirc$ temporal relations of precedence and overlap), where both structures are constrained by various postulates. The event structure $\mathcal{E} = \langle E, <, \bigcirc \rangle$ is related to the instant structure $\mathcal{T}$ by a mapping LOC, which assigns to each event e of the event structure $\mathcal{E}$ a closed interval of $\mathcal{T}$, such that the instant structure generated from $\mathcal{E}$ by $\mathcal{I}(\mathcal{E})$ is a substructure of $\mathcal{T}$ (see Kamp&Reyle(1993) for details).

In (37) the definitions in Kamp&Reyle(1993:677) are adapted to the intensional framework: we assume each world $w \in W$ to come with an eventuality and instant structure $\mathcal{EV}_w$ and $\mathcal{T}_w$, which are otherwise as in Kamp&Reyle(1993). Since we will only consider worlds with identical temporal structures we will assume that each possible world $w \in W$ is characterized by identical instant structures: $\forall w, w' \in W : \mathcal{T}_w = \mathcal{T}_{w'}$. In Kamp(1978) a model that satisfies this condition is called *perfect*.

Similar to the above definition in Kamp(1978) we now extend the model by a 3–place relation $\approx$, which encodes the notion of *historical necessity*: if two worlds w and w' coincide up to some time (instant) t, they do so for each $t' \leq t$, and – in analogy to the well–foundedness constraint in Kamp(1978) – we define all those worlds w, w' that satisfy the equivalence relation $w \approx_t w'$ for some t to "coincide in every particular fact at t": $I_{w,t,M} = I_{w',t,M}$, where $I_{w,t,M} = \mathrm{U}_{w,M} \cup \mathrm{Name}_M \cup \mathrm{Pred}_{w,t,M}$, and where we further require that every eventuality referent e that is located at time t or at some time earlier than t in w or w' (by $LOC(e) \leq t$) is in the intersection of EV_w and $EV_{w'}$, and thus mapped to the same interval in w and w'.

(37) $\mathbf{M} = \langle\ W, \mathcal{EV}, \mathcal{T}, \mathrm{LOC}, \equiv, \approx, \mathrm{U}_{w,M}, \mathrm{Name}_M, \mathrm{Pred}_{w,t,M}, \mathrm{Quant}_M, *\ \rangle$

W: a nonempty set of worlds

$\mathcal{EV}$: a function from W to event structures $\mathcal{EV}_w$, $\mathcal{EV}_w$ defined as $\langle EV_w, <, \bigcirc, E_w \rangle$

$\mathcal{T}$: $\mathcal{T}$ is a function from W to linear time orderings $\mathcal{T}_w$, with $\mathcal{T}_w$ defined as $\langle T_w, < \rangle$ and where $\forall w, w' : \mathcal{T}_w = \mathcal{T}_{w'}$

LOC: a function from EV_w to $\mathcal{I}nt(\mathcal{T}_w)$

$\equiv$ an equivalence relation on $\mathcal{I}nt(\mathcal{T}_w)$

$\approx$ a 3–place relation $\subseteq W^2 \otimes T$, with $T = \bigcup_{w \in W} T_w$ such that, for w, w', t,
$w \approx_t w'$ iff $\forall t' \leq t : t' \in T_w \cap T_{w'}$ & $w \approx_{t'} w'$; and
if $w \approx_t w'$ then $I_{w,t,M} = I_{w',t,M}$, for $I_{w,t,M} = \mathrm{U}_{w,M} \cup \mathrm{Name}_M \cup \mathrm{Pred}_{w,t,M}$
& $(\forall e \in EV_w \cup EV_{w'})$ if $LOC(e) \leq t$ then $e \in EV_w \cap EV_{w'}$

where $\mathrm{U}_{w,M}$, Name_M, $\mathrm{Pred}_{w,t,M}$, Quant_M and * as defined in (50) Section 3.3.

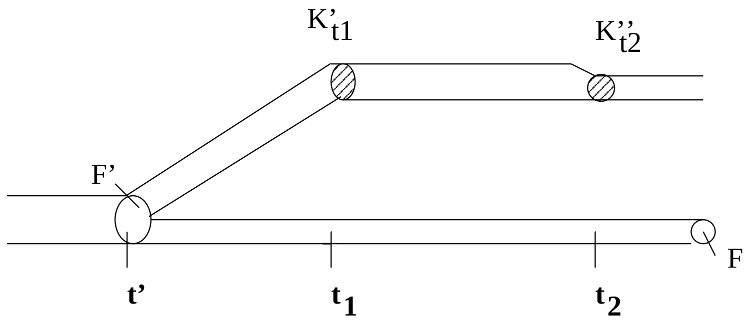
As mentioned above, we want to make use of the notion of *historical necessity* in order to implement, in our DRT framework, a refined analysis of counterfactual conditionals which accounts for their asymmetric temporal dependence, and which is otherwise closely analogous to the *analysis–by–fiat* rejected by Lewis.

The basic idea is that condition (2) of the *analysis–by–fiat* (see p. 272) can be substituted by a condition that exploits the notion of historical necessity. In the *analysis–by–fiat* condition (2) constrains the set of accessible counterfactual worlds w where A holds true to be "exactly like our actual world [w_0] at all times before a transition period beginning shortly before t_A". We could replace this condition by constraining the set of accessible counterfactual A–worlds w to be such that they *historically determine* the same set of facts as does the actual world w_0, *up to a time* t' *(shortly) before* t_A, the temporal location of the state of affairs described by the (counterfactual) antecedent A. I.e., for every A–world w in the quantificational domain we require that w is *historically identical* to w_0 *up to time* t': $w \approx_{t'} w_0$, with $t' < t_A$. Together with the constraint that t' must be chosen to *minimally precede* the temporal location t_A of the counterfactual antecedent, the asymmetry of counterfactual dependence will then fall out as an immediate consequence.

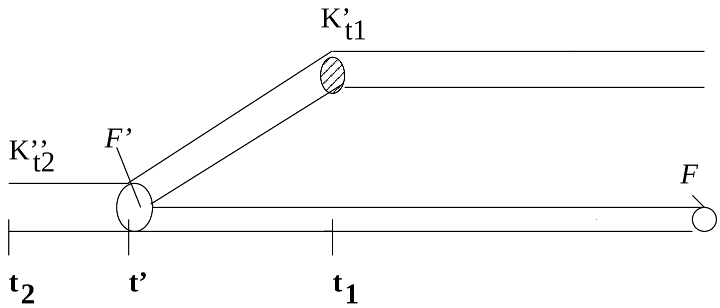
Put differently, if the factual context F relative to which a counterfactual $K'_{t_1} \Rightarrow K''_{t_2}$ is to be interpreted is *historically determined* up to some time $\mathbf{t_0}$, while the counterfactual antecedent K'_{t_1} is located at some time $\mathbf{t_1} \leq \mathbf{t_0}$, we can substitute condition (2) by the constraint that from the factual context F, historically determined up to time $\mathbf{t_0}$, we have to select a *reduced context* F' to constitute the modal base, where F' is *historically determined* up to some time $\mathbf{t}'$ that minimally precedes $\mathbf{t_1}$, while allowing for consistent update with K'_{t_1}. If K''_{t_2}, the counterfactual's consequent, is located at some time $\mathbf{t_2}$ later than $\mathbf{t_1}$, the counterfactual expresses in which way K''_{t_2} counterfactually depends on the truth of K'_{t_1} at the earlier time $\mathbf{t_1}$, while if $\mathbf{t_2} < \mathbf{t_1}$, such that $\mathbf{t_2} < \mathbf{t}' < \mathbf{t_1}$, the counterfactual can only be true if K''_{t_2} is true relative to the factual context F (and thus also relative to the reduced context F' that historically determines the same set of facts as does the factual context F *up to time* $\mathbf{t}'$). I.e., in this case the counterfactual tells us that the truth of K''_{t_2} at time $\mathbf{t_2}$ is *not* counterfactually dependent on the truth of K'_{t_1} at the later time $\mathbf{t_1}$.

This main idea is roughly illustrated by the figures below.

(38) a.



b.



In order to implement this basic idea we have to refine our definition of context reduction on context referents, $F' \subseteq F$, to respect the notion of *historical necessity.* I.e. for evaluation of a counterfactual conditional with antecedent DRS K'_{t_1} relative to a factual antecedent context F we have to define, by context reduction $F' \subseteq F$, a *reduced* context F' in such a way that F' denotes a set of states $\langle w', f' \rangle$ that historically determines the same set of facts that are historically determined relative to F, yet only up to a time t' that minimally precedes the temporal location t_1 of the counterfactual antecedent K'_{t_1}.[18]

Now, in a theory like DRT a DRS K or context referent F is a *partial* representation of (what we take to be) the actual world. If context reduction $F' \subseteq F$ were constrained to yield a reduced context F' that supports *every fact* that is historically determined up to a time $\mathbf{t}'$ that minimally precedes the temporal location $\mathbf{t_1}$ of the state of affairs described by the counterfactual antecedent K'_{t_1} (i.e. $\forall w, w' \in cs(e(F')) : w \approx_{\mathbf{t}'} w'$), by resorting to the notion of historical necessity defined by $\approx$ in (37), the denotation of the reduced context F' would be much too strong: The factual antecedent context F is only a partial representation of the actual world, where many facts or events that took place in worlds w', $w' \approx_{\mathbf{t_0}} w_0$ at past times $\mathbf{t}' \leq \mathbf{t_0}$ are not determined, or "unsettled", simply because they have, in the first place, not been mentioned within the actually processed discourse F, which is nevertheless "about" the actual world.

We therefore define a weaker relation of *context reduction* $\subseteq$, which in (39) takes two additional parameters, a temporal referent t' and a DRS K'_{t_1}, where the latter will be instantiated by the antecedent DRS K'_{t_1} of the counterfactual conditional that triggers the introduction of the relation of context reduction.

The relation $F' \,{}^{t'}_{?K'_{t_1}}\!\subseteq F$ is verified by a state $\langle w, e \rangle$ iff the set of states $\langle w'', f' \rangle$ in the denotation of F' is constrained by two conditions: the first condition is roughly as in our original definition of context reduction $\subseteq$ in Section 3.3, stating that for every state $\langle w', f \rangle$ in the denotation of F there will be some ("reduced") state $\langle w'', f' \rangle$ in $e(F')$, where f' is a "reduction" of f that is defined for t' (by $f'' \subseteq f$ and $f'' \subseteq_{\{t'\}} f'$), and such that w'' and w' are *identical.* In the case of a counterfactual conditional that is interpreted relative to a factual context F where K'_{t_1} is false, every such reduced state $\langle w'', f' \rangle$ will thus also be a state that does not verify K'_{t_1}.

By the second condition the set of states $\langle w'', f' \rangle \in e(F')$ is further constrained in such a way that for all those states $\langle w'', f' \rangle \in e(F')$ that verify K'_{t_1} w'' is *historically identical* to w' *up to some time* $f'(t')$ (which by necessity will be earlier than the temporal location $g'(t_1)$ of the counterfactual antecedent K'_{t_1}), and where the choice of $f'(t')$ is further restricted to *minimally precede* $g'(t_1)$: there may not be a time $\mathbf{t}'$ preceding $g'(t_1)$ that is later than $f'(t')$ and such that there is some state $\langle w''', g'' \rangle$ that verifies K'_{t_1} (with $g''(t_1) = g'(t_1)$), and where w''' is historically identical to w'' *up to* $f'(t')$, and where, furthermore, w''' is

[18]From now on we are using the notion of *a DRS K_t being temporally located at time t* to express that the state of affairs, or eventuality that is represented by a (sentence's) DRS K is temporally related to a temporal discourse referent t by a condition of the form $e \circ t, e \subseteq t$, etc. (see Kamp&Reyle(1993)), and where the referent t in turn denotes a temporal instant $\mathbf{t}$ in the model, relative to some evaluation state $\langle w, f \rangle$. We will at times use the notion of the *distinguished temporal referent t* of a DRS K_t to express that K is *temporally located at time t.*

Since t may be assigned different denotations by different states in the denotation of a context referent F, distinguished discourse referents t_1 and t_2, or else make use of valuations of embedding functions $f(t_1)$ and $f(t_2)$ that are in the denotation of F.

historically identical to w' up to the later time $\mathbf{t}'$.[19] Notice that due to the implication in the second condition we could dispense with the first condition, since, trivially, if $w'' = w'$, then $w'' \approx_{f'(t')} w'$ for any value of $f'(t')$. We nevertheless stated the first condition in order to clearly indicate that the refined (four–place) relation of context reduction in (39) constitutes a special case of the more general (two–place) reduction relation $\subseteq$ defined in Section 3.3 and the (three–place) relation ${}_{?K''}\subseteq$ defined for the analysis of deontic conditionals in Section 4.1.3 (for an overview see below p. 296).

(39) $\langle w, e\rangle \models_M F' \ {}^{t'}_{?K'_{t_1}}\!\subseteq F$ iff

$$\begin{array}{l}(\forall\langle w', f\rangle \in e(F))(\exists\langle w'', f'\rangle \in e(F'))[(\exists f'')(f'' \subseteq_{\{t'\}} f' \ \&\ f'' \subseteq f \ \&\ w'' = w')] \ \& \\ (\forall\langle w'', f'\rangle \in e(F'))(\exists\langle w', f\rangle \in e(F))[(\exists f'')(f'' \subseteq_{\{t'\}} f' \ \&\ f'' \subseteq f) \ \&\ w'' \approx_{f'(t')} w' \ \& \\ \quad ((\exists g')({}_{\langle w'', f'\rangle}[\![K'_{t_1}]\!]_{\langle w'', g'\rangle} \ \&\ f'(t') < g'(t_1) \\ \qquad \to \neg(\exists \mathbf{t}')(f'(t') < \mathbf{t}' < g'(t_1) \ \&\ (\exists w''')(w''' \approx_{f'(t')} w'' \ \&\ w''' \approx_{\mathbf{t}'} w' \ \& \\ \qquad\qquad (\exists g'')(\langle w''', g''\rangle \models_M K'_{t_1} \ \&\ g''(t_1) = g'(t_1))))))].\end{array}$$

How does this new definition of context reduction account for the observed asymmetry of counterfactual dependence?

Let us first illustrate the main idea by reconsidering the figures in (38a–b), for the two interesting types of counterfactual conditionals, the non–backtracking and the backtracking ones, where – for the antecedent DRS K'_{t_1} and consequent DRS K''_{t_2}, temporally located at times t_1 and t_2 – either t_1 precedes t_2 (38a) or else t_2 precedes t_1 (38b), respectively.

We will then go into more detailed discussion of example (27), discussed by Lewis, in particular the cases of (apparently) backtracking counterfactuals with embedded modal *have to* that seem to violate the asymmetry of counterfactual dependence.

For both types of conditionals in (38a–b) it holds that if the counterfactual is interpreted as *relative to* a factual antecedent context F, context reduction must yield a (*relevant*) reduced context F' – relevant for the conditional test – where the issue of the counterfactual antecedent K'_{t_1} is not settled and which therefore allows for consistent update with K'_{t_1}.

If the counterfactual's antecedent DRS K'_{t_1} is located at some time t_1, then, in order to allow for consistent update with K'_{t_1}, the reduced context F' must be chosen in such a way that F' does not *historically determine*, or "settle" the issue K'_{t_1}. Thus, since by (39) the temporal index t' of context reduction ${}^{t'}_{?K'_{t_1}}\!\subseteq$ determines that F' historically determines the same set of facts "settled" by F *up to time* $f'(t')$, for every state $\langle w', f'\rangle$ denoted by F' the temporal index t' must be earlier than t_1: $f'(t') < g'(t_1)$. I.e., by (39) F' will still historically determine all those facts out of those settled by F that are located at times earlier than $f'(t')$, while F' will *not* historically determine, or "settle" any of those facts, located at times t'' later than t', that were *historically determined* relative to F. F' therefore allows for consistent update with the counterfactual assumption K'_{t_1}.

By update of F' with K'_{t_1}, the annotating referent G' of the conditional antecedent will then denote a *counterfactual* context $G' :: F + K'_{t_1}$ which historically determines a certain set of facts – those conveyed by F and K'_{t_1} – *up to time* t_1.

Now, if the consequent DRS K''_{t_2} (with annotating referent G'') is located at some time t_2 later than t_1 (i.e. $(\forall\langle w', g''\rangle \in e(G''))(g''(t_1) \leq g''(t_2)))$, which instantiates the type of a

[19]The minimal precedence constraint in (39) is, of course, too strong, since there may be an infinity of temporal instants $\mathbf{t}$ that come closer and closer to $g'(t')$ without ever reaching $g'(t')$. See Lewis(1973).

non–backtracking counterfactual (38a), given that F' settles those facts that are *historically determined (by F) up to time* t', and given $g''(t') < g''(t_1) \leq g''(t_2)$, the truth of K''_{t_2} will in general *not* be historically determined by F'. Update of F' with K'_{t_1} yields a set of (counterfactual) states G' where K' is historically determined at time t_1, such that finally the conditional "test" will succeed iff every state denoted by G' that pertains to a "normal" world can be extended to a state that verifies K''_{t_2}. This implements the type of conditional that obeyes the asymmetry of counterfactual dependence: the way things are later is (conditionally) dependent on the way things are earlier.

On the other hand, if K''_{t_2} is located at some time t_2 earlier than t_1 – this corresponds to the type of backtracking conditionals (38b) – then the temporal index t' of the reduced context F' could in principle be chosen (i) to precede t_2, or else (ii) to follow t_2 – if in (39) we hadn't imposed the constraint that the temporal index t' must be chosen to *minimally* precede the temporal location t_1 of the counterfactual antecedent.

If – in violation of the minimality constraint – t' could be chosen to precede t_2, the truth or falsity of K''_{t_2} would *not* be historically determined relative to F'. By contrast, on the second option, where by the minimality constraint t' is chosen to follow t_2, since F' will *historically determine* the same facts that are settled by F *up to time* t', F' historically determines the truth or falsity of K''_{t_2}, depending on whether or not K''_{t_2} is true relative to F. Thus, on the second option the counterfactual $K'_{t_1} \Rightarrow K''_{t_2}$, with t_2 preceding t_1, will be true only if K''_{t_2} is true, or *historically determined* relative to the factual context F, exactly as claimed by Lewis, while the first option corresponds to an analysis of "backtracking" counterfactuals that Lewis showed to be odd (without an additional *have to* in the consequent clause).

So the concept of *historical necessity*, implemented in terms of (37) and (39) does *only* yield the asymmetry of counterfactual dependence observed by Lewis if the relation of context reduction (39) respects a minimality constraint for the selection of t', such that t' *minimally precedes* t_1, the temporal location of the counterfactual antecedent K'_{t_1} – while still allowing for consistent update with K'_{t_1}. This will rule out option (i) above, where t' is chosen to precede t_2, and thus the unwarranted backtracking counterfactuals.

But there remains a problem which this solution does not address: while option (i) rules out cases of "ordinary" backtracking conditionals, this type of counterfactual is perfectly wellformed provided the consequent clause exhibits an additional modal *have to*. So one might argue that option (i) should perhaps not be ruled out by brute force in terms of the minimality constraint, but conclude, with Lewis, that in certain cases the temporal index t' can be chosen to *not* minimally precede the temporal location of the antecedent DRS.

Counterfactual asymmetry and the selection of a reduced modal base

We will now argue that our analysis of conditionals – in conjunction with the notion of *historical necessity* (37) and the new definition of context revision (39) – accounts for the standard type of wellformed non–backtracking conditionals, as well as *both* the oddity of ordinary backtracking conditionals *and* the perfectly wellformed backtracking conditionals which involve an embedded modal *have to*, by making use of a *minimality* condition for the selection of the temporal index t' to determine a reduced modal base F', as defined by context reduction in (39), or – alternatively – by giving up the minimality constraint and instead constrain the selection of F' (and thus t') in terms of the notion of *relevance.*

Let us first reconsider Lewis' example (40),[20] with a wellformed non–backtracking counterfactual, which is of the first kind considered above in (38a), where the distinguished temporal referent t_1 of the antecedent DRS K'_{t_1} is naturally interpreted to precede the distinguished temporal referent t_2 of the consequent DRS K''_{t_2}. On a counterfactual interpretation (assuming that Jim actually didn't ask Jack for help)[21] K'_{t_1} can only be (consistently) updated relative to a *reduced* context G' of the factual antecedent context G. If for context reduction $G' \overset{t'}{\underset{K'_{t_1}}{\subseteq}} G$ the temporal index t' is chosen to *minimally precede* the temporal location t_1 of the antecedent DRS K'_{t_1}, while allowing for update with K'_{t_1}, G' will still historically determine the information about yesterday's quarrel. Update of G' with K'_{t_1} then determines a context H' where Jim asks Jack for help after yesterday's quarrel, such that *if everything holds that is normal in such a situation*, Jack will not help Jim today.

On the other hand, the fact that there has been a quarrel yesterday is certainly *relevant* for the conditional "test" whether Jack will help Jim if he asks him for help today. So the *relevance* constraint will also constrain the selection of the reduced modal base G' to support that yesterday's quarrel took place, while t' must again be chosen to precede the temporal location t_1 of the counterfactual antecedent K'_{t_1}.[22]

(40) Jim and Jack had a quarrel yesterday.
If Jim had asked Jack for help today, Jack wouldn't have helped him.

F G H
F :: [*x y* / *jim(x)* *jack(y)*]
G :: F + [e t n / e:quarrel(x,y) / yesterday(t) / e $\subseteq$ t t $<$ n]
H :: G + [H′ H″ G′ / $G' \overset{t'}{\underset{?K'_{t_1}}{\subseteq}} G$ / H′ :: G′ + [e_1 t_1 / e_1:ask-for-help(x,y) / today(t_1) $e_1 \subseteq t_1$] $\Rightarrow$ H″ :: H′ + [J / ¬ J :: H′ + [e_2 t_2 / e_2:help(y,x) / $e_2 \subseteq t_2$ $t_1 < t_2$]]]

So in this case – irrespective of whether the choice of G' is determined by a *minimality* constraint for the selection of the temporal index t' for context reduction or else by the criterion of *relevance* – G' will not settle, or *historically determine* the truth or falsity of K''_{t_2}, which by the condition $t_1 < t_2$ is later than t_1. The counterfactual is therefore predicted to obey the asymmetry of counterfactual dependence: the counterfactual conditional tells us that the truth of K''_{t_2} is conditionally dependent on the truth of K'_{t_1}, where $t_1 \leq t_2$.

Lewis' observation was that we cannot have counterfactuals $A > C$ where the antecedent A is tied to a time t_A and the consequent C is tied to a time t_C, such that t_C precedes t_A

[20] Cf. example (27) p. 271 and Lewis(1979:456).
[21] We will not explicitly represent this negative condition in the DRS.
[22] From now on we use the arrow $\Rightarrow$ for universally quantified conditionals. Also, to keep the DRSs reasonably sized, we will not explicitly display the antecedent DRS K'_{t_1} of the counterfactual in the relation of context reduction, but just use the abbreviation $G' \overset{t'}{\underset{?K'_{t_1}}{\subseteq}} G$.

and C is false in the world of evaluation. In such a case, Lewis observes, the counterfactual $A > C$ must bear the "syntactic peculiarity" of an additional modal expression *have to* in the consequent – for which he does not give an explicit analysis, nor any explanation.

(41) vs. (42) roughly correspond to Lewis' example. The antecedent context differs from the one in (40) by the additional information that *Jim is a prideful fellow.*

Let us first consider the "ordinary" backtracking counterfactual in (41), which is odd. If the selection of the temporal index t' for context reduction is constrained by the minimality condition, just as for (40) H' will denote a context were it is *historically determined* that there has been a quarrel yesterday and that Jim is a prideful fellow,[23] and where it is *not* determined whether Jim asked Jack for help today. Since H' historically determines that there has been a quarrel yesterday, (41) is straightforwardly predicted to be false. And again the relevance criterion gives the same results: both yesterday's quarrel and Jim being a proud man are *relevant* facts for the issue of Jim asking Jack for help today. So H' will have to be chosen to settle, or *historically determine* these facts, which will immediately falsify the conditional in (41), given that H' settles the issue of yesterday's quarrel.

(41) Jim and Jack had a quarrel yesterday. Jim is a prideful fellow.
\# If Jim had asked Jack for help today, there would have been no quarrel yesterday.

$$\boxed{\begin{array}{l}
\text{F G H I} \\
\text{F} :: \boxed{\begin{array}{l} x\ y \\ jim(x)\quad jack(y) \end{array}} \\
\text{G} :: \text{F} + \boxed{\begin{array}{l} \text{e t n} \\ \text{e:quarrel(x,y)} \\ \text{yesterday(t)} \\ \text{e} \subseteq \text{t} \quad \text{t} < \text{n} \end{array}} \\
\text{H} :: \text{G} + \boxed{\begin{array}{l} \text{s} \\ \text{s:prideful(x)} \\ \text{n} \subseteq \text{s} \end{array}} \\
\text{I} :: \text{H} + \boxed{\begin{array}{l} \text{I}'\ \text{I}''\ \text{H}' \\ \text{H}' \ {}^{t'}_{?K'_{t_1}}\!\subseteq \text{H} \\ \text{I}' :: \text{H}' + \boxed{\begin{array}{l} \text{e}_1\ \text{t}_1 \\ \text{e}_1\text{:ask-for-help(x,y)} \\ \text{today(t}_1) \\ \text{e}_1 \subseteq \text{t}_1 \end{array}} \Rightarrow \text{I}'' :: \text{I}' + \boxed{\begin{array}{l} \text{J} \\ \neg\ \text{J} :: \text{I}' + \boxed{\begin{array}{l} \text{e}_2\ \text{t}_2 \\ \text{e}_2\text{:quarrel(x,y)} \\ \text{yesterday(t}_2) \\ \text{e}_2 \subseteq \text{t}_2 \quad \text{t}_2 \leq \text{t}_1 \end{array}} \end{array}} \end{array}}
\end{array}}$$

Now what about (42), where we have the second type of *wellformed* backtracking counterfactuals, with the "syntactic peculiarity" of an embedded *have to*?

For the analysis of this type of *apparently* backtracking counterfactuals we will follow our analysis of deontic conditionals in Section 4.1.4, i.e. our claim is that for this type of counterfactuals with embedded *have to* we have to assume an embedded modal operator in the consequent clause, to be interpreted as relative to a *complex* modal base, which is partly established by the annotating context referent of the governing conditional's antecedent. Provisionally, we refer to the – still unknown – additional intensional background context of this complex modal base by use of a context referent L. Finally, we claim that

[23] We'll have more to say about this condition shortly. In any case, we assume that the condition *prideful(x)* is verified at many times t'' earlier than n, and in particular that it persists in the reduced context H' where t' minimally precedes t_1.

– just as for the "ordinary" wellformed non–backtracking (40) and odd backtracking (41) counterfactuals – the selection of the reduced context G' to establish the modal base of the governing conditional is determined by either a *minimality constraint* on the selection of t' for context reduction, or – alternatively – by a *relevance* constraint on G'.

(42) Jim and Jack had a quarrel yesterday. Jim is a prideful fellow. So, if Jim had asked Jack for help today, there would *have to* have been no quarrel yesterday.

In order to show this, we have to go through a chain of hypotheses and falsifications. To facilitate understanding we first give a rough overview of our line of argumentation.

Our first observation is that an analysis of (42) where the temporal index t' for context reduction $H' \, {}^{t'}_{K'_{t1}} \subseteq H$ is chosen to minimally precede the temporal location of the antecedent is somehow contradictory. Since by the minimality constraint it is historically determined by H' that there was yesterday's quarrel, given that Jim is a proud man, he *cannot*, in light of yesterday's quarrel, be consistently assumed to ask Jack for help while acting in accordance with his sense of pride, which is, however, how we interpret the counterfactual (42). The relevant examples that support this interpretation are (43)/(44).

Of course, one could try to circumvent this problem by denying that the minimality condition holds for this special kind of backtracking counterfactuals, and assume that the reduced context H' does *not* historically determine that there has been a quarrel yesterday, just as is argued by Lewis. But this would predict that from (42) we could infer that *If Jim had asked Jack for help today, there would have been no quarrel yesterday*, which is just the kind of ordinary backtracking conditional (41) that is to be ruled out. Moreover, we argue that for (42) selection of a reduced context H' which undoes the existence of yesterday's quarrel is at odds with the relevance criterion.

Another way to confront the problem presented by (42) is to posit that the (implicit) condition that *Jim asked Jack for help while acting in accordance with his sense of pride* is accommodated not within the antecedent or consequent of the embedding conditional structure, but within the restrictor argument of the embedded modal quantification. But we will argue, by way of (45), that this cannot be the right solution.

Our (almost final) account is then that we stick to the minimality or relevance constraint for selection of H', such that it supports the existence of yesterday's quarrel, but go on to argue that the implicit contradiction between Jim having quarrelled yesterday and asking Jack for help today (while acting in accordance with his sense of pride) is only detected *at the level of* and *by means of* the embedded modal quantification, where the complex modal base is constituted by the antecedent context (referent) of the embedding conditional structure, and an additional, deontic–like intensional background context L which specifies conditions for *proud behaviour*. By taking into account both the facts supported by the antecedent context I' (there was yesterday's quarrel, and Jim asked Jack for help today) and what proud behaviour comes down to, we can then derive that there *must not* have been a quarrel yesterday... Yet we just assumed that I' *has to* support yesterday's quarrel, and with I' also the complex modal base for the embedded modal quantifier will determine this fact.

Although it seems as if we were stuck, we are almost done: in (48) we show that this special kind of backtracking counterfactuals relies on a *counterfactual*–like interpretation of the embedded deontic modal, which is finally represented by making use of the special reduction relation $_{?K''}\subseteq$ which we defined for deontic modal quantification in Section 4.1.3, and which differs context reduction defined in (39) in not being subject to the notion of *historical necessity*. The final analysis of (42) is then as in (49), which should perhaps be consulted at this point, to get an idea of where the discussion will lead us.

Assuming, as we do, that for evaluation of the counterfactual in (42) the index t' for context reduction is to be constrained to *minimally precede* the temporal location t_1 of the antecedent DRS K'_{t_1}, it is predicted, just as for (41), that the context H' *historically determines* that there has been yesterday's quarrel, and that Jim is a proud man, while leaving open the issue of Jim asking Jack for help today. Updating H' with K'_{t_1} then yields a context I' where proud Jim asks Jack for help today in light of yesterday's quarrel.

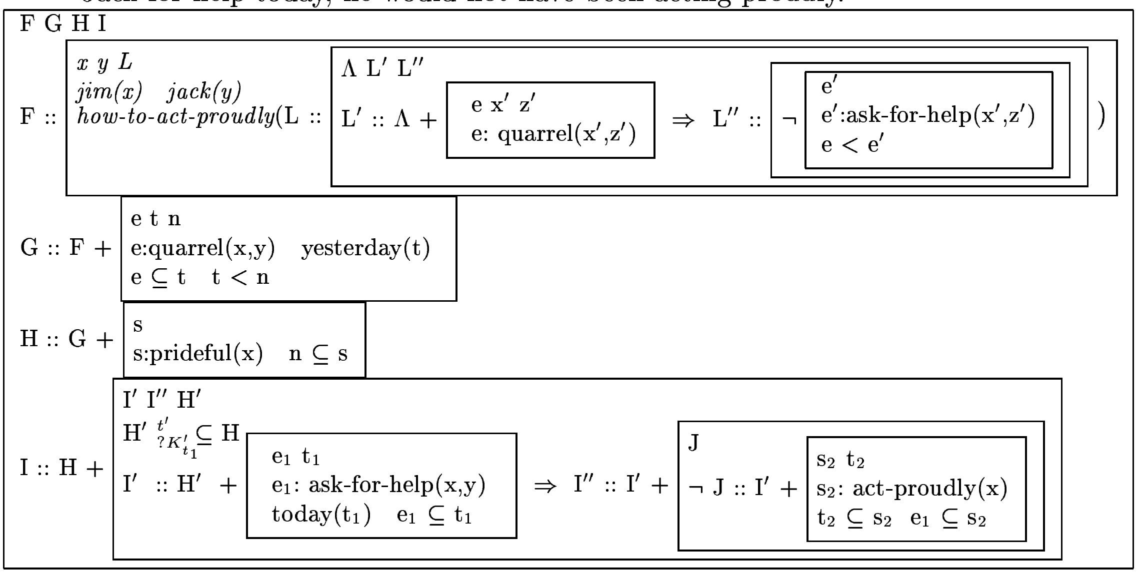
Yet, there seems to be some contradiction: If Jim asks Jack for help in spite of yesterday's quarrel, he cannot be acting in a way that is in accordance with his sense of pride.

But now consider (43). Here the consequent explicitly states that Jim – though being a proud man – assuming that he asked Jack for help after yesterday's quarrel, didn't act in accordance with his sense of pride. So we can – at least for (40) and (41) – assume that the antecedent DRS comes with an implicit condition, that if Jim had asked Jack for help today, he would not have been acting in accordance with pride. Nevertheless, this may still be compatible with him being – in general, and in view of his character – a proud man.

In the tentative DRS representation for (43) we have specified the relevant piece of world knowledge in terms of an (accommodated) condition *how-to-act-proudly*, taking as argument an annotated DRS $L :: K_L$ that consists of a single implicative condition describing proud behaviour: acting proudly means, e.g., that you don't ask for help someone you have been quarrelling with just before.

Choosing the reduced modal base H' in (43) to support this additional condition – together with the fact of yesterday's quarrel and Jim being a proud man – predicts that if Jim had asked Jack for help, relative to H', given what is known in H' about *how to act proudly*, this would not qualify as proud behaviour.

(43) Jim and Jack had a quarrel yesterday. Jim is a prideful fellow. If Jim had asked Jack for help today, he would not have been acting proudly.



On the basis of this observation we can argue that both (40) and (41) are based on the additional piece of world knowledge displayed in (43), and thus that the counterfactual assumption of Jim asking Jack for help after yesterday's quarrel comes together with the additional, implied fact that he cannot, then, on this particular occasion, have been acting in accordance with what is considered proud behaviour. It is evident that our explanation for the oddity of (41) is unaffected by this additional assumption, as is the wellformedness and truth of (40).

Now, for (42) things are still different. Here much more emphasis is put on Jim's being a proud man, such that the interpretation relies on the assumption that Jim not only is a proud person, but in fact would have *acted* in accordance with his sense of pride when asking Jack for help. This is corroborated by (44):

In (44a) the consequent is *disjunctive*, where the second disjunct is just the consequent of the otherwise identical counterfactual in (42). And, as is shown by the oddity of (44b) where the consequent is *conjunctive*, the disjunction in (44a) can only be exclusive: Since both disjuncts are dependent on the same context and the same antecedent clause, the incompatibility evidenced in (44b) must be due to the disjuncts themselves. Since the first disjunct only states that Jim didn't act proudly when asking for help today, we can safely assume that Jim *not* acting proudly when asking for help today is *inconsistent* with the second disjunct (stating that there would have had to be no quarrel yesterday), which is just the scope argument of the counterfactual in (42).

(44) a. Jim and Jack had a quarrel yesterday. Jim is a prideful fellow.
If Jim had asked Jack for help today, either he would not have been acting proudly, or else there would have *had to* be no quarrel yesterday.

b. Jim and Jack had a quarrel yesterday. Jim is a prideful fellow.
If Jim had asked Jack for help today, he would not have been acting proudly and there would have *had to* be no quarrel yesterday.

Therefore we have to assume that in (42) the counterfactual rests on the assumption not only that Jim is a proud man, but also that he would have been acting in accordance with his sense of pride, when asking Jack for help today.

As we argued above, both the relevance criterion and the (temporal) minimality condition for the selection of the index t' for context reduction to yield the reduced modal base H' for (42) constrain this context to settle the fact that the quarrel has taken place, that Jim is a proud man, and additional world knowledge stating implicative conditions, or "rules" on how to act in accordance with pride, in exactly the same way as for (40) and (41).

On the assumption we just argued for, that the issue of (42) is to reason about what is (counterfactually) implied by Jim asking Jack for help where Jim is in fact *acting* in a proud manner, we are naturally driven to assume that this latter condition further restricts the antecedent clause of the counterfactual in (42).

But this confronts us with a problem: according to the relevant piece of world knowledge (the condition on *how to act proudly*) asking Jack for help in the particular situation at issue is in fact *incompatible* with acting in a proud manner. This is just what (43) is about. So if in fact dependent on these assumptions, the counterfactual in (42) should be odd, since vacuously true. But it is perfectly wellformed.

Now, this still cannot mean that the reduced context H' is to be chosen to undo the fact that there has been a quarrel the day before, to allow for *consistent* update with the counterfactual assumption that Jim asked Jack for help while acting in accordance with his sense of pride. If it were, (41) would be on the same footing with (42), licensing the immediate conclusion that *if Jim had asked Jack for help today, there would have been no quarrel yesterday.* Also, we have been arguing that yesterday's quarrel is *relevant* for the issue of what follows from prideful Jim asking for help today.

On the other hand, if H' is chosen to settle the fact that yesterday's quarrel has taken place, the assumption that Jim acted proudly when asking for help today is inconsistent, given what is known about proud behaviour in H'. So we seem to be stuck.

But there seems to be a way out. First, on the basis of (44a) one can argue that in (42) the additional assumption of Jim *acting* proudly is not to be accommodated into the antecedent clause, but locally within the consequent of the counterfactual. (44a) must in fact rely on this assumption (with local accommodation within the second disjunct of the consequent clause) for otherwise either one of the disjuncts will always fail – which does not meet our intuitions.

By this move we could get an explanation for why (42) is only wellformed with an embedded modal *have to*: the (implicit) condition of Jim *acting* proudly could be claimed to be accommodated – not immediately within the consequent of the counterfactual itself – but within the restrictor DRS of an *embedded* modal quantification, as suggested by (45a).

(45) a. If *Jim had asked for help today* then [*if he (had) acted in a proud manner* then *there would have been no quarrel yesterday*].

b. If *Jim had asked for help today* then [*if he (had) acted in a proud manner* then *there would have had to be no quarrel yesterday*].

But this is not yet the whole story. As the contrast between (45a–b) should make explicit, this analysis does not account for the need of an embedded *deontic* modal for this particular kind of counterfactual. (45b) shows that we still need to have an embedded modal *have to* within the embedded structure!

So it seems preferable to follow the structure of our analysis of *deontic conditionals* in Section 4.1.4, where the embedded modal quantification is built on a *complex modal base*, consisting of the hypothetical (epistemically based) context set up by the antecedent of the governing conditional and a *deontic* background context. In the case of (42) then, we take the relevant deontic background context for the complex modal base of the embedded quantification to be provided by the context (referent) L, which represents general conditions for *how to act proudly* (see (43) above). This yields (46) as a paraphrase for (42).

(46) If *Jim had asked for help today*, then [if *taking into account what we know about proud behaviour* and assuming *he (had) acted in a proud manner*, then there would not have been a quarrel yesterday].

Thus, we could argue that the inconsistency between having had a quarrel yesterday and asking for help today while acting in a proud manner is not located within the governing counterfactual structure, but is only "detected" at the level of the embedded quantification, where we have to build a *consistent* complex modal base from the governing counterfactual's antecedent I' and the deontic context L, which characterizes implicative conditions for *how to act proudly.* And in fact, building this complex modal base comes down to what we referred to as the implicit assumption that Jim asked Jack for help *while acting in accordance with his sense of pride.*

...But note that we cannot, in fact, build such a *consistent* complex modal base: the context established by the counterfactual antecedent, where Jim asks Jack for help, still, by the minimality assumption, settles that there was yesterday's quarrel, which immediately contradicts what is characterized by L as proud behaviour!

But here another observation comes in. Consider the contrast in (47). Again the assumption is that the quarrel has taken place yesterday, but now the conditionals are *indicative.* This is most obvious for German, where, in contrast with English, subjunctive conditionals must bear subjunctive mood not only in the consequent, but also in the antecedent clause. Now, the indicative conditionals in (47a), with indicative mood in both the antecedent and consequent clause, are odd, while the parallel cases in (47b) are fine, which – though indicative in their antecedent clause – bear subjunctive mood in their consequent clause.

(47) a. # Wenn Jim Jack jetzt um Hilfe bittet, durften sie gestern keinen Streit haben.
'If Jim asks Jack for help now, they mustn't have had a quarrel yesterday.'

b. Wenn Jim Jack jetzt um Hilfe bittet, *hätten* sie gestern keinen Streit
If Jim Jack now for help asks, would they yesterday no quarrel
haben dürfen.
have may.
'If Jim asks Jack for help now, it should not have been the case that they had a quarrel yesterday.'

In our view these data clearly indicate that in such cases of wellformed "backtracking conditionals" the *embedded* modal quantification involves an aspect of counterfactuality.

So we can argue that nothing speaks against seeing the governing antecedent clause as supporting the fact of yesterday's quarrel: in cases like (47a), then, with *indicative* mood in the consequent clause, an inconsistency arises once the deontic context L, specifying conditions for proud behaviour, is "applied to" the situation at hand by way of the embedded modal quantification, such that the conditional is predicted to be false or odd.[24]

By contrast, cases like (47b) – which correspond to the typical *wellformed* backtracking conditionals with embedded modal quantification – and which bear *subjunctive* mood in the consequent clause, can then be accounted for as usual, as inducing a relation of *context reduction* for the epistemically based context established by the conditional antecedent, to build a *consistent* complex modal base with the context L.

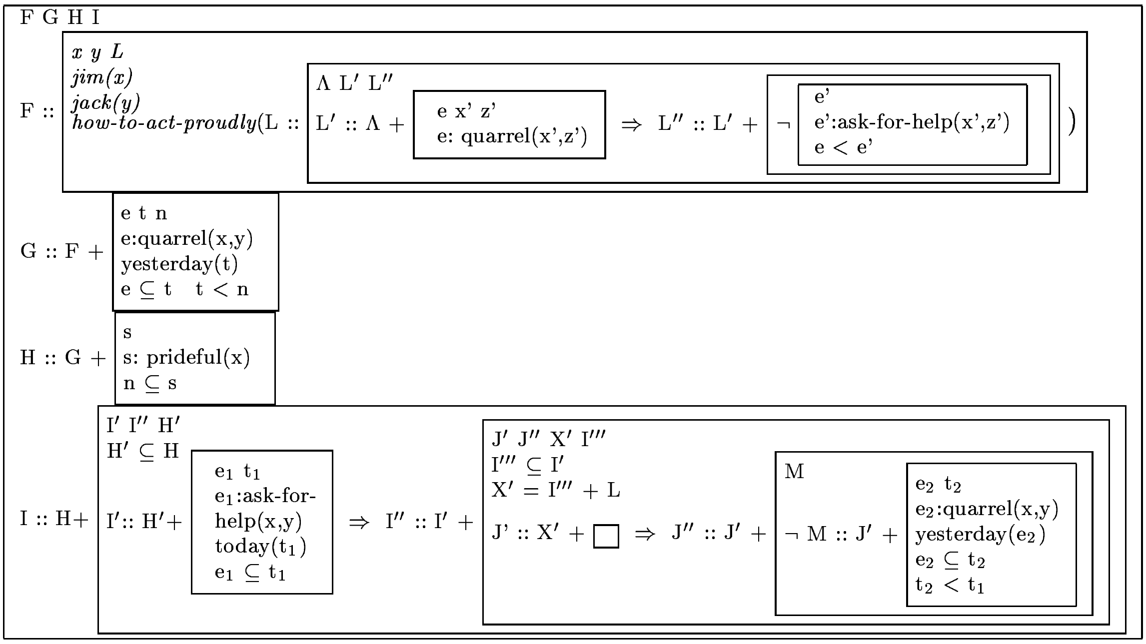
In other words, in cases like (42) – represented in (48) – given that the context established by the counterfactual antecedent cannot build a consistent complex modal base with the deontic background context (here L), the conditional can only be wellformed and true if the conditional's antecedent context is *reduced* to allow for consistent merge with L. It is

[24]See below for a slightly diverging explanation for the oddity of (47a)

this aspect of *context reduction* that is indicated by the use of subjunctive mood in (47b).

So (48) turns out as a (still preliminary) representation of (42), a *wellformed* (apparently) backtracking conditional with an embedded deontic modal quantification, where the embedded consequent is interpreted relative to the complex modal base consisting of the deontic context L, stating relevant implicative conditions that specify what proud behaviour comes down to, and a reduced context I''' of the counterfactual's antecedent context I'.

(48) Jim and Jack had a quarrel yesterday. Jim is a prideful fellow. So, if Jim had asked Jack for help today, there would *have to* have been no quarrel yesterday.



The interesting question is now how to determine the reduced modal base I''' for the interpretation of (48), where we only used the relation $\subseteq$ as defined in Section 3.3.

(48) will only be verified if I''' supports the fact that Jim asked Jack for help today, *but not the fact of yesterday's quarrel.* For only then will the complex modal base $X' = I''' + L$ be consistent, and, moreover, support the conclusion – based on contraposition applied to the implicative condition in L – that there has been no quarrel (shortly) before the time of Jim's asking for help.

If the relation $I''' \subseteq I'$ in (48) is strengthened to context reduction as defined in (39), it turns out that the (maximality) constraint on *historical necessity* that is built into this definition is inappropriate for the present case: according to (39) the temporal index t' for context reduction $I''' \subseteq I'$ must be chosen to minimally precede the temporal location of the antecedent DRS K'_{t_1} to allow for consistent update with K'_{t_1}, and such that every fact that is historically determined relative to I' up to time t' is also historically determined relative to I'''.

Although the antecedent DRS of the embedded quantification is empty, I''' must still be chosen to undo the existence of yesterday's quarrel, to allow for verification of the scope DRS K''_{t_2}. Now, according to the constraint on *historical necessity* that was built into the definition of context reduction in (39), this constrains the choice of t' to minimally precede t_2, the time of yesterday's quarrel, which precedes t_1, the time of Jim asking for help today. For if t' were chosen to be later than t_2, I''' would have to settle every fact that is historically determined, up to time t', relative to I', and therefore yesterday's quarrel! Thus, the temporal constraints on context reduction (39) predict that I''' must be chosen in such a way that along with the fact that there has been a quarrel yesterday at time t_2, it must also undo the counterfactual assumption that Jim asks Jack for help today.

Also the relevance criterion is at odds with the particular selection of I''' and t' that we saw is necessary in order to verify the embedded modal quantification. For even if we could argue that the fact that yesterday's quarrel took place is somehow not relevant for computing the embedded modal quantification, which is in fact not implausible, the problem is again that we have constrained context reduction (39) to obey the notion of *historical necessity*. Once I' is reduced to a context I''' that does not support the condition that Jim and Jack quarreled at time t_2, every fact that is settled by I' and which is later than t_2 is not *historically determined* by I'''. Thus, I''' will not historically determine, or settle the fact that Jim asked Jack for help today, which is however decisive for the verification of the embedded modal's consequent.

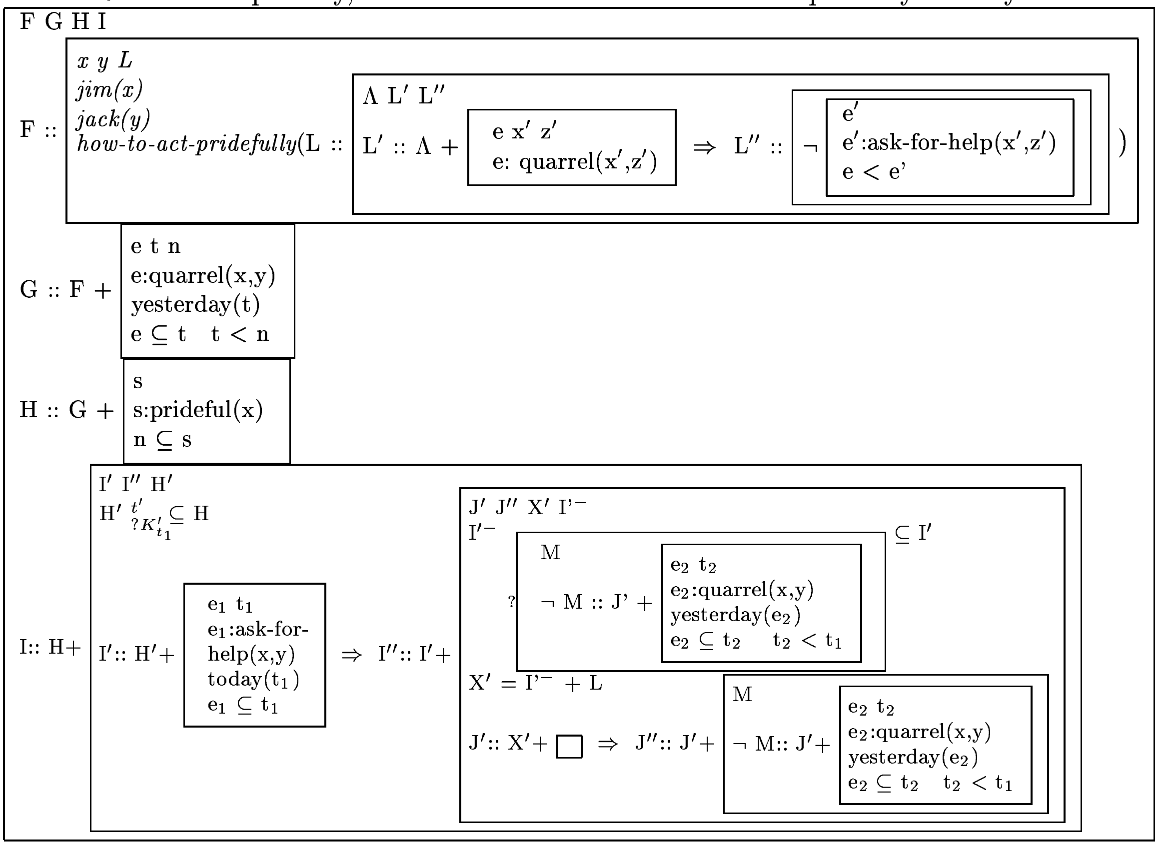
So the selection of the reduced modal base cannot be based on the relation of *context reduction* as defined in (39), which strictly observes the notion of *historical necessity*.

Instead we will, as displayed in (49), resort to the relation of context reduction $_{?K''}\subseteq$, which we made use of for the analysis of deontic modality, and which we did not and will not define to respect the notion of *historical necessity*. This move is clearly motivated by the fact that the class of wellformed backtracking conditionals invariably makes use of the embedded modal *have to* (*dürfen/müssen* in German), which has a preferred deontic meaning. According to our intuition these backtracking conditionals always invoke a "law-like" interpretation, to be understood as "computing" what the world is predicted to (*has to/ought to*) look like if the laws defined by the "deontic" context are observed – irrespective of whether or not these laws are obeyed in the factual (or hypothetical) situation.

So (49) is represented – in full analogy with the analysis of deontic conditionals (see Section 4.1.4) – by building a complex modal base $X' = I'^{-} + L$, where I'^{-} is characterized as a *reduction* of I', the annotating referent of the governing conditional's antecedent, such that the "issue" stated by the consequent DRS K_2'' of the embedded modal, of there not having been a quarrel between Jim and Jack yesterday, is not settled by I'^{-}. Given the definition of $_{?K''}\subseteq$ in Section 4.1.3, p. 186, this predicts I'^{-} not to settle either the truth or falsity of there having been a quarrel yesterday, while still determining that Jim asked Jack for help today, such that by *merge* with the context L (i.e. by assuming that Jim in fact acted in accordance with his sense of pride), based on contraposition, it can be derived that there cannot (must not) have been a quarrel yesterday.

This analysis is finally in accordance with the constraints on sentence mood we set up in Section 3.4: the set of normal worlds that constitute the domain of quantification for the embedded modal quantifier does *not* contain the world of evaluation, which (in virtue of the governing conditional) can only be a world where there has been a quarrel yesterday. This predicts the oddity of the indicative mood of the embedded modal in (47a) in contrast to subjunctive mood, as in (47b).

(49) Jim and Jack had a quarrel yesterday. Jim is a prideful fellow. So, if Jim had asked Jack for help today, there would *have to* have been no quarrel yesterday.



Finally, note that on this analysis the corresponding backtracking conditional (41) *without* embedded modal quantification is still predicted to be odd: since the relation of context reduction $H' \ {}^{t'}_{?K'_{t1}} \subseteq H$ for evaluation of the counterfactual $K'_{t_1} \Rightarrow K''_{t_2}$ with $t_2 \leq t_1$ is constrained in terms of the notion of *historical necessity* and respects either the minimality constraint on the selection of t', or – alternatively – the relevance constraint for the selection of H', H' will support the condition that there has been a quarrel yesterday, which leads to immediate falsification of the consequent DRS K''_{t_2}. Thus, it is *only* by way of the embedded *deontic–like* modal quantification that – by revision of the counterfactual's antecedent context to "undo" facts that precede the temporal location t_1 of the counterfactual assumption, and which by *historical necessity* are settled within the counterfactual's antecedent context – an (apparently) backtracking counterfactual can be verified.

Recall that according to Lewis' analysis the appearance of the "syntactic peculiarity" of an embedded modal *have to* serves as an indication that the "standard resolution of vagueness" (of the relation of overall similarity) is not in force. As such, this is a mere stipulation rather than explanation. And, we may reason, *if* under certain contextual conditions the vagueness of the similarity criterion is resolved in a "non–standard" way, i.e. allows for the selection of worlds where the counterfactual worlds exhibit a past that differs from the actual past, why should such counterfactuals be odd without this "syntactic peculiarity"?

We have tried to give an answer to these open questions, while not necessarily the ultimate answer. Our analysis is much more restrictive than is Lewis's analysis in that the relation of context reduction (39) is constrained to respect the notion of (maximal) *historical necessity.* It therefore successfully accounts not only for the difference between (odd) "ordinary" backtracking conditionals (41) and the "ordinary" cases of (wellformed) non–backtracking conditionals of type (40) which obey the asymmetry of counterfactual dependence. We also account, on the basis of our analysis of conditional deontic modality, for the perfect wellformedness of (apparently!) backtracking conditionals (42) with embedded modal quantification, which – as we have seen – are in fact in full accordance with both (maximal) *historical necessity* and the derived property of *asymmetric counterfactual dependence*, as far as the epistemically quantified conditional structure is concerned. In particular, we have shown that the analysis of all three types of counterfactuals is in accordance with the *analysis–by–fiat* rejected by Lewis, which predicts that the counterfactual worlds must be chosen to coincide with the actual world up to a time t' that minimally precedes the temporal location of the counterfactual antecedent, while allowing for consistent update with the counterfactual assumption.

The analysis of the last type of counterfactuals, (42), clearly showed that we have to distinguish between two types of *context reduction.*

For epistemically based modal quantification, i.e. in particular for subjunctive conditionals, the relation of context reduction must respect the asymmetry of counterfactual dependence as defined by (39), repeated below as (50c). Here the reduced context F' must be chosen to settle the same set of facts that are historically determined by F up to some time t' shortly preceding the temporal location t_1 of the antecedent DRS K'_{t_1}, while allowing for consistent update with the counterfactual assumption. This accounts for the contrast between ordinary backtracking conditionals (41) and non–backtracking conditionals (40), on the assumption that either t' must be chosen to *minimally precede* t_1, while still allowing for consistent update with the counterfactual antecedent DRS, as defined in (39), or alternatively, as we have been arguing when going through the examples (40)–(42), in terms of a *relevance* condition for the choice of F'.

But as we have just been discussing, neither the minimality constraint nor the relevance criterion are appropriate to determine the choice of a reduced modal base for the *embedded* quantificational structure in (apparently) backtracking conditionals, nor will it do for ordinary cases of (conditional) deontic modality (see Sections 4.1.3 and 4.1.4). In these cases *context reduction* is tied to non–epistemic modal quantification, and was defined in terms of the three–place relation ${}_{?K''}\subseteq$ (see p. 186), which we repeat below in (50b), together with the four–place reduction relation that is in accordance with *historical necessity* (50c).

(50) a. $\langle w, e\rangle \models_M F' \subseteq F$ iff $\forall\langle w', f\rangle \in e(F)\ \exists\langle w', f'\rangle \in e(F') : f' \subseteq f.$

b. $\langle w, e\rangle \models_M F'\ {}_{?K''}\subseteq F$ iff $\forall\langle w', f\rangle \in e(F)\ \exists\langle w', f'\rangle \in e(F') : f' \subseteq f\ \&$
$\exists\langle w'_1, f'_1\rangle \in e(F') : \langle w'_1, f'_1\rangle \models_M K''\ \&\ \exists\langle w'_2, f'_2\rangle \in e(F') : \langle w'_2, f'_2\rangle \not\models_M K''.$

c. $\langle w, e\rangle \models_M F'\ {}^{t'}_{?K'_{t1}}\subseteq F$ iff
$(\forall\langle w'', f'\rangle \in e(F'))(\exists\langle w', f\rangle \in e(F))[(\exists f'')(f'' \subseteq_{\{t'\}} f'\ \&\ f'' \subseteq f)\ \&\ w'' \approx_{f'(t')} w'$
$\&\ ((\exists g')({}_{\langle w'', f'\rangle}[\![K'_{t_1}]\!]_{\langle w'', g'\rangle}\ \&\ f'(t') < g'(t_1)$
$\rightarrow \neg(\exists \mathbf{t}')(f'(t') < \mathbf{t}' < g'(t_1)\ \&\ (\exists w''')(w''' \approx_{f'(t')} w''\ \&\ w''' \approx_{\mathbf{t}'} w'\ \&$
$(\exists g'')(\langle w''', g''\rangle \models_M K'_{t_1}\ \&\ g''(t_1) = g'(t_1))))))].$

While our analysis of (counterfactual) conditionals is fairly constrained in that the relation of context reduction (50c) hard–wires the *asymmetry of counterfactual dependence*, it nevertheless leaves room to account for exceptional cases like (51a), which exhibit a violation of asymmetric counterfactual dependence. If in our analysis we decide to resort to the notion of *relevance* to determine a reduced modal base F' in terms of the relation of context reduction (50c) – instead of the *minimality constraint* for the selection of the temporal index t', it is the *vague* and context dependent criterion of relevance that accounts for the contrast in (51a–b).

(51a) is a perfectly natural sentence, no less than the expected (51b), although the time of Clarissa's birth *necessarily* precedes her being 30 years old now.[25]

(51) a. If Clarissa were 30 now, she would have been born in 1966.

b. If Clarissa were 30 now, she would have *had to* be born in 1966.

But according to our intuition (51a) and (51b) are subject to distinct contextual conditions. (51a) is most naturally uttered in a context where the speaker either doesn't have very firm beliefs as to Clarissa's date of birth, or else does have firm beliefs about it, but is ready to suspend them in the context of (counterfactual) conditional reasoning. Thus, if based on the criterion of *relevance*, rather than on the minimality constraint as in (50c), the reduced modal base for evaluation of (51a) will in fact not settle the date of Clarissa's birth, such that by *hypothetical* assumption that Clarissa is 30 now, it necessarily follows that her date of birth is/would be 1966, if the sentence is uttered in 1996.

By contrast, on our intuition, (51b) is characteristically used in a context where the speaker is firmly convinced that Clarissa is not 30 years old, given his firm beliefs about her date of birth, which is not 1966, and – in the particular context in which the counterfactual is uttered – is not prepared to suspend this belief for counterfactual reasoning. Thus (51b) could find a natural continuation like *And this is not possible, since she told me she was born during the 1968 student revolution.* If the reduced modal base is therefore chosen to settle the fact that Clarissa was born in 1968 during the student revolution, it necessarily follows that, *given arithmetical laws*, she would have *had to* be born in 1966 – which contradicts the date of birth that is settled by the context of the governing conditional's antecedent. On the basis of our analysis of embedded non–epistemic modality the embedded *complex* modal base of the embedded quantification must rely on a *reduction* of the governing counterfactual's antecedent context where the "issue" settled by the consequent DRS K''_{t_2}, that Clarissa was born in 1966, is undone ($F' {}_{?K''_{t2}} \subseteq F$). And this can only succeed if any contradictory assumption about her actual date of birth is retracted from F. It then follows from F', i.e. on the assumption that Clarissa is 30 years old now (in 1996), together with *arithmetical laws*, that she has been/would have to have been born in 1966.

To conclude this Section we would like to focus on the following aspects:

We have reviewed Lewis' arguments for an analysis of counterfactual conditionals in terms of a contextually determined relation of "overall similarity", which was refined, in

[25]Further examples are given in (i).

(i) a. ? If I were done by now, I would have started much earlier.

b. ? If Caesar had been in the Vietnam war, he would have been born in our century.

Lewis(1979), in a way to capture the asymmetry of counterfactual dependence. Our discussion brought out that Lewis' arguments against the *analysis–by–fiat* are not really convincing: we have argued that counterfactuals such as (29), with non–determinate temporal location of the counterfactual antecedent, though vague wrt. the particular instantiation of the indefinite temporal variable, nevertheless strictly obey the characteristic of asymmetric counterfactual dependence (see (32)). Also, we tried to show that our intuitions about the truth of counterfactuals are intimately tied to the specific time structure and the causal laws that govern our actual world, and that reference to worlds with different time structure therefore cannot really be taken as a counterargument to invalidate the *analysis–by–fiat*.

We therefore have chosen, in our analysis of (counterfactual) conditionals, to only consider possible worlds that are consistent with the temporal and causal laws that govern our actual world, and therefore are in accordance with the notion of *historical necessity* of Kamp(1978) (see also Thomason(1984)). The relation of context reduction (39) for *epistemically based* (subjunctive) conditionals was defined in close analogy with the *analysis–by–fiat* rejected by Lewis, by resorting to the notion of *historical necessity*: the reduced modal base F' for evaluation of the counterfactual $K'_{t_1} \Rightarrow K''_{t_2}$ is defined to *historically determine* a set of facts that are determined by the factual antecedent context F *up to a time* t' that (shortly) precedes the temporal location t_1 of the antecedent DRS K_{t_1}. By further restricting the selection of F' by constraining t' to *minimally precede* t_1, or else in terms of a *relevance* condition for the selection of F' this yields the asymmetry of counterfactual dependence, i.e. the contrast between "ordinary" non–backtracking (40) vs. backtracking conditionals (41).

Finally, we consider our analysis of the asymmetry of counterfactual dependence to be superior to Lewis' account in that it characterizes (apparently) backtracking counterfactuals of type (42), with an obligatory embedded modal *have to* as being in fact not a case of backtracking. Lewis' analysis predicts that these conditionals are based on "non–standard resolution of overall similarity", i.e. as being tied to a set of worlds that are *not* in accordance with the asymmetry of counterfactual dependence. Our analysis of this special type of counterfactuals is analogous to our analysis of conditional deontic modality and in fact *respects* the asymmetry of counterfactual dependence.

5.2 *Normalcy*–restriction of conditional sentences

5.2.1 Vagueness and variability of conditionals and the notion of *normalcy*

The analysis of the *asymmetry of counterfactual dependence* brought out that the selection of a reduced context F' for update with the counterfactual antecedent DRS K' can be assumed to be determined by the criterion of context dependent *relevance*. This is in accordance with the results of Section 4.3.1, where we argued against the notion of maximal "overall similarity" to govern the selection of accessible worlds for the evaluation of (indicative and) counterfactual conditionals. The range of data we reviewed there led us to the hypothesis that it is preferable to ground the analysis of counterfactuals – and of indicative conditionals – in the notions of *contextually determined relevance* and *contextually determined normalcy* – and, in view of the previous Section, in the notion of *historical necessity*.

The aim of the present Section is to clarify why we want to distinguish between these notions of *relevance* and *normalcy*, and to give a brief sketch of our overall account of conditional vagueness and variability. We will then, in Sections 5.2.2 to 5.2.4, investigate in more detail the notion of *normalcy*, where we will review two selected approaches to *genericity* and *nonmonotonicity*, and finally, in Section 5.3, defend our initial position, pronounced in Section 5.1.1, that the *variability* of conditionals is just another side of the same "coin" that is the context dependent *vagueness* of conditionals, but where the vagueness (or normalcy restriction) is subject to *variation* in a dynamically evolving context.

At various places we came up with arguments against the (maximal) similarity approach to (indicative and subjunctive) conditionals. Not only did we show that the Lewis construction for (counterfactual) conditionals in terms of a sphere system based on the similarity relation is inappropriate for an adequate analysis of sequences of variably strict conditionals with conflicting defaults within a dynamically evolving discourse. We also reviewed various examples brought up in the literature against the similarity criterion itself (see in particular Section 4.3.1), and we investigated in some detail the theory of counterfactuals in Ginsberg(1986), which builds on the similarity assumption. This discussion brought out that any theory of conditionals that is based on the notion of similarity must in fact resort to a very inhomogeneous notion of similarity, to be broken down into distinct – and more or less motivated – criteria for similarity, plus extraneous mechanisms, to get the data right.

When discussing these problems we also illustrated that it is much more natural to characterize the selection criteria underlying the accessibility function of conditionals in terms of the – vague and context dependent – notions of *relevance* and *normalcy*. And the results of the previous Section corroborate the importance of the notion of *relevance* for the analysis of the asymmetry of counterfactual dependence.

But why do we want to distinguish between these two concepts of *contextually determined relevance* on the one hand, and *contextually determined normalcy* on the other, to govern the selection of the quantificational domain of a conditional? Couldn't it just be that the quantificational domain of a conditional is pragmatically restricted to contextually *relevant* worlds where everything holds what is considered to be *normally* the case in a situation where the antecedent is true? In other words, couldn't it be that the restriction to *normal worlds* can just as well be imposed as a further criterion for the selection of *contextually relevant* worlds for the evaluation of a conditional?

The notion of *contextually determined relevance* was argued, in Section 4.3.1, to determine the selection of a relevant (reduced) modal base for the evaluation of a (counterfactual) conditional, relevant in view of the particular pragmatic conditions that characterize the actual context in which the conditional is uttered.

An example we had considered in Section 4.3.1 was (52). Here the selection of a *relevant* (reduced) modal base $X' \subseteq F$ of the antecedent context F is determined by the particular pragmatic conditions of the utterance context:[26] whether we judge (52a–b) true or false crucially depends on whether we are investigating the possible actions of Caesar, placed into the Vietnam war as a general of the ancient world, with knowledge of ancient weapons only, or else his possible actions if not only placed in the time and place of the Vietnam war, but also on the supposition that he possesses that time's knowledge of modern weapons.

[26]In the following we will only make use of the general relation of context reduction in (50a) instead of the more correct reduction relation (50c) that respects the notion of *historical necessity.*

(52) a. If Caesar had been in Vietnam, he would only have used catapults.

b. If Caesar had been in Vietnam, he would only have used nuclear weapons.

Applied to (52) the above question comes down to the following: Could it be that the *normalcy restriction* – to constrain the domain of quantification to a set of *normal* worlds where the antecedent is true in the context of the modal base – is already covered by the selection of a *relevant* modal base, in that this selection comprises only "normal" worlds?

The answer seems to be *no*. It is evident from example (53) that – within the general restriction to a *contextually relevant* reduced modal base (here taking into account only worlds where Caesar has knowledge of the weapons of the ancient world, but not of modern ones) – there is still room for *vagueness*, or *variability* of conditionals, which is best explained on the basis of *contextually determined normalcy*: Among the worlds where Caesar is placed into the Vietnam war and where he has knowledge only of the weapons of the ancient world – this is the pragmatic "issue" – *and where everything holds that normally holds in such a situation*, he would only use catapults. But if reckoning with slightly more exceptional worlds – still within this general restriction to *relevant* worlds where he has knowledge only of ancient weapons – where he knows the secret of the Gauls' magic potion *and everything else holds that normally holds in such a – somewhat more exceptional – situation*, things would turn out differently again, and so forth.

(53) If Caesar had been in Vietnam, he would only have used catapults.
But if he also knew the secret of the Gauls' magic potion, he wouldn't have used any weapons at all.
But if then someone had told the secret, he would have used catapults after all.

Of course, one could argue that the individual conditionals in this sequence are interpreted relative to *distinct relevant* modal bases, which are appropriate for these increasingly specific "issues". Yet, such a view will not allow for a satisfactory analysis of conditional variability, which we didn't yet address. Without going into too much detail at this point, it is quite evident, in light of Section 3.4, that such sequences are a challenge for any *anaphoric* analysis of modal subordination: While the antecedents of these conditionals are related in terms of anaphoric dependencies, and thus call for an analysis in terms of modal subordination, none of these subordinated conditionals can be interpreted by use of the very same set of worlds that constituted the quantificational domain of the preceding conditional, or even of some subset of that set, for the successive consequents are conflicting.

This problem will be dealt with by our *anaphoric* analysis of modal subordination in that we distinguish between a *contextually relevant* modal base X', which – by update with the conditional's antecedent DRS K' – determines a context referent G' that denotes the context dependent *intension* $e(X' + K')$ of K', while the *normalcy restriction*, defined by the selection function $*(w, e(X' + K'))$ in the verification condition for modally quantified structures (see Section 3.3), further restricts the domain of quantification for the modal operator to the subset of the states denoted by G' that are tied to worlds w' where *everything holds that is normally the case, in w, in a context X' where K' holds true*, with w the world of evaluation. This basic approach allows for a successful analysis of conditional variability. For more detail see Section 5.3.1.

Another – somehow reversed – example that points to a necessary distinction to be made between a *relevance criterion* for the selection of the modal base on the one hand and a *normalcy restriction* to further constrain the quantificational domain of the modal quantifier on the other is (54).

We saw that in (52a–b) it was possible to have conflicting consequents for *identical* antecedent clauses on the basis of different (reduced) modal bases X'_1 and X'_2, which are determined by distinct criteria of contextually determined *relevance.* The conditionals (54a–b), however, again with identical antecedent clauses but conflicting consequents, are most naturally understood to be tied to the very same kind of pragmatic contextual setting. Now, in this case it is not possible to have conflicting consequent clauses for identical antecedent clauses: If the interpretation of (54a–b) is determined by one and the same criterion of contextual relevance, (54a) and (54b) cannot both be true.

The reason is that the *normalcy selection function*, which we make use of to further constrain the quantificational domain, is defined to be *context dependent.* The verification conditions for modally quantified structures in Section 3.3 define the context (set of states) in the second argument of * as the update of the (possibly reduced) modal base X' with the antecedent DRS K': $*(w, \{\langle w'', g'\rangle : \exists\langle w'', x'\rangle \in e(X')$ s.th. ${}_{\langle w'', e_{\prec_G} \cup x'\rangle}[\![K']\!]_{\langle w'', g\rangle}\})$, which we stated, throughout, by use of the somewhat imprecise notation $*(w, e(X' + K'))$, for given verifying function e. Since by assumption X' is the same in (54a–b), and obviously K' is, too, the normalcy selection function will yield the same set of normal worlds, and thus for both conditionals the quantification will range over the very same set of *contextually relevant* and *normal* worlds, such that these conflicting conditionals cannot both be true. Only if the antecedent DRS is further constrained to a more specific DRS K'', as in (54c), the normalcy accessibility function may yield a different set of normal worlds to restrict the quantificational domain, now determined by $*(w, e(X' + K''))$, such that (54a) and (54c) can both be true *while still tied to the same relevant context* X'.

(54) a. If Nixon had pressed the button, there would have been a nuclear holocaust.

b. If Nixon had pressed the button, there would not have been a nuclear holocaust.

c. If Nixon had pressed the button, but the machinery had been disconnected, there would not have been a nuclear holocaust.

In sum then, the contrast between (52) (where it is plausible to assume contextually distinct criteria of *relevance* and thus distinct modal bases for the a. and b.–examples) and (54) (where this is not so evident) provides further support for our analysis, where we distinguish between the two notions of *relevance* and *normalcy* that contribute to the determination of the quantificational domain for modal operators.

We therefore follow the view pronounced above, that (i) the selection of the modal base for the evaluation of modally quantified structures is to be determined by the notion of *contextually determined relevance*, and that (ii) the denotation of the modal quantifier is further restricted, in terms of the notion of *contextually determined normalcy*, to a subset of "normal" worlds (or states) out of those denoted by the antecedent context referent.

While the latter notion is implemented in terms of the *normalcy selection function* $*$ in the verification conditions for modally quantified structures (see Section 3.3), the former does not contribute in any way to the semantic, or logical form we assign to these structures.[27]

Having been silent about the notion and the formal properties of this normalcy restriction so far, we now turn to investigate it in detail. The notion of normalcy we will finally adopt closely follows the one of Morreau(1992) and Asher&Morreau(1991,1995), where the function $*$ assigns, to a world w and a proposition p, "the set of worlds where p holds along with everything which, at w, is normally the case where p holds" (A&M(1995:311)).

In our analysis of modal constructions the *normalcy selection function* $*$ is defined to be *context sensitive*, being dependent not only on the evaluation world w and the denotation of the antecedent DRS K' (corresponding to p in Morreau's analysis), but in addition on the (possibly reduced) modal base X': $*(w, e(X' + K'))$. The accessibility function yields, for these two parameters, a set of world–sequence pairs where "everything holds that is considered, in w, as the *normal course of events* in a context X' where K' holds true".

In order to be in a position to state formal constraints on the selection function $*$ we will have to investigate the concept underlying the phrasings *normally* or *what is to be considered the normal course of events.* The most promising area one can think of when trying to get closer to the meaning of *normally* is the literature on generics.

In the next Section we will focus on the intimate relationship that has been observed between conditionals and generic sentences. We will then, in Section 5.2.3, discuss some selected approaches to generics and nonmonotonicity, which will help us to substantiate the formal concept of *context dependent normalcy* in our DRT–analysis of conditionals.

5.2.2 "Normally": Conditionals and generic sentences

When in the following we use the term "generic sentences", we intend to refer to the so–called *object–referring* generic sentences, such as (55), as opposed to so–called *kind–referring* generic sentences, exemplified by (56) (see Krifka et al(1995)). Another way to distinguish these cases is Krifka's terminology, who distinguishes between *i–generic* (55) and *d–generic* (56) sentences (Krifka(1988)). The difference is explained, in Morreau(1992), as follows:

> The prefixes stand for "definite" and "indefinite", names chosen in order to reflect the ways in which, according to Krifka, sentences of these types are typically expressed in natural language. The distinction he seems to have in mind is, however, very much a semantic one: d–generic sentences attribute to a kind a property which cannot, without making a category mistake, be attributed to an individual of that kind. *Dinosaurs are extinct* is an example of a d–generic sentence [...]
> [...] i–generics: sentences in which a property is attributed to a kind which could in principle also be had by individuals of that kind. Morreau(1992:48)

(55) Potatoes contain vitamin C, amino acid, protein and thiamin. Morreau(1992:48)

(56) Dinosaurs are extinct. Morreau(1992:48)

[27] Although *in principle* we could impose an explicit relevance constaint on the relation of context reduction $X' \subseteq F$ in terms of, e.g., a DRS condition *relevant(X')*, we will not do so. The notion of *relevance* is a general, genuinely pragmatic notion, not specific for conditionals, which we therefore assume to be applied independently, to yield a relevant reduced context X' for evaluation of a (counterfactual) conditional.

If restricted to *object–referring*, or *i–generic* sentences, the main concern of a semantic analysis of generic sentences is to specify in which way the truth of a generic sentence about a certain kind of individuals depends on the properties to be observed with individuals of this kind.[28] The most pervasive characteristic of generic sentences is that they allow for exceptions: *Birds fly* is considered true, although many of them do not, such as penguins, or birds with broken wings. And also, *Potatoes contain vitamin C* is a true generalization, "even though large numbers of them are boiled for so long that it is lost. Potatoes would still contain vitamin C if *all* of them were to be boiled for so long that it is lost." (Morreau(1992:50)).

The analysis of generic sentences is closely related to the analysis of conditional sentences in a variety of ways, where the most important aspect, for our present concerns, is the aspect of nonmonotonicity. There is, however, still another striking parallelism between generic sentences and conditionals, which is tied to Kratzer's notion of *relative modality.*

Generic sentences: Vagueness, variability and relative modality[29]

(i) Quantificational (tripartite) structure. While earlier semantic analyses of genericity made use of a "monadic" genericity operator **Gn**, applied to a verbal predicate,[30] it has now become standard to interpret generic sentences in terms of a dyadic operator, or tripartite quantificational structure, consisting of a restrictor, a scope, and a quantifier relation holding between these two arguments.[31]

Among the arguments to support a quantificational analysis of generic sentences the following is prominent:

Carlson(1989) pointed out that generic sentences can give rise to ambiguities: (57) can be understood as a generic statement about either typhoons (they typically arise in this part of the pacific), or about this part of the Pacific (it is typical for it that typhoons arise in it). This kind of ambiguity cannot be represented by use of a monadic genericity operator.

(57) Typhoons arise in this part of the Pacific. Krifka et al(1995:24,25)
a. For typhoons it holds [in general]: They arise in this part of the Pacific.
b. For this part of the Pacific it holds [in general]: There arise typhoons.

By contrast, with a dyadic operator **GEN** the two readings can be represented as in (58), where the restrictor part is filled by semantic conditions corresponding to the phrases *typhoons*, or *this part of the Pacific*, respectively.[32] Much work is devoted to find out which principles and restrictions govern the semantic partition of material into restrictor and scope, e.g. Diesing(1988, 1992), Kratzer(1995), Krifka(1995), Rooth(1995), yet we will not go into any of these questions.

[28] *If* one assumes that generic sentences have truth values, which is not the case for all theories of genericity.

[29] This paragraph essentially relies on Krifka et al(1995), in particular pp. 23–27, 30–36 and 43–63.

[30] See Krifka et al(1995) for references.

[31] Reference is made to Lewis(1975), Kamp(1981), Kratzer(1981), Heim(1982), Farkas & Sugioka(1983), Rooth(1985), ter Meulen(1986), Schubert & Pelletier(1987) and Declerck(1988), which for generic sentences containing a conditional or *when*–clause assume a dyadic operator. Heim(1982) is cited as the first analysis of indefinite generic NPs using a dyadic operator.

[32] In (58a–b) only x, the variable that precedes the semicolon in $[x; y]$ is bound by the generic quantifier. Variables that follow the semicolon are existentially quantified in the matrix (see Krifka et al(1995:26)).

(58) Typhoons arise in this part of the Pacific. Krifka et al(1995:26)
a. **GEN**[x;y](x **are typhoons;** y **is this part of the Pacific** & x **arise in** y)
b. **GEN**[x;y](x **is this part of the Pacific;** y **are typhoons** & y **arise in** x).

The analogy with the analysis of conditionals is evident: taking seriously the observations of Lewis(1975) and Kratzer(1978,1991) we have strongly favoured an analysis of conditionals in terms of generalized quantification, i.e. in terms of a tripartite structure. And, as has been noted by Partee(1991), also conditionals are subject to ambiguities that arise from the partition problem, which she argues to be governed by the distribution of topic and focus. The example she is referring to is Dretske's (Dretske(1972)).[33] As for the particular use of a genericity operator **GEN** for generic sentences, as opposed to a universal quantifier for (implicitly) universally quantified conditional sentences, see below (ii) and (iii).

(59) a. If Clyde hadn't married BERTHA, he would not have been eligible for the inheritance.

b. If Clyde hadn't MARRIED Bertha, he would not have been eligible for the inheritance. Partee(1991:8)

A final, important parallelism between the analysis of generics and conditionals in terms of quantificational structures regards the determination of the restrictor part, which is heavily dependent on pragmatic conditions. While we have already seen this for conditionals (recall the case of Caesar being placed into the Vietnam war), this is also argued to be the case for generic sentences: A restricted generic sentence such as (60a) is naturally analyzed as not quantifying over an individual variable, but rather a situation variable s, which is restricted to situations s where Mary comes home. This is based on Kratzer's(1995) theory, which predicts the availability of a situation variable with episodic verbs.

Now, for a non–restricted generic sentence such as (60b), if a tripartite quantificational analysis is assumed, the question arises as to which conditions – if any – must be assumed to fill the restrictor argument. Here several theories (e.g. Krifka(1987), Schubert & Pelletier(1989)) assume a pragmatically determined restriction argument, as displayed in the logical form of (60b).

(60) a. Mary smokes when she comes home. Krifka et al(1995:30)
GEN[s,x;](x = **Mary** & x **comes home** in s; x **smokes** in s)

b. Mary smokes.
GEN[s,x;](x = **Mary** & s **is a normal situation with respect to smoking** & s **contains** x; x **smokes** in s) Krifka et al(1995:31)

[33] A possible situation where the two counterfactuals differ in truth value is one where Clyde married Bertha, Clyde and Bertha had been living together for a long time without having decided whether they should marry, and where Clyde's father had pronounced the will that Clyde must be married in order receive the inheritance, irrespective of whom he might marry. In such a situation (59a) is false, while (59b) is true.

Similar observations are made by Morreau(1992:65,66), who discusses an apparent counterexample brought up by Carlson(1977) to disclaim an analysis of generics in terms of universal quantification over "normal" individuals:[34]

> *Chickens lay eggs* is a true sentence. ... We also know it to be true that only female chickens lay eggs. It then follows that only female chickens can be included among the normal chickens; if any males were allowed [then *chickens lay eggs* ... MM] would be falsified. So we know that all normal chickens are female. Since all female chickens that lay eggs are hens, the following sentence is predicted to be true: *Chickens are hens.* But [this sentence] is simply not true. Carlson(1977:64,65), cited from Morreau(1992:65)

Morreau argues correctly that the problem with the egg–laying chickens is not universal quantification over normal chickens, but the general problem of determining the restrictor argument of a quantifier: it is a problem also for explicitly universally quantified sentences such as *Everybody joined the meeting*, or *John always feeds the cat*, which does not mean that John feeds his cat *all the time*. So, Morreau concludes, "chickens lay eggs does not mean that all normal ones do; it just means that all normal hens do." (Morreau(1992:66)). (See also Krifka(1995), Rooth(1995)).

A similar case is Arnauld's sailor example, again discussed by Carlson as constituting a problem for the quantificational analysis of generics as universal quantification over normal individuals. "suppose *Dutchmen are good sailors* is true. Then by "all normal" truth conditions, all normal dutchmen are good sailors. So, Carlson argues, since every good sailor is a sailor, it follows that all normal Dutchmen are sailors." (Morreau(1992:66)). Again, the point is that the quantified structure must be pragmatically restricted to *sailing Dutchmen/Dutchmen who are sailors.*

This line of reasoning is also pursued in McGivern(1995), where the tripartite structure posited for generic sentences is assumed to be governed by a topic/focus distinction for the partition problem. Yet, he observes that this does not fully capture the meaning of generic sentences and therefore – besides the notion of a *restricted generic* reading – introduces, for habitual sentences of the type (60b), an *unspecified DRS* $\mathcal{D}$, to instantiate the restrictor DRS of the generic quantificational structure: "This unspecified DRS is meant to represent some unknown conditions which hold when Fido indulges in cat–chasing. [His example is: *Fido chases cats*]" (McGivern(1995:54)). Although it remains unclear how to identify such conditions, this seems to be directly in line with the general strategy to assume a pragmatically constrained restrictor argument.

(ii) "Normally": tolerating exceptions. Besides the general tripartite quantificational representation format, there is an even more important characteristic that closely relates generic and conditional sentences: they allow for exceptions.

As we have seen, conditional sentences make (universal) claims about possible situations (or worlds) of a given type, while being fully compatible with exceptional situations that

[34]Here we anticipate a bit as to the particular type of quantification postulated by some theories of genericity, the so–called "normalcy theories", in Morreau's terminology. What is at issue now is essentially the determination of the restrictor argument, irrespective of the particular quantificational relation.

defeat the truth of the conditional consequent. In much the same way, many generic sentences can be understood to make claims about individuals of a particular kind, while being fully compatible with there being individuals of this very kind that do not satisfy these claims. It is in this respect that we can consider (61a) and (61b) as related constructions.

(61) a. If something/an animal is a bird, it can fly.

b. Birds can fly.

So it seems that the genericity operator **GEN** to be assumed for (61b) is to be interpreted on a par with the (implicit) universal quantifier of the conditional (61a), with a common proviso for dealing with the defeasibility, or nonmonotonicity inherent to both constructions.

But it has been pointed out, by Schubert&Pelletier(1987), that a defeasible universal quantification does not correctly account for the "multiple degrees of falsification" different generic sentences allow for: according to Schubert and Pelletier, the relevant "degrees of quantification" for (62a–d) would be *all, most, some small percentage*, and *almost none*, respectively. So it seems that the genericity operator cannot be reduced to one of the standard generalized quantifier relations.

(62) a. Snakes are reptiles.

b. Telephone books are thick books.

c. Frenchmen eat horsemeat.

d. A turtle lives a long life.

Now note that the very same differences in degrees of defeasibility can also be observed with conditional sentences: here the relevant "degrees of quantification" would be *all, most, many,* and *some very small percentage.*

(63) a. If John rides a unicycle, he towers above other people who walk on the ground.

b. If John comes to work late, it is because he stayed up late the day before.

c. If you come to England, you'll see many people queuing at the bus stations.

d. If you come to France, you'll meet people eating horsemeat.

It is then not surprising that for both conditional and generic sentences reference is made to the concept of *normality*: We already have seen that there is some appeal in reading conditional sentences as saying "if ϕ then *normally* ψ", and it is equally natural to understand a generic sentence *an* α *has property* β as saying: *an* α *normally has property* β, or *a normal* α *has property* β. Let us again cite Morreau(1992) to underpin this view:

> The view that generic sentences involve universal quantification is recurrent in logic, philosophy and linguistics. Quine notes in *World and Object* that "sometimes the plural form of a general term does merely the work of the singular form plus *every*; thus 'lions like red meat' ". That the quantification must then be over normal or typical individuals seems almost inevitable, since generic sentences including Quine's can be true even where there are exceptions. This idea that generic sentences make claims about normal individuals has such a long pedigree in philosophy that any list of references has to be arbitrary. It is there in an article by John Bacon called "Do Generic Descriptions Denote?" It was there centuries earlier in the Port–Royal Logic, and with not too much imagination its earliest antecedent is Plato's doctrine of Ideas. In the linguistics literature it is common too, just one reference here is Östen Dahl in "Generics". This view of what goes to make generics true I take to be essentially correct. Morreau(1992:64)

Given the striking parallelism between conditionals and generics it is not surprising that there have been various approaches to give an analysis of (the defeasibility of) generic sentences in terms of conditional logic. The most prominent ones which are important for our present concerns are the so–called "normalcy theories" of Delgrande(1987,1988), Asher&Morreau(1991,1995) and Morreau(1992), which are tied to a possible worlds framework, as opposed to the nonmodal Circumscription theory of McCarthy(1980,1986), as well as theories of "default reasoning" (e.g. Reiter(1980)) and e.g. Channel Theory (Barwise(1993), Barwise&Seligman(1993)).[35]

Common to the modal *normalcy* theories of generics is that they involve quantification over, or statements about "normal" individuals ϕ, to have a property ψ.[36] The connection to conditional sentences is made explicit in Morreau(1992):[37] "generics are universal statements about normal individuals. Generics are interpreted as very weak, universally quantified counterfactuals." (Morreau(1992:88)). Similarly, Delgrande(1987,1988) refers to the notion of "normality" to get at a conditional logic of genericity: "The intended interpretation of $\alpha \Rightarrow \beta$ is "if α then normally β" [...] In this logic then one can represent statements such as "ravens are normally black" (Delgrande(1988:68)).

There are, however, important differences between these modal normalcy theories of genericity as to the degree of parallelism they posit between generic sentences and conditional logic with respect to their interpretation and inference patterns. This will be discussed in more detail in the next Section. Before, in (iii) and (iv), we will complete our review of the parallelism between generic and conditional sentences.

(iii) Nonmonotonicity. The main characteristic of generic and conditional sentences, due to their inherent relativization to *normal* individuals or possible situations, is *nonmono-*

[35] Krifka et al(1995) discuss further classes of semantic theories of genericity in terms of (i) quantification over relevant entities (Declerck(1991)), (ii) quantification over prototypes, and finally (iii) analyses of generic sentences as expressing stereotypes.

[36] Morreau(1992:144) gives a formal characterization of a "normalcy theory", which is, however, not essential for our discussion.

[37] We continue to refer to the much more detailed discussion in Morreau(1992), while the essentials of Commonsense Entailment are already in place in Asher&Morreau(1991), and are further elaborated in Asher&Morreau(1995).

tonicity in the antecedent: from $\phi > \psi$ we cannot conclude that $\phi \wedge \chi > \psi$. As illustrated by (64) and (65), this property is common to both conditionals and generics.

Nonmonotonicity in the antecedent:

(64) If there's sugar in your coffee, it will taste good.
If there's sugar and diesel–oil in your coffee, it will not taste good.

(65) Birds fly.
Fledglings are birds, but do not fly.

As a consequence, we do not have transitivity as a valid inference with nonmonotonic conditional or generic sentences.

Transitivity:

(66) If J. Edgar Hoover had been born a Russian, then he would have been a Communist.
If he had been a Communist, he would have been a traitor.
$\not\vdash$ If he had been born a Russian, he would have been a traitor. Lewis(1973:33)

(67) Birds fly.
Penguins are birds.
$\not\vdash$ Penguins fly.

Not surprisingly, generics also pattern with conditionals in what Lewis called (conditional) *variability*:

Variability:

(68) If the USA threw its weapons into the sea tomorrow, there would be war;
but if the USA and the other nuclear powers all threw their weapons into the sea tomorrow, there would be peace;
but if they did so without sufficient precautions against polluting the world's fisheries there would be war; ... Lewis(1973:10)

(69) Birds can fly.
Penguins are birds, but penguins cannot fly.
Penguins with rockets strapped to their backs can fly.
Penguins with spent rockets strapped to their backs cannot fly. Morreau(1992:53)

The main objective of theories of *nonmonotonic reasoning* is to capture *patterns of defeasible reasoning* which – despite the failure of monotonicity and transitivity – appear to be licit, again, for both conditional and generic sentences.

Nonmonotonic or defeasible inference patterns: $\Gamma \mid\approx \phi$

Defeasible modus ponens is the simplest pattern of defeasible reasoning: from *Lions are dangerous* and *Leo is a lion* it follows – defeasibly ($\mid\approx$) – that *Leo is dangerous.* In which sense the conclusion is *defeasible* is shown in (71): Adding the additional premise *Leo is not dangerous* defeats the conclusion. The full pattern is stated as (72).

Defeasible modus ponens:

(70) Lions are dangerous
Leo is a lion
$\mid\approx$ Leo is dangerous. Morreau(1992:56)

Defeat of modus ponens:

(71) Lions are dangerous
Leo is a lion
Leo is not dangerous
$\not\mid\approx$ Leo is dangerous Morreau(1992:56)

(72) *Defeasible Modus Ponens:*
$\forall x(\phi > \psi), \phi(\delta) \mid\approx \psi(\delta)$,
but not $\forall x(\phi > \psi), \phi(\delta), \neg\psi(\delta) \mid\approx \psi(\delta)$ Asher&Morreau(1991:387)

(73a) gives an example of defeasible modus ponens with conditional sentences, while (73b) shows that the inference can be defeated by an additional premise.

(73) a. If Nixon presses the button, there will be a nuclear holocaust.
Nixon presses the button.
$\mid\approx$ There will be a nuclear holocaust.

b. If Nixon presses the button, there will be a nuclear holocaust.
Nixon presses the button.
The button is disconnected, such that there will not be a nuclear holocaust.
$\not\mid\approx$ There will be a nuclear holocaust.

Further important patterns of defeasible reasoning are stated in (74)–(77), accompanied with examples involving generic sentences (see Asher&Morreau(1991:387–388,1995), Morreau(1992:56–58)).

(74) *The Penguin Principle*

$\forall x(\phi > \psi)$	Penguins are birds
$\forall x(\psi > \chi)$	Birds can fly
$\forall x(\phi > \neg\chi)$	Penguins cannot fly
$\phi(\delta)$	Tweety is a penguin
$\mid\approx \neg\chi(\delta)$	Tweety cannot fly

(75) *The Nixon Diamond*

$\forall x(\phi > \psi)$	Quakers are pacifists
$\forall x(\chi > \neg\psi)$	Republicans are nonpacifists
$\phi(\delta)$	Dick is a Quaker
$\chi(\delta)$	Dick is a Republican
$\not\approx \psi(\delta)$	$\not\approx$ Dick is a pacifist
$\not\approx \neg\psi(\delta)$	$\not\approx$ Dick is a nonpacifist

(76) *Irrelevance/Pointwise defeasible strengthening of the antecedent*

$\forall x(\phi > \psi)$	Lions are dangerous.
$\phi(\delta)$	Leo is a lion.
$\chi(\delta)$	Leo is brown.
$\mid\approx \psi(\delta)$	$\mid\approx$ Leo is dangerous.

but:

$\forall x(\phi > \psi)$	Lions are dangerous.
$\phi(\delta)$	Leo is a lion.
$\chi(\delta)$	Leo is a lion cub.
$\forall x(\phi \wedge \chi > \neg\psi)$	Lion cubs are not dangerous.
$\not\approx \psi(\delta)$	$\not\approx$ Leo is dangerous

(77) *Graded Normality*

$\forall x(\phi > \psi_1)$	Lions are dangerous
...	...
$\forall x(\phi > \psi_n)$	Lions are brown
$\phi(\delta)$	Leo is a lion
$\neg\psi_1(\delta)$	Leo is not dangerous
$\mid\approx \psi_n(\delta)$	$\mid\approx$ Leo is brown.

but:

$\forall x(\phi > \psi_1)$	Lions are dangerous
...	...
$\forall x(\phi > \psi_n)$	Lions are brown
$\phi(\delta)$	Leo is a lion
$\neg\psi_1(\delta)$	Leo is not dangerous
$\not\approx \psi_1(\delta)$	$\not\approx$ Leo is dangerous.

Again, corresponding examples involving conditional sentences are given in (78)–(81):

(78) *The Penguin Principle*
If John is speaking very fast, he's speaking.
If John is speaking, everybody listens.
If John is speaking very fast, no one listens.
John is speaking very fast.
$\mid\approx$ No one listens.

(79) *The Nixon Diamond*
If John walks the dog, he's happy.

If John stays with his aunt, he's unhappy.
John is staying with his aunt.
John is walking the dog.
$\not\approx$ John is happy.
$\not\approx$ John is unhappy.

(80) *Irrelevance*
If Nixon presses the button, there will be a nuclear holocaust.
Nixon presses the button.
The button is green.
$|\approx$ There will be a nuclear holocaust.

(81) *Graded normality*
If John goes to London, he goes to the National Museum.
If John goes to London, he goes to a famous restaurant.
John goes to London next week.
Unfortunately, the National Museum is closed during his stay.
$|\approx$ John will go to a famous restaurant.
$\not\approx$ John will go to the National Museum.

Given these striking similarities between generic sentences and conditionals as regards both their logical form (a tripartite quantificational structure), and their inherent vagueness and the resulting patterns of defeasible inference they give rise to, in order to get at a clearer picture of how to capture the vagueness and variability of conditionals, it seems promising to have a closer look at some selected theories of genericity and nonmonotonic reasoning with generics. Most important for our concerns is, for one, the particular semantic analysis that in those theories is attributed to the **GEN**–quantifier that relates the restrictor and scope part of such sentences, and, secondly, the particular definition of the defeasible, or nonmonotonic inference relation. It will turn out that some theories of nonmonotonic reasoning set up a demarcation between the semantics of the genericity–operator on the one hand, viewed as closely related to the operator of conditional sentences, and the nonmonotonic inference relation, on the other, which is clearly distinguished from conditional logic, while in other accounts the nonmonotonic inference relation is based on the particular conditional logic underlying the genericity operator. Two theories that can be taken as representative in this respect are Asher&Morreau(1991,1995),Morreau(1992) and Delgrande(1987,1988), respectively. Our discussion in Section 5.2.3 will, besides a very brief overview of the area of nonmonotonic reasoning, be mainly concerned with these two representative theories, in order to prepare our own analysis of conditional vagueness and variability in DRT.

But first we want to focus on a final important parallelism between generics and conditionals, discussed to some depth by Krifka et al(1995), which is tied to Kratzer's notion of *relative modality*.

(iv) Relative modality. Krifka et al(1995:49,50) explicitly refer to the just discussed, and long–noticed resemblance of generic and conditional sentences: "it has often been remarked (e.g. by Lawler(1973), Burton–Roberts(1977), Thrane(1980)) that characterizing generic sentences resemble conditional sentences. For example, a characterizing sentence such as *A lion has a bushy tail* can be rephrased as *If something is a lion, it has a bushy tail.*"

They therefore discuss, at some length, the modal approach to genericity, where they focus in particular on Kratzer's analysis of *relative modality* in terms of a *modal base* and an *ordering source.* Given the semantic correspondence between *A lion has a bushy tail* and *If something is a lion, it has a bushy tail*, they try to extend Kratzer's analysis of conditionals to generic sentences, which – they mention – has already been prepared by Heim(1982), who also notes the striking parallelism between the various kinds of conditionals in (82) and corresponding sentences involving indefinite NPs: "[(83)] suggests that the full range of operators restrictable by "if"–clauses also accept mere indefinite NPs as their restrictive terms." (Heim(1982:191)).

(82) a. If a cat has been exposed to 2,4–D, it can go blind.

b. If a cat has been exposed to 2,4–D, it often goes blind.

c. If a cat has been exposed to 2,4–D, it always goes blind.

d. If a cat has been exposed to 2,4–D, it goes blind. Heim(1982:191)

(83) a. A cat that has been exposed to 2,4–D can go blind.

b. A cat that has been exposed to 2,4–D often goes blind.

c. A cat that has been exposed to 2,4–D always goes blind.

d. A cat that has been exposed to 2,4–D goes blind. Heim(1982:191)

Heim's analysis of conditionals is essentially built on Kratzer's theory (Kratzer(1981)) and assumes, for bare conditional sentences such as (82d), a "realistic" modal base and ordering source. Now, Heim refrains from assigning the same type of modal base and ordering source to restrict the implicit necessity operator in (83d),[38] "[...] then "An F is G" should always entail "Every F is G"." (Heim(1982:194)). But this, Heim concludes, does not capture the essential characteristic of generic sentences to easily allow for exceptions, as opposed to sentences involving universal quantification over individuals by "every".

She therefore conjectures that generic sentences "invite stereotypical, rather than realistic ordering sources. A "stereotypical" ordering source ranks worlds in terms of their closeness to an ideal of "normality" of some sort. This opens up the possibility that the actual world w_0 is not as close to the ideal as some other accessible world w, say, because w_0 contains a few abnormally chemical–resistant cats and w does not. Then [(83d)] could be true in w_0 even though some abnormal cats of w_0 were exposed to 2,4–D without going blind." (Heim(1982:194,195)).

Krifka et al(1995) rightly object to Heim's claim (viz. that generic sentences and bare conditionals cannot host the same (implicit) necessity operator): They give (84a) as an

[38] We do not share Heim's opinion: *If a cat has been exposed to 2,4–D it goes blind*, according to our intuition, admits just as easily for exceptions as does (83d).

example of a bare conditional that is not interpreted relative to a "realistic", but a deontic ordering source. They therefore conclude that the covert operators in conditional and generic sentences are the same.[39] While for examples such as (85a–b) they assume Kratzer's "human necessity operator" **must** – tied to a stereotypical ordering source – for both the bare conditional and the generic sentence, they review various cases of generic sentences that make use of other kinds of modal bases and/or ordering sources, such as (84b), which has a deontic interpretation, or (86a), which can be interpreted as circumstantial. Similarly, (86b) must be interpreted as being "relative to biological parameters of turtles", while disregarding facts about relevant ecological conditions.

Krifka et al(1995) conclude that generic sentences, while they may differ in interpretation, or paraphrasing, should be reduced to a single (covert) generic operator, which is interpreted, depending on pragmatic and contextual conditions, relative to different (kinds of) modal bases and ordering sources.

(84) a. If a gentlemen is in the company of a lady, he doesn't peel bananas. Krifka et al(1995:53)

b. A gentleman that is in the company of a lady doesn't peel bananas.

(85) a. If John is in Stuttgart now, he has a car.

b. A lion has a bushy tail. Krifka et al(1995:51)

(86) a. Bob sells vacuum cleaners. Krifka et al(1995:55)

b. A turtle lives to a grand old age. Morreau(1992:95)

We have mentioned these observations of Krifka et al(1995) in order to draw attention to the fact that *relative modality* not only is a common characteristic of both conditional and generic sentences, which is evident from the above examples, but furthermore that it is of great importance for theories of nonmonotonic reasoning. A generic sentence that is unambiguously interpreted as deontic, such as *a boy doesn't cry*, if supplemented by the premise *Jim is a boy* does, in our view, **not** license the defeasible inference that *Jim doesn't cry*, while it **does** license the defeasible inference that *Jim should/must not cry.*

(87) A boy doesn't cry.
Jim is a boy.
$\not\mid\!\approx$ Jim doesn't cry.
$\mid\!\approx$ Jim should/must not cry.

This claim needs some clarification. Theories of nonmonotonic reasoning tend to treat all of (88) on a par with so–called *descriptive* generics (see Morreau(1992:63)): while it is

[39]We think that it is not necessary – and in fact quite misleading – to make use of examples like (84a) to substantiate this view. It is sufficient to recall the inherent vagueness of conditionals, first discussed by Lewis(1973) (see also footnote 38 above).

recognized that examples like (88) are based on lawlike prescriptions, both descriptive and prescriptive generic sentences are treated all the same in terms of truth conditions, and in terms of defeasible inferencing.[40]

So it is expected, e.g. by the modal normalcy theory of Commonsense Entailment (Asher&Morreau(1991,1995), Morreau(1992)), that – if combined with a premise that attributes the property of the restrictive clause to a particular individual d – the generic sentences in (88) *all* give rise to the defeasible inference that the individual in question satisfies the property stated in the scope of the generic sentence. While this seems quite natural for (88a–b), where the deontic sentences describe laws that are in fact observed by almost everyone – while still possibly defeated in case of exceptional circumstances – this defeasible conclusion gets more and more dubious the more we know that people tend to disobey such lawlike rules, as those of (88c–d). Is it reasonable, while recognizing the truth of the prescriptive generic sentence (88c), to defeasibly conclude that any particular businessman in fact declares his full income? According to our intuition, we should recognize the truth of (88c–d), while denying any such defeasible conclusion. Similarly, we do not share the intuition that (89) – if interpreted as *relative to* particular biological parameters of turtles, while neglecting facts about relevant ecological conditions – gives rise to the defeasible conclusion that Pepi lives a long life.

(88) a. Germans drive on the right hand side of the road. Morreau(1992:63)

b. A car owner pays taxes.

c. A German businessman declares his full income.

d. A school boy doesn't cheat.

(89) A turtle lives a long life.
Pepi is a turtle.
$\not\approx$ Pepi lives a long life.

Any "normalcy" theory of generic sentences where truth is determined by what is found to be "normal" on the basis of the facts of our actual world will have to deny both the generic sentences in (88c–d) and (89) and (along with them) the defeasible conclusions derived from them, as in (89). This will be discussed in more detail in the next Section. But it must be noted at this point that, by contrast, a modal theory of generic sentences that allows for different kinds of ordering sources – *stereotypical*, *deontic*, etc. –, as does Kratzer's theory, not only accounts for the truth of these diverse kinds of generic sentences, but moreover is able to provide an explanation of why the defeasible conclusions do not go

[40]This is also pointed out by Krifka et al(1995), while they do not consider the impact of specific kinds of ordering sources on the possibility of drawing defeasible inferences, as illustrated in (87):

> Our final remark on nonmonotonic reasoning is that there is nothing in current theories which corresponds to the different modal bases and ordering sources of the modal approach presented earlier. We have argued that the interpretation of characterizing sentences clearly shows a dependency on these parameters. To give an adequate semantics to characterizing sentences in a nonmonotonic reasoning framework requires a reconstruction of those parameters in this framework. Krifka et al(1995:62,63)

through for the examples (88c–d) and (89), while this is perfectly possible for descriptive generics such as *A lion has a bushy tail.*

Recall from Section 5.1.1 that the phenomenon of *vagueness* could be shown to be restricted to epistemic, as opposed to non–epistemic (deontic, etc.) modality. The possibility of drawing the *defeasible*, or *nonmonotonic inference* $\psi(d)$ from premises $\forall(\phi(x) > \psi(x))$ and $\phi(d)$ therefore is naturally tied to an epistemic interpretation of the modal operator $>$. Further recall that for conditionals involving non–epistemic modal operators, such as (90a), we postulated an *embedded* deontic modal operator within the scope of the restricted epistemic modal quantifier. Given the close correspondence of (90a–b), this argument must be taken to carry over to deontic – or in general non–epistemic – readings of generics: for (90b) we equivalently postulate a universal ("generic") quantifier over gentlemen being in the company of a lady, for which the sentence then states that *under normal conditions* they are subject to the (universal) deontic rule that they shouldn't peel bananas.

(90) a. If a gentleman is in the company of a lady, he should not peel bananas.

b. A gentleman that is in the company of a lady should not peel bananas.

The reason for not admitting the defeasible inference that *Jim doesn't cry* in (87), as opposed to the defeasible inference that *Jim shouldn't cry* is then evident: Since a defeasible inference is necessarily tied to the nonmonotonic characteristic of modal operators, i.e. to epistemically based and essentially *vague* modal operators, a defeasible inference in (87) is only licensed insofar as we may defeasibly assume Jim to be a normal boy, to which the deontic, or prescriptive rule – that is embedded in the consequent clause of the generic sentence – applies. It is therefore correct to defeasibly conclude – from the premises $\forall(\phi(x) > \psi(x))$ and $\phi(d)$ – that $\psi(d)$: *Jim shouldn't cry.* By contrast, the non–admitted defeasible inference that *Jim doesn't cry* – which cannot get a deontic interpretation – is not an instance of the formula $\psi(d)$, to be defeasibly derived from $\forall x(\phi(x) > \psi(x))$ and $\phi(d)$.

This explanation carries over to cases like (91) and (92), which correspond to a non–epistemic "capability" reading of the modal *can* (be able to), which must be given an analysis that is structurally analogous to deontic modality. If we accept the conclusion to defeasibly follow from the premises, as we surely do, the conclusion can only be understood to refer to the general, or normal *capabilities* of the particular specimen, but in no case as conclusions about actual performance of the corresponding action. In this respect (91) and (92) pattern with (87), in being necessarily tied to a non–epistemic modal interpretation of the defeasible conclusion.[41]

(91) An athlete jumps 7 meters.
Fred is an athlete.
$|\approx$ Fred jumps 7 meters.

(92) A camel walks 4 days without water.
Gooma is a camel.
$|\approx$ Gooma walks 4 days without water.

[41] We will come back to these examples by the end of Section 5.2.3, where we substantiate the claim that the defeasible conclusions in (91) and (92) (only) allow for a non–epistemic modal interpretation, as opposed to the (unwarranted) defeasible conclusion in (89), which does not admit a modal interpretation.

In order to be able to give a precise analysis of the nonmonotonicity, i.e. vagueness and variability of conditionals (and – by analogy – of generics), along these lines, it will be necessary to review some selected approaches to nonmonotonic reasoning. Of special interest are, for our concerns, modal theories of genericity, in particular Asher&Morreau's Commonsense Entailment, and Delgrande's theory of Conditional Default Reasoning.

5.2.3 Two selected approaches to genericity and nonmonotonicity

In Morreau(1992) a distinction is made between two different varieties of theories of nonmonotonic reasoning: "normalcy theories" on the one hand, and "inference ticket theories" (or "default theories") on the other: Reiter's theory of Default Reasoning is given as an example of the latter, while both Commonsense Entailment and Circumscription are given as representatives of the former.

The main characteristic of "default theories" of generic sentences (such as Reiter(1980), Veltman(1990)) is that they conceive of generic sentences merely as rules of inference, which are devoid of truth conditions. A major problem for default theories of generic sentences is therefore how to assign meanings to composite sentences, where genericity mixes up with, e.g., counterfactuality, knowledge, and nested genericity, such as *Healthy cats jump at small moving objects* (Asher&Morreau(1995:302), A&M henceforth).

"Normalcy theories", on the other hand, such as Delgrande's Conditional Logic, McCarthy's Circumscription, or Asher&Morreau's Commonsense Entailment, being based on a view of generic sentences as being true or false, must provide for proper truth conditions for generic sentences. Once such truth conditions have been stated, the truth of composite sentences involving genericity can be defined in the ordinary way.

Common to "normalcy theories" is that they determine the truth of generic sentences in terms of quantification over *normal* individuals: a statement such as *A lion has a bushy tail* is then – informally – to be understood as: *A lion that is not abnormal has a bushy tail*, or *If something is a lion, then normally it has a bushy tail.*

The main differences between these normalcy theories are of course tied to the particular formal account of this informal rendering: while McCarthy's Circumscription theory is restricted to first order predicate logic, Delgrande's and Asher&Morreau's theories, which are closely related to conditional logic, are stated within the framework of possible worlds.

In the nonmodal setting of *Circumscription Theory* (McCarthy(1980)) a generic sentence such as *Birds (normally) can fly* is represented as (93): **Ab** is a first order predicate which applies to an individual x just in case it is abnormal. In more elaborated versions of this theory, the abnormality predicate is in fact two–place, taking as a second argument a constant, viewed as an abstract object, which expresses particular "respects" in which an individual may be abnormal. *Birds (normally) can fly* is then formalized as (94).

(93) $\forall x((\mathrm{bird}(x) \wedge \neg \mathbf{Ab}(x)) \rightarrow \mathrm{fly}(x))$ A&M(1995:336)

(94) $\forall x((\mathrm{bird}(x) \wedge \neg \mathbf{Ab}(\text{respect–of–flying},x)) \rightarrow \mathrm{fly}(x))$ A&M(1995:336)

In Circumscription Theory the nonmonotonicity, or defeasibility of inferences based on generic sentences is captured by restricting the interpretation to models where the extension of the **Ab**–predicate is minimal, while still satisfying the set of premises. I.e. defeasible reasoning is modelled as assuming individuals to be as normal as is consistent with the information provided by the premise set.

While Circumscription captures important patterns of defeasible reasoning, including *Graded Normality* (see above p. 309ff.), Morreau(1992) raises various objections, both from the viewpoint of linguistics and in terms of logical considerations, which we will not review here. We just mention one of these objections, which is concerned with the nonmodal setting of Circumscription Theory: while we certainly would like the generic sentence *Tyrannosaurs cannot fly* to be true, in the extensional setting of Circumscription Theory, given that in our world dinosaurs are extinct, both *Tyrannosaurs cannot fly* and *Tyrannosaurs can fly* will be verified.

Another general objection against Circumscription Theory is that – according to Asher&Morreau(1991) – it is committed to what they call *The Hypothesis of the Ghost in the Machine* in order to cope with the *Penguin Principle*:

> That specific information takes precedence over general information is not to be accounted for by the semantics of generic statements itself. Rather, it is due to the intervention of a power which is extraneous to the semantic machinery, but which guides this machinery to have this effect (by ordering the defaults, deciding the priorities of predicates to be minimized, or whatever). Asher&Morreau(1991:388)

The theory of *Commonsense Entailment* is designed to improve – inter alia – upon these two deficiencies of Circumscription: its nonmodal setting, and the use of an additional machinery, *prioritized circumscription* to account for the *Penguin Principle*.

Commonsense Entailment

Commonsense Entailment and Circumscription Theory share the view that generic sentences[42] universally quantify over *normal* individuals. However, Commonsense Entailment differs from Circumscription in that generics are viewed as *modalized sentences*: "[...] the generic sentences which interest us should be thought of as universally quantified, normative conditionals", in fact, counterfactuals: "The sentence *Potatoes contain vitamin C*, for example, we take to mean: Any object would contain vitamin C, if it were a potatoe and all other things were to hold which would normally hold if it were a potatoe." (A&M(1995:310)).

The truth conditional semantics for generic sentences is stated in a possible worlds framework (95) and (96). The notion of *normality* is captured in terms of the selection function *, which assigns to a world w and a proposition p "the set of worlds where p holds along with everything which, at w, is normally the case where p holds." (A&M(1995:311))

(95) A $L_{>}$ frame is a triple $F = \langle W, D, * \rangle$ where
 (i) W is a nonempty set of worlds,
 (ii) D is a nonempty set of individuals, and
 (iii) *: $W \times \wp(W) \rightarrow \wp(W)$ A&M(1995:311)

[42] Again, restricted to *i–generic* sentences. See above.

(96) A *base model* M for $L_>$ is a tuple $\langle W, D, *, [\![\ ]\!]\rangle$, where
(i) $\langle W, D, *\rangle$ is a $L_>$ frame, and
(ii) $[\![\ ]\!]$ is a function from nonlogical constants of L to appropriate intensions (functions from worlds to appropriate extensions). A&M(1995:313)

In a base model (96) a generic sentence $\forall x(\phi > \psi)$ is considered true at a possible world w iff in w being a normal ϕ involves being a ψ (97). More precisely: "$\forall x(\phi > \psi)$, our representation of the sentence *ϕ's are normally ψ's*, is true at a possible world w of a model M just in case for each individual δ in the domain of M, $*(w, [\![\phi\underline{\delta}]\!]_M) \subseteq [\![\psi\underline{\delta}]\!]_M$. Just in case, in other words, for every individual δ, if we look at the worlds where $\phi\underline{\delta}$ holds along with what relative to w is normally the case where $\phi\underline{\delta}$ holds, we find that $\psi\underline{\delta}$ holds. This, then, is my formal rendering of the idea introduced earlier, that $\forall x(\phi > \psi)$ is true if being a normal ϕ involves being a ψ." (Morreau(1992:95))

(97) For any base model M, and possible world w, and any variable assignment α:
(A) $M, w, \alpha \models \phi$, as usual, for ϕ an atomic formula of first–order logic.
(B) i) The usual clauses for complex formulas involving $\forall, \exists, \vee, \&, \rightarrow, \neg$
ii) $M, w, \alpha \models \phi > \psi$ iff $*(w, [\![\phi]\!]_{M,\alpha}) \subseteq [\![\psi]\!]_{M,\alpha}$. A&M(1995:313)

Obviously, everything here depends on the particular definition of the selection function *. Except from FACTICITY (98a), the DUDLEY DOORITE constraint (98b) and CUT (98c), no formal restrictions are imposed on *.[43] And in fact, there is not much more to be said about the notion of *normality*, which is highly dependent on pragmatic and contextual factors: "what is normally the case where p holds is in general a contingent matter, varying from possible world to possible world" (Morreau(1992:94)).

(98) a. FACTICITY: $*(w,p) \subseteq p$.

b. DUDLEY DOORITE: $*(w, p \cup q) \subseteq *(w,p) \cup *(w,q)$.

c. CUT: If $*(w,p) \subseteq q$, and $*(w, p \cap q) \subseteq r$, then $*(w,p) \subseteq r$. Morreau(1992:94,95)

Also, it is observed that there is no "absolute normality order on possible worlds. [...] I explicitly reject the idea that $*(w,p)$ is to be identified with those most normal of all possible worlds where p holds." (Morreau(1992:94)).[44]

On the basis of the $L_>$ frame a notion of *logical consequence* $\models$ and a corresponding syntactic entailment relation $\vdash$ is defined: this allows, e.g., for verification of logically true sentences like *People who don't like to eat out don't like to eat out*, or other patterns of valid reasoning with generic sentences, such as *Weakening of the Consequent*, or *Dudley Doorite* (see A&M(1995:304)).

[43] For construction of the $L_>$ frame, however, only FACTICITY is assumed.

[44] Morreau argues that this construal allows for a more natural analysis of the turtle–example (89), which is true although the actual world is such that turtles mostly do not live to a grand old age (see Morreau(1992:95)). But recall our objection raised above, that the generic sentence *A turtle lives a long life* can only be considered true if understood as relative to a contextual background that specifies relevant biological parameters of turtles (jointly with *ideal* ecological conditions), which does in no case correspond to what, in our actual world, is *normally* the case for turtles.

Although equally based upon the concept of *normality*, the notion of *defeasible inference*, or *Commonsense Entailment* $|\approx$ is distinguished from the counterfactual analysis of generic sentences as such. An informal characterization of *defeasible inference* is given as follows:

> - Firstly, you assume the premises in question, and no more than that.
> - Secondly, you assume that individuals are normal representatives of various kinds, if this is doxastically consistent. That is, you strenghten your assumptions by assuming that individuals are as normal as is consistent with whatever assumptions are currently being made about them.
> - Thirdly, you check whether you are forced to assume the conclusion in question.
>
> Morreau(1992:105)

The first assumption, assuming no more than the premises of an argument, is rendered in terms of the notion of an "informationally minimal information state". An information state is given as a set of possible worlds, such that being in a particular information state s is equivalent to "being informed that the actual world is among the possibilities in s" (A&M(1995:318)). Further, an update notion $+$ is defined on information states, as indicated in (99):

(99) The *information model* based on the base model $\langle W, D, *, [\![\ ]\!] \rangle$ is the tuple $\langle \wp(W), D, *, + \rangle$, where
$+ \colon \wp(W) \times \wp(L_>) \rightarrow \wp(W)$ is defined such that for all information states $s \in \wp(W)$ and all $\Gamma \in \wp(L_>) : s + \Gamma = s \cap [\![\Gamma]\!]_M$. A&M(1995:318)

The informationally minimal state $\odot$ is defined in terms of the information model $\mathcal{A}_{can}$, the information model based on the canonical model for $L_>$: W_{can}, the set of possible worlds of $\mathcal{A}_{can}$ is defined as the set of all maximal$-\vdash$ consistent sets of $L_>$ sentences, i.e., the only sentences supported by W_{can}, or $\odot$, are the valid sentences of $L_>$. (A&M(1995:316,319)). Based on this concept, "assuming just the premises Γ of an argument is modeled as being in the information state $\odot + \Gamma$ of $\mathcal{A}_{can}$." (A&M(1995:319)).

The second assumption in the informal characterization of Commonsense Entailment, "assuming individuals to be as normal as is consistent with the premises" is modelled in terms of *normalization.* This involves a *normalization function* $\underline{N}(s,p)$ (100b), which yields an information state that strengthens s by assuming that "where p holds, p holds along with that which, according to the information available in s, is normally the case where p holds" (A&M(1995:319)). The normalization function is reduced to the selection function $*$ in that $\underline{N}(s,p)$, in the non–trivial case, results from s by "kicking out" all those worlds $p \backslash *(s,p)$ that do not count as normal p–worlds relative to s.[45]

The second clause in (100b) is important for the application of normalization in defeasible inference patterns: if s is incompatible with the assumption that "everything holds that is normally the case where p holds", s is returned unchanged.

(100) a. $*(s,p) := \cup_{w \in s} *(w,p)$.

b. $\underline{N}(s,p) := \begin{cases} s \backslash (p \backslash *(s,p)), & \text{if } s \cap *(s,p) \neq \emptyset; \\ s & \text{otherwise} \end{cases}$ A&M(1995:320)

[45] In case $s \subseteq p$, $\underline{N}(s,p) := s \cap *(s,p)$ (see A&M(1995:320)).

In order to fully capture the informal characterization above, to "assume that individuals are normal representatives of various kinds", the notion of a *P–normalization chain* is defined. First, a set P_Γ of *propositions for normalization* is obtained from a conjunctive normal form Γ^* of the premise set Γ by taking the subset of all "propositions $[\![\phi(d)]\!]$, where d is an individual constant appearing in Γ^*, and $\phi(x)$ is the antecedent of a "positive" occurrence of a universally quantified $>$ conditional in Γ^*" (A&M(1995:322)). Based on this set P_Γ, chains of normalization are defined, by iterative application of normalization $s^{\alpha+1} := \underline{N}(s^\alpha, p_i)$, for some serialization $p_1, \ldots, p_n$, where $p_1 \ldots p_n \in P_\Gamma$. Any such chain of normalization C, depending on the particular serialization imposed upon the set P_Γ, gives rise to a fixed point $\textsc{fix}(C)$, where $s^{\alpha+1} = s^\alpha$.

Commonsense Entailment (101) is then defined to "cancel[] out the order sensitivity of normalization by requiring that a conclusion be drawn from a given set of premises only if it is supported by the fixed points of *all* normalization chains to which those premises give rise" (A&M(1995:323)).

(101) COMMONSENSE ENTAILMENT:
$\Gamma \mid\!\approx_P \phi$ iff for any P–normalization chain C beginning from $\odot + \Gamma$:
$\mathcal{A}_{can}$, $\textsc{fix}(C) \models \phi$ A&M(1995:323)

The reason for assuming quantification over fixpoints resulting from all possible (order sensitive) applications of normalization with propositions p_i out of P_Γ is motivated by the defeasible inference pattern *Nixon Diamond* (see p. 309ff.):

The information state $\odot$ + {∀x (republican(x) > ¬ pacifist(x)), republican(d), ∀x (quaker(x) > pacifist(x)), quaker(d)}, if normalized first with the proposition [[republican(d)]], will give rise to a fixed point which supports the proposition [[¬ pacifist(d)]], while, if first normalized with [[quaker(d)]], it will yield a fixed point that supports the proposition [[pacifist(d)]]. Given that intuitively *no* conclusion may be drawn as to the truth of either [[pacifist(d)]] or [[¬ pacifist(d)]], quantification over *all* fixed points resulting from different P–normalization chains gives the desired result.

Commonsense Entailment, based on normalization chains as defined in (101), is shown to account for various patterns of *reasonable inference*, as there are: *Defeasible Modus Ponens*, *Nixon Diamond*, *Irrelevant Information*, and *Defeasible Chaining*. Yet, it turns out that additional constraints must be imposed on the selection function * in order to obtain the *Penguin Principle* (106) and the *Weak Penguin Principle* (103): the DUDLEY DOORITE CONSTRAINT (102a), and SPECIFICITY (102b), respectively. While the effect of (102a) on the *Penguin Principle* falls out as a surprise (see Morreau(1992) for details), it is instructive to investigate how SPECIFICITY accounts for the *Weak Penguin Principle* (103):

(102) a. DUDLEY DOORITE CONSTRAINT: $*(w, p \cup q) \subseteq *(w,p) \cup *(w,q)$ A&M(1995:331)

b. SPECIFICITY: A&M(1995:333)
If $*(w,p) \subseteq q$, $*(w,p) \cap *(w,q) = \emptyset$, and $*(w,p) \neq \emptyset$, then $*(w,q) \cap p = \emptyset$.

	Adults are employed.	(a)	$A(x) > E(x)$
	Students are not employed.	(b)	$S(x) > \neg E(x)$
(103)	Students are adults.	(c)	$S(x) > A(x)$
	Sam is a student.	(d)	$S(sam)$
	$\mid\!\approx$ Sam is not employed.	(e)	$\mid\!\approx \neg E(sam)$

With $p = [\![S(sam)]\!]$ and $q = [\![A(sam)]\!]$, SPECIFICITY rewrites as (104):

(104) If $*(w, [\![S(sam)]\!]) \subseteq [\![A(sam)]\!]$, $*(w, [\![S(sam)]\!]) \cap *(w, [\![A(sam)]\!]) = \emptyset$, and $*(w, [\![S(sam)]\!]) \neq \emptyset$, then $*(w, [\![A(sam)]\!]) \cap [\![S(sam)]\!] = \emptyset$.

Note that here $*(w, [\![S(sam)]\!]) \subseteq [\![A(sam)]\!]$ comes down to reasoning defeasibly, from (c) + (d) in (103) to $[\![A(sam)]\!]$. $*(w, [\![S(sam)]\!]) \cap *(w, [\![A(sam)]\!]) = \emptyset$ may be considered a rationality constraint following from (a) + (b): given that the conclusions of these generics are conflicting, Sam – if assumed to be normal student and thus an adult – cannot be both a completely normal student *and* a completely normal adult. The further assumption, that Sam can consistently be assumed to be a normal student by $*(w, [\![S(sam)]\!]) \neq \emptyset$, together with the conclusion that $*(w, [\![A(sam)]\!]) \cap [\![S(sam)]\!] = \emptyset$ – i.e., if Sam is assumed to be a normal student, he cannot be regarded as a normal adult –, then in fact implements the intuition underlying the inference pattern *Weak Penguin Principle* (103): that in such an argument we are not allowed to defeasibly infer, from the weaker generic (a), with (d) and (c) – while disregarding (b) –, that Sam is a normal adult, and thus employed, but that we can only defeasibly infer, from the more specific (b), with (d), that Sam, if we can consistently assume him to be a normal student, is not employed.[46]

Note that a revised form of SPECIFICITY in (105) captures the stronger *Penguin Principle*:

(105) SPECIFICITY II: (for *Penguin Principle*):
If $[\![p]\!] \subseteq [\![q]\!]$, $*(w,p) \cap *(w,q) = \emptyset$, and $*(w,p) \neq \emptyset$, then $*(w,q) \cap p = \emptyset$.

	Birds fly.	(a)	$B(x) > F(x)$
	Penguins do not fly.	(b)	$P(x) > \neg F(x)$
(106)	Penguins are birds.	(c)	$P(x) \rightarrow B(x)$
	Tweety is a penguin.	(d)	$P(tweety)$
	$\mid\!\approx$ Tweety does not fly.	(e)	$\mid\!\approx \neg F(tweety)$

[46]Given the definition of a P–normalization chain, further normalization with $[\![A(sam)]\!]$ is not required, even though – if carried out – it would not eliminate any world, according to (100b), thus lead to a fixed point of normalization where Sam is a normal student, but not a normal adult, and thus not employed.

By contrast, if we extend the schema (103) by the further premise that *Sam is an adult*, we have to normalize with two propositions, $[\![S(sam)]\!]$ and $[\![A(sam)]\!]$. While this determines a second chain of normalization where we first normalize with $[\![A(sam)]\!]$ and then with $[\![S(sam)]\!]$, COMMONSENSE ENTAILMENT (99) still predicts that Sam is defeasibly inferred to be not employed: Since by SPECIFICITY our student Sam cannot be assumed a normal adult, the first normalization step will be trivial (see 100b), while the second step of normalization will again induce restriction to worlds where everything holds that is normally the case where Sam is a student, which yields that Sam is not employed. Together with the outcome of the first chain of normalization, where we first normalize with $[\![S(sam)]\!]$ and subsequently with $[\![A(sam)]\!]$ we then derive, just as for (103), that Sam is not employed.

While these two versions of SPECIFICITY can be viewed as fully natural constraints, their presence could be considered as weakening the general claim of Commonsense Entailment, to give a theory of *defeasible inference* that does not make use of any additional mechanism to guide the inference machinery, of any "ghost in the machine". Given that the inference machinery, Commonsense Entailment, is defined as (101), the additional constraints in (102) could be regarded as an extraneous mechanism to guide this machinery. However, since these constraints are stated in terms of the selection function *, which determines the semantics of generic sentences, we do not consider (102), nor (106), for that matter, as "extraneous" to the machinery of nonmonotonic reasoning that is Commonsense Entailment.

Another observation is that, as is acknowledged by Asher&Morreau, Commonsense Entailment does not account for *Graded Normality* (see (77) above). The reason is – roughly – that in this theory normality is considered an absolute matter: the selection function *, if applied to $[\![lion(leo)]\!]$) picks out the set of worlds where *everything* holds that is normally the case, according to the evaluation world w, where Leo is a lion. Once it is assumed in the premises that Leo is not dangerous, and therefore not "normal" in *every* respect, normalization cannot non–trivially apply to $[\![lion(leo)]\!]$ to allow for the defeasible inference that Leo is brown. So, Asher&Morreau conclude, in order to capture *Graded Normality* the theory must adopt some mechanism that allows for normality "to come in degrees". We will return to this point later.

Finally, and relatedly, in Morreau(1992) a comparison is made between Commonsense Entailment and Delgrande's Conditional Logic for Default Reasoning. The main difference that Morreau sees between Commonsense Entailment and Default Conditional Logic is that defeasible inference is built upon the nonmonotonicity of the conditional operator in the latter theory, while in Commonsense Entailment defeasible inferencing is *not* reduced to conditional logic, but captured in terms of quantification over fixed points of normalization chains.[47] The interesting point of this comparison is that while Commonsense Entailment captures *Irrelevance*, but fails to account for *Graded Normality*, Delgrande's Conditional Logic captures *Graded Normality*, but meets difficulties to account for *Irrelevance* without resorting to extraneous mechanisms, something which, according to Morreau, is inherently tied to the conditional approach to nonmonotonic inference. Given that our attempt, in Section 5.3.3, will be to explore an account of nonmonotonicity which is built on the semantics of the nonmonotonic conditional, this is an important observation we will have to reconsider once we have sketched the basic ingredients of Delgrande's Conditional Logic.

Conditional Default Reasoning

Delgrande(1987,1988) develops an account of default reasoning, or defeasible inference that is built upon a conditional logic N for the "variable conditional operator $\Rightarrow$". This conditional logic was introduced in Delgrande(1987), in a possible worlds framework, to assign a meaning to "default statements" $\alpha \Rightarrow \beta$ (i.e. conditionals and generics) that corresponds to the informal characterization "if α then normally β. [...] Informally, $\alpha \Rightarrow \beta$ is true at a world if, ignoring exceptional conditions, β is true whenever α is" or "just when the least exceptional worlds in which α is true also have β true." (Delgrande(1988:68)).

[47]The comparison between Commonsense Entailment and Conditional Default Reasoning which we will undertake later on will show that this line of demarcation that Morreau argues for is not fully justified.

To this end, an accessibility relation E is defined to hold, between worlds w_1 and w_2 (Ew_1w_2), if "w_2 is at least as uniform, or at least as unexceptional, as w_1." (Delgrande(1988:68)). E is assumed to be reflexive, transitive and forward connected (defining a logic S4.3). The semantics of a default statement $\alpha \Rightarrow \beta$ is given in terms of a selection function f, based on E, as given in (107): f yields, for a given world w and proposition $[\![\alpha]\!]^M$, the set of "least exceptional worlds" where α is true. The truth of $\alpha \Rightarrow \beta$ is defined relative to a possible worlds model M and a world w as in (108):

(107) $f(w, [\![\alpha]\!]^M) = \{w_1 \mid Eww_1$ and $\models^M_{w_1} \alpha$, and for all w_2 such that Ew_1w_2 and $\models^M_{w_2} \alpha$, we also have $Ew_2w_1\}$. Delgrande(1988:69)

(108) Given a model $M = \langle W, E, DI, V\rangle$ [with W a set of possible worlds, E an accessibility relation (see above), DI a domain of individuals, V a valuation function on terms and predicate symbols]
(iv) $\models^M_w \alpha \Rightarrow \beta$ iff $f(w, [\![\alpha]\!]^M) \subseteq [\![\beta]\!]^M$
(v) $\models^M_w (x)\alpha$ iff for every V' which is the same as V except possibly $V(x) \neq V'(x)$, and where $M' = \langle W, E, DI, V'\rangle$, $\models^{M'}_w \alpha$. Delgrande(1988:69)

This conditional logic N allows to consistently represent assertions like (109)–(111).

(109) (x)(Bird(x) ⇒ Fly(x)),
Bird(opus),
¬ Fly(opus). Delgrande(1988:64)

(110) □(x)(Penguin(x) ⊃ Bird(x)),
(x)(Bird(x) ⇒ Fly(x)),
(x)(Penguin(x) ⇒ ¬ Fly(x)). Delgrande(1988:64)

(111) (x)(Quaker(x) ⇒ Pacifist(x)),
(x)(Pacifist(x) ⇒ Vegetarian(x)),
¬(x)(Quaker(x) ⇒ Vegetarian(x)). Delgrande(1988:65)

It also allows reasoning about the consistency of a set of default statements. However, "the logic N did not — in fact *could not* — allow modus ponens as a rule of inference for the variable conditional. For if it did, then in the first example above we could deduce Fly(opus) and so arrive at an inconsistency" (Delgrande(1988:65)).

The objective of Delgrande(1988) is to build, on the basis of the conditional logic N, an approach to default reasoning that allows for defeasible modus ponens, i.e., allows to draw the "default" conclusion, from (112), that Black(opus).

(112) (x)(Raven(x) ⇒ Black(x))
(x)((Raven(x) ∧ Albino(x)) ⇒ ¬Black(x))
Raven(opus)
Has_wings(opus).

To this end, Delgrande defines a "*default theory T*" as "an ordered pair $\langle D, C \rangle$ where D is a set of wff of N and C is a nonempty consistent set of wffs of FOL. D is a set of necessary or default sentences, ... constraining how the world *must* be or *could* be, while C is a set of contingent sentences constraining how the world being modelled *is*." In this theory, a "default provability operator $|\!\sim$" is defined, where $T \mid\!\sim \rho$ is to indicate that "ρ follows by default from T" (Delgrande(1988:70,71)).

The approach to default reasoning relies upon the following basic assumptions:

- **Assumption of Normality.** *The world being modelled is among the least exceptional worlds according to D in which the sentences of C are true.*
- **Assumption of Relevance.** *Only those sentences known to bear on the truth value of a conditional relation are assumed to, in fact, have a bearing on that relation's truth value.* Delgrande(1988:71,72)

Thus, for (112) we arrive at the default conclusion Black(opus) if we assume (i) that the world at hand, and with it opus, is *as unexceptional as possible*, consistent with what is known, *and* (ii) that having wings is *irrelevant* to the blackness of a raven. The assumption of irrelevance is essential for this defeasible conclusion, since – if relying only on (i) – nothing excludes the possibility that – while in the simplest (or least exceptional) worlds where Raven(opus) is true, Black(opus) is true, as stated by the first premise – in all those simplest (or least exceptional) worlds where Raven(opus) $\wedge$ Has_wings(opus) is true, Black(opus) may not be true. However, if it can be assumed that having wings is irrelevant to the blackness of ravens, we can safely assume that in all the least exceptional worlds where opus is a raven (and has wings), it is black.

Two approaches are considered to implement the notion of a default inference, on the basis of the conditional logic N.

On the first approach, a "*maximal default extension E(D)* of D" is defined, such that a proposition ρ can be inferred by default, from a default theory $T = \langle C, D \rangle$, if the maximal default extension $E(D)$ validates that ρ follows conditionally from the known facts in C.[48]

(113) $T \mid\!\sim \rho$ iff $E(D) \vdash_N C \Rightarrow \rho$. Delgrande(1988:76)

The maximal default extension $E(D)$ of D narrows down the set of models considered for default inferences in order to implement the assumption of relevance: for every conditional statement $\alpha \Rightarrow \gamma$, and any β, D is extended by the statement $\alpha \wedge \beta \Rightarrow \gamma$ if β is *irrelevant* to the truth of $\alpha \Rightarrow \gamma$. Once (ir)relevance is thus implemented in terms of the default extension $E(D)$ of D, (113), where reference is made to the variable conditional operator $\Rightarrow$, accounts for the basic assumptions of both relevance and normality in default inferencing.

The conditions under which β can be assumed to be irrelevant to the truth of $\alpha \Rightarrow \gamma$, on a first approximation could be stated as in (114a): if the truth of the conditional is unaffected by the additional assumption, in the antecedent, of either β or $\neg\beta$.

So one could extend the set D by "considering each conditional $\alpha \Rightarrow \gamma$ in D and each wff of FOL, and if $\alpha \wedge \beta \Rightarrow \gamma$ is consistent, adding it to D." (Delgrande(1988:73)). But this does not give the right result for the pattern of *Nixon Diamond*: if $D = \{Q(x) \Rightarrow P(x), R(x) \Rightarrow$

[48] $\vdash_N$ stands for validity in the conditional logic N.

$\neg P(x)\}$ one could add to D either $(Q(x) \wedge R(x)) \Rightarrow P(x)$ or $(Q(x) \wedge R(x)) \Rightarrow \neg P(x)$ (but not both). Yet, intuitively, $\alpha \wedge \beta$ may only be added to D if "there is no other "relevant" conditional that denies γ." (ibid:73).

Delgrande therefore defines a notion of *support* (114b), such that a generic statement $\alpha \Rightarrow \gamma$, which is stronger (by condition (1)) than a conditional $\beta \Rightarrow \gamma$ in T (2), can contribute to the extension $E(D)$ of D provided (3) that – if there is some β' such that γ does not normally go along with β' – β implies β' (β is more specific than β'). In other words: "Thus basically $\alpha \Rightarrow \gamma$ is supported in Γ if there is a conditional $\beta \Rightarrow \gamma$ where β follows from α and there is no conditional in Γ with a stronger antecedent that denies γ." (Delgrande(1988:74)).

(114) a. β is irrelevant to $\alpha \Rightarrow \gamma$ iff $(f(w, [\![\alpha\wedge\beta]\!]^M) \subseteq [\![\gamma]\!]^M$ and $f(w, [\![\alpha\wedge\neg\beta]\!]^M) \subseteq [\![\gamma]\!]^M)$.

b. $\alpha \Rightarrow \gamma$ is *supported* in T if there is β such that: Delgrande(1988:73)
(1) $\vdash_{FOL} \alpha \supset \beta$,
(2) $T \vdash_N \beta \Rightarrow \gamma$,
(3) if there is β' such that $\vdash_{FOL} \alpha \supset \beta'$ and $T \vdash_N \neg(\beta' \Rightarrow \gamma)$, then $\vdash_{FOL} \beta \supset \beta'$.

Condition (3) has two effects. First it accounts for the *Nixon Diamond*, where $D = \{Q(x) \Rightarrow P(x), R(x) \Rightarrow \neg P(x)\}$. Let $\beta = Q(x)$, $\beta' = R(x)$ and $\gamma = P(x)$. Then $R(x)$ in $\alpha := \beta \wedge R(x)$ cannot be regarded as irrelevant for the truth of $\gamma := P(x)$: $\alpha \Rightarrow \gamma$ is not supported since there is some $\beta' := R(x)$, such that $T \vdash_N \neg(\beta' \Rightarrow \gamma)$, but it is not the case that $\vdash_{FOL} \beta \supset \beta'$. Conversely for $Q(x)$ in $\alpha := \beta' \wedge Q(x)$ and $\gamma := \neg P(x)$.

But moreover, this condition respects the *Penguin Principle*: its effect is that a generic $\alpha \Rightarrow \gamma$ with a stronger antecedent than β in $\beta \Rightarrow \gamma$ is supported according to (114b), while D may contain other generics with still weaker antecedents β' and conflicting consequents, but not the other way around! Let $\beta \Rightarrow \gamma$ correspond to *Birds fly*, and $\beta' \Rightarrow \neg\gamma$ to *Penguins do not fly*, and let us consider whether $\alpha \Rightarrow \gamma$, corresponding to *Penguins with long beaks fly* is *supported* by these defaults. Given $\alpha \supset \beta'$ and $\beta' \supset \beta$, α is stronger than β. Now, the "conflicting" generic $\beta' \Rightarrow \neg\gamma$ violates the condition that in such a case of conflicting defaults β – the antecedent to "support" the irrelevant condition α – be stronger than β'. Thus, $\alpha \Rightarrow \gamma$ *Penguins with long beaks fly* is *not* supported by T.

Interestingly then, Relevance is accounted for in terms of the *supports* condition, which very much reminds us of the specificity constraint(s) in Commonsense Entailment. We will return to this observation below.

The second, alternative approach to implement the assumptions of normality and relevance for default reasoning is described as "the dual" of the first: the actual world is assumed to be "among the simplest [least exceptional] worlds, consistent with what is contingently known. [...] The idea is to first make whatever conclusions we can about [the state of affairs modelled by] C under the assumption of normality" (Delgrande(1988:76)).

Thus, if $D = \{\text{Raven(x)} \Rightarrow \text{Black(x)}\}$, $C = \{\text{Raven(opus), Has\_wings(opus)}\}$, by definition of $\Rightarrow$, if we assume the world where C is true to be among the simplest worlds, Black(opus) must be true in this world.

While in the first approach the set of defaults D of T had been extended to $E(D)$ to implement the *assumption of relevance* for (113), on this new approach the set of contingent facts C is extended to a *maximal contingent extension E(C)* as defined in (116) in order to implement the *assumption of normality* for the relation of default inference $|\!\sim'$ in (117), which specifies that "ρ follows by default iff ρ follows in all maximal contingent extensions" (Delgrande(1988:78), see also (ibid:76)).

(115) $\alpha \supset \gamma$ is *contingently supported* in a default theory $T = \langle D, C\rangle$ if
(1) $D \vdash_N \alpha \Rightarrow \gamma$.
(2) $C \cup D \cup \{\alpha \supset \gamma\}$ is consistent.
(3) If there is a α' s.th. $\vdash_{FOL} C \supset \alpha'$ and $(C \cup D) \vdash_N \neg(\alpha' \Rightarrow \gamma)$ then $\vdash_{FOL} \alpha \supset \alpha'$.
Delgrande(1988:77)

(116) A *maximal contingent extension E(C)* of C is defined by:
(1) $C_0 = C$
(2) If $\alpha \supset \gamma$ is contingently supported in $\langle D, C_i\rangle$, then $C_{i+1} = C_i \cup \{\alpha \supset \gamma\}$.
(3) $E(C) = \bigcup_{i=0}^{\infty} C_i$. Delgrande(1988:77)

(117) $T \mid\!\sim' \rho$ iff $\cap E(C) \vdash_{FOL} \rho$.[49] Delgrande(1988:77)

Again, the crucial point is the definition of the *(contingently) supports* relation (115) that drives the construction of $E(C,\Delta)$ in (116′). The definition licenses an implication $\alpha \supset \gamma$ to be added to C_i if (1) D contains a default statement $\alpha \Rightarrow \gamma$, thus restricting the truth of $\alpha \supset \gamma$ to the "least exceptional worlds", if (2) the implication $\alpha \supset \gamma$ – which on assumption of α validates γ – is consistent with the (extended) default theory, and if (3)

[49] As observed by Hans Kamp, the definition (117) is quite misleading: it is not clear whether it should be read as (i),

(i) $T \mid\!\sim' \rho$ iff $(\forall E(C) \in \mathcal{E})E(C) \vdash_{FOL} \rho$,
where $\mathcal{E} = \{\ E(C) : E(C)$ is a maximal contingent extension of $C\}$.

or else as (ii),

(ii) $T \mid\!\sim' \rho$ iff $\bigcap \mathcal{E} \vdash_{FOL} \rho$,
where $\mathcal{E} = \{\ E(C) : E(C)$ is a maximal contingent extension of $C\}$.

or finally as (iii), which is equivalent to (i):

(iii) $T \mid\!\sim' \rho$ iff for every model M $[\![\bigcup \mathcal{E}]\!]^M \subseteq [\![\rho]\!]^M$,
where $[\![\bigcup \mathcal{E}]\!]^M = \bigcup\{[\![E(C)]\!]^M : E(C) \in \mathcal{E}\}$ and $[\![E(C)]\!]^M = \bigcap\{[\![\alpha]\!]^M : \alpha \in E(C)\}$.

His proposal is to choose an interpretation according to (i) or (iii), and to rewrite (116) and (117) as follows:

(116′) For any enumeration $\Delta = \{\phi_1, \phi_2, \ldots \phi_n\}$ of implications $\alpha_i \supset \gamma_i$ we define the maximal contingent extension of C according to T and Δ, $E(C,\Delta)$, as follows:
(1) $C_0 = C$
(2) $C_{i+1} = \begin{cases} C_i \cup \{\alpha_i \supset \gamma_i\} & \text{if } \alpha_i \supset \gamma_i \text{ is } \textit{contingently supported} \text{ by } T_i = \langle D, C_i\rangle \\ C_i & \text{otherwise.} \end{cases}$
(3) $E(C,\Delta) = \bigcup C_i$.

(117′) $T \mid\!\sim' \rho$ iff $(\forall E(C) \in \mathcal{E}(C))E(C) \vdash_{FOL} \rho$,
where $\mathcal{E}(C) =_{def} \{E(C,\Delta) : \Delta$ some enumeration of implicational formulae $\}$.

In our discussion we will refer to the concepts $E(C,\Delta)$ and $\mathcal{E}(C)$ as defined by (116′) and (117′).

in case there exist "conflicting" generic statements in D, which deny γ to hold in the most simple worlds where α' holds, α' is weaker than α.

Just as the notion of *support* in (114b), *contingent support* (115) accounts both for the inference pattern of *Nixon Diamond* and the *Penguin Principle*: For the former, Delgrande posits $D = \{Q(x) \Rightarrow P(x), R(x) \Rightarrow \neg P(x)\}$ as before, and $C = \{Q(x), R(x)\}$. By (115) $Q(x) \supset P(x)$ is *not* contingently supported by T: while $C \cup D \cup \{Q(x) \supset P(x)\}$ is consistent (see (2)), there is some α', namely $R(x)$, such that $(C \cup D) \vdash_N \neg(R(x) \Rightarrow P(x))$, but $\not\vdash Q(x) \supset R(x)$.

For the *Penguin Principle*, consider the prototypical case: *Birds fly, Penguins are birds, Penguins do not fly, Tweety is a penguin.* If $D = \{B(x) \Rightarrow F(x), P(x) \supset B(x), P(x) \Rightarrow \neg F(x)\}$, and $C = \{P(x)\}$, $P(x) \supset F(x)$ is not contingently supported in T, since – while consistent with $D \cup C$ – it violates condition (3) of (115): there is $\alpha' = P(x)$, implied by C, such that $\neg(P(x) \Rightarrow F(x))$ holds in T, but $P(x)$ is stronger than $B(x)$. Thus, the condition $\alpha \supset \alpha'$ in (3) prevents the illicit default inference that *Tweety flies*.

Notice again that the notion of *contingent support* in (115) is very similar to the specificity principle(s) of Commonsense Entailment (this will be discussed in more detail below.) In fact, Delgrande's second approach to default reasoning is in some other important respects closely related to Commonsense Entailment. This will become evident in the now following discussion of two final aspects of Conditional Default Reasoning: the characterization of defeasible inference $|\!\sim'$ in (117) (viz. (117$'$)) in terms of quantification over all maximal contingent extensions $E(C, \Delta) \in \mathcal{E}(C)$, and the related aspect of how we get at such extensions $\mathcal{E}(C)$ which may consist of distinct sets $E(C, \Delta)$, for distinct orderings Δ of implications.

An example where $\mathcal{E}(C)$ contains distinct sets $E(C)$ is the following. Assume $D = \{Q(x) \Rightarrow P(x), P(x) \Rightarrow V(x), R(x) \Rightarrow \neg V(x)\}$ and $C = \{Q(x), R(x)\}$. According to (115$'$) and (116), C_{11} may result from adding to C_0 the supported implication $Q(x) \supset P(x)$, in which case it is not possible to extend C_{11} further by adding $P(x) \supset V(x)$ to it, so C_{11} ends up as one "fixed point". Alternatively, C_0 may be extended to C_{12} by the implication $R(x) \supset \neg V(x)$, which then in turn does not support a further extension by $P(x) \supset V(x)$. $\mathcal{E}(C)$ being defined as the union of all $E(C, \Delta)$ generated by (116$'$), will then not license the defeasible inference of either $V(x)$ nor $P(x)$.[50]

Finally, Delgrande concedes the necessity, in his framework, to adopt some "ordering" of default statements to account for the *Weak Penguin Principle* (118). Note that while the ordinary *Penguin Principle*, being based upon the implication Penguin(x) $\supset$ Bird(x), is captured by the definition of *contingent support* in (115), this does not carry over to the *Weak Penguin Principle*, where the antecedent Univ_st(x) is related to Adult(x) not by implication, but by the generic statement Univ_st(x) $\Rightarrow$ Adult(x).

(118) $D = \{$ Adult(x) $\Rightarrow$ Employed(x), Univ_st(x) $\Rightarrow \neg$ Employed(x),
Univ_st(x) $\Rightarrow$ Adult(x) $\}$ Delgrande(1988:83)

The ordering to be imposed upon defaults is, however, not introduced by stipulation, but motivated by the semantics of generic statements: Since $\alpha \Rightarrow \beta$ holds iff $f(w, [\![\alpha]\!]^M) \subseteq [\![\beta]\!]^M$,

[50]Below we try to sketch an alternative way to account for such defeasible inference patterns, which does not yield distinct sets $E(C, \Delta)$ in $\mathcal{E}(C)$, and thus could offer a way to simplify the definition of $|\!\sim'$ in (117$'$) (or (117), for that matter).

i.e. if β holds in the least unexceptional worlds where α is true, "(... this is the key) the least exceptional worlds in which β is true are no more exceptional than the least exceptional worlds in which α is true." (Delgrande(1988:83)). This is stated by the condition in (119), which determines, for a set D of default statements, a partial order $\leq$ over sets of worlds determined by propositions.[51]

(119) $f(w, [\![\beta]\!]^M) \leq f(w, [\![\alpha]\!]^M)$ iff $\models_w^M \alpha \Rightarrow \beta$ Delgrande(1988:83)

While I simply couldn't understand Delgrande's argumentation, stated in footnote 51, especially the step that is indicated by italics, Hans Kamp decided that it is utterly wrong.

Yet, in the following discussion and comparison of (the second version of) Delgrande's Conditional Default Reasoning and Commonsense Entailment, we will investigate whether, as an alternative, the *Weak Penguin Principle* can be captured by extension or revision of the *contingently supports*–condition in (115).

As a preliminary, partial conclusion, let us just note that we do not quite see how the objection raised by Morreau(1992) – that the conditional account of nonmonotonic reasoning cannot, for principled reasons, account for irrelevance without resorting to extraneous mechanisms – can be justified. It seems to us that irrelevance is in fact captured in both versions of Conditional Default Reasoning. Moreover, the particular definition of the *supports*–relation (114b) of the first version, which is crucial for irrelevance, is needed and thus motivated anyway, in order to cope with the *Penguin Principle.* This is particularly obvious once we consider the structural similarity of this condition with the definition of the *contingently supports*–relation (115) of the second version.

Furthermore, we perceive a strong similarity between the second version of Delgrande's Conditional Default Reasoning and Commonsense Entailment. Given that nonetheless the theories differ in that (i) the inference pattern of *Graded Normality* can be accounted for in Delgrande's theory, while not so in Commonsense Entailment, and (ii) *Weak Specificity* is accounted for by Commonsense Entailment, while it is not by the theory of Conditional Default Reasoning, we will, in the next Section, undertake the attempt of an – informal – comparison between these two theories.

[51] From the ordering principle in (119) it follows that if M is a model of (118),
$f(w, [\![\text{Adult(x)}]\!]^M) \leq f(w, [\![\text{Univ\_st(x)}]\!]^M)$,
$f(w, [\![\text{Employed(x)}]\!]^M) \leq f(w, [\![\text{Adult(x)}]\!]^M)$,
$f(w, [\![\neg\ \text{Employed(x)}]\!]^M) \leq f(w, [\![\text{Univ\_st(x)}]\!]^M)$, and by transitivity
$f(w, [\![\text{Employed(x)}]\!]^M) \leq f(w, [\![\text{Univ\_st(x)}]\!]^M)$.

Delgrande then concludes that, since $f(w, [\![\neg\ \text{Employed(x)}]\!]^M)$ and $f(w, [\![\text{Employed(x)}]\!]^M)$ are certainly disjoint sets of worlds, and given that $f(w, [\![\text{Univ\_st(x)}]\!]^M) \subseteq [\![\text{Adult(x)}]\!]^M)$, $f(w, [\![\text{Adult(x)}]\!]^M)$ is strictly less exceptional than $f(w, [\![\text{Univ\_st(x)}]\!]^M)$, which is rewritten as $f(w, [\![\text{Adult(x)}]\!]^M) < f(w, [\![\text{Univ\_st(x)}]\!]^M)$.

He then concludes that if Sue is known to be both a student and an adult, and *if we "assume the world being modelled (call it w_R) is as unexceptional as possible consistent with what is known*, [t]hus $w_R \in [\![\text{Adult(sue)}]\!]^M \cup [\![\text{Univ\_st(sue)}]\!]$, *and since $f(w_R, [\![\textit{Adult(x)}]\!]^M) < f(w_R, [\![\textit{Univ\_st(x)}]\!]^M)$, we obtain that $w_R \notin f(w_R, [\![\textit{Adult(sue)}]\!]^M)$*. But it is consistent that $w_R \notin f(w_R, [\![\text{Univ\_st(sue)}]\!]^M)$ and so, under the assumption of normality, we can conclude that in fact $w_R \in f(w_R, [\![\text{Univ\_st(sue}]\!]^M$. From the second default we have that $f(w_R, [\![\text{Univ\_st(sue)}]\!]^M) \subseteq [\![\neg\text{Employed(sue)}]\!]^M$. Hence, $w_R \in [\![\neg\text{Employed(sue)}]\!]^M$" (Delgrande(1988:83,84)).

Comparison and Discussion

We undertake this comparison between Commonsense Entailment and Conditional Default Reasoning in order to get at a better understanding of these respective theories and, in particular, at a better understanding of how one or the other (part) of these theories could be reformulated. Given the strong similarities we perceive between Commonsense Entailment and the second approach of Conditional Default Reasoning, we want to investigate, inter alia, which particular features of these two theories are responsible for failure or success in dealing with *Graded Normality*, and explore ways to "carry over" the account of *Weak Specificity* provided by Commonsense Entailment to Delgrande's theory of Conditional Default Reasoning.

Based on the discussion of differences and similarities between *normalization* in Commonsense Entailment, and the construction of a set $\mathcal{E}(C)$ of *maximal contingent extensions* $E(C, \Delta)$ *of* C in Conditional Default Reasoning, we will try to find out whether we can do without construction of several distinct "fixed points" to quantify over for defeasible reasoning.

Finally, we want to discuss an aspect of these two modal theories of defeasible inferencing which, in our view, is problematic. We will argue that a representation of generic sentences in terms of relative modality, as initiated by Kratzer and Heim (and slightly revised in our own account), makes it possible to overcome these problems.

But first of all we have to disclaim any pretension of establishing a formal proof of equivalence between (parts of) these theories. We will follow a much more informal way of characterizing similarities and differences between these two theories, which in no way satisfies serious formal criteria. Nonetheless, we believe that – although at an informal level – we can argue rather convincingly in which ways the theories are similar, and in which they differ, which helps to understand the various points of divergence in coverage or explanation of diverse patterns of defeasible inference. We therefore beg for the reader's indulgence, and invite those with the requisite formal background to carry through a serious comparison.

Let us start with a brief overview of the respects of comparison we want to consider in turn. First, there are various respects which motivate a more or less strong "overall" similarity between Commonsense Entailment (CE) and Conditional Default Reasoning (CDR):

(s.i) Both CE and CDR are modal theories of genericity, where

(s.ii) the semantics of a generic statement is reduced to the (variable) conditional, which is characterized by an accessibility relation that is intended to encode *normalcy* (see **(d.i)** below for differences).

(s.iii) Defeasible inference, in particular defeasible modus ponens, is obtained in CE and the second version of CDR (CDR.ii) by *assuming maximal normality, respecting consistency*, which yields potentially distinct "fixed points" of normalization. Default inferences are drawn by quantification over all "fixed points" of normalization.

(s.iv) Normalization (in CE) and construction of a set of maximal contingent extensions (in CDR.ii) are both relativized to "only the premises of the argument", and finally

(s.v) both theories adopt particular principles or devices to capture the pattern of *Weak Penguin Principle*: the SPECIFICITY–constraint on the selection function * in CE, and ordering of defaults in CDR.ii (which, however, is not successful).

Besides (and within) these similarities, several differences are of importance.

(d.i) The theories differ wrt. the precise notion of *normality* underlying the variable conditional operators $\Rightarrow$ and $>$.

(d.ii) While both CE and CDR.ii use similar devices of "normalization" to implement the *assumption of normality, respecting consistency* for defeasible inferencing – *normalization* in CE and the construction of a set $\mathcal{E}(C)$ of *maximal contingent extensions* $E(C, \Delta)$ *of* C in CDR.ii – the pattern of *Nixon Diamond* yields distinct fixed points of normalization in CE, while for this case $\mathcal{E}(C)$ yields a singleton set in CDR.ii.

(d.iii) Further, and connected to (d.ii), while the basic device of $\mathcal{E}(C)$–construction in CDR.ii immediately captures *Defeasible Modus Ponens*, the *Nixon Diamond*, the *Penguin Principle* and *Defeasible Transitivity*, the additional device of an ordering over defaults is proposed to account for the *Weak Penguin Principle.* On the other hand, the "bare" *normalization* process in CE, if only subject to the FACTICITY constraint on *, captures only *Defeasible Modus Ponens*, the *Nixon Diamond* and *Defeasible Transitivity.* The *Penguin Principle* is obtained by adding the DUDLEY DOORITE constraint (102a) on * (or equivalently by constraining * in terms of our SPECIFICITY II (105)), and the *Weak Penguin Principle* in terms of the SPECIFICITY–constraint (102b).

(d.iv) While in CDR.ii the construction of a *maximal contingent extension* $E(C, \Delta)$ *of* C for defeasible inference considers, for any generic statement $(x)\alpha \Rightarrow \beta$ in D, *every* possible instantiation of $\alpha \Rightarrow \beta$ in order to determine whether $\alpha \supset \beta$ is *contingently supported* by the theory, *normalization* in CE is much more constrained in that the normalization process is restricted to a set P_Γ of *propositions for normalization*, which is defined to contain only those formulae $\phi(\delta)$ that occur in the premise set of the argument, together with a corresponding default statement $\forall x(\phi > \psi)$.

(d.v) Finally, as already noted, CDR.ii accounts for the pattern of *Graded Normality*, while this is not achieved by CE.

Let us now consider these various aspects in turn:

(s.i), (s.ii), (d.i): While undeniably both theories are modal theories of genericity **(s.i)**, and both assign generic sentences a conditional meaning in terms of *normalcy* **(s.ii)**, the theories differ wrt. the precise notion of *normality* underlying the variable conditional operators $\Rightarrow$ and $>$:

(d.i): In CE the accessibility function * selects, for w and p those worlds where "p holds, along with everything which, at w, is normally the case where p holds." (A&M(1995:311)). What is normally the case where p holds is taken to vary from world to world, and most importantly, "we suppose no absolute normality order on possible worlds. In particular, we explicitly reject the idea that $*(w,p)$ is to be identified with those most normal of all possible worlds where p holds" (A&M(1995:312)).

By contrast, the selection function f in CDR (see (107)) is based upon a (reflexive, transitive and forward connected) accessibility relation E, which holds between worlds w_1 and w_2 (Ew_1w_2) if – roughly – "w_2 is at least as unexceptional as w_1".

In our view, CE's weaker selection function $*$ is much to be preferred: e.g. it seems to us that it naturally accounts for generics like *A cat that owned money would buy Whiskas*, by accessing, from our quite "normal" actual world w, some set of rather eccentric worlds $*(w,p)$ where "everything holds that normally holds, according to w, where p is true" (with p the proposition corresponding to the indefinite NP). Assuming that in our actual world cats like Whiskas, we would certainly conclude that in a situation where cats own money (and are able to go shopping), if everything holds what normally holds for cats in w, e.g. they like Whiskas, they would buy it in all of these rather eccentric worlds.[52] By contrast, the *normalcy* accessibility function f in CDR, does not allow for evaluation of such counterfactual generic sentences, where, from some rather "normal" evaluation world w we have to access rather eccentric worlds w_1 where the generic's antecedent α holds true: According to the definition of f in (107), the selected worlds w_1 where α holds true are constrained to be *at least as unexceptional as* w. This certainly does not capture the kind of obviously counterfactual generics just considered.

As far as I can see, it should be possible, in principle, to adopt in CDR the weaker selection function $*$ (98) of CE. However, this has important implications for the behaviour of the theory with respect to the inference pattern of *Graded Normality.* See below **(d.v)**.

(s.iii), (s.v), (d.ii), (d.iii): Another set of "differences within similarity" is connected to the use of a "normalization" device in both CE and CDR.ii. Below we will show that **(s.iii)** the definition of *P–normalization chains* in CE and the construction of a *maximal contingent extension* $E(C,\Delta)$ *of* C in CDR.ii are structurally similar/equivalent in that (i) they both implement the "assumption of normality, respecting consistency with what is known/assumed", and (ii) determine a set of "fixed points" of normalization that provide the basis for defeasible inferences (in terms of $|\approx$ and $|\sim'$, respectively), where in both theories defeasible inference is defined in terms of quantification over the set of "fixed points" of normalization.

(s.iii): First recall the definition of normalization in CE, where the first clause of $\underline{N}(s,\alpha)$ reduces to $\underline{N}(s,\alpha) := s \cap *(s,\alpha)$ in case $s \subseteq \alpha$.

$$(120)\quad \underline{N}(s,\alpha) := \begin{cases} s\backslash(\alpha\backslash *(s,\alpha)) & \text{if } s \cap *(s,\alpha) \neq \emptyset, \text{ where } *(s,\alpha) := \cup_{w\in s} *(w,\alpha) \\ s & \text{otherwise} \end{cases} \qquad \text{A\&M(1995:320)}$$

For comparison, consider the relation of *contingent support* (121) in CDR.ii: Taking our departure from (121) we now try to give an informal comparison between normalization in CE (where we assume SPECIFICITY II and FACTICITY to constrain the selection function $*$) and the construction of a *maximal contingent extension* $E(C,\Delta)$ *of* C in CDR.ii. We do this by isolating, in CE, conditions corresponding to the concepts and conditions occurring in (121), where the skeleton of (121) is as in (122):

[52] There is some problem here, for CE, that has to do with the problem of Graded Normality, which will be discussed below **(d.v)**.

(121) $\alpha \supset \gamma$ is *contingently supported* in a default theory $T = \langle D, C \rangle$ if
(1) $D \vdash_N \alpha \Rightarrow \gamma$.
(2) $C \cup D \cup \{\alpha \supset \gamma\}$ is consistent.
(3) If there is a α' s.th. $\vdash_{FOL} C \supset \alpha'$ and $(C \cup D) \vdash_N \neg(\alpha' \Rightarrow \gamma)$ then $\vdash_{FOL} \alpha \supset \alpha'$.
Delgrande(1988:77)

(122) (N) if (1) & (2) & (3)
where (3): if (3.a) then (3.b).

The conditions corresponding to (N) and (1)–(3) in CDR.ii are stated in (123).

(123) CDR.ii:
(N) : $C_i = C \cup \{\alpha \supset \gamma\}$, for $T = \langle D, C \rangle$
(1) : $D \vdash_N \alpha \Rightarrow \gamma$
(2) : $D \cup C \cup \{\alpha \supset \gamma\}$ is consistent
(3) : if (3.a) $\exists \alpha' : \vdash_{FOL} C \supset \alpha'$ and $(C \cup D) \vdash_N \neg(\alpha' \Rightarrow \gamma)$ then (3.b) $\vdash_{FOL} \alpha \supset \alpha'$.

In CE, we find the following conditions to correspond to (N) and (1)–(3) of (123):

(124) CE:
(N) : $\underline{N}(s, \alpha) := s \cap *(s, \alpha)$ and $\underline{N}(s, \alpha) \subseteq [\![\gamma]\!]_M$
(1) : $*(w, \alpha) \subseteq [\![\gamma]\!]_M$, for $w \in s$
(2) : $s \cap *(s, \alpha) \neq \emptyset$ (modulo *Graded Normality*, see **(d.v)** below)
(3) : if (3.a) $\exists \alpha' : s \cap \alpha' \neq \emptyset$ and $*(s, \alpha') \not\subseteq [\![\gamma]\!]_M$ then (3.b) $[\![\alpha]\!]_M \subseteq [\![\alpha']\!]_M$.

In (123.N) a contingently supported implication $\alpha \supset \gamma$ is defined to yield a new set $C_i = C \cup \{\alpha \supset \gamma\}$, which – if we follow the definition of a *maximal contingent extension* $E(C, \Delta)$ in (116′) – constitutes a new theory $T_i = \langle D, C_i \rangle$ that potentially qualifies as a fixed point, or maximal extension $E(C, \Delta)$ of C. This corresponds, in CE, to a normalization step, where – in the non–trivial case – $\underline{N}(s, \alpha) := s \cap *(s, \alpha)$, such that $\underline{N}(s, \alpha) \subseteq [\![\gamma]\!]_M$. The latter condition is in effect captured by condition (124.1) – given the definition of $*(s, \alpha)$ by $\bigcup_{w \in s} *(w, \alpha)$ – and corresponds to (123.1): the truth of a default statement $\alpha \Rightarrow \gamma$ relative to D at some world w corresponds, in CE, to the truth of γ in all accessible worlds $*(w, \alpha)$.[53] The consistency constraint in (123.2) is mirrored, in CE, by condition (124.2): If α occurs in the premise set of an argument, i.e. $\alpha \in C$, and the implication $\{\alpha \supset \gamma\}$ can consistently be assumed, given D and C, condition (123.2) implements the notion of *assuming α to be normal, while consistent with the premises.* In particular, $D \cup C$ must be consistent with γ. The very same conception underlies condition (124.2): Given that according to (124.1) γ holds in all normal α–worlds accessible from worlds $w \in s$, a nonempty intersection of s, the current premise set, with the normal α–worlds accessible from s mirrors this consistency–constraint: α can consistently be assumed to be normal relative to s, and thus, in particular, s is consistent with γ.

[53]Taken together, (N) and (1) in (124) lead to a simplification of (N): given (1), (N) simplifies to (N'): $\underline{N}(s, \alpha) := s \cap *(s, \alpha)$.

Taken together, (124.1) and (124.2) characterize the preconditions for a non–trivial application of the normalization function $\underline{N}$ to s and α in CE (compare (120)): the application leads to a reduction of the set of worlds in s just in case s is consistent with what is normally the case if α is true. By definition of *, this reduction of s is to a subset $s' = \underline{N}(s, \alpha)$, where α holds, along with everything that is normally the case where α holds, in particular, γ. This very same effect is obtained, in CDR.ii, by conditions (123.1) and (123.2): C is extended by the implication $\alpha \supset \gamma$ in (123.N) – which leads to the derivation of γ if α figures in the premise set C[54] – if "supported" by the validity of the corresponding generic statement $\alpha \Rightarrow \gamma$ in D, and if the material conditional – and with it the assumption of γ, given α – is consistent with the actual extension of T.

We can therefore complete the skeleton in (122) by filling in the abstract concepts (N), (1) and (2) underlying the *normality assumption*, which are common to both CE and CDR.ii,[55] and we can also this for (120), as in (126) (where P corresponds to $T = \langle D, C \rangle$ in (125) and to s in (126)).

(125) (N) assume α to be normal relative to P if
(1) 'if α then normally γ' is true in P &
(2) α can consistently be assumed to be normal in P &
(3) conflicting defaults are respected.

(126) (N) assume α to be normal relative to P if
(2) α can consistently be assumed to be normal in P
where (1) 'if α then normally γ' is true in P.
Do not assume α to be normal otherwise.

(s.v), (d.ii), (d.iii): While focussing on the similarities between the two theories, (123) and (124) also highlight the differences between normalization in CE and CDR.ii. In CDR.ii conditions (1) and (2) are not considered as sufficient conditions for normalization (N).

As we have seen, (123.3) accounts for the *Penguin Principle* and the *Nixon Diamond*: in case conflicting defaults $\alpha \Rightarrow \gamma$ and $\neg(\alpha' \Rightarrow \gamma)$ are valid in D (and C), and C implies α', α can only be assumed to be "normal" by extending C with the *contingently supported* implication $\alpha \supset \gamma$, if α implies α'. On the other hand, while CE does not impose additional restrictions (corresponding to (3)) on normalization, we have seen that it accounts for the *Penguin Principle* by imposing an additional constraint upon *, the DUDLEY DOORITE constraint (102a), or alternatively, the constraint SPECIFICITY II we proposed in (105). Also, we have noticed that the pattern of *Nixon Diamond* yields distinct fixed points of normalization in CE, but not so in CDR.ii. Given our above considerations, which suggest that normalization in CE and CDR.ii is structurally equivalent wrt. conditions (1) and (2), we therefore conjecture that these distinct properties originate from the additional restriction (3) in CDR.ii on the one hand, and constraints on the selection function * in CE on the other.

It is easy to see how our "reconstructed" condition (124.3) corresponds to condition (123.3) in CDR.ii: if there is some α' consistent with s, where * is such that γ does *not* hold in every normal α'–world, then in order to license the non–trivial normalization step

[54] Modulo, of course, quantification over the different subsets $E(C, \Delta)$ of $\mathcal{E}(C)$.

[55] We will have more to say about condition (3) below.

$\underline{N}(s,\alpha)$ in (124.N), α must imply α'. The comparison between CE and CDR.ii then reduces to the question whether the particular conditions carried by (124.3) are in any way related to the effects that the SPECIFICITY II–constraint on * (which we argued to account for the *Penguin Principle* in CE) has for normalization in (120).

Here it may help to associate, with the particular conditions of both SPECIFICITY II, repeated below as (127), and condition (124.3) (*in the "context" of* (124.1) and (124.2)), the corresponding abstract concepts they implement in either one of these theories (128).

(127) SPECIFICITY II:
If (a) $[\![\alpha]\!]_M \subseteq [\![\alpha']\!]_M$,
(b) $*(w,\alpha) \cap *(w,\alpha') = \emptyset$, and
(c) $*(w,\alpha) \neq \emptyset$,
then (d) $*(w,\alpha') \cap \alpha = \emptyset$.

Both (124.2) and (127c) correspond to the *normality*–assumption for α.[56] Furthermore, (124.1) in conjunction with (124.3a), and (127b) both assume "conflicting" defaults for α and α'. Finally, it is obvious that the implication $[\![\alpha]\!]_M \subseteq [\![\alpha']\!]_M$ in (124.3b) is equivalent to (127a).

In (128) we use these correspondences in order to get at a clearer picture of the differences between normalization (120) with SPECIFICITY II imposed on * (128i), and normalization as sketched in (124), corresponding to the approach taken in CDR.ii (128ii).

(128)

(i) CE: SPECIFICITY II	(ii) CE: conditions (1)–(3)
(a) If α implies α'	If /
(b) conflicting defaults for α and α'	(1) + (3a) conflicting defaults for α and α'
(c) assuming α normal	(2) assuming α normal
then (d) α not a normal α'	then (3.b) α implies α'

It is obvious that (128i) is restricted to patterns with "conflicting" defaults where the respective antecedents α and α' are such that α implies α'. Thus, (128i) is restricted to the pattern of the *Penguin Principle*, where it prevents normalization with α'. It does *not* apply to other patterns involving "conflicting" defaults, such as the *Nixon Diamond*, or the *Weak Penguin Principle*. By contrast, the range of application of (128ii) is wider: the conditions apply to any[57] inference pattern where the set of premises contains "conflicting" defaults for α and α' and where α can consistently be assumed to be normal. Besides the *Penguin Principle* (128ii) therefore also applies to the pattern of the *Nixon Diamond*: By (128ii.3b), the condition $\alpha \supset \gamma$, which – on assumption of α – (potentially) licenses the defeasible conclusion that γ, is only supported for the (possibly) stronger antecedent α. Thus, (128ii) not only implements the *Penguin Principle*, but automatically prevents any (defeasible) conclusion γ or $\neg\gamma$ to be drawn for the *Nixon Diamond*.

[56]The differences between (127c) and (124.2) result from the fact that (127) only indirectly interacts with normalization (120), where the consistency of assuming α to be normal is checked relative to s.

[57]Here the concept of "conflicting defaults" is of course restricted to non–transitive cases, according to the definitions in both (127) and (126)/(123). For transitivity see below.

We now also understand why the pattern of *Nixon Diamond* yields distinct fixed points of *normalization* in CE, while only one fixed point of *maximally contingent extensions* of C in CDR.ii: Since SPECIFICITY II does not apply to this pattern of "conflicting defaults", *Defeasible Modus Ponens*, which in CE is built into *P–normalization*, may apply to either one of the conflicting patterns of modus ponens we find in the *Nixon Diamond*, and therefore gives rise to different fixed points of normalization.

Note further the correspondence between condition (128i.d) and condition (128ii.3b) as a condition for (124.N): while by (128i.d) the selection function * is explicitly restricted to encode α as not being a normal α', therefore precluding the unwarranted (defeasible) inference from the weaker concept in the *Penguin Principle*, the same effect is obtained by condition (128ii.3b) if occurring with (124.N) in the skeleton (122): in cases of conflicting defaults for α and α' where α implies α' and α can consistently be assumed to be normal, non–trivial normalization is restricted to α by (128ii.3b).

Besides the differences in range of application, this comparison between (128i) and (128ii) also brings out a conceptual difference between the two approaches: For the particular case of the *Penguin Principle*, where $\alpha = penguin(tweety)$, the SPECIFICITY II–constraint on * explicitly imposes a further constraint on the selection function *, which precludes that Tweety, being a penguin, may be assumed to be a normal bird. In CDR.ii, however, the conflict that arises in this type of inference pattern is *not* reflected by a corresponding constraint on the *normalcy*–selection function f. The specificity constraint is only reflected in terms of the *contingently supports* relation, which – together with the construction of *maximal contingent extensions* $E(C, \Delta)$ *of* C – implements the notion of the *assumption of normality, preserving consistency.* In our view, the conception of CE is in this respect much to be preferred.

We now come to evaluate the two approaches with respect to two further defeasible inference patterns: the *Weak Penguin Principle* and *Defeasible Transitivity*, where we finally speculate about possible modifications of the two theories.

As discussed above, the *Weak Penguin Principle* can be accounted for, in CE, in terms of the SPECIFICITY–constraint on *, while in CDR.ii an additional device, *ordering of defaults* is proposed to get hold of this pattern, but which did not, in fact, yield the desired result. Given the close correspondence of SPECIFICITY and SPECIFICITY II (repeated below), and the similarly close correspondence of the respective patterns *Penguin Principle* and *Weak Penguin Principle*, the analysis in CE – if we take it to adopt SPECIFICITY II instead of (or in addition to) the DUDLEY DOORITE CONSTRAINT – seems to be much more natural than the approach taken in CDR.ii, where these two related argument patterns are accounted for by radically different concepts.

(129) a. SPECIFICITY II:
If $[\![\alpha]\!]_M \subseteq [\![\alpha']\!]_M$, $*(w,\alpha) \cap *(w,\alpha') = \emptyset$, and $*(w,\alpha) \neq \emptyset$, then $*(w,\alpha') \cap \alpha = \emptyset$.

b. SPECIFICITY: A&M(1995:333)
If $*(w,\alpha) \subseteq \alpha'$, $*(w,\alpha) \cap *(w,\alpha') = \emptyset$, and $*(w,\alpha) \neq \emptyset$, then $*(w,\alpha') \cap \alpha = \emptyset$.

However, it is easy to imagine how to modify CDR.ii so that it simulates the solution of CE. We just modify condition (3) of the *contingently supports*–relation such that the specificity constraint (in case of conflicting defaults $\alpha \Rightarrow \gamma$ and $\neg(\alpha' \Rightarrow \gamma)$) not only applies if α implies α', but also if α and α' are "generically" or conditionally related by $\Rightarrow$: $\alpha \Rightarrow \alpha'$. By adopting this modification, the additional device of an ordering imposed on defaults (see (119)) can be dispensed with, and it will then in fact be possible, in CDR.ii, to account for the *Weak Penguin Principle.*

(130) $\alpha \supset \gamma$ is *contingently supported* in a default theory $T = \langle D, C\rangle$ if
(1) $D \vdash_N \alpha \Rightarrow \gamma$.
(2) $C \cup D \cup \{\alpha \supset \gamma\}$ is consistent.
(3') If there is a α' s.th. $\vdash_{FOL} C \supset \alpha'$ and $(C \cup D) \vdash_N \neg(\alpha' \Rightarrow \gamma)$
then $\vdash_{FOL} \alpha \supset \alpha' \vee D \vdash_N \alpha \Rightarrow \alpha'$.

Finally, note that we might even go one step further and try to capture the pattern of *Defeasible Transitivity* (131) not in terms of quantification over distinct sets $E(C, \Delta) \in \mathcal{E}(C)$ in CDR.ii, or over distinct fixed points FIX(C) resulting from different *P–normalization chains* C in CE, but equally well by imposing further constraints upon normalization for these specific contexts of conflicting defaults: in terms of constraints on the selection function * in CE, or by further specifying the characterization of conflicting defaults in the definition of the *contingently supports*–relation in CDR.ii.

(131) Quakers are pacifists.
Pacifists are vegetarian.
Republicans are not vegetarian.
Dick is a Quaker.
Dick is a Republican.
$\not\models\!\!\approx$ Dick is vegetarian.
$\not\models\!\!\approx$ Dick is not vegetarian.

For CE, we propose the following constraint on *, which we term TRANSITIVE DIAMOND (132). Note that it not only accounts for (131), but furthermore results in a single fixed point of *P–normalization chain C*, which in fact does not support the defeasible inference of either *Dick is vegetarian*, or *Dick is not vegetarian.* Similar observations hold for the pattern of *Nixon Diamond*, if the selection function is restricted by the simple DIAMOND–constraint (133), which, however, is already covered by the TRANSITIVE DIAMOND (132).

(132) TRANSITIVE DIAMOND:
If $[\![\alpha]\!]_M \not\subseteq [\![\alpha']\!]_M$,
$*(w, \alpha) \subseteq \beta_i$, $*(w, \beta_i) \subseteq \beta_{i+1}$, $\ldots$ $*(w, \beta_{n-1}) \subseteq \beta_n$, (for $i = 1 \ldots n$) and
$*(w, \alpha \wedge \beta_i \wedge \ldots \beta_n) \cap *(w, \alpha') = \emptyset$,
then $*(w, \alpha) = \emptyset$ and $*(w, \alpha') = \emptyset$.

(133) DIAMOND:
if $[\![\alpha]\!]_M \not\subseteq [\![\alpha']\!]_M$ and $*(w, \alpha) \cap *(w, \alpha') = \emptyset$, then $*(w, \alpha) = \emptyset$ and $*(w, \alpha') = \emptyset$.

Now, *if*, in general, by imposing these (and possibly additional) constraints on *, normalization always resulted in a *single* fixed point FIX(C) – a stipulation which we did not prove, but go on to pursue – the definition of Commonsense Entailment in (101) would reduce to (134):

(134) COMMONSENSE ENTAILMENT: (modified version)
$\Gamma \mid\approx_P \phi$ iff $\mathcal{A}_{can}$, FIX(C) $\models \phi$,
where FIX(C) the fixed point of any P–normalization chain C beginning from $\odot + \Gamma$.

For CDR.ii we can similarly come up with a redefinition of the *contingently supports*–relation (130), adapted to account for the pattern of *Defeasible Transitivity* in terms of a singleton set $\mathcal{E}(C)$ of *maximally contingent extensions of* C.

(135) $\alpha \supset \gamma$ is *contingently supported* in a default theory $T = \langle D, C \rangle$ if
(1) $D \vdash_N \alpha \Rightarrow \gamma$.
(2) $C \cup D \cup \{\alpha \supset \gamma\}$ is consistent.
(3") If there is α' and $\beta_i \ldots \beta_n$, for $i = 1 \ldots n$ s.th.
$\vdash_{FOL} C \supset \alpha'$ and $(C \cup D) \vdash_N \alpha' \Rightarrow \beta_i \wedge \beta_i \Rightarrow \beta_{i+1} \wedge \ldots \wedge \beta_{i+1} \Rightarrow \beta_n \wedge \neg(\beta_n \Rightarrow \gamma)$
then $\vdash_{FOL} \alpha \supset \alpha' \vee D \vdash_N \alpha \Rightarrow \alpha'$.

To sum up, we have shown – although by way of some rather nonformal comparison of CE and CDR.ii – that the concept of "normalization" defined by *P–normalization chains* in CE and by generation of a set $\mathcal{E}(C)$ of *contingent extensions of C* in CDR.ii are similar wrt. to their "core": the *assumption of normality, respecting consistency with the premise set.* Besides this essential similarity the two theories differ wrt. the particular restrictions that are imposed, as an extension to this core notion, in order to account for various patterns of default inference involving "conflicting" defaults, which are of course the most interesting aspect of the defeasible inference relation.

It turned out that there are three main differences between these two theories with respect to these additional devices:

(i) First, while in CE the restrictions are *uniformely* encoded by additional restrictions on the selection function *, CDR.ii makes (unsuccesful) use of the particular device of an ordering over defaults to account for the *Weak Penguin Principle*, which introduces a new concept into the theory. We have argued that not only is it possible to modify the *contingently supports* relation to account for the *Weak Penguin Principle* without such an additional device, but, moreover, that this modification mirrors, in the formal account, the close relation between the ordinary *Penguin Principle* and the *Weak Penguin Principle.* We have argued that also in CE it is possible to treat these inference patterns in terms of a structurally more uniform way, by adopting the SPECIFICITY II constraint on * – in addition to, or by substitution of the DUDLEY DOORITE constraint.

(ii) A further difference between normalization in CE and CDR.ii showed up when we investigated the additional restrictions imposed upon normalization in CDR.ii in terms of condition (3) in (121), as compared to the SPECIFICITY II–constraint on *. While both theories account for the *Penguin Principle* and the *Nixon Diamond*, they do so in different ways. Roughly, the definition of normalization in CDR.ii directly captures the pattern of conflicting defaults we find in the *Nixon Diamond*, and immediately precludes the assumption of normality for either one of the antecedents involved, while in CE defeasible modus ponens can be applied to either one of the conflicting default statements, yielding distinct fixed points.

(iii) This difference reflects a deeper, underlying conceptual difference between the two accounts: in CE we find a clear separation between *P–normalization* on the one hand, which in essence comes down to an implementation of (repeated) defeasible modus ponens, and specific restrictions on the selection function *, which prevent non–trivial normalization steps for specific patterns of defeasible reasoning involving conflicting defaults. There is thus a clear separation between the "(defeasible) reasoning engine", i.e. *normalization*, and a "controlling device" for this machinery, in terms of special restrictions on *, which covers the essentials and characteristics of "commonsense", or defeasible reasoning.

In CDR.ii (at least in the modified version we suggested) we can also find those two components of default reasoning, but here they are merged together in the definition of *contingent support* (together, of course, with the recursion implemented by the construction of a *maximal contingent extension* $E(C, \Delta)$ *of* C): conditions (1) and (2) implement necessary conditions for defeasible modus ponens under the assumption of normality, while condition (3) imposes specific restrictions on its application for various patterns of conflicting defaults. So CE and CDR.ii can at best – if at all – be taken to be weakly equivalent.

It is difficult to come up with hard arguments to prefer one of these approaches over the other. However, it seems to us that the modularity that is built into CE is highly desirable. It turned out that in both theories – in fact, in *any* theory of nonmonotonic reasoning – the "bare" *assumption of normality* is not sufficient to account for the various patterns of defeasible reasoning. In particular the *Penguin Principle* seems to require the introduction of very specific *rationality principles*, which prefer application of defeasible modus ponens to the stronger over application to the more general concept (in case of conflicting defaults). So there is a clear motivation to isolate such *rationality principles* that are operative in various patterns of defeasible inference, by stating them in a modular part of the theory.

If we further stipulate that it should be possible, in CE, to define a whole family of such constraints, or *rationality principles* (as we did by way of SPECIFICITY, SPECIFICITY II, and TRANSITIVE NIXON DIAMOND) such that normalization turns out to work in a deterministic way, yielding a *single* fixed point of normalization which does or does not license a particular defeasible conclusion, this position receives even more impact. We then have a clear separation between a *nonmonotonic* logical machinery on the one hand and a set of *rationality principles for conflicting defaults* on the other, which interacts with the basic machinery in a clearly defined way: in terms of constraints on the selection function *.[58]

One motivation for going into this extensive discussion of the concept of "normalization" is that we are highly sympathetic to such a modular account and will suggest something along these lines in our DRT–approach in Section 5.3.3. Given, however, that we are not in a position to work out a full theory of nonmonotonic reasoning, the present discussion is intended to make plausible that a full–fledged theory of this kind could be spelled out.

Let us now turn to the remaining respects of comparison, **(s.iv)**, **(d.iv)** and **(d.v)**. **(s.iv)** and **(d.iv)** will be passed over quite briefly.

[58]Note that CE in its original version is in this respect still hybrid, in that the *Nixon Diamond* and *Defeasible Transitivity* are not treated in terms of specific constraints on *, but in terms of quantification over distinct fixed points of normalization.

(s.iv) Both CE and CDR.ii adopt the quite sensible assumption that the relation of defeasible inference must be defined relative to the set of premises only. In CE this is achieved by starting the process of normalization relative to the special "informationally minimal information state" $\odot$ updated with the set of premises Γ (see definition of commonsense entailement (101)). The informationally minimal information state $\odot$ is obtained from the canonical model, and supports just the valid sentences of the language $L_>$.

In CDR.ii, this assumption is not *explicitly* adopted. In fact, the comments in Delgrande(1988:70) are rather misleading: There a *default theory* $T = \langle D, C \rangle$ is introduced as follows: "D is a set of necessary or default sentences, or negations of such sentences, constraining how the world *must* be or *could* be, while C is a set of contingent sentences constraining how the world being modeled *is*." While these comments strongly suggest that D and C provide a full description of what is taken to be known about our world, this cannot be what is intended for a theory of default reasoning. In fact, the theory can *only* account for the various patterns of nonmonotonic reasoning if $T = \langle D, C \rangle$ is restricted to the set of contingent sentences introduced by the premises of a particular argument pattern. Imagine the following case. We are interested in the (defeasible) conclusion of *Opus is black* from the premises: *Ravens are black. Opus is a raven.* Now take it that the world is such that *Opus is an albino raven.* and *Albino ravens are not black.* are both true. If the corresponding formulae *albino_raven(opus)* and *(x)(albino_raven(x)* $\Rightarrow \neg$ *black(x))* were contained in C and D, respectively, we would *not* get the desired defeasible conclusion that *Opus is black.* Therefore at least the set C of T must be restricted to the contingent sentences occurring in the premise set of the actual argument pattern, while D might in fact comprise all necessary and default sentences that hold true in the actual world.

One might argue then, that there is still some difference between CE and CDR.ii, given that D may contain the full set of generic statements that are true in our world, while in CE only those generic statements are considered that figure in the premise set Γ. Yet, we do not believe this difference to be decisive.

(d.iv) There is still another, but minor difference between CE and CDR.ii, which again concerns the implementation of the *normality assumption.* In CDR.ii the construction of a set $\mathcal{E}(C)$ of *maximal contingent extensions of* C in fact corresponds to a maximal normality assumption in that for *every* $\alpha \Rightarrow \gamma$ that is N–valid in the set D of default and valid sentences it is considered whether the implication $\alpha \supset \gamma$ is *contingently supported*, in which case it is defined to contribute to a *maximal contingent extension of C.* So, roughly, when considering the validity of a defeasible conclusion γ from T, the assumption of normality is computed for *any* individual that satisfies the antecedent of a generic statement in D. This is undoubtedly more than is necessary, while it seems to be harmless.

Normalization in CE differs from this picture in that it avoids the computation of any "unnecessary" normality assumption: Asher&Morreau define the notion of *a set* P_Γ *for normalization* : "let Γ^* be the result of rewriting Γ in conjunctive normal form. Then P_Γ is the set of all propositions $[\![\phi(d)]\!]$, where d is an individual constant appearing in Γ^*, and $\phi(x)$ is the antecedent of a "positive" occurrence of a universally quantified $>$ conditional in Γ^*." (A&M(1995:322)). Together with the definition of a *P–normalization chain* the normality assumption is thus restricted to those individuals d (more precisely: propositions $[\![\phi(d)]\!]$) that are introduced in the premise set of an argument, and for which we find a generic statement in those premises.[59]

[59] Asher&Morreau briefly mention that there are various different choices to define the set P_Γ:

(d.v) Finally we have to consider an important difference between CE and CDR.ii: While CDR.ii accounts for the pattern of *Graded Normality*, this is not the case for CE.

(136) Dogs are normally hairy.
Dogs normally have four legs.
Fido is a dog.
Fido has three legs.
$|\approx$ Fido is hairy. A&M(1995:334)

Delgrande does not explicitly discuss the problem of *Graded Normality*, yet presents an example that is very similar to this pattern: He posits a set of defaults $D_3 = \{$ Raven(x) $\Rightarrow$ Black(x), Raven(x) $\Rightarrow$ Fly(x), (Raven(x) $\wedge$ Albino(x)) $\Rightarrow \neg$ Black(x) $\}$, for which he states that "we can conclude by default that ravens with wings are black, and that ravens that fly (or don't fly) are black. Moreover albino ravens are concluded by defualt to fly but not be black." (Delgrande(1988:81)). We might also consider a case that is in fact an instantiation of *Graded Normality*, namely $D = \{$ Raven(x) $\Rightarrow$ Black(x), Raven(x) $\Rightarrow$ Fly(x)$\}$ and $C = \{$ Raven(b), $\neg$Black(b)$\}$. Since raven b is known not to be black, the implication $Raven(b) \supset Black(b)$ is not *consistently supported* in $T = D, C$ (in particular, $D \cup C \cup \{Raven(b) \supset Black(b)\}$ is not consistent. However, the implication $Raven(b) \supset Fly(b)$ is consistent with $D \cup C$, and thus is contintently supported by the theory. Conditional Default Reasoning therefore licenses the default inference that raven b flies, $Fly(b)$, while it doesn't support the default inference that raven b is black, $Black(b)$.

The reason why CE fails to account for *Graded Normality* seems to depend crucially on the particular definition of the accessibility function $*$, which selects, for some world w and proposition $\phi(\delta)$ "the set of worlds where $\phi(\delta)$ holds along with *everything* which, at w, is normally the case where $\phi(\delta)$ holds". I.e., the concept of *normality* underlying the semantics of the generic, or conditional sentence is a notion of *absolute* normality.

Given only the generic sentences in the premise set Γ of (136), the normalcy selection function must be such that $*(w, [\![dog(fido)]\!]) \subseteq [\![has\_four\_legs(fido)]\!]$ and $*(w, [\![dog(fido)]\!]) \subseteq [\![hairy(fido)]\!]$. But since $s = \odot + \Gamma$ supports $has\_three\_legs(fido)$, i.e., $s = \odot + \Gamma \subseteq [\![has\_three\_legs(fido)]\!]$, if normalizing $\odot + \Gamma$ with $P = \{dog(fido)\}$ there is in fact no non–trivial normalization step $\underline{N}(s, [\![dog(fido)]\!])$ to provide worlds where "everything holds that normally holds where $[\![dog(fido)]\!]$ is true": $s \cap *(s, [\![dog(fido)]\!]) = \emptyset$. I.e., the fixed points of normalization do not support the proposition $[\![has\_four\_legs(fido)]\!]$, which is desired, but also do not support the proposition $[\![hairy(fido)]\!]$, which is unwarranted.

What is needed instead – and this is acknowledged by Asher&Morreau(1995) – is a *normalcy*–selection function that reflects a notion of *normality* that is "not an absolute manner, as it is assumed to be in this chapter, but [...] come[s] in degrees instead. [...]

"For example, instead of choosing propositions for normalization on the basis of the premises of some argument one has in mind [...] one might normalize information states using all of the propositions they support. Or even all propositions in the entire model. The definition of the propositions of normalization given below is just one such choice [...]. Future work to be done on our theory will need to map out the different possibilities that are open here, and how they affect the formal properties of the notion of commonsense entailment." A&M(1995:322)

The premises of the above argument exclude the possibility that Fido is a completely normal dog. But they do not exclude the possibility that Fido is a halfway normal dog; some mechanism for assuming maximal normality could thus be expected to give rise to the conclusion that Fido is a mammal." (A&M(1995:335)). Thus, what is needed is a *normalcy* selection function that provides a notion of different *degrees of, or "graded" normality*: in particular *maximal normality, respecting consistency.*[60]

We will come back to the problem of *Graded Normality* in Section 5.3.3.

To conclude our discussion of Commonsense Entailment and Conditional Default Reasoning, we want to focus on the following results we obtained by way of a detailed comparison:

- Both modal theories of nonmonotonic reasoning heavily rely upon the semantics of generic sentences in terms of the variable conditional operator, where the accessibility relation encodes some notion of *normality*, which is, however, slightly different in these two theories: In Commonsense Entailment *normalcy* implements an *absolute* notion of normality, while in Conditional Default Reasoning *normality* is a matter of degree. This has implications for the analysis of the inference pattern *Graded Normality.*

- Abstracting away from this difference, in both theories the notion of *defeasible inference* is built upon the *assumption of normality, respecting consistency with the premises.* We have argued that the particular implementations of the *assumption of normality* in terms of "normalization" in conjunction with the respective notions of *defeasible inference* are by and large equivalent.

- Besides the *normality assumption* both theories adopt additional conditions or constraints to account for various patterns of nonmonotonic reasoning involving "conflicting defaults": *(Weak) Penguin Principle*, *Nixon Diamond*, *Defeasible Transitivity*, and probably many more. We have argued that it should be possible to define a whole family of such restrictions, either in terms of special constraints on the normalcy–selection function * in CE, or else by integrating such additional constraints directly into the definition of the *assumption of normality*, (i.e., the definiton of *contingent support* for the construction of *maximally contingent extensions of C*) in CDR.ii. In our view, there is some appeal to the former solution, which features more modularity.

- We have seen that it is sufficient, in CE, to restrict normalization for some defeasible argument pattern $\Gamma \mid\approx \gamma$ to the set P_Γ, as opposed to the construction of *maximal contingent extensions of C* in CDR.ii. *P–normalization* in CE therefore corresponds to (repeated) application of Defeasible Modus Ponens, for every $\phi \in P_\Gamma$, to generic sentences in the set of premises Γ.

- Finally, we have expressed our hope that it should be possible to define a family of special, refined restrictions on the normalcy selection function * such that *P–normalization* will always yield a single, instead of multiple fixed points. If it is possible

[60]According to Morreau(1992:131), a natural way to account for *Graded Normality* in CE – which is very similar to the analysis in Circumscription – could be to introduce a third parameter for the normalcy selection function *, which refers to "respects in which things can be normal [...]. Thus we would write $*(w, p, respect)$ instead of $*(w, p)$, *respect* being a constant referring to an abstract object. [...] the resulting defeasible entailment notion should capture graded normality at least to the same extent that these applications of Circumscription do."

to come up with such a set of constraints on * that account for a comprehensive set of defeasible argument patterns in this way, there seems in fact to be a very close connection between the semantics of the variable conditional $>$ – which is based on the selection function * – and the relation of defeasible inference $|\approx$: A defeasible inference $\Gamma \mid\approx \gamma$ can then be understood – roughly – as *If* Γ, *then normally* γ, where *normally* is to be analyzed by repeated application of normalization (based on the normalcy selection function *): $s_{i+1} := N(s_i, p)$, for $i = 1 \ldots n$, $p \in P_\Gamma$ and $s_0 = \odot{+}\Gamma$, and where * respects the various specific constraints for "conflicting" defaults.

Normally and the logical form of generic sentences

We now come to discuss a distinction that is made between analyses of genericity classified as the *rules–and–regulations* approach and the *inductive* approach to genericity. We basically refer to the discussion in Carlson(1995), who characterizes these two approaches as follows:

> ...contrasting the two basically different views of generic sentences, each of which handles with apparent ease what the other handles only clumsily. The first approach, one I have argued against in the past (e.g., Carlson 1982), is what I will call the *inductive* approach. The driving intuition behind it lies in the conviction that generics essentially express inductive generalizations, where the base of the generalization is some observed set of instances; after "enough" instances have accumulated, the generic form can be truly asserted. Paradigm cases of generics under this view would be sentences like *Dogs bark*, *The sun rises in the East, Max spends every Friday at his mother's*, and *Jill walks to school.* The most natural adherents of this approach would be empiricists, verificationalists, and nominalists of varying stripes.
>
> On the other side of the coin is what I will call the *rules–and–regulations*, or *realist*, approach, which does not hold that generics are truly asserted on the basis of an array of observed (or even unobserved) instances. According to this approach, generic sentences depend for their truth or falsity upon whether or not there is a corresponding structure in the world, structures not being the episodic instances but rather the causal forces behind those instances. The paradigm cases of generics on the realist approach are rules and regulations that we can stipulate, and hence know directly, such as *Bishops move diagonally, The Speaker of the House succeeds the vice president*, or *Tab A fits in slot B* (on a cereal box cut–out toy), or, for that matter, the content of a computer program. People who take properties and propositions as real entities would be most naturally inclined toward this approach [...]. Carlson(1995:225)

One of the basic premises of Carlson – in fact of theories of genericity in general – is that generic sentences constitute a *unified phenomenon*, which can be given an "all–encompassing semantics". Now, as Carlson observes, the data divide into two classes, (i) one class of generics which best fits into the *inductive* view, but is difficult to handle for the *rules–and regulations* approach, while (ii) another class of generics accords with the *rules–and–regulations* view, but poses considerable problems for *inductive* theories.

(ii) The *rules–and–regulations* view easily accounts for generics that are grounded on rules and regulations of, e.g., games: Games are determined by a set of rules, which in turn, to a large extent, guide our activities: "I move my knight in chess in that particular way, I am to keep the tennis ball between the white lines, I play trump card on my opponent's ace, and so forth, all because of the rules I know about these various games." (Carlson(1995:228))

The rules–and–regulations approach is more problematic for generic sentences that express *weak and descriptive generalizations*: while there may be genetic structures which determine that *Crows are black*, there are no corresponding genetic structures that directly determine that *Crows are larger than bullfinches.*[61] Also, there seem to be no "rules and regulations" for generics such as *Mary shows up at psychology classes every once a while* (Carlson(1995:229)).

(i) The *inductive* approach perfectly accounts for this latter type of examples, where the truth of the generic sentence can be taken to be induced by empirical observations. But it meets serious difficulties when it comes to generics the truth of which is not supported by *any* observable "instance". Carlson's example is *Supermarket A sells bananas for $1.00/lb.* The example is set up such that the price has just been raised from $.49/lb to $1.00/lb. Thus, although *no* banana has yet been sold for $1.00/lb, it is nevertheless true that *bananas now sell for $1.00/lb.* Another wellknown example is *The speaker of the House succeeds the vice president* which is true on the basis of the constitutional text even if this law has never been applied in history. The *inductive* approach also meets difficulties to capture the basic characteristic of generic sentences which do only depend on nonaccidental generalizations. Of the many accidental coincidences of particular events in our world only those events that are supported by some principled pattern do qualify for the justification of a corresponding generic sentence.

Carlson(1995), in his rather programmatic discussion, strongly favours the *rules–and–regulations* approach to generics, and we will not go into his arguments in any detail. Rather, we will argue that we take the domain of generic sentences to require a line of division which must also be reflected within the semantic analysis of these distinct types of generics. Briefly, we question Carlson's basic premise which takes generic sentences to constitute a *uniform phenomenon.*

What goes wrong with an analysis of generics that tries to capture all types of generic sentences under one and the same "heading" is best exemplified by focussing on a concrete analysis which subscribes to this *uniformity hypothesis.* In particular, the problematic aspect of this uniformity hypothesis shows up once we consider which sentences are supported as defeasible conclusions in response to generic premises of the different types: prescriptive and normative.

To illustrate our point, we choose Commonsense Entailment, in particular because one challenge the theory tries to meet is that of "reconciling" the seemingly incompatible approaches, the *rules–and–regulations* and the *inductive* approach. Commonsense Entailment, which gives an analysis of generics in terms of universal quantification over *normal* indi-

[61] One might argue against that view: there is a certain height of crows and bullfinches, each one determined by the specific genetic structures of crows and bullfinches, respectively, such that – determined by metric rules – crows are larger than bullfinches.

viduals, is open to account for both *prescriptive* and *descriptive* generics in that “the kind of normality involved differs from case to case” (Morreau(1992:64)). In examples such as *Bishops move diagonally*, or *Germans drive on the right hand side*, or the above bananas–example *Supermarket A sells bananas for $1.00/lb* the notion of normality involved has prescriptive force. Thus, a *prescriptive* notion of normality to some extent captures the insights of the rules–and–regulations approach: given the specifics of German traffic law, it is *normal* to drive on the right hand side in Germany. However, the notion of normality can also be *descriptive* in nature, decribing what – according to our knowledge, or any kind of more or less scientific theories – is the case for particular individuals or situations, if no interfering forces come about to cause “abnormal” circumstances. In part, however, such knowledge or theories are essentially grounded in empirical observation of facts, and therefore connect up to the *inductive* approach to generics. The *descriptive* notion of normality therefore allows to account for the type of generic sentences that are in accord with the *inductive* approach, but turns out to be problematic for the *rules–and–regulations* approach.

Thus, an analysis of generic sentences in terms of universal quantification over *normal* individuals is able to cover the entire set of data that can only partially be accounted for by the *inductive* and *rules–and–regulations* approach, respectively: The clue is that the underlying notion of *normality* is variable, or *vague*, oscillating between the corresponding opposite poles of *descriptive* and *prescriptive normality*.

Though this is a viable way to go, the cost of covering these two kinds of generic sentences under one uniform concept of normality is a considerable loss with respect to distinguishing criteria: The vagueness that is imported into the notion of normality, while allowing for a uniform analysis of simple generic sentences, fails to capture important differences between these two types of generics as to their ability to license defeasible inferences in patterns of nonmonotonic reasoning.

By the end of Section 5.2.2 we have argued that the generics in (137), while all prescriptive in nature, come with varying degrees of probability that the rules or regulations they express are observed by the individuals to which they apply. Thus, while it seems sensible to defeasibly conclude, from (137a) and *Fred drives his car in Germany*, that *Fred drives his car on the right hand side*, this is not so evident for (137c–e): If we know that *John is a businessman*, we cannot defeasibly conclude, with (137c), that *John declares his full income*. And similarly for (137d), which does not license us to assume, for any particular school kid, that he doesn't cheat; or, with (137e), for anyone playing tennis (even the world–best tennis players) that the next tennis ball played will stay within the two white lines – if so, the game would (normally) never end!

(137) a. Germans drive on the right hand side of the road. Morreau(1992:63)

b. An car owner pays taxes.

c. A German businessman declares his full income.

d. A school boy doesn't cheat.

e. The tennis ball stays within the two white lines.

Similarly, we have argued that, in our view, this failure to give rise to the defeasible conclusions predicted by Asher&Morreau's – in fact *any* – theory of nonmonotonic reasoning carries over to the generic in (138), which however differs from those in (137) in that it is not *prescriptive*, or *normative* in any way.

(138) A turtle lives a long life.
Pepi is a turtle.
$\not\approx$ Pepi lives a long life.
$|\approx$ Pepi can live a long life.

If we inspect our intuitions about the generic in (138), given we know that in our actual world turtles have almost no chance of living to a grand old age, it can only be understood in what Kratzer calls a circumstantial reading: *in view of their biological parameters*, turtles (*can*) live a long life. On this interpretation the sentence must be assigned a logical form that corresponds to the non–epistemic *capability* reading of the conditional sentence *If something is a turtle, it (necessarily) can (is able to) live a long life.*[62] It is then obvious, given the analysis we proposed for non–epistemically modalized *if*–conditionals in Section 4.1.4, that the additional premise *Pepi is a turtle* in the argument pattern (138) may result in an application of defeasible modus ponens to the governing, epistemically based operator of the generic sentence, and therefore licenses the defeasible conclusion that *(In view of its biological parameters) Pepi can live a long life*, but in no case that *Pepi lives a long life.*

Yet, if it is agreed that the generic sentence in (138) can be interpreted as circumstantial without the occurrence of the modal *can*, the question is why this should not be possible for the (unwarranted) conclusion *Pepi lives a long life*, which would then be predicted by the theory.

We have no fully worked–out answer to this question, but we reason as follows: We may safely assume that the circumstantial reading is necessarily tied to a modal context, thus to the presence of an (implicit) modal operator. The question then reduces to the question of why we cannot assume a modal operator for *Pepi lives a long life*, which leads to the question why this sentence cannot get a generic interpretation. To this final question there is in fact an answer, which has been given by Krifka et al(1995:31f): They consider the question why sentences with a specific subject, such as (139a) and (139d), need a habitual predicate in order get a generic interpretation.

(139) a. ??Minette is infertile when she is tricolored.

b. A cat is infertile when it is tricolored.

c. The cat is infertile when it is tricolored.

d. Minette is hungry when she meows.

e. A cat is hungry when it meows. Krifka et al(1995:31)

[62] The extension of the deontic case to the *capability* reading is straightforward, as briefly sketched in Section 4.1.3, footnote 33.

The answer is – very briefly – that (i) if one follows Kratzer's(1995) theory, episodic verbs come with an additional argument for the location where the event decribed by the verb occurs, while stative verbs do not, and (ii) it is assumed that a *generalization* is restricted to quantificational structures where at least one of the variables quantified over "must not be *explicitly* tied to *exactly* one entity by the restrictor, [...] such a case would not result in a "generalization"." (Krifka et al(1995:32)). This restriction is given in (140):

(140) An expression **Q**[... x... ;...](**Restrictor**[... x...]; **Matrix**[... {x}...]) is a *generalization over x* iff it allows for models in which there is more than one value for x for which ∃[**Restrictor**[... x...]] is true (where ∃ binds all free variables except x). Krifka et al(1995:32)

Given this restriction, (139a), with the stative predicate *be tricolored* filling the restrictor argument, does then not qualify for a generic reading: the only variable that the quantifier can bind is the individual variable x for Minette, which must be assumed to map to a single individual in the model. By contrast, (141b) licenses a generic interpretation, given that the restrictor allows for more than one value of x. For quantified sentences where the restrictor hosts an episodic verb, such as (139d–e), it is immaterial whether the range of the individual variable x is restricted to map on a single individual, as in (139d): the generic quantification then ranges over the situation variable s.

(141) a. (??)**GEN**[x;](x = **Minette** & x **is tricolored**; x **is infertile**)

b. **GEN**[x;](x **is a cat** & x **is tricolored**; x **is infertile**)

c. **GEN**[x,s;](x **is a cat** & x **meows** in s; x **is hungry** in s)

d. **GEN**[x,s;](x = **Minette** & x **meows** in s; x **is hungry** in s) Krifka et al(1995:33)

This explanation could be argued to carry over to the unwarranted conclusion in (138). The subject of the third sentence of (138), being a proper name, maps to a unique individual. Since the predicate *live a long life* is not episodic, according to Kratzer's theory it does not host an event or situation variable. The sentence therefore does not qualify as a generic sentence, and in particular cannot be interpreted in terms of a restricted circumstantial modal quantification.

There is, however, the additional complication that there are generic sentences of the type *Mary smokes*, where it is generally assumed that such sentences quantify over a situation variable, where a restrictor argument is accommodated, implicitly constrained to "only those situations that are relevant for the generalization at hand" (Krifka et al(1995:32)).

Now, if accommodation of such an implicit restriction argument were an unrestricted option, there would be no explanation for why this should not be possible for the third sentence in (138), or, e.g., for *Mary is intelligent*, to yield a generic interpretation. But here it is in fact relevant which type of predicate fills the quantificational scope. In particular, the contrast between *Mary smokes* and *Mary is intelligent* strongly suggests that the predicate in the quantificational scope must project a situation variable that can be bound to the quantified situation variable of the implicit restrictor argument. Given this additional restriction, it is now evident why the third sentence in (138) fails to get a generic interpretation: The predicate *live a long life* is stative, and therefore does not provide a situation variable that is able to bind the situational variable of an implicit situation–type restriction argument. The (unwarranted) conclusion that *Pepi lives a long life* can therefore not be understood as a quantified structure, and thus in particular not as a circumstantial modal quantification.

Further support comes from example (142), where the generic sentence in the premise set may be interpreted as circumstantial (e.g., as a *capability* reading), but where – contrasting with (138) – the conclusion *Pepi finds his way home* can in fact be read generically, in particular circumstantially, given that the predicate *find one's way home* is episodic.

(142) A carrier pigeon finds its way home.
Pepi is a carrier pigeon.
$|\approx$ Pepi finds its way home.

We now also have a clue for why (143) and (144), where we also take the generic sentences in the premise set to be read *circumstantially*, contrasting with (138), *do* license the defeasible conclusions indicated. Here the predicates involved are episodic, and therefore allow for a quantificational reading, such that the defeasible conclusions can be interpreted as non–epistemically modalized sentences along the following paraphrases: *in view of his capabilities, Fred can jump 7 meters* and *given its biological parameters, Gooma can walk 4 days without water.*

(143) An athlete jumps 7 meters.
Fred is an athlete.
$|\approx$ Fred jumps 7 meters.

(144) A camel walks 4 days without water.
Gooma is a camel.
$|\approx$ Gooma walks 4 days without water.

The preliminary conclusions to be drawn from this discussion are twofold: First, as was already observed by Krifka et al(1995), generic sentences are open to various readings of "relative modality", in Kratzer's sense, ranging from purely *descriptive* generics, to *prescriptive* (or *deontic*) and *circumstantial* readings. Second, the unwarranted defeasible inference in (138) (and similarly for corresponding unwarranted defeasible conclusions to be drawn on the basis of (137c–d)) as opposed to the licit defeasible inference in (138) and (142)–(144) provide further support for our analysis of *if*–conditionals involving non–epistemic modal adverbs in terms of an embedded non–epistemic modal quantification.

In sum, these observations lead us to the following conclusion: A theory of non–monotonic reasoning that aims at an account of these data must by necessity dispense with the *uniformity hypothesis.* The logical form of generic sentences must be much more fine grained if it is to reflect the various interpretational differences known under the heading of "relative modality". In particular, the division between *descriptive* and *prescriptive* generic sentences must be assumed to cut deeper than currently assumed: the examples we considered strongly suggest that nonmonotonic reasoning is *essentially restricted* to generic sentences that are built upon *epistemically based* modal operators.

This conclusion fits nicely with the observations we made at the beginning of Section 5.1.1, where we argued that the vagueness and variablity of conditionals and non–restricted modals is essentially restricted to epistemic modality. Given that nonmonotonicity is just one of the reflexes of this inherent vagueness, and given the close correspondence between conditional and generic sentences it is thus even expected that we should find the same kind of restriction in the domain of generic sentences.

Neither Commonsense Entailment or Conditional Default Reasoning, nor any other (modal) theory of nonmonotonic reasoning we know of captures these more fine–grained distinctions. Although we are far from being able to provide a theory of nonmonotonic reasoning on our own, we will in the following Sections try to give a very rough sketch of how the basic ingredients of Commonsense Entailment may be carried over to our analysis of the vagueness and variability, i.e., the nonmonotonicity of conditionals, where one of our aims will be to capture the distinction between epistemically based and non–epistemically based modal quantification as regards the potential of licensing defeasible conclusions.

5.2.4 Context dependent normalcy in the DRT analysis of conditionals

We have reviewed two theories of nonmonotonic reasoning that successfully implemented the notion of *normalcy* both into the analysis of conditionals and generics and into the nonmonotonic reasoning component, while still differing in various respects, in particular as regards the specific definitions they give of the underlying normalcy accessibility function. Having seen the advantages and disadvantages of both approaches it is now up to us to choose, as a basis for our own DRT–analysis of the *vague* conditional, some particular definition for the *normalcy selection function* * which we built into the verification condition for modally quantified structures in Section 3.3 p. 121.

As we have observed in the previous Section, the main differences between the normalcy selection function * in Commonsense Entailment (CE) and f in Conditional Default Reasoning (CDR) were tied to the notion of *Graded Normality* on the one hand, and the question of whether we should assume, as in CDR, that the accessible "normal" worlds must be "at least as normal as" the world of evaluation on the other. We argued that – except for its inability to account for graded notions of normality – the definition of * in Commonsense Entailment is much to be preferred. In particular, it allows for evaluation of counterfactual–like generics, as e.g. *Cats who own money would buy Whiskas*, were the evaluation of the restrictor clause is necessarily tied to worlds that are quite abnormal, from the standpoint of our actual world. The accessibility function f of CDR does not account for such sentences, being constrained to select only worlds that are "at least as unexceptional as" the evaluation world w. The normalcy accessibility function $*(w,p)$ of CE, by contrast, accounts for such types of generics, being defined to yield a set of worlds where "everything holds that, relative to w, is normally the case where p is true": if by assumption cats like Whiskas in w, we can safely assume that the set of worlds where "everything holds that relative to w is normally the case where cats own money (and are able to go shopping)" will be a set of worlds where cats buy Whiskas.

We therefore defined our normalcy selection function * in (50) of Section 3.3 in close correspondence with $*$ in Commonsense Entailment, to yield a set of worlds where *everything holds that, relative to w, is normally the case in a context* **G**.

This normalcy selection function * is used, in our analysis of modally quantified structures (see verification conditions in Section 3.3), to restrict the quantificational domain to a set of worlds where *everything holds that is normally the case, relative to world w, in a context X′ where K′ holds true*, where X' corresponds to the modal base and K' to the conditional's antecedent DRS.

(145) * is a *normalcy selection function* which maps a world w and a set of world–sequence pairs **G**, intuitively a context, to a set of worlds w', where *everything holds that, relative to w, is normally the case in a context* **G**.

In (146) we state formal constraints on *, which mirror the constraints (98) that were imposed on * in Commonsense Entailment,[63] yet adapted to the distinct types of parameters of * in our framework, an evaluation world w and a set of world–function pairs **G**.

(146) Let boldface capital letters **G**,**H**, etc. stand for sets of world–function pairs, where $cs(\mathbf{X}) = \{w' : (\exists x)\langle w', x\rangle \in \mathbf{X}\}$.
Let further $[\![K]\!] = \{\langle w', g\rangle : (\exists f)\mathcal{FV}(K) \subseteq dom(f)\ \&\ {}_{\langle w',f\rangle}[\![K]\!]_{\langle w',g\rangle}\}$,
where $\mathcal{FV}(K)$ the set of free variables of K, and
$\mathbf{H} +^{\bullet} \mathbf{I} = \{\langle w', j\rangle : \exists\langle w', h\rangle \in \mathbf{H}\ \&\ \exists\langle w', i\rangle \in \mathbf{I}\ \&\ j = h \cup i\}$ (see Section 4.2).

a. FACTICITY: $*(w, \mathbf{G}) \subseteq cs(\mathbf{G})$.

b. TRANSITIVITY (= CUT in CE):
If $*(w, \mathbf{G}) \subseteq cs(\mathbf{H})$ and $*(w, \mathbf{G} +^{\bullet} \mathbf{H}) \subseteq cs(\mathbf{I})$ then $*(w, \mathbf{G}) \subseteq cs(\mathbf{I})$.

By this, we also have, for the specific case where $\mathbf{H} = [\![K'']\!]$:
If $*(w, \mathbf{G}) \subseteq cs([\![K'']\!])\ \&\ *(w, \mathbf{G} +^{\bullet} [\![K'']\!]) \subseteq cs([\![K''']\!])$ then $*(w, \mathbf{G}) \subseteq cs([\![K''']\!])$.

c. CLOSURE IN THE CONSEQUENT:
If $*(w, \mathbf{G}) \subseteq cs(\mathbf{H})$ and $*(w, \mathbf{G}) \subseteq cs(\mathbf{I})$ then $*(w, \mathbf{G}) \subseteq cs(\mathbf{H} +^{\bullet} \mathbf{I})$.

By this, we have, for the specific case where $\mathbf{H} = [\![K']\!]$ and $\mathbf{I} = [\![K'']\!]$:
If $*(w, \mathbf{G}) \subseteq cs([\![K']\!])$ and $*(w, \mathbf{G}) \subseteq cs([\![K'']\!])$, then $*(w, \mathbf{G}) \subseteq cs([\![K' \oplus K'']\!])$.

In the following Section we will introduce further constraints on * to account for various patterns of defeasible inference (with conflicting defaults), as well as the phenomenon of *conditional variability*.

[63]We omit DUDLEY DOORITE, as we will account for the *Penguin Principle* through SPECIFICITY in conjunction with VARIABILITY I (see below).
We also assume CLOSURE IN THE CONSEQUENT (146c), where $\oplus$ is simple DR–theoretic union of two DRSs K_1 and K_2: $K_1 \oplus K_2 = \langle U_{K_1} \cup U_{K_2}, Con_{K_1} \cup Con_{K_2}\rangle$.

5.3 Conditional variability and the dynamics of discourse

5.3.1 Increasingly vs. decreasingly strict conflicting conditionals

Let us now reconsider the phenomenon of conditional variability, where the inherent vagueness of epistemic conditionals interacts with the dynamics of discourse.

First notice that sequences of increasingly strict conditionals such as (148), in contrast with generic sentences of varying strictness (147), do *not* allow for defeasible inferences corresponding to the pattern of *Defeasible Modus Ponens*: While on the basis of the premises in (147) Tweety might very well turn out to be an abnormal bird, namely a penguin, still, by the assumption of normality built into *Defeasible Modus Ponens*, as long as Tweety can consistently be assumed to be a normal bird, this leads to the defeasible conclusion that he can fly. By contrast, in the corresponding inference pattern with increasingly strict conditionals in (148) the premise that Otto will come to the party does not give rise to the defeasible conclusion, licensed by *Defeasible Modus Ponens*, that the party will be lively.[64]

Nevertheless, it will turn out that (147) and (148) are closely related, in particular as regards the dynamic interpretation of their respective premise sets.

(147) Birds can fly.
Penguins cannot fly.
Penguins are birds.
Tweety is a bird.
$\mid\!\approx$ Tweety can fly.

(148) If Otto comes, the party will be lively.
If Otto and Anna come, the party will be dreary.
If Waldo comes as well, the party will be lively.
Otto comes.
$\not\mid\!\approx$ The party will be lively.

As we argued in Section 2.2.2, an important characteristic of sequences of variably strict conditionals (148) is their contextual dynamics. First, these sequences allow for modal subordination wrt. the preceding conditional's antecedent clause (see e.g. *as well* in (148)). But this is only a secondary aspect of the contextual dynamics that is relevant here.

More decisive is the fact that such sequences of increasingly strict conditionals with conflicting consequents seem to necessitate some successive *revision* of what, at various stages of this tiny piece of discourse, is taken to be the set of "normal worlds where Otto comes to the party", a revision that is guided by the context itself.

This idea we first raised in Section 2.2.2, where we objected against Lewis' analysis of *conditional variability* in terms of a system of spheres.

In Lewis' analysis distinct sets of "normal" worlds where Otto (perhaps in the company of other people) comes to the party – and where the party is either lively or dreary, depending on who else will show up besides Otto – can, so–to–speak, live peacefully together in a system of spheres, which is assumed to be "pre–established" in the way sketched in (149), and which verifies simultaneously *all of* the variably strict conditionals in (148).

[64] We will explain this contrast in Section 5.3.3 on the basis of the results of the present Section.

(149) $S_1 \subset S_2 \subset S_3$ where $S_1 = \{w_3, w_4\}$, $S_2 = \{w_3, w_4, w_2\}$, $S_3 = \{w_3, w_4, w_2, w_1\}$ and

w_1	comes(o)	comes(a)	comes(w)	lively(p)
w_2	comes(o)	comes(a)	¬ comes(w)	¬ lively(p)
w_3	comes(o)	¬ comes(a)	comes(w)	lively(p)
w_4	comes(o)	¬ comes(a)	¬ comes(w)	lively(p)

We have argued that it is not only highly implausible to assume the background context for (148) to provide such a pre–established sphere system, but – even more importantly – that it will license the unwarranted conclusion from (148) that *if Otto comes, the party will be lively.* It does so for the same reason that the first premise is true: the system of spheres must contain a sphere S_1 that verifies the first premise, and thus, also the conclusion.

In Section 2.2.2 we briefly outlined an alternative view of the interpretation of such sequences of conflicting conditionals. We sketched a dynamic interpretation process for (148), in which the interpretation of each one of the successive conditionals is influenced by, or contextually determined by the (conflicting) preceding conditionals in the discourse. Thus, for the first conditional the set of *normal worlds where Otto comes to the party* comprises the set of worlds N_1 in (150a), where it is left open whether or not Anna and Waldo will also join the party. If the second conditional is assumed to hold true relative to the context set up by the first conditional, its quantificational domain must by necessity be a set of *normal worlds where Otto and Anna come to the party* and where the party is not lively. This set of worlds N_2 cannot be a subset of the set of normal worlds N_1: w_1 and w_2 in N_1, where both Otto and Anna join the party, are such that the party is lively. In Section 2.2.2 we had argued that this inconsistency can be resolved by *partial revision* of the set of worlds N_1 that count as *normal worlds where Otto comes to the party*, to yield the set N_2 in (150b), where the worlds w'_1 and w'_2 where both Otto and Anna come to the party are such that the party is not lively. Finally, for the third conditional, interpreted relative to the context set up by the second one, we again assumed revision of N_2 to yield N_3, which again contains a world w''_1 where Otto, Anna and Waldo join the party, and where the party is again lively.

(150) a. $N_1 = \{w_1, w_2, w_3, w_4\}$

w_1	comes(o)	comes(a)	comes(w)	lively(p)
w_2	comes(o)	comes(a)	¬ comes(w)	lively(p)
w_3	comes(o)	¬ comes(a)	comes(w)	lively(p)
w_4	comes(o)	¬ comes(a)	¬ comes(w)	lively(p)

b. $N_2 = \{w'_1, w'_2, w_3, w_4\}$

w'_1	comes(o)	comes(a)	comes(w)	¬ lively(p)
w'_2	comes(o)	comes(a)	¬ comes(w)	¬ lively(p)
w_3	comes(o)	¬ comes(a)	comes(w)	lively(p)
w_4	comes(o)	¬ comes(a)	¬ comes(w)	lively(p)

c. $N_3 = \{w_1, w'_2, w_3, w_4\}$

w''_1	comes(o)	comes(a)	comes(w)	lively(p)
w'_2	comes(o)	comes(a)	¬ comes(w)	¬ lively(p)
w_3	comes(o)	¬ comes(a)	comes(w)	lively(p)
w_4	comes(o)	¬ comes(a)	¬ comes(w)	lively(p)

We will now try to state an analysis of *conditional variability*, i.e., an analysis of sequences of variably strict conditionals with conflicting consequents, which does justice to this dynamic perspective of an interpretation that seems to involve some kind of "revision" of what, within the dynamically evolving discourse, is considered the set of "normal worlds" where Otto (and perhaps other people) join the party.

To this end, let us first make explicit a *persistence* assumption that in our framework is already built into the notions of *update* and *context reduction*: If a condition of *context reduction* $F \subseteq G$, or else an *update condition* $G :: F + K'$, for some DRS K', is verified, relative to some evaluation state $\langle w, e \rangle$ such that the context referents F and G are in the domain of e, then it is necessarily the case that everything that holds true relative to F must also do so relative to G. This persistence requirement is built into the verification conditions for *update* and *context reduction*: in both cases it comes down to the requirement that the context set $cs(e(G))$ determined by G be a (possibly improper) subset of the context set $cs(e(F))$ determined by F (151). We will in the following use the notion *G extends F* to refer to configurations of *persistence* that result from *context reduction* (151i) or *updates* (151ii).

(151) *Persistence*:
Let e be an embedding function for annotated DRSs with $F, G \in dom(e)$.
i. If $\langle w, e \rangle \models_M F \subseteq G$, then $cs(e(G)) \subseteq cs(e(F))$.
ii. If $\langle w, e \rangle \models_M G :: F + K'$, for some DRS K', then $cs(e(G)) \subseteq cs(e(F))$.

If *persistence* is applied to the DRS in (152), for a sequence of increasingly strict, but *nonconflicting* consequents, we get the following picture:[65]

(152) If Otto comes to the party, the party will be lively.
If he meets Mary, they will talk to each other.

F G H

F :: [*o m p* / *otto(o)* *mary(m)* *party(p)*]

G :: F + [G′ G″ X_1 / X_1 = F / G′ :: X_1 + $\boxed{\text{comes(o)}}$ ⇒ G″ :: G′ + $\boxed{\text{lively(p)}}$]

H :: G + [H′ H″ X_2 / X_2 = G / H′ :: X_2 + $\boxed{\text{comes(o) meet(o,m)}}$ ⇒ H″ :: H′ + $\boxed{\text{talk-to-each-other(o,m)}}$]

Since *G extends F* and *H extends G*, and thus – according to persistence (151ii) – everything that holds true in F persists in G, and everything that holds true in G persists in H, this persistence assumption must carry over to the denotations of the normalcy selection

[65] For ease of discussion, we do not represent the second conditional as "anaphorically" subordinated to the first one, but just accommodate the restrictor of the first conditional.

function *: Since $cs(e(H)) \subseteq cs(e(G))$, each set $*(w', h(X_1 + K'))$ – in our abbreviated notation[66] – with $\langle w', h\rangle \in e(H)$ is identical with the set of the form $*(w, g(X_1 + K'))$, with $\langle w, g\rangle \in e(G)$, and such that $w = w'$ and $g(X_1) = h(X_1)$. Thus, if every world w in the context set $cs(e(G))$ "supports" the selection of a set of normal worlds where Otto comes, and where the party is lively, then every world in the context set $cs(e(H))$ of the extended context H will do so as well.[67]

(153) By *Persistence* in (152):
$\forall\langle w', h\rangle \in e(H)\ \exists\langle w, g\rangle \in e(G)$:
$w' = w\ \&\ *(w', h(X_1 + [: \mathit{comes}(o)])) = *(w, g(X_1 + [: \mathit{comes}(o)]))$.

A further question is now whether the assumptions as to what is *normally* the case in a situation $X_1 + K'$ where Otto comes (namely that the party will be lively) – and which by (151) persist in the extended context H – will carry over to what is considered *normal* for a more specific situation $X_2 + K''$, which we consider in the extended context H, where we assume that Otto comes and meets Mary. So the question is whether we assume the party to be lively, under normal circumstances, in the more specific situation where Otto comes to the party and meets Mary. This is not predicted by (151). But we take this to be a natural *defeasible specificity assumption for normalcy*, which is valid in *standard* cases like (152), with *nonconflicting conditionals.*

To put it in more formal terms, we assume – *defeasibly* – that the normalcy assumptions for a hypothetical situation $X_1 + K'$ within some context G carry over to the normalcy assumptions for a more specific situation $X_2 + K'$, within the same context G, or alternatively, via *persistence*, that the normalcy assumptions for $X_1 + K'$ within context G carry over to those for a more specific context $X_2 + K''$ within an context H that *extends* G.

Much as in the theory of Commonsense Entailment, where *defeasible inferences* are implemented in terms of formal constraints on the normalcy selection function *, we now introduce a formal constraint on our normalcy selection function * to implement this *defeasible* SPECIFICITY assumption of normalcy:

In (154) we constrain the set of normal worlds determined by $*(w, e(X_2 + K''))$, for appropriate w and e, to a (possibly improper) subset of the set of worlds determined by $*(w, e(X_1 + K'))$ in case $X_2 + K''$ is *more specific* than $X_1 + K'$. But, since we assume *Specificity* to only hold *defeasibly*, this may only be assumed in case the normality assumptions for $X_1 + K'$ relative to w and e do not conflict with the more specific context $X_2 + K''$, i.e. only if $*(w, e(X_1 + K')) \cap cs([\![X_2 + K'']\!]) \neq \emptyset$.

(154) *Defeasible* SPECIFICITY:
Let $\mathbf{X_1}, \mathbf{K}'$, and $\mathbf{X_2}, \mathbf{K}''$ be sets of world–function pairs.
If $cs(\mathbf{X_2} +^\bullet \mathbf{K}'') \subseteq cs(\mathbf{X_1} +^\bullet \mathbf{K}')$, then
if $*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap cs(\mathbf{X_2} +^\bullet \mathbf{K}'') \neq \emptyset$, then $*(w, \mathbf{X_2} +^\bullet \mathbf{K}'') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}')$.

Thus, based on this *defeasible* SPECIFICITY assumption for normalcy, we can assume, for (152), that the set of normal worlds, relative to states $\langle w, g\rangle \in e(G)$, where Otto comes,

[66]For the exact definition the reader should consult the verification conditions of Section 3.3. p. 121.
[67]In the following, we adopt the convention of stating DRSs in a linear format $[U_K : Con_K]$.

$*(w, g(X_1 + K'))$, forms a superset of the set of normal worlds $*(w, g(X_1 + K''))$ where Otto comes and meets Mary, given that there is no conflicting information provided by the discourse to defeat this assumption. By (151) both of these normalcy assumptions *persist* in H, and, furthermore, by application of *defeasible* SPECIFICITY we also get, from either $*(w', h(X_1 + K'))$ or $*(w', h(X_1 + K''))$, for $\langle w', h\rangle \in e(H))$, that $*(w', h(X_2 + K''))$ is a set of normal worlds where Otto meets Mary at the party, and where the party is lively, given that X_2 qualifies as an extension of X_1.

Let us now reconsider the more problematic cases of variably strict conditionals with *conflicting* consequents, on the basis of a *preliminary* representation in (148).[68]

(155) If Otto comes, the party will be lively.
If Otto and Anna come, the party will be dreary.
If Waldo comes as well, the party will be lively.

$$
\boxed{\begin{array}{l}
\mathrm{F\ G\ H\ I} \\
\mathrm{F} :: \boxed{\begin{array}{l} o\ a\ w\ p \\ otto(o)\quad anna(a)\quad waldo(w)\quad party(p) \end{array}} \\
\mathrm{G} :: \mathrm{F} + \boxed{\begin{array}{l} \mathrm{G'\ G''\ X_1} \\ \mathrm{X_1 = F} \\ \mathrm{G'} :: \mathrm{X_1} + \boxed{\mathrm{come(o)}} \Rightarrow \mathrm{G''} :: \mathrm{G'} + \boxed{\mathrm{lively(p)}} \end{array}} \\
\mathrm{H} :: \mathrm{G} + \boxed{\begin{array}{l} \mathrm{H'\ H''\ X_2} \\ \mathrm{X_2 = G} \\ \mathrm{H'} :: \mathrm{X_2} + \boxed{\begin{array}{c} \mathrm{come(o)} \\ \mathrm{come(a)} \end{array}} \Rightarrow \mathrm{H''} :: \mathrm{H'} + \boxed{\neg\ \mathrm{lively(p)}} \end{array}} \\
\mathrm{I} :: \mathrm{H} + \boxed{\begin{array}{l} \mathrm{I'\ I''\ X_3} \\ \mathrm{X_3 = H} \\ \mathrm{I'} :: \mathrm{X_3} + \boxed{\begin{array}{c} \mathrm{come(o)} \\ \mathrm{come(a)} \\ \mathrm{come(w)} \end{array}} \Rightarrow \mathrm{I''} :: \mathrm{I'} + \boxed{\mathrm{lively(p)}} \end{array}}
\end{array}}
$$

The first sentence, uttered relative to an "initial" context F (where we find accommodated conditions for the proper names and a party), states that all "normal" worlds, relative to evaluation worlds $w \in cs(e(G))$, where in the context denoted by X_1 Otto comes to the party, are such that the party is lively. In terms of our context dependent normalcy selection function $*$, this set of normal worlds is to be determined by $*(w, g(X_1 + [: come(o)]))$, for $\langle w, g\rangle \in e(G)$. The second sentence is represented as an update, and thus an extension of the context G established by the first conditional. If this second sentence is to be judged true, then, given the conditional's (conflicting) consequent, the evaluation of the modally quantified structure must be based upon a set of normal worlds where both Otto and Anna come to the party, and where the party is dreary. This set of normal worlds is to be determined by $*(w', h(X_2 + [: comes(o)\&comes(a)]))$, where $\langle w', h\rangle \in e(H)$, i.e., it is characterized as a set of worlds where everything holds that is normally the case, relative to w', in a situation where Otto and Anna both come to the party, relative to context $X_2 = G$. Finally, the third conditional, which is represented as contextually dependent on the context referent

[68]Again we will, for ease of discussion, neglect the fact that the successive conditionals are to be represented as modally subordinated relative to the antecedents of the respective preceding conditionals.

H to provide its modal base X_3, can only be judged true if the normalcy selection function selects "normal" worlds, relative to evaluation worlds $w'' \in cs(e(I))$, where in the context established by $X_3 = H$ we assume all three of Otto, Anna and Waldo to join the party, and where the party is again lively.

Now, by SPECIFICITY (154) we can infer that, within the context G established by the first conditional, since there is no conflicting evidence available, what normally holds in a situation $X_1 + K'$ where Otto comes, namely that the party will be lively, will carry over to any more specific situation $X_1 + K''$, e.g. one where Anna comes along with Otto.

Once we are to interpret the second sentence relative to this context G, established by the first one, we see that this SPECIFICITY assumption is immediately defeated: if the second sentence is to be judged true, the normal worlds where Otto and Anna come together must qualify as worlds where the party is dreary. Specificity is thus defeated: While – by *persistence* – the first sentcence gave us that for all $\langle w', h\rangle \in e(H)$ $*(w', h(X_1 + K')) \subseteq [\![lively(p)]\!]$, and by SPECIFICITY that $*(w', h(X_1 + K'')) \subseteq [\![lively(p)]\!]$, we now have that $*(w', h(X_2+K'')) \subseteq [\![\neg lively(p)]\!]$, where $cs(h(X_2+K'')) \subseteq cs(h(X_1+K'))$, since X_2 *extends* X_1 and K'' implies K'. I.e, the SPECIFICITY assumption is explicitly defeated with respect to $*(w', h(X_1 + K'))$ and $*(w', h(X_2 + K''))$: $*(w', h(X_2 + K'')) \cap *(w', h(X_1 + K')) = \emptyset$.

Thus, what we get, in virtue of the second conditional, is the new information that what initially, i.e. within the context G, was assumed to be normally the case if Otto comes, that these are worlds where the party is lively, and that among these worlds we may assume there to be some where also Anna joins the party, is now to be "revised", on the basis of this new information, to a more refined picture, where we learn that in a situation where Anna also comes, the party will, under normal circumstances, be dreary.

We could try to go along with this new information, and – taking the new, conflicting normalcy restriction $*(w', h(X_2 + K''))$ for granted – compute a new value for the normalcy assumption $*(w', h(X_2 + K'))$ for $\langle w', h\rangle \in e(H)$ as the complement set of worlds $*(w', h(X_1 + K'))\backslash(*(w', h(X_1 + K')) \cap [\![K'']\!])$, i.e. settle on a new value for what counts as normal, relative to this new context, in a situation where Otto comes, and where the party is lively, where we now exclude those worlds where Anna comes along, given that the normalcy assumptions for $*(w', h(X_1 + K'))$ and $*(w', h(X_2 + K''))$ are conflicting.

This can be formally implemented in terms of a further constraint on the normalcy selection function *, as stated in (156):

(156) VARIABILITY:
Let $\mathbf{X_1}, \mathbf{K}', \mathbf{X_2}$ and $\mathbf{K}''$ be sets of world–function pairs, where $cs(\mathbf{X_2}) \subseteq cs(\mathbf{X_1})$

i. $*(w, \mathbf{X_2} +^{\bullet} \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^{\bullet} \mathbf{K}') \setminus (*(w, \mathbf{X_1} +^{\bullet} \mathbf{K}') \cap cs(\mathbf{K}''))$
if $cs(\mathbf{X_2} +^{\bullet} \mathbf{K}'') \subseteq cs(\mathbf{X_1} +^{\bullet} \mathbf{K}')$ and $*(w, \mathbf{X_1} +^{\bullet} \mathbf{K}') \cap *(w, \mathbf{X_2} +^{\bullet} \mathbf{K}'') = \emptyset$

ii. $*(w, \mathbf{X_2} +^{\bullet} \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^{\bullet} \mathbf{K}')$ otherwise.

In particular, the VARIABILITY constraint states that – given two sets of normal worlds $*(w, e(X_1 + K'))$ and $*(w, e(X_2 + K''))$, for given $\langle w, e\rangle$ where $e(X_2 + K'')$ *extends* (is more specific than) $e(X_1 + K')$ – (156i) if the normality assumptions for $X_1 + K'$ and $X_2 + K''$ are inconsistent ($*(w, e(X_1 + K')) \cap *(w, e(X_2 + K'')) = \emptyset$) and $X_2 + K''$ is more specific than/implies $X_1 + K'$, then the normality assumptions for $X_2 + K'$ relative to w cannot carry over to those for $X_1 + K'$ (as we would otherwise expect in virtue of SPECIFICITY), but must be computed anew, i.e. must be "revised", *in light of the more specific, conflicting normalcy assumptions conveyed for* $X_2 + K''$. For computation of this *revision in light of conflicting information* the set of worlds $*(w, e(X_2 + K'))$ is defined such that only those "normal worlds" in $*(w, e(X_1 + K'))$ will persist in $*(w, e(X_2 + K'))$ for which there is no conflicting information stated by $*(w, e(X_2 + K''))$. This refinement of the normality assumption for $X_2 + K'$ is defined in terms of the complement set: $*(w, e(X_2 + K')) \subseteq *(w, e(X_1 + K')) \backslash (*(w, e(X_1 + K')) \cap cs([\![K'']\!]))$. The effect of this condition is, roughly, to carry over *as many assumptions as possible*, from the previously established normalcy conditions for $*(w, e(X_1 + K'))$ as we can consistently assume, given the conflicting information defined by $*(w, e(X_2 + K''))$.

Clause (156ii) implements the "default case": in any configuration where there is no conflicting information as regards the set of "normal worlds" determined by $*(w, e(X_1 + K'))$ and $*(w, e(X_2 + K''))$ where $X_2 + K''$ *extends* $X_1 + K'$, the normalcy assumptions valid for $X_1 + K'$ just carry over to those of $X_2 + K'$. Note that clause (156ii) applies both to sequences of non–conflicting increasingly strict conditionals, and to sequences of conditionals where K' and K'' are logically independent, while X_2 *extends* X_1.

Note that it is in fact possible, in our framework, to adopt such a redefined characterization of a set of "normal" worlds $*(w, h(X_2 + K'))$ where Otto comes, for subsequent "stages" within a dynamically evolving discourse:

Since in our analysis the normalcy restriction for conditionals is *context sensitive* in that it takes into account the conditional's modal base X', the normalcy assumptions for situations where Otto comes will, for the two subsequent conditionals, be distinguished by way of the second parameter of *, ($h(X_1 + K')$ vs. $h(X_2 + K')$ in our example (155)), since the context denoted by $X_2 = G$ properly *extends* the one denoted by $X_1 = F$. This would not be the case in an analysis of conditionals where the quantificational domain, the set of "normal" worlds, is only defined in virtue of the conditional's antecedent, as e.g. in Lewis' or in Morreau's analysis: If the second parameter of * were only dependent on the conditional antecedent, i.e. $*(w, [\![K']\!])$, it would, on principle, not be possible to "redefine" the normalcy assumptions for situations where Otto comes, "*in light of*" the conflicting information provided by the new context.

So, we could choose to go along with an analysis of variably strict conflicting conditionals along these lines, by repeatedly inducing "revision" of the normalcy assumptions for situations where, e.g., Otto (and Anna) comes, by use of the VARIABLITY constraint (156).

Yet, there is a serious objection against an analysis along these lines:[69] It does not seem particularly clear how we could justify, or motivate – without further assumptions – that, again for (155), relative to worlds $w' \in cs(e(H))$ the set of "normal worlds" where Otto comes in the context (denoted by) $X_2 = G$ should be different from the set of normal worlds where Otto comes in the context (denoted by) $X_1 = F$, as it was determined relative to worlds $w \in cs(e(G))$: the set of worlds $w \in cs(e(G))$ from which we access normal worlds where Otto (and maybe Anna and Waldo) come(s) in the context of an

[69]I owe this insight to Hans Kamp, to whom I am grateful for his patient insistence in telling me that there is *some* respect in which an analysis of (155) along the lines just sketched is still unintuitive, or insufficient, while basically correct in view of its dynamic perspective involving some kind of "revision" of what is considered as "normal" at various stages in such a dynamically evolving context.

otherwise fully underspecified situation F, and where the party is lively, and the set of worlds $w' \in cs(e(H))$ where we access a distinct set of normal worlds where Otto and Anna come, in a context G, and where the party is *not* lively, do not differ in a significant way that could justify this divergence in the selection of "normal" worlds where Otto (and maybe other people) come(s) to the party.

It is not sufficient to argue – as seems natural, given the above discussion – that it is the presence (and supposed truth) of the second, conflicting conditional that justifies this divergence in the selection of normal worlds where Otto (and Anna) come. Somehow, there must be some motive for going from the "first" set of normal worlds where Otto comes to the party, where the party will be lively, and which contains worlds where Anna is coming as well – to a "second", "revised" set of normal worlds where Otto comes to the party, and the party is lively, but which now may not contain a world where Anna comes as well.

Thus, what is missing at this stage is a reflection of the fact that the utterance of the second conditional relative to the context of the first one is somehow *unexpected*, or introduces some kind of *correction* of an earlier, somehow imprecise statement. In other words, what is missing is a reflection of the fact that sequences like (155) are naturally used with the particle *but* introducing the second and third, i.e., the "conflicting" conditionals, or else some short break, indicating that some unexpressed reflection "comes in", to support the truth of the subsequent, conflicting conditional.

Note further that, even though it would in principle be possible to just go on with repeatedly revised normalcy assumptions for the respective extended contexts G, H and I in (155), this would not give us a sound interpretation for the DRS in (155).

Recall that we assumed the normalcy selection function to be centered for indicative conditionals. I.e., by evaluation of the first conditional, where we learn that in any possible and "normal" situation where Otto joins the party, the party will be lively, the evaluation world w is constrained to be within this set of normal worlds, for every $w \in cs(e(G))$. And, since we assume *defeasible specificity* to hold, also those worlds where both Otto and Anna join the party are within this set of normal worlds where Otto comes and the party is lively. Thus, by update with the conditional structure the ensuing context G does not contain any world where Otto (and maybe other people) join(s) the party, and where the party is *not* lively. In exactly the same way it is demanded that, by (supposed) truth of the second conditional, where we then learn that in any possible and "normal" situation where Otto and Anna both join the party the party will be dreary, the evaluation world w' must be within the new selected set of "normal worlds", for every $w' \in cs(e(H))$.

If this is so, then it is in fact not possible that the context H constitutes a strict update of the preceding context G, since by *persistence* we have that $cs(e(H)) \subseteq cs(e(G))$!

Thus, the "evaluation" context H must be distinct from G, in that some further, in fact, conflicting assumption is adopted within H, to support the truth of the second conditional.

We can now take up the remarks we made when first considering these cases, in Section 2.2.2, where we argued that when uttering the second conditional, some further assumption comes in, which was not taken into account when uttering the first sentence, such as, e.g., that Otto and Anna always begin to quarrel when they come together, such that, if this additional fact is taken into account, we come to the conclusion that under normal circumstances, the party will be dreary if Otto and Anna both show up. Thus, we could revise our representation (155) as in (157), assuming that the second conditonal is stated relative to a (slightly) *reduced* context G^* of G,[70] which undoes the earlier, oversimplifying implicit assumption within G, where we assumed, e.g., that *everybody likes Otto*. Relative to such a reduced context G^* we may adopt the now salient fact that *Anna doesn't like Otto*, which then *justifies* the selection of a set of "normal worlds", relative to evaluation worlds $w' \in cs(e(H^*))$, where given that both Otto and Anna join the party, the party will be dreary.[71] And, further, when encountering the third indicative conditional, we are then again driven to assume that some further fact is taken into account now, relative to a *reduced context* H^{**} *of* H^*, e.g., that Waldo tends to engage in endless conversations with Anna, which then again *justifies* the new "revised" normalcy assumptions, such that – on the basis of what is considered "normal", relative to worlds that reckon with this newly adopted fact, which was not assumed in H^* – we come to conclude that if Waldo comes as well, the party will be lively again, since Otto and Anna will then have no chance of quarrelling.

(157) If Otto comes, the party will be lively.
But if Otto and Anna come, the party will be dreary.
But if Otto, Anna and Waldo come, the party will be lively.
?? If Otto comes, the party will be lively.

$$
\begin{array}{|l|}
\hline
\mathrm{F\ G\ G^*\ H^*\ H^{**}\ I^{**}\ J} \\
\mathrm{F} :: \begin{array}{|l|}\hline o\ a\ w\ p \\ otto(o)\quad anna(a)\quad waldo(w)\quad party(p) \\ \hline\end{array} \\
\mathrm{G} :: \mathrm{F} + \begin{array}{|l|}\hline \mathrm{G'\ G''\ X_1} \\ loved\text{-}by\text{-}everyone(o) \\ \mathrm{X_1 = F} \\ \mathrm{G'} :: \mathrm{X_1} + \boxed{\mathrm{come(o)}} \Rightarrow \mathrm{G''} :: \mathrm{G'} + \boxed{\mathrm{lively(p)}} \\ \hline\end{array} \\
\mathrm{G^* \subseteq G} \\
\mathrm{H^*} :: \mathrm{G^*} + \begin{array}{|l|}\hline \mathrm{H'\ H''\ X_2} \\ \neg\ likes(a,o) \\ \mathrm{X_2 = G^*} \\ \mathrm{H'} :: \mathrm{X_2} + \begin{array}{|c|}\hline \mathrm{come(o)} \\ \mathrm{come(a)} \\ \hline\end{array} \Rightarrow \mathrm{H''} :: \mathrm{H'} + \boxed{\neg\ \mathrm{lively(p)}} \\ \hline\end{array} \\
\mathrm{H^{**} \subseteq H^*} \\
\mathrm{I^{**}} :: \mathrm{H^{**}} + \begin{array}{|l|}\hline \mathrm{I'\ I''\ X_3} \\ \mathrm{X_3 = H^{**}} \\ talks\text{-}to\text{-}anna\text{-}all\text{-}the\text{-}time(w) \\ \mathrm{I'} :: \mathrm{X_3} + \begin{array}{|c|}\hline \mathrm{come(o)} \\ \mathrm{come(a)} \\ \mathrm{come(w)} \\ \hline\end{array} \Rightarrow \mathrm{I''} :: \mathrm{I'} + \boxed{\mathrm{lively(p)}} \\ \hline\end{array} \\
\mathrm{J} :: \mathrm{I^{**}} + \begin{array}{|l|}\hline \mathrm{J'\ J''\ X_4} \\ \mathrm{X_4 = I^{**}} \\ \mathrm{J'} :: \mathrm{X_4} + \boxed{\mathrm{come(o)}} \Rightarrow \mathrm{J''} :: \mathrm{J'} + \boxed{\mathrm{lively(p)}} \\ \hline\end{array} \\
\hline
\end{array}
$$

[70] We are using the notation G^* in order to notationally distinguish those context referents that result from context reduction. Though equally marked by "*" this has nothing to do with the normalcy selection function. We just have a context referent G^*, which we could also have chosen, e.g., as G_1.

[71] Of course, we do not assume that the additional conditions in (157) are actually part of the *semantic* representation of such sequences. At best, such additional conditions may be introduced on the basis of pragmatic information. We only state these – quite arbitrarily selected – conditions for the purpose of exposition.

So, it turns out that – on the basis of this new conception of how to make sense of sequences of variably strict conflicting conditionals – the "revision" that we felt was at work in these contexts actually stems from another source: What is "revised" is the underlying "factual" context to support the selection of "normal worlds", and thus the truth of these confliciting conditionals. And this, we take it, is a natural semantic reflex of what is conveyed by the use of *but* in this specific type of example.

As a consequence of this analysis, where by "revision" of the original evaluation context G we end up within a "new", conflicting context H^*, we thus get that – contrary to Lewis' analysis, where *all of* the subsequent conflicting conditionals can be judged non–trivially true by evaluation relative to an appropriate (pre–established) sphere system – in our dynamic analysis, involving repeated revision of the underlying evaluation context, and thus, of normalcy assumptions in response to the presence of newly uttered, conflicting conditionals, the subsequently stated conditionals (and thus the DRS (157)) *cannot all* be true relative to a single evaluation state $\langle w_0, e\rangle$.

Recall from Section 3.3 that the verification condition for an update $G :: F{+}K'$ builds in a "truth predicate": the condition is only verified by $\langle w, e\rangle$ if there is some state $\langle w', g\rangle \in e(G)$ where $w' = w$, i.e. if we can consistently assume that the evaluation world is within the "context set", the set of worlds that give a (partial) characterization of what holds true within the actual world. Since we got that $cs(e(G))$ and $cs(e(H^*))$ yield distinct sets of worlds, the evaluation world w_0 for (157) cannot be within *both* of these context sets.

So the analysis is in accordance with our intuition, according to which the utterance of a new, conflicting conditional in a sequence like (157) in fact involves some *revision*, or *correction* of what was stated to be true by the just preceding discourse, which is also reflected by the use of *but*: The speaker is making up her mind.

We thus assume that (157) cannot be verified relative to a single evaluation state $\langle w_0, e\rangle$. Just as intuition tells us, the previously uttered sentences must be considered invalid in light of the new, revised context. In other words, we assume that the evaluation world w_0 is in fact *not* to be found within the context set $cs(e(G))$, and also not to be found within the context set $cs(e(H^*))$, but only – finally – within the context set $cs(e(I^{**}))$.[72]

Yet, we still may ask ourselves why it is, that, once we turn to a *distinct* set of evaluation worlds in $cs(e(H^*))$, worlds where Otto and Anna are known to dislike each other, as opposed to those of $cs(e(G))$ where it was quite naively presupposed that everybody (who might show up) likes Otto, we still assume that relative to H^* the set of "normal worlds" where Otto (while not Anna) comes, will be such that the party is lively, which, as we have just seen, was derived on the basis of the *distinct* set of evaluation worlds $cs(e(G))$.

This, we conjecture, is best explained by assuming the "revision" that takes us from G to H^* via the reduced context G^* to be as "small" as possible, while allowing for the truth of the new, conflicting conditional.

If the reduction relation $G^* \subseteq G$ yields a context $e(G^*)$ that retains as much information as possible of what is provided by $e(G)$, while allowing for consistent update of G^* with the DRS for the second sentence to yield an extended context H^* where this second sentence is true, then, given the (accommodated) condition that *Anna doesn't like Otto*, which provides a justification for the truth of the second conditional, if the reduction is as small as possible, the context set $cs(e(H^*))$ will contain worlds w' where we take it that as many

[72] In Section 5.3.3 we will state a definition *verifies** for verification of DRSs that involve revison of the underlying factual background context.

people of those that were previously assumed to like Otto will still like him, (though not, of course, Anna). This, then, supports the revised normalcy assumptions, relative to worlds $w' \in cs(e(H^*))$ for situations $X_2 + K'$ where Otto comes to the party, such that among the set of normal worlds where Otto comes, and where the party is assumed to be lively, we will find worlds where all of these other people might show up, while no worlds where Anna comes as well. And this is just the same normalcy assumption for $*(w', h^*(X_2 + K'))$ that we obtained earlier, via application of the VARIABILITY constraint (156i) – modulo the now revised evaluation function h^*, in contrast to our earlier h.

So it seems as if these refinements of normalcy assumptions, which we earlier derived by adopting the VARIABILITY constraint (156) on * not only are in accordance with the defeasible SPECIFICITY constraint, but may in fact be viewed as an explicit computation of *maximal persistence of normalcy assumptions in view of conflicting information*, which, we argued, follows from assuming the *revision* of the factual evaluation context to be minimal.

The only adjustment we have to make to our original version of VARIABLITY in (156) is then to account for the fact that such sequences of conflicting conditionals necessarily involve *revision* of the underlying "evaluation context", as indicated by the particle *but*, and which we represented, in (157), in terms of a *reduction* relation on the actual "evaluation context" in order to allow for consistent update with the new, *conflicting* conditional.

Since the second conditional is evaluated relative to a distinct context set $cs(e(H^*))$, the "revised", but maximally consistent normalcy assumptions $*(w', h^*(X_2 + K'))$ for $\langle w', h^* \rangle \in e(H^*)$ must be defined for worlds $w' \in cs(e(H^*))$ that are distinct from every world $w \in cs(e(G))$, which determined the "earlier" normalcy assumptions $*(w, g(X_1 + K'))$, for $\langle w, g \rangle \in e(G)$. To be precise, $e(H^*)$ is to consist of all states $\langle w', h^* \rangle$, such that for some $\langle w, g \rangle \in e(G)$ there is some g^* where $g^* \subseteq g$ and $g^* \subseteq h^*$, and such that (158) is satisfied.

(158) VARIABILITY:

Let $\mathbf{X_1}, \mathbf{K}', \mathbf{X_2}, \mathbf{K}'', \mathbf{G}$ and $\mathbf{H}^*$ be sets of world–function pairs.

If $\langle w, g \rangle \in \mathbf{G}$ and $\langle w', h^* \rangle \in \mathbf{H}^*$, and $cs(\mathbf{X_2}) \subseteq cs(\mathbf{X_1})$, then

i. if $cs(\mathbf{X_2} +^\bullet \mathbf{K}'') \subseteq cs(\mathbf{X_1} +^\bullet \mathbf{K}')$ and
$\forall \langle w, g \rangle \in \mathbf{G}\ \forall \langle w', h^* \rangle \in \mathbf{H}^*$: $*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap *(w', \mathbf{X_2} +^\bullet \mathbf{K}'') = \emptyset$,
then $\forall \langle w', h^* \rangle \in \mathbf{H}^*\ \exists \langle w, g \rangle \in \mathbf{G}$:
$*(w', \mathbf{X_2} +^\bullet \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}') \setminus (*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap cs(\mathbf{K}''))$

ii. otherwise, $\forall \langle w', h^* \rangle \in \mathbf{H}^*\ \exists \langle w, g \rangle \in \mathbf{G}$: $*(w', \mathbf{X_2} +^\bullet \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}')$.

We consider the VARIABILITY constraint (158) as a quite natural *rationality principle*, appropriate for contexts involving variably strict conflicting conditionals, which, in contexts that confront us with *conflicting defaults*, takes us from a context G to a revised context H^*, with assumption of *maximal persistence (of normality assumptions), respecting consistency with what is explicitly introduced by the newly asserted sentence*. And this is conceptually very similar to the use that has been made of constraints on the normalcy selection function * in Commonsense Entailment, to implement *rationality principles* for nonmonotonic reasoning on the basis of generic sentences that involve conflicting defaults.

Finally, we also saw, in the course of the above discussion, that also in our refined analysis of variably strict conflicting conditionals in (157) we still have to adopt the *defeasible* SPECIFICITY constraint (154), which revealed as a necessary precondition to "detect" a conflict between the first and second conditional, and which in turn induces "revision" of the underlying "evaluation context" G to H^*.

To illustrate this in more detail, let us compute through example (157) by adopting VARIABILITY (158) and SPECIFICITY (154) as general constraints on the *normalcy selection function* $*$, along with the conditions in (146). We get the following values for $*$ (159):

What is considered normal, relative to states $\langle w, g\rangle \in e(G)$, for situations $X_1 + K'$, is denoted by $*(w, g(X_1+K'))$, which yields a set of "normal worlds" that all support that the party will be lively. Given that K'' implies K', and the conflicting consequents of the first and second conditional in (157), the set of normal worlds determined by $*(w', h^*(X_2+K''))$ for states $\langle w', h^*\rangle \in e(H^*)$ of the revised context H^* does not overlap with those determined by $*(w, g(X_1+K'))$. The variability constraint therefore defines what we earlier – informally – described by the notion of *revision of normalcy assumptions*: given the (conflicting) information conveyed by the context H^*, the normality assumptions for $X_2 + K'$ relative to $\langle w', h^*\rangle$ are not identified with (or assumed to carry over from) those for $X_1 + K'$ relative to $\langle w, g\rangle \in e(G)$. Yet, given the assumption of minimal revision, the "conflicting" information provided by H^*, as to the normality assumptions for $X_2 + K''$, is used to define the normalcy assumptions for $X_2 + K'$ relative to $\langle w', h^*\rangle \in e(H^*)$ on the basis of the normalcy assumptions $*(w, g(X_1 + K'))$ that were valid within the previous context G: the normality assumptions, in the revised context H^*, for $X_2 + K'$ are now defined as the complement set of worlds $*(w, g(X_1 + K'))\backslash(*(w, g(X_1 + K')) \cap cs([\![K'']\!]))$.

Note that this "redefinition" of what counts as "normal" in a situation where Otto comes to the party and the party is lively, in the revised context H^*, comes down to explicit defeat of the *specificity assumption* for $*(w', h^*(X_2 + K'))$ and $*(w, h^*(X_2 + K''))$.

The assertion of the third conditional, relative to the antecedent context H^*, characterizes all worlds where "everything holds that is normally the case in a context X_3 where K''' holds true" to be such that the party is lively. Thus, the set of worlds determined by $*(w'', i^{**}(X_3+K'''))$, for $\langle w'', i^{**}\rangle \in e(I^{**})$ does not overlap with those determined by $*(w', h^*(X_2+K''))$, where K''' implies K'' and X_3 *extends* X_2. Condition (158i) of VARIABILITY therefore defines the normality assumptions for $X_3 + K''$ relative to $\langle w'', i^{**}\rangle \in e(I^{**})$ to correspond to the complement set of worlds $*(w', h^*(X_2 + K''))\backslash(*(w', h^*(X_2 + K'')) \cap cs([\![K''']\!]))$.

Thus, again, by application of (158i) the SPECIFICITY constraint (154) is defeated for $*(w'', i^{**}(X_3 + K''))$ and $*(w'', i^{**}(X_3 + K'''))$.

Given that the set of normal worlds $*(w'', i^{**}(X_3+K'''))$ relative to $\langle w'', i^{**}\rangle \in e(I^{**})$ does not overlap with the set of normal worlds $*(w', h^*(X_2 + K'))$ relative to $\langle w', h^*\rangle \in e(H^*)$, the values of $*(w'', i^{**}(X_3 + K'''))$ must be defined in terms of (158i), though this will yield the same result as we get by application of (158ii), since $*(w'', h^*(X_2+K'))\cap cs([\![K''']\!]) = \emptyset$.

(159) For $K' = [\colon \mathit{come}(o)]$, $K'' = [\colon \mathit{come}(o)\&\mathit{come}(a)]$,
$K''' = [\colon \mathit{come}(o)\&\mathit{come}(a)\&\mathit{come}(w)]$ and $F, G, H^*, I^{**}, X_1, X_2, X_3$ as in (157):[73]

$$\forall\langle w, g\rangle \in e(G) : *(w, g(X_1 + K')) \subseteq [\![\mathit{lively}(p)]\!]$$
$$\forall\langle w', h^*\rangle \in e(H^*) : *(w', h^*(X_2 + K'')) \subseteq [\![\neg \mathit{lively}(p)]\!]$$
$$\forall\langle w', h^*\rangle \in e(H^*)\exists\langle w, g\rangle \in e(G) : *(w', h^*(X_1 + K')) \subseteq *(w, g(X_1 + K'))$$
$$\forall\langle w', h^*\rangle \in e(H^*)\exists\langle w, g\rangle \in e(G) : *(w', h^*(X_1 + K'')) \subseteq *(w, g(X_1 + K''))$$
$$\forall\langle w', h^*\rangle \in e(H^*)\exists\langle w, g\rangle \in e(G) :$$
$$*(w', h^*(X_2 + K')) \subseteq *(w', g(X_1 + K'))\backslash(*(w', g(X_1 + K')) \cap cs([\![K'']\!]))$$

$$\forall\langle w', i^{**}\rangle \in e(I^{**}) : *(w', i^{**}(X_3 + K''')) \subseteq [\![lively(p)]\!]$$
$$\forall\langle w'', i^{**}\rangle \in e(I^{**})\exists\langle w', h^*\rangle \in e(H^*) : *(w'', i^{**}(X_1 + K')) \subseteq *(w', h^*(X_1 + K'))$$
$$\forall\langle w'', i^{**}\rangle \in e(I^{**})\exists\langle w', h^*\rangle \in e(H^*) : *(w'', i^{**}(X_2 + K')) \subseteq *(w', h^*(X_2 + K'))$$
$$\forall\langle w'', i^{**}\rangle \in e(I^{**})\exists\langle w', h^*\rangle \in e(H^*) :$$
$$*(w'', i^{**}(X_3 + K')) \subseteq *(w', h^*(X_2 + K'))\backslash(*(w', h^*(X_2 + K')) \cap cs([\![K''']\!]))$$
$$\forall\langle w'', i^{**}\rangle \in e(I^{**})\exists\langle w', h^*\rangle \in e(H^*) :$$
$$*(w'', i^{**}(X_3 + K'')) \subseteq *(w'', h^*(X_2 + K''))\backslash(*(w'', h^*(X_2 + K'')) \cap cs([\![K''']\!])).$$ [74]

By this repeated "revision" of normalcy assumptions within revised evaluation contexts in terms of VARIABILITY we achieve an analysis where – contrary to what is obtained in Lewis' approach – for the distinct occurrences of *if Otto comes, the party will be lively* we obtain distinct sets of normal worlds to support the truth of these respective conditionals: while for the first occurrence, by SPECIFICITY, we assume the set of normal worlds where Otto comes, and where the party is lively to contain also worlds where Anna comes, by repeated revision of the evaluation context and applications of VARIABILITY I, once we turn to evaluate the second occurrence of this conditional in (157) the set of normal worlds where Otto comes and the party is lively will not contain worlds where Anna comes as well.

While this nicely renders the distinct contextual interpretation of the two occurrences of the same conditional, it does not, by itself, give an explanation for why the second occurrence of *If Otto comes, the party will be lively* in the context (157) is not fully acceptable. Why this should be so will become clearer if we consider the contrast between (160a–b): (160a) instantiates the pattern of (157), where the successive conditionals are *increasingly* strict, while in (160b) the conditionals form a sequence of *decreasingly* strict conditionals. Now, we have seen that the pattern in (160a) yields perfectly wellformed discourses; however, example (161), which instantiates the pattern of (160b) does not.[75] Note that the second and third conditional in (161) can at best be understood as a coherent contextual extension of the first one if they are restricted by "only": *if only Otto (and Anna) come.* Yet, it seems impossible to interpret (161) in this way without overt realization of *only.* By contrast, the first three conditionals in (157), which instantiate the pattern of (160a), form a coherent discourse without such overt realization of *only.*

Recall from Section 2.2.2 that there is no way in Lewis' analysis to make sense of this striking contrast.[76] The system of spheres is pre–established to make variably strict conditionals true, whether in a sequence of increasingly or decreasingly strict conditionals. By contrast, our *context sensitive* normalcy selection function *, together with the defeasible SPECIFICITY (154) and the VARIABILITY (158) constraint, will not only account for the oddity of the conclusion in (157), but also offer an explanation for the difference in acceptability between sequences of conditionals corresponding to the two schemata in (160).

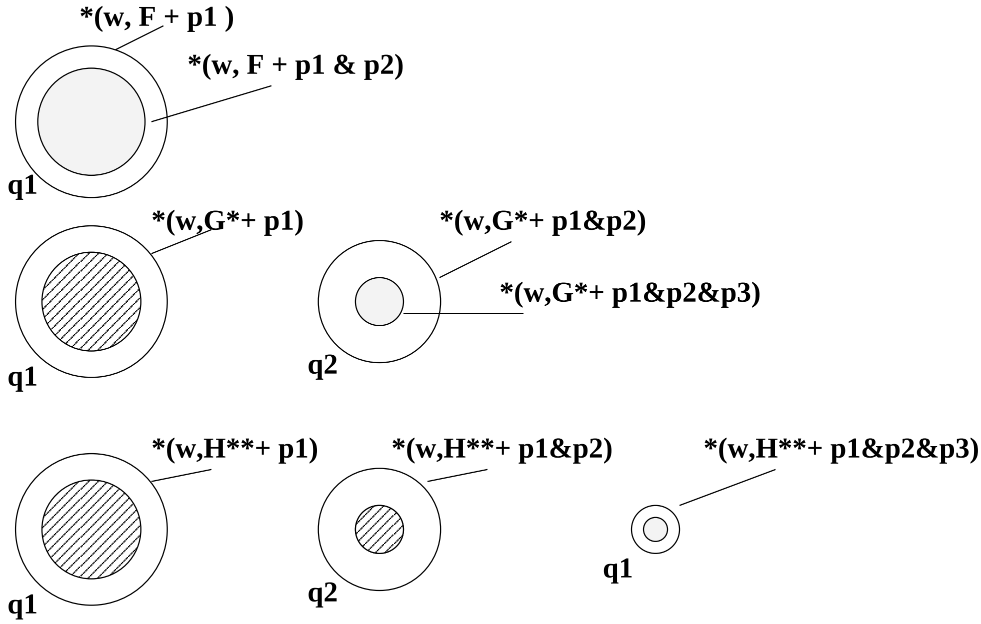
[74]The example illustrates that for a correct analysis we have to impose an additional constraint within the definition of VARIABILITY (158), to the effect that it may only apply in cases where for the context sets $cs(\mathbf{X_2}) \subseteq cs(\mathbf{X_1})$ there is no context $\mathbf{X_3}$ with $cs(\mathbf{X_2}) \subset cs(\mathbf{X_3}) \subset cs(\mathbf{X_1})$ for which we have that SPECIFICITY is defeated for $\mathbf{X_3} +^\bullet \mathbf{K}'$ and $\mathbf{X_3} +^\bullet \mathbf{K}''$, i.e., it may not be the case that, if $cs(\mathbf{X_3} +^\bullet \mathbf{K}'') \subseteq cs(\mathbf{X_3} +^\bullet \mathbf{K}')$, then $*(w, \mathbf{X_3} +^\bullet \mathbf{K}'') \not\subseteq *(w, \mathbf{X_3} +^\bullet \mathbf{K}')$.

Adopting this further constraint on VARIABILITY prevents, in (157), that the normalcy assumptions $*(w'', i^{**}(X_3{+}K''))$ for $\langle w'', i^{**}\rangle \in e(I^{**})$ are defined in terms of the normalcy assumptions $*(w, g(X_1{+}K''))$, for $\langle w, g\rangle \in e(G)$, to yield a set of normal worlds where Otto and Anna come, and where the party is lively.

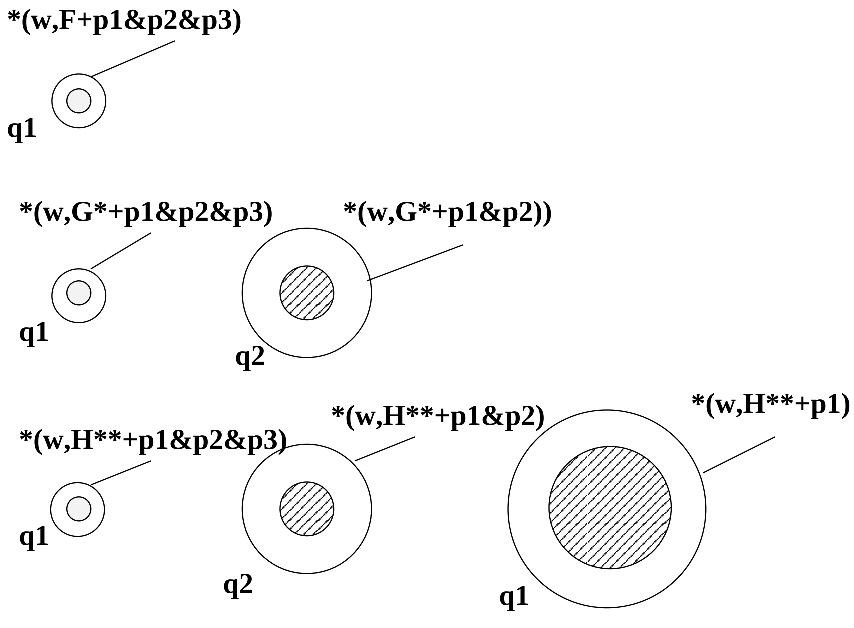
[75]Ede Zimmermann drew my attention to the fact that the context sensitive interpretation of normalcy should in fact predict this difference between (160a–b).

[76]See citation from Lewis(1979b) in Section 2.2.2 p. 19.

(160) a. $p_1 \rightarrow q_1$
p_1 & $p_2 \rightarrow q_2$ (with $q_2 = \neg\, q_1$)
p_1 & p_2 & $p_3 \rightarrow q_1$



b. p_1 & p_2 & $p_3 \rightarrow q_1$
p_1 & $p_2 \rightarrow q_2$ (with $q_2 = \neg\, q_1$)
$p_1 \rightarrow q_1$



(161) If Otto, Anna and Waldo come, the party will be lively.
?? But if Otto and Anna come, the party will be dreary.
?? But if Otto comes, the party will be lively.

Together with the schemata in (160a–b) we have given graphical representations of the sets of worlds determined by the values of the selection function * for these variably strict conditionals, which are contextually dependent on context referents F, G^*, and H^{**} that represent the continuously evolving context set up by these very conditionals (cf. (157)). The only figure in the first line of (160a) represents the set of "normal" p_1–worlds that make up the quantificational domain of the first conditional. The outer white circle encompasses the set of worlds $*(w, g(F + p_1))$ for $\langle w, g\rangle \in e(G)$ – determined as "normal" p_1–worlds where q_1 holds true in virtue of the first conditional.[77] The grey shaded inner circle is intended to represent the set of worlds $*(w, g(F + p_1\&p_2))$, which is assumed to form a subset of $*(w, g(F + p_1))$ on the basis of the defeasible SPECIFICITY–constraint (154). The specificity assumption predicts q_1 to hold true in all worlds in $*(w, g(F + p_1\&p_2))$.

When processing the second conditional, relative to the minimally reduced context G^* to yield the revised context H^*, we saw, this specificity assumption gets explicitly defeated for worlds $w' \in cs(e(H^*))$: for these worlds, given the conflicting consequents q_1 and q_2, the VARIABILITY constraint restricts the set of worlds $*(w', h^*(G^* + p_1))$ to form a subset of the complement set of worlds $*(w, g(F, +p_1))\backslash(*(w, g(F + p_1)) \cap [\![p_1\&p_2]\!])$, for $\langle w, g\rangle \in e(G)$, which is represented in the first figure of the second line in (160a) by the outer white *ring*. Given the assertion of the second conditional, the set of worlds $*(w', h^*(G^* + p_1\&p_2))$ are worlds where q_2 holds true, and thus cannot form a subset of $*(w', h^*(G^* + p_1))$, which supports that q_1 holds true. The SPECIFICITY assumption is thus explicitly defeated for $p_1\&p_2$ relative to $*(w', h^*(G^* + p_1))$. In the graphical representation, this is represented by the line–shaded inner circle of the first figure in the second line. By contrast, for the second figure in the second line, which represents the set of "normal p_1 & p_2–worlds" relative to G^*, $*(w', h^*(G^* + p_1\&p_2))$, quantified over by the second conditional, we again assume SPECIFICITY to hold: this is represented in terms of the grey shaded inner circle, representing the set of "normal $\mathrm{p}_1\&\mathrm{p}_2\&\mathrm{p}_3$–worlds", relative to G^*, which forms a subset of $*(w', h^*(G^* + p_1\&p_2))$.

Finally, this (defeasible) specificity assumption for "normal $\mathrm{p}_1\&\mathrm{p}_2$–worlds" denoted by $*(w', h^*(G^* + p_1\&p_2))$ is again defeated by the assertion of the third conditional. Given the specificity assumption for $*(w', h^*(G^* + p_1\&p_2))$, the third conditional cannot be based on the "evaluation context" established by the second conditional, which induces *minimal* reduction of H^* to a context H^{**}, which is chosen as the input argument for the next sentence, and to instantiate the modal base of the third conditional. And again, for worlds $w'' \in cs(e(I^{**}))$ within the ensuing revised context I^{**} the VARIABILITY constraint restricts the set of "normal $\mathrm{p}_1\&\mathrm{p}_2$–worlds", now relative to H^{**}, $*(w'', i^{**}(H^{**} + p_1\&p_2))$, to form a subset of the complement set $*(w', h^*(G^* + p_1\&p_2))\backslash(*(w', h^*(G^* + p_1\&p_2)) \cap [\![p_1\&p_2\&p_3]\!])$, for $\langle w', h^*\rangle \in e(H^*)$, corresponding to the outer white *ring* in the second figure of line three, which again contains an inner line shaded circle to visualize the defeat of the SPECIFICITY assumption for $p_1\&p_2$ and $p_1\&p_2\&p_3$ relative to H^{**}. Finally, the assertion of the third conditional itself defines a new set of "normal $\mathrm{p}_1\&\mathrm{p}_2\&\mathrm{p}_3$–worlds relative to H^{**}, where q_1 holds true, and for which we again assume SPECIFICITY to hold, as indicated by the inner grey circle.

The general pattern that characterizes a discourse with conflicting *increasingly* strict conditionals is now obvious: For each conditional $C_i : p_i \Rightarrow q$ in such a sequence we

[77] We simplify, in referring to p_1, p_2, etc. instead of the corresponding DRSs.

start out with assuming SPECIFICITY to hold for the set of worlds picked out by the context dependent *normalcy* selection function. If then a *conflicting*, stricter conditional $C_{i+1} : p_{i+1} \Rightarrow \neg q$, with $cs(p_{i+1}) \subseteq cs(p_i)$, is to be interpreted relative to the context set up by C_i, due to the earlier *specificity* assumption we have to induce *minimal reduction* of the preceding factual, or evaluation context, to allow for consistent update with the new, conflicting conditional, which then necessitates the *defeat* of the earlier specificity assumption for p_i wrt. p_{i+1}, which is obtained via VARIABILITY I. Yet, at the same time, the assertion of C_{i+1} again establishes, in the context of the slightly revised context C_i^*, a new set of "normal p_{i+1}–worlds", for which again SPECIFICITY is assumed to hold.

The important point to note here is that in such a discourse we can, for each *newly asserted* conditional – even if increasingly strict and conflicting with "previous" specificity assumptions – assume SPECIFICITY to hold.

For the pattern in (160b) this differs radically. Starting out with a conditional that characterizes all "normal $p_1\&p_2\&p_3$–worlds" to be worlds that verify q_1, we can assume SPECIFICITY to hold, as indicated graphically by the grey shaded inner circle in the figure of the first line of (160b). Now, given the conflicting consequent q_2 of the second conditional, the set of "normal $p_1\&p_2$–worlds" $*(w', h(G + p_1\&p_2))$, for $\langle w', h\rangle \in e(H)$ in the extended context H is conflicting with what, in virtue of the first conditional, is assumed by SPECIFICITY.

If the second conditional is to be interpreted as being true within the extended discourse H, this is only possible if – from the start – the SPECIFICITY assumption is denied for this second conditional. And this is so whether or not we assume revision of the factual evaluation context G, by context reduction to a context G^* to yield a revised context H^* through update with the conflicting conditional: According to the VARIABILITY constraint (158i), "refinement" of the normalcy assumptions $*(w', h^*(X_2 + K'))$ in terms of the normalcy assumptions $*(w, g(X_1 + K'))$ is only possible in case the conflicting normalcy assumptions $*(w, g(X_1 + K'))$ and $*(w', h^*(X_2 + K''))$ are such that $X_2 + K''$ is more specific than is $X_1 + K'$. Now, in the present case of decreasingly strict conflicting conditionals, due to the more specific antecedent of the preceding conditional, $X_2 + K''$ does not imply/extend $X_1 + K'$, and thus, we can only apply the second clause of VARIABILITY.

Thus, the normalcy assumptions for $\langle w', h^*\rangle \in e(H^*)$ are such that $*(w', h^*(X_2 + p_1\&p_2\&p_3)) \subseteq *(w, g(X_1 + p_1\&p_2\&p_3))$, for $\langle w, g\rangle \in e(G)$. And, as just stated, this determines that the SPECIFICITY assumption must be defeated, from the start, for the newly asserted conditional within the context H^*. In other words, the set of worlds determined by $*(w', h^*(G^* + p_1\&p_2))$ for $\langle w', h^*\rangle$ may *not* contain "normal $p_1\&p_2\&p_3$–worlds", which by $*(w, g(F + p_1\&p_2\&p_3))$, and thus $*(w', h^*(G^* + p_1\&p_2\&p_3))$, are asserted to verify q_1. This is again represented graphically by the line–shaded inner circle of the second figure in the second line of (160b).

The same pattern is finally encountered when processing the third conditional: here the set of "normal p_1–worlds" is characterized to support q_1. Again, we cannot assume SPECIFICITY to hold for $*(w'', i(H^* + p_1))$, for worlds w'' within the extended context I, since in virtue of the preceding conditional we just got that the set of normal worlds $*(w', h^*(G^* + p_1\&p_2))$ supports the truth of $\neg q_1$. If SPECIFICITY were to hold, the set of $\mathrm{p}_1\&p_2$–worlds (represented by the line–shaded inner circle of the third figure in the third line of (160b)) would have to satisfy q_1 as well, therefore conflicting with what is explicitly stated, by the second conditional, to be normally the case, relative to context G^*, where $p_1\&p_2$ hold true. Again, also if we assume revision of H^*, such that the third conditional is evaluated relative to a reduced context H^{**} to yield a revised context I^{**}, given that the new conflicting conditional is *decreasingly* strict, we can only apply clause (ii) of VARIABILITY (158ii), which defines the normalcy assumptions for $p_1\&p_2$–worlds, $*(w'', i^{**}(H^{**}+p_1\&p_2))$ relative to $\langle w'', i^{**}\rangle$, to carry over from those of $*(w', h^*(G^*+p_1\&p_2))$. The third conditional cannot, therefore, satisfy the SPECIFICITY assumption.

So it turns out that the general pattern for sequences of *decreasingly* strict conditionals differs from the one observed for increasingly strict conditionals in that for none of the conditionals that successively extend the preceding discourse the SPECIFICITY constraint can be assumed to hold true.

We now begin to understand why it is that the second conditional in (161) can only be understood as a coherent utterance in the context of the first conditional if explicitly restricted by use of *only*. If we adopt a general principle to the effect that the assertion of a conditional in a discourse H, as being relative to some context X', must satisfy, within H, the SPECIFICITY assumption, and if we further assume that – if this constraint cannot be trivially fulfilled – this must be indicated by linguistic means, it is straightforward to do so, in (161), by use of *only*, thereby restricting the antecedent DRS K'', e.g., to situations where Otto and Anna, but not Waldo join the party.

But not only does this principle account for the oddity of sequences of conflicting, decreasingly strict conditionals: it now also gives an explanation for the oddity of the last conditional in (157). Obviously, this last conditional qualifies as a *decreasingly* strict conditional following a sequence of *increasingly* strict, conflicting conditionals. And thus, we here meet the same difficulties as regards fulfillment of the principle that the assertion of a conditional in a context J, relative to a modal base X_4, is only (pragmatically) wellformed if – *within* J – the SPECIFICITY constraint can be assumed to hold for $*(w, j(X_4 + K'))$, K' the conditional's antecedent DRS. In (157), it is already stated, by the preceding discourse context I^{**}, that the set of normal worlds where Otto joins the party is such that SPECIFICITY does not hold for $*(w, j(X_4 + K'))$ wrt. $K'' = [\text{: } comes(o)\&comes(a)]$ (cf. the first figure in the third line of (160a)) – and even more, doesn't go through wrt. $K''' = [\text{: } comes(o)\&comes(a)\&comes(w)]$. Again the conclusion can only be understood as pragmatically wellformed, in this particular context, by addition of *only*: *If only Otto comes, the party will be lively.*

Let us briefly summarize the main points we made in this Section:

We argued that the quantificational domain of conditional or non–restricted modal sentences is not only to be constrained in terms of the selection of a *relevant* (reduced) modal base, and in accordance with the notion of *historical necessity*, but must further respect the notion of *normalcy*. This has been shown, in Section 5.2.1, to be of particular importance for the analysis of conditional variability. Having reviewed, in Sections 5.2.2 and 5.2.3, various notions of *normalcy* that have been investigated in theories of nonmonotonic reasoning, in particular the modal theories of genericity of Commonsense Entailment and Conditional Default Reasoning, we have adapted the normalcy selection function of Commonsense Entailment (Asher&Morreau(1991,1995) and Morreau(1992)) to our DRT framework, yet provided it with a context–type argument that for the analysis of modally quantified structures is instantiated by the *update* of the modal base X' with the antecedent

DRS K' (see Section 3.3). The context sensitivity that we thus built into the normalcy restriction for the analysis of conditionals turned out to allow for a successful analysis of the problematic cases of variably strict conditionals with conflicting consequents.

As we suggested in Section 2.2.2, when reviewing Lewis' analysis of variably strict conditionals with conflicting consequents, the interpretation of such sequences is heavily dependent on a context dependent, *dynamic* interpretation. This dynamic perspective led us to an analysis of sequences of increasingly strict conditionals with conflicting consequents that does justice to the intuition that such contexts involve successive revision of what is considered, at the various intermediate stages of the sequence, to be *normally* the case in situations where Otto comes to the party. And, as it finally turned out, this revision is in last analysis induced by (minimal) revision of the underlying "evaluation context", in response to the conflicting conditionals, in conjunction with the *defeasible* SPECIFICITY constraint. The VARIABLITY constraint on * sort of "computes" the effects of this more fundamental *minimal* revision of the evaluation context, in that it defines refined normalcy assumptions within this new, minimally revised context, for those hypothetical situations for which *Specificity* is defeated, in virtue of the "new" conflicting conditional.

In sum, our analysis of variably strict conflicting conditionals differs crucially from Lewis' analysis in terms of a pre–established sphere system, in that it posits a *dynamic* interpretation process for such sequences of conflicting conditionals. We do not assume that there is a single context that verifies *all of* these subsequent conditionals, but posit a process of repeated (minimal) revision of the underlying evaluation context in response to the newly asserted conflicting conditionals. Together with the SPECIFICITY constraint on * we thereby get an explanation for the contrast between increasingly vs. decreasingly strict conditionals.

Having gone this far, we will, in Section 5.3.3, try to extend this analysis of vague and variably strict conditionals in context to phenomena of nonmonotonic reasoning, where we will rely on the results that were emerging from our discussion and comparison between Commensense Entailment and Conditional Default Reasoning (see Section 5.2.3).

But first, we want to briefly address the issue of the non–transitivity of the (counterfactual) conditional, which was claimed, by Lewis(1973), to be a consequence of the variability, or nonmonotonicity of conditionals (see Section 2.2.2).

5.3.2 Transitivity revisited: Fallacious "counterfactual fallacies" and modal subordination

The classical example that illustrates the non–transitivity of (counterfactual) conditionals is (162).[78] If transitivity were to hold, the conclusion in (162) should be valid. Yet it isn't.

(162) If J. Edgar Hoover had been born a Russian, then he would have been a Communist.
If he had been a Communist, he would have been a traitor.
$\vdash$ If he had been born a Russian, he would have been a traitor. Lewis(1973:33)

If considered with care (162) must be interpreted along the lines of (163a), where we have added *implicit* conditions that further restrict the conditionals' antecedent and consequent

[78]The example is originally from Stalnaker(1968).

clauses. In this more explicit rendering it is evident that transitivity cannot hold: the antecedent of the second conditional is incompatible with the consequent of the first one, and thus, the argument scheme of *transitivity* cannot, in the first place, be applied to (163a).

(163b) illustrates the issue from the opposite viewpoint: *If* the antecedent of the second conditional were to be interpreted as identical to the consequent of the first conditional, in order to license application of *transitivity*, the second conditional cannot be judged true, and *no* conclusion that relies on the second premise can be considered true.

(163) a. If J. Edgar Hoover had been born a Russian, then he would have been a Communist *while not head of the FBI.*
If he had been a Communist, *while being the head of the FBI*, he would have been a traitor.
$\not\vdash$ If he had been born a Russian, he would have been a traitor.

b. If J. Edgar Hoover had been born a Russian, then he would have been a Communist *while not head of the FBI.*
If he had been a Communist *while not being the head of the FBI*, he would have been a traitor.

This observation is made explicit in terms of the DRS representation (164) for (163a), where we have chosen the modal base of the second conditional to be anaphorically dependent on the scope argument of the first conditional. Yet, due to the conflicting (implicit) information of the scope argument of the first, and the antecedent of the subordinated conditional, the second conditional cannot be judged true, unless in a trivial way, which in general results in a reading that is perceived as odd, or even false in natural language understanding. Thus, even if the modal base of the third conditional were chosen to anaphorically refer to the context referent H, given that the second conditional cannot be judged (non–trivially) true, it is then also predicted that the final conditional cannot be judged true.

(164)
$$
\begin{array}{|l|}\hline
\text{F G H I} \\
\text{F} :: \begin{array}{|l|}\hline \text{x} \\ \text{J.Edgar-Hoover(x)} \\ \textit{american(x)} \\ \textit{head–of–FBI(x)} \\ \hline\end{array} \\
\text{G} :: \text{F} + \begin{array}{|l|}\hline \text{G}'\ \text{G}''\ \text{X}' \\ \text{X}' \subseteq \text{F} \\ \text{G}' :: \text{X}' + \boxed{\text{russian(x)}} \Rightarrow \text{G}'' :: \text{G}' + \begin{array}{|l|}\hline \neg\ \textit{american(x)} \\ \neg\ \textit{head-of-FBI(x)} \\ \text{communist(x)} \\ \hline\end{array} \\ \hline\end{array} \\
\text{H} :: \text{G} + \begin{array}{|l|}\hline \text{H}'\ \text{H}''\ \text{X}'' \\ \text{X}'' \subseteq \text{G}'' \\ \#\ \text{H}' :: \text{X}'' + \begin{array}{|c|}\hline \textit{head-of-FBI(x)} \\ \text{communist(x)} \\ \hline\end{array} \Rightarrow \text{H}'' :: \text{H}' + \boxed{\text{traitor(x)}} \\ \hline\end{array} \\
\text{I} :: \text{H} + \begin{array}{|l|}\hline \text{I}'\ \text{I}''\ \text{X}''' \\ \text{X}''' \subseteq \text{H} \\ \text{I}' :: \text{X}''' + \boxed{\text{russian(x)}} \not\Rightarrow \text{I}'' :: \text{I}' + \boxed{\text{traitor(x)}} \\ \hline\end{array} \\
\hline\end{array}
$$

The only way to interpret the premises in (162)/(163a) is as in (165), where the modal bases of both conditionals are chosen to be anaphorically dependent on the context referents that represent the directly preceding discourse, F and G, respectively. Yet, since as we have seen the truth of the first conditional is dependent on the additional assumption that Hoover's being born a Russian goes along with him not being head of the FBI, and that he can only be judged a traitor on the counterfactual assumption that he is a communist, it follows that if we are considering contexts H where he is head of the FBI, we cannot derive that *relative to* H, if he were a Russian, he would be a traitor. So, revision to, or counterfactual assumption of a context that makes the second conditional true produces at the same time a context in which the first one cannot be true.

So it turns out that the failure of transitivity with examples like (162) is not necessarily tied to the nonmonotonicity or variability of conditionals, as claimed by Lewis, but can be accounted for on the basis of a *context dependent* analysis of conditionals, in the spirit of Kratzer's notion of *relative modality.*

(165)

$$\boxed{\begin{array}{l}
\mathrm{F\ G\ H\ I} \\
\mathrm{F} :: \boxed{\begin{array}{l} \mathrm{x} \\ \text{J.Edgar-Hoover(x)} \\ \textit{american(x)} \\ \textit{head–of–FBI(x)} \end{array}} \\
\mathrm{G} :: \mathrm{F} + \boxed{\begin{array}{l} \mathrm{G'\ G''\ X'} \\ \mathrm{X'} \subseteq \mathrm{F} \\ \mathrm{G'} :: \mathrm{X'} + \boxed{\text{russian(x)}} \Rightarrow \mathrm{G''} :: \mathrm{G'} + \boxed{\begin{array}{l} \neg\ \textit{american(x)} \\ \neg\ \textit{head-of-FBI(x)} \\ \text{communist(x)} \end{array}} \end{array}} \\
\mathrm{H} :: \mathrm{G} + \boxed{\begin{array}{l} \mathrm{H'\ H''\ X''} \\ \mathrm{X''} \subseteq \mathrm{G} \\ \mathrm{H'} :: \mathrm{X''} + \boxed{\begin{array}{l} \textit{head-of-FBI(x)} \\ \text{communist(x)} \end{array}} \Rightarrow \mathrm{H''} :: \mathrm{H'} + \boxed{\text{traitor(x)}} \end{array}} \\
\mathrm{I} :: \mathrm{H} + \boxed{\begin{array}{l} \mathrm{I'\ I''\ X'''} \\ \mathrm{X'''} \subseteq \mathrm{H} \\ \mathrm{I'} :: \mathrm{X'''} + \boxed{\text{russian(x)}} \not\Rightarrow \mathrm{I''} :: \mathrm{I'} + \boxed{\text{traitor(x)}} \end{array}}
\end{array}}$$

Another example that was raised by Lewis in order to substantiate that the non–transitivity of counterfactuals can be accounted for in terms of the analysis of counterfactual variability by means of a sphere system was (166a) (see Section 2.2.2).

The argument went as follows: we cannot conclude, as in (166a), that *if Otto had gone, then Waldo would have gone*, since: "The fact is that Otto is Waldo's successful rival for Anna's affections. Waldo still tags around after Anna, but never runs the risk of meeting Otto. Otto was locked up at the time of the party, so that his going to it is a far–fetched supposition; but Anna almost did go. Then the premises are true and the conclusion false." (Lewis(1973:32f)).

But, as we argued in Section 2.2.2, on a context dependent analysis of conditionals, if the additional assumption that "[Waldo] never runs the risk of meeting Otto" is taken into account as an additional premise, as in (166b), then we cannot derive the conclusion that *if Otto had gone, then Waldo would have gone.* On the basis of the first premise in (166b) the third conditional can only be judged true if the antecedent is further restricted as in (166b), and thus, the argument scheme is not an instance of *transitivity.*

(166) a. If Otto had gone to the party, then Anna would have gone.
If Anna had gone, then Waldo would have gone.
Therefore, If Otto had gone, then Waldo would have gone. Lewis(1973:32)

b. If Anna goes out with Otto, Waldo avoids him.
If Otto had gone to the party, then Anna would have gone.
If Anna had gone, *but not Otto*, then Waldo would have gone.
$\not\vdash$ If Otto had gone, then Waldo would have gone.

We did not yet explain how in our analysis of conditionals we will account for (nonmonotonic) reasoning with conditionals, as e.g. with argument schemata like (166a), which seem to satisfy *Transitivity.* The main point we wanted to make at this point is that the classical examples of "counterfactual fallacies" can be accounted for by a *context dependent* analysis of conditionals, without resorting to the notion of vagueness or variability of conditionals.

5.3.3 Conditional nonmonotonic reasoning and the dynamics of discourse

Our objective in this last Section is to investigate whether our *context dependent* and *dynamic* analysis of (variably strict) conditionals can be extended to account for the interpretation of (sequences of) generic senences. And, moreover, we will investigate whether the use that we have made, in the analysis of variably strict *conflicting* conditionals, of the SPECIFICITY and VARIABILITY constraints on the normalcy selection function * to account for conflicting "defaults", will also account for basic schemata of nonmonotonic reasoning with generic sentences.

The ideas we are developing here are crucially relying on the results of Section 5.2.3, where – in an informal way – we undertook a comparison between two theories of nonmonotonic reasoning: Commonsense Entailment and Conditional Default Reasoning.

First let us consider some data, to find out whether the observations we made for sequences of increasingly vs. decreasingly strict conditionals carry over to corresponding sequences of generic sentences. Given the close correspondences we observed, in Section 5.2.2, between these two sentence types, we should expect that they in fact do so.

But, apparently, the contrast between (167) and (168) seems to challenge this supposition: In (167) we restate the example of a sequence of *increasingly strict conflicting conditionals* used above, where we came up with an explanation for why it is odd to draw the conclusion that *If Otto comes, the party will be lively.* Now, the sequence of generics in (168) can surely be conceived of as a parallel example of *increasingly strict conflicting generics*, given the additional material implication that *(All) penguins are birds.* Yet, while it is odd, in (167), to conclude from the premises that *If Otto comes, the party will be lively*, we can, in (168), make the additional assumption that *Tweety is a bird* and draw the (defeasible) conclusion that *Tweety can fly.* Or, to make the parallelism more obvious, we can conclude defeasibly, from the first three premises in (168), that *if Tweety is a bird, Tweety can fly.*

(167) If Otto comes, the party will be lively.
But if Otto and Anna come, the party will be dreary.
But if Waldo comes as well, the party will be lively.
$|\approx$?? If Otto comes, the party will be lively.

	Birds can fly.	Birds can fly.
	Penguins are birds.	Penguins are birds.
(168)	Penguins cannot fly.	Penguins cannot fly.
	Tweety is a bird.	
	$\mid\approx$ Tweety can fly.	$\mid\approx$ If Tweety is a bird, he can fly.

On the other hand, when considering parallel examples involving *decreasingly strict conflicting conditionals* and *generics*, such as (169) and (170), we observe that it is rather odd, in (170), to state that *Birds can fly* in the context of the first premise, which tells us that *Penguins (which are birds) cannot fly.* In this respect, sequences of *decreasingly strict generics* with conflicting consequents exactly pattern with *decreasingly strict conditionals* with conflicting consequents. However, we presume that – *if*, in fact, we accept the utterance of *Birds can fly* in (170), on a specific interpretation where we quantify over non–penguin birds only – it is possible to draw the defeasible conclusion *If Tweety is a bird, he can fly.*

(169) If Otto, Anna and Waldo come, the party will be lively.
?? But if Otto and Anna come, the party will be dreary.
?? But if Otto comes, the party will be lively.
Otto will come.
$\mid\approx$?? The party will be lively.

	Penguins cannot fly.	Penguins cannot fly.
	Penguins are birds.	Penguins are birds.
(170)	?? Birds can fly.	?? Birds can fly.
	Tweety is a bird.	
	$\mid\approx$ Tweety can fly.	$\mid\approx$ If Tweety is a bird, he can fly.

Thus, while conditionals and generics seem to behave similarly with respect to the acceptability of sequences involving increasingly vs. decreasingly strict restrictive clauses and conflicting consequents, there is a difference as regards possible (defeasible) conclusions relative to such sequences. Our conjecture – to be substantiated below – is that the first aspect, on which generics pattern with conditionals, is predicted by a dynamic, context dependent interpretation of generic sentences, which directly follows the model of our analysis of variably strict conditionals in context, in Section 5.3.1.

The second aspect, in which they differ – the defeasible truth of the conditional conclusion in (168) vs. (167) and (170) vs. (169) – is predicted by the pragmatic condition, established in Section 5.3.1, that for any newly asserted conditional – or generic sentence, for that matter – we have to assume that the normalcy restriction for the respective antecendent clause is in accordance with SPECIFICITY.

This latter point is best explained by considering (preliminary) DRSs for the two cases, (171) and (172): In (171) the defeasible conclusion is represented in terms of a vague conditional, which is contextually dependent on the context I established by the premises. Note that the antecedent DRS $K'_{j'}$ of the conditional structure annotated by J' is *less strict* than the antecedents K'' and K''' of the preceding *conflicting* conditionals. Now, the initial SPECIFICITY assumption for situations K' where Otto comes is defeated in virtue of the more specific, conflicting conditionals: As we saw in Section 5.3.1, by repeated refinements of normalcy assumptions we end up in a context where the pragmatic SPECIFICITY constraint is by necessity violated for the last conditional.[79]

(171) If Otto comes, the party will be lively.
But if Otto and Anna come, the party will be dreary.
But if Waldo comes as well, the party will be lively.
$\approx$?? If Otto comes, the party will be lively.

F G G* H H* I J

F :: $\boxed{\begin{array}{l} o\ a\ w\ p \\ otto(o)\quad anna(a)\quad waldo(w)\quad party(p) \end{array}}$

G :: F + G′ :: F + $\boxed{\text{come(o)}}$ ⇒ G″ :: G′ + $\boxed{\text{lively(p)}}$

H :: G* + H′ :: G* + $\boxed{\begin{array}{c}\text{come(o)}\\ \text{come(a)}\end{array}}$ ⇒ H″ :: H′ + $\boxed{\neg\ \text{lively(p)}}$

I :: H* + I′ :: H* + $\boxed{\begin{array}{c}\text{come(o)}\\ \text{come(a)}\\ \text{come(w)}\end{array}}$ ⇒ I″ :: I′ + $\boxed{\text{lively(p)}}$

J :: I + J′ :: I + $\boxed{\text{come(o)}}$ ⇒ J″ :: J′ + $\boxed{\text{lively(p)}}$

In (172), in the spirit of Commonsense Entailment, generic sentences are represented as vague conditionals where, e.g. in the first structure, the quantification ranges over situations where *everything holds that is normally the case, in w, relative to a context F where there is some object x that is a bird.* And – as we will explain in more detail below – the following *conflicting* generic sentence *Penguins cannot fly* will lead to revision, or refinement of normalcy assumptions in much the same way as for increasingly strict conflicting conditionals. Thus, our dynamic analysis for sequences of conditional (or generic) structures will define an updated context I where the normalcy restrictions for K' (*birds*) are refined to respect the conflicting information about what is normally the case for *penguins*, which are birds.

Now, though equally dependent on a context involving increasingly strict conflicting defaults, the last conditional in (172) receives a sound interpretation, as opposed to the last conditional in (171): The antecedent of the vague conditional in J, $K'_{j'}$, differs from the antecedent K' constructed for the generic *birds can fly*, in that the predicate *bird* applies, not to an arbitrary object x, but to the reference marker t representing a particular individual called Tweety. Thus, since the antecedent DRS $K'_{j'}$ is stricter than is K', it is predicted that the conditional *If Tweety is a bird, he can fly* will satisfies the SPECIFICITY constraint, irrespective from the fact that within the previous context the normalcy assumptions for the more *general* concept K' (*birds*) have been revised.

[79]In the following, we will still further reduce the DRS representations by omitting the declaration of the context referents for conditional structures (i.e. those for the anaphoric modal base and the annotating referents of restrictor and scope) in the universe of the DRSs.

Moreover, we will not display the successive revision process that we argued is at stake in the interpretation of such sequences, and which we assume to carry over to the case of sequences of conflicting generic sentences. That some such revision process is assumed will only be reflected by the use of context referents G^*, H^*, etc., where "*" is to indicate that, e.g., G^* results from G by context reduction: $G^* \subseteq G$.

(172) Birds can fly.
Penguins are birds.
Penguins cannot fly.
$|\approx$ If Tweety is a bird, he can fly.

F G G* H H* I J
F :: $\boxed{\text{t} \quad \text{Tweety(t)}}$
G :: F + $\boxed{\text{G}' :: \text{F} + \boxed{\begin{array}{l}\text{x}\\ \text{bird(x)}\end{array}} \Rightarrow \text{G}'' :: \text{G}' + \boxed{\text{can-fly(x)}}}$
H :: G* + $\boxed{\boxed{\begin{array}{l}\text{y}\\ \text{penguin(y)}\end{array}} \rightarrow \boxed{\text{bird(y)}}}$
I :: H* + $\boxed{\text{I}' :: \text{H} + \boxed{\begin{array}{l}\text{z}\\ \text{penguin(z)}\end{array}} \Rightarrow \text{I}'' :: \text{I}' + \boxed{\neg\ \text{can-fly(z)}}}$
J :: I + $\boxed{\text{J}' :: \text{I} + \boxed{\text{bird(t)}} \Rightarrow \text{J}'' :: \text{J}' + \boxed{\text{can-fly(t)}}}$

This – still quite sketchy – explanation of the differences between the data observed for conditionals and generics in (171) and (172) (and equally for (169) and the lefthand side of (170)) rests on the basic assumption – which is the backbone of Delgrande's theory of Conditional Default Reasoning – that nonmonotonic inference from a set of premises $\phi_1 \ldots \phi_n$ to a defeasible conclusion ψ is to be analyzed in terms of the vague conditional.

Note that the fourth premise within the left hand side argument pattern in (168) shows up, in the right hand side argument pattern in (168), as the *antecedent* of the vague conditional, and the conclusion of the lefthand side argument pattern instantiates the scope of this conditional. Since in our analysis the interpretation of conditionals is *context sensitive*, evaluation of the conditional in the righthand side argument pattern as being *relative* to the set of premises can thus be viewed as a natural implementation of a default inference from the set of premises $\phi_1 \ldots \phi_3$ (and further assumption of ϕ_4) to the conclusion ψ.

Within our analysis of modally quantified structures the two alternative inference patterns in (168) can be represented in terms of the schematic DRS representations in (173):

For the first pattern, we represent the premises $\phi_1 \ldots \phi_4$ by way of subsequent update conditions, which define a context referent J.[80] The nonmonotonic inference relation $\phi_1 \ldots \phi_4 \mid\approx \psi$, which is to support that – given the set of premises, and by assumption of maximal normality – we can (defeasibly) infer that *Tweety can fly*, is represented in terms of the final conditional structure, with empty antecedent DRS, but which is marked as contextually dependent on the antecedent context J established by the premise set.

The schematic DRS in (173b) directly corresponds to the second argument pattern in (168), in that the premises $\phi_1 \ldots \phi_3$ are represented to define a context I in terms of subsequent update conditions, and where the nonmonotonic inference relation is again established in terms of a vague conditional, anaphorically related to the referent I that represents the informational content conveyed by the premise set. Yet here, given the slightly distinct structure of the righthand side argument in (168), the equivalent of the final premise in (173a), expressing that Tweety is a bird, is represented to fill the antecedent DRS of the

[80]For the moment, we ignore the additional complication of potential revision of the underlying evaluation context in terms of reduction relations on G, H, etc.

conditional structure that is to implement the nonmonotonic inference relation: What it states is, roughly, that – on the basis of the informational content I conveyed by the premises $\phi_1 \ldots \phi_3$, and under assumption of maximal normality – if Tweety is a bird, he can fly.

Since in our analysis of the vague conditional the quantification is constrained to range over a set of "normal" worlds, defined in terms of a *context dependent* normalcy selection function * – where the second, context–type argument is instantiated by the context denoted by the modal base X', updated with the conditional's antecedent K', and where * is restricted to observe FACTICITY (see (146)) – the two argument schemata in (173a–b) differ *only* in one particular respect: That *Tweety is a bird* is determined to be true within the context established by the premise set in (173a), while this is hypothetically assumed to be so in (173b), just as it is conveyed by the original argument patterns in (168). Yet, the normalcy restriction defined by the conditional antecedent is identical for (173a–b) as regards its second, context–type argument. In both cases it will denote a context where the premises $\phi_1 \ldots \phi_4$ are true.

On the basis of these observations we assume, as a first approximization, that the nonmonotonic inference relation $|\!\approx$ can be modelled, in our framework, in terms of truth of the *context dependent* vague conditional: We can defeasibly infer ψ from a set of premises $\phi_1 \ldots \phi_n$ iff *relative to* a context (referent) C_n set up by the premises $\phi_1 \ldots \phi_n$ we can verify a conditional that takes (a representation for) ψ in its scope.

(173) a. $\phi_1, \phi_2, \phi_3, \phi_4 \;|\!\approx \psi$

$$\begin{array}{|l|}\hline \mathrm{F\ G\ H\ I\ J\ L} \\ \mathrm{G} :: \mathrm{F} + \boxed{\phi_1} \\ \mathrm{H} :: \mathrm{G} + \boxed{\phi_2} \\ \mathrm{I} :: \mathrm{H} + \boxed{\phi_3} \\ \mathrm{J} :: \mathrm{I} + \boxed{\phi_4} \\ \mathrm{L} :: \mathrm{J} + \boxed{\mathrm{L}' :: \mathrm{J} + \boxed{} \;\Rightarrow\; \mathrm{L}'' :: \mathrm{L}' + \boxed{\psi}} \\ \hline \end{array}$$

b. $\phi_1, \phi_2, \phi_3 \;|\!\approx \phi_4 \Rightarrow \psi$

$$\begin{array}{|l|}\hline \mathrm{F\ G\ H\ J} \\ \mathrm{G} :: \mathrm{F} + \boxed{\phi_1} \\ \mathrm{H} :: \mathrm{G} + \boxed{\phi_2} \\ \mathrm{I} :: \mathrm{H} + \boxed{\phi_3} \\ \mathrm{J} :: \mathrm{I} + \boxed{\mathrm{J}' :: \mathrm{I} + \boxed{\;\phi_4\;} \;\Rightarrow\; \mathrm{J}'' :: \mathrm{J}' + \boxed{\psi}} \\ \hline \end{array}$$

In particular the representation in (173a) is reminiscent of the informal description of nonmonotonic inference in Commonsense Entailment, restated below, if we assume the "initial" context referent F to correspond to Morreau's *informationally minimal state* $\odot$:

Assuming the premises in question, and no more than that is then modelled in terms of stepwise update of F with the (representations for) the premises $\phi_1 \ldots \phi_n$. Assuming – in the second step (see below) – that the individuals that are introduced within the premise set are *as normal as is consistent with whatever assumptions are currently being made about them* is represented, in (173a), by anaphoric reference of the conditional structure's modal base to the context referent J that represents the premise set: Due to the context dependent normalcy restriction that is built into the verification condition for modally quantified structures, the quantificational domain of this conditional structure is restricted to a set of worlds (states) where "everything holds that is normally the case, relative to the evaluation world w, in the context denoted by J". Finally, the third step corresponds to establishing, for each state in the quantificational domain, whether it verifies the conditional's scope, i.e., establishing whether the conditional that has the (representation of) the defeasible conclusion for its scope is true relative to the context established by the premises.

- Firstly, you assume the premises in question, and no more than that.
- Secondly, you assume that individuals are normal representatives of various kinds, if this is doxastically consistent. That is, you strenghten your assumptions by assuming that individuals are as normal as is consistent with whatever assumptions are currently being made about them.
- Thirdly, you check whether you are forced to assume the conclusion in question.

Morreau(1992:105)

Yet, besides this overall similarity, the particular implementation of the *normalcy assumption* is quite different from what is done in Commonsense Entailment: While the DRS representation in (173a) characterizes a *conditional* approach to nonmonotonic reasoning, from a set of premises $\phi_1 \ldots \phi_n$ to a (defeasible) conclusion ψ, Commonsense Entailment assumes a specific *normalization process*, which Morreau explicitly sets apart from, i.e. conceives of as being independent of the (normalcy–restricted) conditional.

COMMONSENSE ENTAILMENT, repeated below in (174), is defined in terms of quantification over fixed points of P–normalization chains. It is based upon the construction of a set P_Γ, which, roughly, consists of those premises $\phi(d)$ out of the premise set Γ for which there is an occurrence of a generic or conditional $\phi(x) > \psi$ in Γ. Based on this set P_Γ, chains of normalization are defined, by iterative application of normalization $s^{\alpha+1} := \underline{N}(s^\alpha, p_i)$, for some serialization $p_1, \ldots, p_n$, where $p_1 \ldots p_n \in P_\Gamma$. Any such chain of normalization C, depending on the particular serialization imposed upon the set P_Γ, gives rise to a fixed point $\textsc{fix}$(C), where $s^{\alpha+1} = s^\alpha$ (see Section 5.2.3 for detail).

(174) COMMONSENSE ENTAILMENT: A&M(1995:323)

$\Gamma \mid\approx_P \phi$ iff for any P–normalization chain C beginning from $\odot + \Gamma$:

$\mathcal{A}_{can}$, $\textsc{fix}(\mathrm{C}) \models \phi$

In our discussion of Commonsense Entailment and Conditional Default Reasoning in Section 5.2.3 we expressed our hope that it should be possible, by adopting further constraints on the normalcy selection function * (such as our (TRANSITIVE) NIXON DIAMOND, SPECIFICITY, SPECIFICITY II, etc.), to come up with a refined version of Commonsense Entailment (175), where P–normalization always results in a *single* fixed point, in other words, that the serialization imposed on P_Γ makes no difference to the fixed point one obtains. We argued that by way of this modification the process of *normalization* comes down to repeated application of *Defeasible Modus Ponens* to the premise set Γ.

(175) COMMONSENSE ENTAILMENT: (modified version)
$\Gamma \mid\!\approx_P \phi$ iff $\mathcal{A}_{can}$, $\textsc{fix}(\text{C}) \models \phi$,
where $\textsc{fix}(\text{C})$ the fixed point of the P–normalization chain C beginning from $\odot + \Gamma$.

Now, taking for granted that it is a reasonable and successful enterprise to impose formal constraints upon the normalcy selection function * to account for various patterns of non-monotonic inference patterns – such as the *Nixon Diamond*, the *(Weak) Penguin Principle*, and *Defeasible Transitivity* – in terms of a *single* fixed point of normalization, the divergence between the respective implementations of the *normality assumption* in Commonsense Entailment and our – still informal – proposal sketched in (173a) becomes a minor issue.

If the normality assumption of Commonsense Entailment can be reduced to (order–insensitive) application of the normalization function $\underline{N}(s,p)$ to the premise set $\odot + \Gamma$, for every $p \in P_\Gamma$ (where p is non–quantificational), $\Gamma \mid\!\approx_P \psi$ should turn out to be equivalent to the evaluation of a context dependent conditional $J' :: I + K' \Rightarrow J'' :: J' + \psi$, where I is a context referent that represents the informational content $\odot + \Gamma$, and K' either a DRS corresponding to the premise set P_Γ, or else the empty DRS (given that in our analysis the normalcy restriction of conditionals is context sensitive, in taking into account the context denoted by the modal base).

Based on these preliminary observations we now try to sketch a *conditional* approach to nonmonotonic inference that follows the general scheme outlined in (173a), as opposed to the normalization process assumed in Commonsense Entailment.

To this end we will have to impose additional constraints on the *context dependent* normalcy selection function * (defined in Section 5.2.4, p. 349), in order to account for various nonmonotonic inference patterns involving conflicting defaults that, in Commonsense Entailment, lead to *distinct* fixed points of normalization.

The main idea is that, following the model of our *dynamic* analysis of *conditional variability*, we can define repeated "refinements" of normalcy assumptions in response to conflicting defaults within the premise set. This will have to be achieved by imposing refined VARIABILITY constraints on the normalcy selection function. This dynamic interpretation process roughly corresponds to what is done, in Commonsense Entailment, by way of an independent mechanism of *normalization* on the basis of the premises of an argument. And, since we further try to set up constraints on * that yield a single fixed point of normalization, this will lead us a to *conditional approach* to defeasible inference.

Let us first give an outline of CONDITIONAL NONMONOTONIC INFERENCE that closely follows the (informal) characterization of Commonsense Entailment (see above p. 375), yet adapted to our DRT framework.

- First, construct a DRS K_0 from the premises $\phi_1, ..., \phi_n$ in terms of subsequent update conditions on context referents with DRSs $K_1 \ldots K_n$ constructed for $\phi_1, ..., \phi_n$, starting out from the *empty* or *informationally minimal* context referent C_0 (to be defined below).
- Extend K_0 to a DRS K by introducing a further update condition $C_{n+1} :: C_n + K_{n+1}$, where K_{n+1} contains a conditional structure $C'_{n+1} :: C_n + K' \Rightarrow C''_{n+1} :: C'_{n+1} + K^+$, where K' is the empty DRS, where K^+ is the

representation of the (defeasible) conclusion ψ, and where C_n represents the content conveyed by the premise set, i.e., C_n is the $\ll$–largest context referent in the universe of K_0.[81]
Given our definition of the context dependent and vague conditional, the contextual restriction of the conditional to the modal base C_n corresponds to *assuming that individuals (introduced in the premise set) are as normal as is consistent with whatever assumptions are currently made about them.*

- The semantics of the vague conditional $C'_{n+1} :: C_n + K' \Rightarrow C''_{n+1} :: C'_{n+1} + K^+$ implements CONDITIONAL NONMONOTONIC INFERENCE:
  K^+ *follows defeasibly* from C_n in K iff the condition $C'_{n+1} :: C_n + K' \Rightarrow C''_{n+1} :: C'_{n+1} + K^+ \in Con_{K_{n+1}}$ is verified for every state denoted by C_{n+1}.

In order to carry this through, we first have to define a notion of verification for DRSs, *verifies**, that accounts for the fact that in case of conflicting defaults we have to induce *revision* of the underlying evaluation context. As we already noted in Section 5.3.1, revision of an antecedent context G – in terms of a reduction condition $G^* \subseteq G$, where G^* instantiates the "input" referent for a subsequent conflicting conditional or generic sentence – will necessarily result in a new "output"referent H^* of the update condition for this new sentence that determines a context set $cs(e(H^*))$ that is *distinct* from the context set $cs(e(G))$ determined by G. This new notion of *verification** must ensure that the *verifying** embedding function e of K constrains the denotations of the annotating, or "output" context referents $C_1 \ldots C_n$ of the subsequent update conditions – which potentially determine *revised*, i.e., distinct context sets – in such a way that they are nevertheless appropriately related according the VARIABILITY constraint (158), and also satisfy the SPECIFICITY constraint (154) (see (176i)). We then require, in (176ii), that the final update condition $C_n :: C_{n-1} + K_n$ is verified relative to a state $\langle w, e\rangle$, where $w \in W$, or – equivalently – that there is some $\langle w, e\rangle$, $w \in W$, such that w is contained in the context set that is determined by the $\ll$–largest context referent C_n in the universe of K (see Section 3.3 for definition of $\ll$).

(176) Let K be a DRS as below, with update conditions on context referents C'_i, where $i = 0 \ldots$ n$-$1, and
where $C'_i = C_i$ or $C'_i = C^*_i$, in which case K contains a reduction conditon $C^*_i \subseteq C_i$.

$$\boxed{\begin{array}{l} \mathrm{C}_0\ \mathrm{C}'_1\ \mathrm{C}'_2 \ldots \mathrm{C}'_{n-1}\ \mathrm{C}_n \\ \hline \mathrm{C}_1 :: \mathrm{C}_0 + \boxed{K_1} \\ \mathrm{C}_2 :: \mathrm{C}'_1 + \boxed{K_2} \\ \ldots \\ \mathrm{C}_n :: \mathrm{C}'_{n-1} + \boxed{K_n} \end{array}}$$

A wellfounded embedding function e *verifies** K in M iff
(i) for all i = 0 ... n$-$1: $e(C_i)$ and $e(C_{i+1})$ are related in accordance with the principles stated by VARIABILITY (159) and SPECIFICITY (154), and
(ii) there is some pair $\langle w, e\rangle$, where $w \in W$, such that $w \in cs(e(C_n))$.

[81] Cf. Section 3.3 for defintion of the relation $\ll$ on context referents.

(175) can now be restated in more formal terms in (177), where we also define the notion of a *minimal information state* in terms of the “empty” context $\mathbf{\Lambda}$:

(177) CONDITIONAL NONMONOTONIC INFERENCE:

a. Let Λ be a distinguished context referent that denotes the *minimal information state* $\mathbf{\Lambda}$:

For every model M as defined in (50) of Section 3.3, with W a nonempty set of possible worlds,
$\mathbf{\Lambda} = \{\langle w', \lambda\rangle : w' \in W\}$, where λ is the empty function.

b. Let a sequence of premises $\phi_1, ..., \phi_n$ be represented by a DRS K as below, with update conditions on context referents C'_i, where $i = 0 \ldots \mathrm{n}{-}1$, for DRSs $K_1, \ldots, K_n$ constructed for $\phi_1, ..., \phi_n$, starting out with the distinguished *minimal* context referent $C'_0 = \Lambda$, and where $C'_i = C_i$ or $C'_i = C^*_i$, in which case K contains a reduction conditon $C^*_i \subseteq C_i$.

$$\boxed{\begin{array}{l} \Lambda\ \mathrm{C}'_1\ \mathrm{C}'_2 \ldots \mathrm{C}'_{n-1}\ \mathrm{C}_n \\ \mathrm{C}_1 :: \Lambda + \boxed{K_1} \\ \mathrm{C}_2 :: \mathrm{C}'_1 + \boxed{K_2} \\ \ldots \\ \mathrm{C}_n :: \mathrm{C}'_{n-1} + \boxed{K_n} \end{array}}$$

c. Extend K_0 to a DRS K as below, where K' is the empty DRS and K^+ is the representation for the defeasible conclusion ψ:

$$\boxed{\begin{array}{l} \Lambda\ \mathrm{C}'_1\ \mathrm{C}'_2 \ldots \mathrm{C}'_{n-1}\ \mathrm{C}_n\ \mathrm{C}_{n+1} \\ \mathrm{C}_1 :: \Lambda + \boxed{K_1} \\ \mathrm{C}_2 :: \mathrm{C}'_1 + \boxed{K_2} \\ \ldots \\ \mathrm{C}_n :: \mathrm{C}'_{n-1} + \boxed{K_n} \\ \mathrm{C}_{n+1} :: \mathrm{C}_n + \boxed{\begin{array}{l} \mathrm{C}^1_{n+1}\ \mathrm{C}^2_{n+1} \\ \mathrm{C}^1_{n+1} :: \mathrm{C}_n + \boxed{\ K'\ } \Rightarrow \mathrm{C}^2_{n+1} :: \mathrm{C}^1_{n+1} + \boxed{K^+} \end{array}} \end{array}}$$

d. K^+ *follows defeasibly* from K ($K \mid\!\approx K^+$) iff

for every M and e such that e *verifies** K in M

if $\exists\langle w', c_n\rangle \in e(C_n)$ then

$\exists\langle w', c_{n+1}\rangle \in e(C_{n+1}) : \langle w', c_{n+1}\rangle \models_M \mathrm{C}^1_{n+1} :: \mathrm{C}_n + \boxed{\ K'\ } \Rightarrow \mathrm{C}^2_{n+1} :: \mathrm{C}^1_{n+1} + \boxed{K^+}$

(where K' the empty DRS and K^+ the representation for the defeasible conclusion ψ).

As a result of our discussion of Commonsense Entailment and Conditional Default Reasoning in Section 5.2.3 we had identified various (alternative) constraints on * to account for nonmonotonic inference patterns involving conflicting defaults, while being based on a *single* fixed point of normalization: SPECIFICITY II for the *Penguin Principle*, SPECIFICITY for the *Weak Penguin Principle*, as well as (TRANSITIVE) DIAMOND for the *Nixon Diamond* and *Defeasible Transitivity.*

We will now investigate a conditional approach to nonmonotonic reasoning along the lines of (177), where we make use of our basic VARIABILITY constraint of Section 5.3.1 to "propagate" refined normalcy assumptions in response to conflicting defaults in a dynamic analysis of nonmonotonic inference patterns.

We will show that our original VARIABILITY constraint immediately accounts for *Defeasible Modus Ponens, Irrelevance* and the *Penguin Principle*, and – based on the results of Section 5.2.3 – propose a minor modification of it, VARIABILITY I (178i), that also accounts for the *Weak Penguin Principle.* For the *Nixon Diamond* and *Defeasible Transitivity* we introduce a variation of (178i), VARIABILITY II (178ii). Finally, VARIABILITY III (178iii) implements the "default case".

(178) VARIABILITY:
Let $\mathbf{X_1}, \mathbf{K}', \mathbf{X_2}, \mathbf{K}'', \mathbf{G}$ and $\mathbf{H}^*$ be sets of world–function pairs.
If $\langle w, g\rangle \in \mathbf{G}$ and $\langle w', h^*\rangle \in \mathbf{H}^*$, and $cs(\mathbf{X_2}) \subseteq cs(\mathbf{X_1})$, then

i. VARIABILITY I:
if $cs(\mathbf{X_2} +^\bullet \mathbf{K}'') \subseteq cs(\mathbf{X_1} +^\bullet \mathbf{K}') \vee *(w', \mathbf{X_2} +^\bullet \mathbf{K}'') \subseteq cs(\mathbf{K}')$, and
$\forall\langle w, g\rangle \in \mathbf{G}\ \forall\langle w', h^*\rangle \in \mathbf{H}^*$: $*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap *(w', \mathbf{X_2} +^\bullet \mathbf{K}'') = \emptyset$,
then $\forall\langle w', h^*\rangle \in \mathbf{H}^*\ \exists\langle w, g\rangle \in \mathbf{G}$:
$*(w', \mathbf{X_2} +^\bullet \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}') \setminus (*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap cs(\mathbf{K}''))$;

ii. VARIABILITY II:
if $cs(\mathbf{X_2} +^\bullet \mathbf{K}'') \not\subseteq cs(\mathbf{X_1} +^\bullet \mathbf{K}')$ and
$\forall\langle w, g\rangle \in \mathbf{G}\ \forall\langle w', h^*\rangle \in \mathbf{H}^*$: $*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap *(w', \mathbf{X_2} +^\bullet \mathbf{K}'') = \emptyset$,
then $\forall\langle w', h^*\rangle \in \mathbf{H}^*\ \exists\langle w, g\rangle \in \mathbf{G}$:
$*(w', \mathbf{X_2} +^\bullet \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}') \setminus (*(w, \mathbf{X_1} +^\bullet \mathbf{K}') \cap cs(\mathbf{K}''))$
and
$\forall\langle w', h^*\rangle \in \mathbf{H}^*\ \exists\langle w, g\rangle \in \mathbf{G}$:
$*(w', \mathbf{X_2} +^\bullet \mathbf{K}'') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}'') \setminus (*(w, \mathbf{X_1} +^\bullet \mathbf{K}'') \cap cs(\mathbf{K}'))$;

iii. VARIABILITY III:
otherwise, $\forall\langle w', h^*\rangle \in \mathbf{H}^*\ \exists\langle w, g\rangle \in \mathbf{G}$: $*(w', \mathbf{X_2} +^\bullet \mathbf{K}') \subseteq *(w, \mathbf{X_1} +^\bullet \mathbf{K}')$.

Defeasible modus ponens

Following the definition of nonmonotonic inference in (177), the inference pattern of *Defeasible Modus Ponens* in (179) is represented in terms of a DRS K where the premises determine – by subsequent update of the informationally minimal context referent Λ with DRSs $K_1 \ldots K_3$ that represent the premises – a context referent H. According to (177c) we introduce a further update condition, which introduces a conditional structure $I' :: H + K' \Rightarrow I'' :: I' + K^+$ that is to implement the conditional nonmonotonic inference from the premises $K_1 \ldots K_3$, or context referent H, to K^+, that *Leo is dangerous.*

Given that the *minimal* context referent Λ determines the set W of all possible worlds of the model M, by subsequent updates this set is reduced to a subset of worlds $cs(e(H))$ where only the premises are true. According to (177d) the final conditional structure implements the relation of *default inference* $K \mid\approx K^+$, in terms of universal quantification over "maximally normal worlds" where – in virtue of the modal base H – only the premises hold true, and which verify the scope DRS K^+.

(179) Lions are dangerous.
Leo is a lion.
$\mid\approx$ Leo is dangerous.

$$\boxed{\begin{array}{l} \Lambda\ \mathrm{F}\ \mathrm{G}\ \mathrm{H}\ \mathrm{I} \\ \mathrm{F} :: \Lambda + \boxed{\begin{array}{l} \mathrm{l} \\ \mathrm{Leo(l)} \end{array}} \\ \mathrm{G} :: \mathrm{F} + \boxed{\mathrm{G}' :: \mathrm{F} + \boxed{\begin{array}{c} \mathrm{x} \\ \mathrm{lion(x)} \end{array}} \Rightarrow \mathrm{G}'' :: \mathrm{G}' + \boxed{\mathrm{dangerous(x)}}} \\ \mathrm{H} :: \mathrm{G} + \boxed{\mathrm{lion(l)}} \\ \mathrm{I} :: \mathrm{H} + \boxed{\mathrm{I}' :: \mathrm{H} + \boxed{} \Rightarrow \mathrm{I}'' :: \mathrm{I}' + \boxed{\mathrm{dangerous(l)}}} \end{array}}$$

Let us go through the example in some detail. The meaning of the first generic sentence constrains the set of "normal worlds" $*(w', g(F + [x : lion(x)]))$, for $\langle w', g\rangle \in e(G)$ to be such that lions are dangerous: $*(w', g(F + [x : lion(x)])) \subseteq [\![dangerous(x)]\!]$. By SPECIFICITY (154) we derive that this normalcy assumption for lions carries over to any "instance" K'' of K', in which more information is given about x, as e.g. in $[x\ l : loin(x), leo(l), x = l]$. For in this case we have $cs([\![K'']\!]) \subseteq cs([\![K']\!])$ and thus, by SPECIFICITY, $*(w', g(F + K'')) \subseteq *(w', g(F + K'))$.

Given that this generic sentence is indicative – by analogy with indicative conditionals – we adopt the pragmatic constraint that the set of "normal worlds" must be chosen to contain the world of evaluation, as opposed to subjunctive conditionals or generics (see Stalnaker(1976)).[82] So we can conclude that the set of normal worlds determined by $*(w', g(F + K'))$ contains w'.

The next premise introduces the further information that the worlds in the extended context H are such that Leo is a lion. Learning that the worlds $w'' \in cs(e(H))$ are such that Leo is a lion does not conflict with the *specific normalcy* assumption for lion Leo $*(w', g(F + [: lion(l)]))$, which thus carries over, by VARIABILITY III, to $*(w'', h(G + [: lion(l)])$, for all $\langle w'', h\rangle \in e(H)$. The same holds true for the normalcy assumptions for lions in general: since there is no conflicting information stated within H, the normalcy assumptions for lions $*(w', g(F + [x : lion(x)]))$, for $\langle w', g\rangle \in e(G)$ carry over to $*(w', h(G + [x : lion(x)]))$, for every $\langle w'', h\rangle \in e(H)$ by VARIABILITY III.

The final conditional can then be verified relative to the antecedent context H established by the premises: since there is no conflicting information, the normalcy assumptions for lions in general and for lion Leo in particular carry over to the extended context I by VARIABILITY III, such that we can conclude that "if everything holds true that is normally the

[82] Recall that there are generic sentences in subjunctive mood that require a counterfactual interpretation, such as *Katzen würden Whiskas kaufen* (Cats would buy Whiskas) (see Sections 5.2.3 and 5.2.4).

case in context $e(H)$" we will find that lion Leo is dangerous: $*(w''', i(H)) \subseteq [\![dangerous(l)]\!]$, just as we would find that lions in general are dangerous.

By contrast, in (180) – an example of "*Defeat of Modus Ponens*" – due to the third premise, the normality assumptions $*(w'', h(G+K'))$ $(K' = [x : lion(x)])$ and $*(w'', h(G+K''))$ $(K'' = [: lion(l)])$, for $\langle w'', h\rangle \in e(H)$, which are to be computed as just outlined for (179), do not carry over to the extended context I.

(180) Lions are dangerous.
Leo is a lion.
Leo is not dangerous.
$\not\approx$ Leo is dangerous.

Λ F G H H* I J

F :: Λ + $\boxed{\text{l} \quad \text{Leo(l)}}$

G :: F + $\boxed{\text{G}' :: \text{F} + \boxed{\text{x} \quad \text{lion(x)}} \Rightarrow \text{G}'' :: \text{G}' + \boxed{\text{dangerous(x)}}}$

H :: G + $\boxed{\text{lion(l)}}$

I :: H* + $\boxed{\neg\ \text{dangerous(l)}}$

J :: I + $\boxed{\text{J}' :: \text{I} + \boxed{} \not\approx \text{J}'' :: \text{J}' + \boxed{\text{dangerous(l)}}}$

In contrast to (179), the third premise introduces new information about Leo that *defeats* the SPECIFICITY assumption (154) for lion Leo relative to lions in general.

Presupposing, as we do, that the sentence *Leo is not dangerous* is to interpreted as a generic statement about what is "normal" for Leo,[83] we get conflicting values for $*(w''', i(H + K''))$, for $\langle w''', i\rangle \in e(I)$ and $*(w'', h(G + K'))$, for $\langle w'', h\rangle \in e(H)$, since if this third premise is to be true, the set of "normal" worlds $*(w''', i(H + K''))$ must be worlds where Leo is not dangerous.

Given that the "new" normalcy assumptions for lion Leo are now conflicting with what was previously assumed by SPECIFICITY to hold true of Leo, we also deduce that this cannot come about without some minimal *revision* of the antecedent context G, to yield some revised context H^* that supports the truth of this new sentence, and thus provides some justification for the "revised" normalcy assumptions for lion Leo. Viewed from a different perspective, this also follows from of our constraints on sentence mood: In virtue of the first, indicative generic sentence the evaluation world(s) in $cs(e(G))$ and $cs(e(H))$ must be such that *if there is a lion, it is dangerous.* Thus, learning that there is some lion, namely Leo, who is not dangerous cannot, then, be true relative to these evaluation worlds, and the third premise cannot consistently update the antecedent context H.

Just as in cases of increasingly strict conflicting conditionals we investigated in Section 5.3.1 VARIABILITY I in (178) redefines the normality assumptions for lions in general, $*(w''', i(H^* + K'))$ for $\langle w''', i\rangle \in e(I)$, where lions are assumed to be dangerous, to be such

[83]See also Sections 5.2.2 and 5.2.3. Thus, *Leo is not dangerous* must itself be understood as a generic sentence, which yields normalcy assumptions $*(w''', i(H + K''))$, stating that under normal conditions Leo behaves in a non–dangerous way, while there may still be exceptional conditions where is suddenly shows dangerous behaviour. The DRS representation does not render this generic reading.

that they no longer contain worlds where Leo is a lion. Leo no longer is considered to be among the "normal" lions, which are dangerous.

And it is then obvious that we cannot derive, in virtue of the final conditional, relative to this (minimally revised) context I, that *Leo is dangerous*: Not only is this ruled out on the basis of the newly defined normalcy assumptions for Leo, which explicitly state him to be normally not dangerous, it is also precluded in terms of the revised normalcy assumptions for lions in general – which do not count Leo as among the universe of "normal lions" any more. K^+ does not follow *defeasibly* from I in K, since the final *vague* conditional, with consequent K^+, is not verified by every state $\langle w'''', j\rangle \in e(J)$.

Finally, note that it is also quite odd to conclude, instead, as in (181), that *Lions are dangerous.* And this is predicted by the analysis: As just outlined, we end up with a context I where the normalcy assumptions for lions in general are revised, to defeat SPECIFICITY with respect to lion Leo. The generic conclusion that *Lions are dangerous* therefore cannot satisfy SPECIFICITY. And this, we saw, does not yield a wellformed discourse.

To make a true statement in the given context we would rather have to say something like *But other lions are dangerous*, or *Normal lions are dangerous*; the first of these excludes Leo explicitly, while the second excludes him insofar as he has already been registered in the given context as not being a normal lion.

(181) Lions are dangerous.
Leo is a lion.
Leo is not dangerous.
$|\approx$?? Lions are dangerous.

The fact that the pragmatic wellformedness condition for conditionals in terms of SPECIFICITY predicts these differences in acceptability can be viewed as a further argument in support of the *conditional* approach to nonmonotonic reasoning.[84]

Irrelevance

We now turn to the inference pattern of *Irrelevance*, exemplified by (182), which Morreau(1992) argued to be problematic for a conditional account of nonmonotonic reasoning.

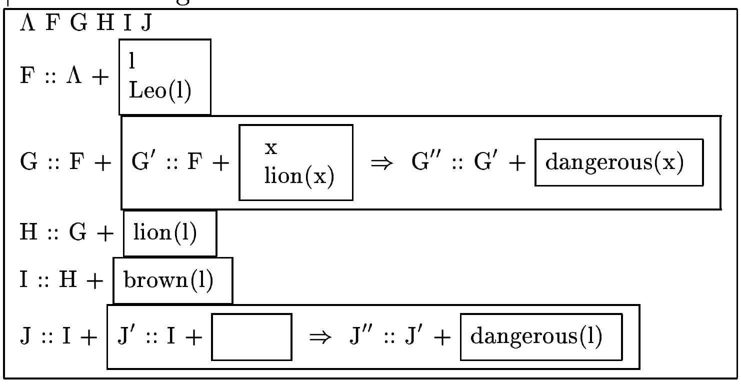
In (182) the normality assumptions for $K' = [x : lion(x)]$ relative to F, $*(w', g(F + K'))$, for $\langle w', g\rangle \in e(G)$ carry over to the extended context H by VARIABILITY III, as in the previous examples: $*(w'', h(G + K')) \subseteq [\![dangerous(x)]\!]$, for every $\langle w'', h\rangle \in e(H)$.

Recall that the set of "normal worlds" determined by the normalcy selection function is constrained to be chosen, for indicative generic sentences, from within the context set that characterizes the actual world. I.e. everything that holds true in the current context set must be assumed to hold true in the set of "normal worlds". Now, once we get, in context I, the new information K''' that *Leo is brown*, this then forces the normalcy selection function $*(w''', i(H + K''))$, for $K'' = [: lion(l)]$ and $\langle w''', i\rangle \in e(I)$, to yield a set of worlds that verify

[84] One might argue that this is even supported by the linguistic means that are generally used in discourse to indicate a relation of (nonmonotonic) inference. In natural language, the relation represented by $|\approx$ is verbalized by particles such as *therefore, thus, so*, and – most closely to the conditional – *then*, which serve to express a consequential relation holding between the set of premises and the conclusion.

the condition *brown(l)*.[85] It is now a matter of world knowledge, which we may assume to be reflected in the class of models that are taken into consideration in our evaluation of defeasible arguments, whether this new constraint on the normalcy assumptions for lion Leo, $*(w''', i(H + K''))$, is compatible with the normality assumptions for lions in general ($*(w'', h(G+K'))$), and the specific normality assumptions for lion Leo $*(w'', h(G+K''))$ in particular. At least our actual world is such that for lions, being brown is not inconsistent with being dangerous, and thus we could conclude that $*(w'', h(G + K')) \cap *(w''', i(H + K'')) \neq \emptyset$, and therefore derive, by VARIABILITY III, that not only the normalcy assumptions for lions relative to context H carry over to I: $*(w''', i(H + K')) \subseteq *(w'', h(G + K'))$; but furthermore, given the assumed compatibility of *lion(x)* & *dangerous(x)* with *brown(x)*, we would get that the normalcy assumptions for lion Leo are such that he can be still assumed to be dangerous: $*(w''', i(H + K'')) \subseteq *(w'', h(G + K''))$. The final conditional will then in fact license the *defeasible* conclusion, relative to the context established by the premise set in (182), that *Leo is dangerous.*

(182) Lions are dangerous.
Leo is a lion.
Leo is brown.
$|\approx$ Leo is dangerous.



Yet, everything depends, here, on whether the class of models taken into account will in fact provide us with this information, to wit, whether or not being brown is recognized to be compatible, for a lion, with being dangerous. If the class of models for nonmonotonic inference is restricted to those that reflect our world knowledge, this basic prerequisite will be fulfilled.

Nixon Diamond

We now turn to the inference pattern called the *Nixon Diamond*, for which we introduced the further condition VARIABILITY II in (178).

This condition is inspired by the definition of *contingent(ly) support(s)* in Delgrande's

[85] Contrasting with *Leo is dangerous*, we cannot assume a generic reading for *Leo is brown*, given that the predicate is static, while one may argue that *dangerous* can be understood/reinterpreted as episodic, as *behave in a dangerous way*. Thus, in contrast with *Leo is dangerous* in (180) and (181) we do not take *Leo is brown* to define, by itself, a normality assumption for Leo in terms of the normalcy selection function.

theory of Conditional Default Reasoning (see Section 5.2.3), which was shown to capture the *Nixon Diamond* in such a way that the result of the "*normalization process*" yields a *singleton* set $\mathcal{E}(C)$ of fixed points of normalization – therein contrasting with Commonsense Entailment.

VARIABILITY II applies in cases of *conflicting* normalcy assumptions $*(w, \mathbf{X_1} +^{\bullet} \mathbf{K}')$ relative world w and $*(w', \mathbf{X_2} +^{\bullet} \mathbf{K}'')$ relative to world w', with $\mathbf{X_2}$ an extension of $\mathbf{X_1}$, if $cs(\mathbf{X_2} +^{\bullet} \mathbf{K}'') \not\subseteq cs(\mathbf{X_1} +^{\bullet} \mathbf{K}')$ and $*(w, \mathbf{X_1} +^{\bullet} \mathbf{K}') \cap *(w', \mathbf{X_2} +^{\bullet} \mathbf{K}'') = \emptyset$. This is exactly the configuration we find in the pattern of the *Nixon Diamond.*

In (183) the discourse starts with a generic statement that reveals the normalcy assumptions for quakers $*(w', g(F + K'))$, for $K' = [x : quaker(x)]$, in context G to be such that every normal quaker is a pacifist: for every $\langle w', g\rangle \in e(G) : *(w', g(F+K')) \subseteq [\![pacifist(x)]\!]$. By assumption of SPECIFICITY we can derive normalcy assumptions $*(w, g(F + K_i'))$ for any more specific DRS K_i', i.e. for specific individuals that are quakers, such that they also are assumed to be pacifists.

By the second generic statement the normalcy assumptions for republicans $*(w'', h(G + K''))$ for $K'' = [x : republican(x)]$, in context H are settled to be such that that normal republicans are nonpacifists: for every $\langle w'', h\rangle \in e(H) : *(w'', h(G+K'')) \subseteq [\![\neg pacifist(x)]\!]$. If we were to conclude, by SPECIFICITY, that for any more specific instance K_j'' of K'' the normalcy assumptions for republicans in general carry over to those particular individuals, we get into a configuration of conflicting defaults – with respect to the normalcy assumptions for specific individuals that are quakers, $*(w', g(F + K_i'))$, and who are also republicans K_j'' – that corresponds to the configuration that is to be captured by VARIABILITY II: In particular, for any K_j'' such that $cs([\![K_j'']\!]) \cap cs([\![K_i']\!]) \neq \emptyset$ we have conflicting defaults as indicated by VARIABILITY II, since $*(w'', h(g + K_j'')) \cap *(w, g(F + K_i')) = \emptyset$.[86] Moreover, $G + K_j''$ and $G + K_i'$ do not stand in the relation of *extension* (or implication) to each other, such that, according to VARIABILITY II the normalcy assumptions for specific individuals that are both quakers and republicans, and thus constitute a conflict to be resolved, are to be redefined in such a way that for *them* the normalcy assumptions yield the empty set: they cannot be assumed to be satisfying any specific property that is characteristic, or *normal* for either quakers or republicans. Also, we will, as usual in case of conflicting defaults, be forced to induce some minimal revision of the underlying factual context. Thus, the normalcy assumptions for the problematic republican quakers will be computed such that $*(w'', h(G^* + K_i')) \subseteq *(w', g^*(F + K_i'))\backslash(*(w', g^*(F + K_i')) \cap cs([\![K_j'']\!])$, and $*(w'', h(G^* + K_j'')) \subseteq *(w', g^*(F + K_j''))\backslash(*(w', g^*(F + K_j'')) \cap cs([\![K_i']\!])$, for appropriate $\langle w', g^*\rangle \in e(G^*)$, G^* a reduction of G, and $\langle w'', h\rangle \in e(H)$.

Thus, by application of VARIABILITY II we end up, within the minimally revised context H with a characterization of what is considered to be normal for quakers and republicans, where, in view of their conflicting characteristics, we compute that there cannot be any specific, fully normal quakers that are also republicans, and also, that there are no specific republicans that are also quakers and that count as fully normal republicans in being nonpacifists. And this is the reason why we must, in fact, assume revision of the previous context G, where we could still *defeasibly* assume that quakers who are republicans are normal quakers, and thus pacifists.

[86]This does not mean that the second generic sentence should therefore be odd: here the defeat of the *specificity* assumption is in fact *induced* by this generic sentence. The cases we had considered before, where the defeat of SPECIFICITY resulted in pragmatically odd, or non–wellformed sentences was restricted to configurations where the defeat of *specificity* is already *defined* within the preceding piece of discourse.

(183) Quakers are pacifists.
Republicans are nonpacifists.
Dick is a Quaker.
Dick is a Republican.
$|\!\not\approx$ Dick is a pacifist.
$|\!\not\approx$ Dick is a nonpacifist.

Λ F G G* H I I* J L M
F :: Λ + [d | Dick(d)]
G :: F + [G′ :: F + [x | quaker(x)] ⇒ G″ :: G′ + [pacifist(x)]]
H :: G* + [H′ :: G* + [x | republican(x)] ⇒ H″ :: H′ + [¬ pacifist(x)]]
I :: H + [quaker(d)]
J :: I* + [republican(d)]
L :: J + [L′ :: J + [ ] ⇒ L″ :: L′ + [pacifist(d)]]
M :: L + [M′ :: L + [ ] ⇒ M″ :: M′ + [¬ pacifist(d)]]

The discourse now carries on by stating Dick to be a quaker. Within this extended context I the normalcy assumptions $*(w''', i(H + K'_d))$, for $K'_d = [d : quaker(d)]$ can be assumed to carry over (by VARIABILITY III) from the (refined) normalcy assumptions for quakers in general, $*(w'', h(G^* + K'))$ in H, which comes down to assuming defeasibly that Dick is a normal quaker, and thus pacifist, yet not a republican.

Finally, the next premise confronts us with another stumbling–block: We now get to know that Dick *is* a republican. Obviously, this must lead to the defeat of the normalcy assumption we just inferred for Dick as a quaker. This necessitates revision of I (by context reduction $I^* \subseteq I$). The conflict will again be resolved by application of VARIABILITY II, in such a way that the normalcy assumptions for Dick – both as a quaker and as a republican – are refined in such a way that he *cannot* be assumed to be a specific "instance" of a normal quaker or republican: $*(w'''', j(I^* + K''_d)) \subseteq (*(w''', i^*(H+K''_d)) \setminus *(w''', i^*(H+K''_d)) \cap cs([\![K'_d]\!])$, for $\langle w'''', j\rangle \in e(J)$ and $\langle w''', i^*\rangle \in e(I^*)$; and equally: $*(w'''', j(I^* + K'_d)) \subseteq (*(w''', i^*(H + K'_d)) \setminus *(w''', i^*(H + K'_d)) \cap cs([\![K''_d]\!])$, for $\langle w'''', j\rangle \in e(J)$ and $\langle w''', i^*\rangle \in e(I^*)$.

As a result, then, we cannot conclude, under normalcy assumptions, in terms of conditional structures, as indicated in (183), that Dick is a quaker or a republican. These conditionals can only be true vacuously, which – as we assume – does not allow for a natural interpretation in natural language. Thus, it is not possible to assume Dick to be a normal quaker, nor a normal republican, just because – in virtue of the second generic sentence in context of the first one – it was determined, via VARIABILITY II, that the sets of normal quakers and normal republicans must be disjoint.

Penguin Principle

The next pattern to consider is the *Penguin Principle* (184).

(184) Penguins are birds.
Birds can fly.
Penguins cannot fly.
Tweety is a penguin.
$\mid\!\approx$ Tweety cannot fly.
$\mid\!\not\approx$ Tweety can fly.

Λ F G H H* I J M

F :: Λ + $\boxed{\text{t} \quad \text{Tweety(t)}}$

G :: F + $\boxed{\boxed{\begin{array}{l}\text{x}\\ \text{penguin(x)}\end{array}} \rightarrow \boxed{\text{bird(x)}}}$

H :: G + $\boxed{\text{G}' :: \text{F} + \boxed{\begin{array}{l}\text{x}\\ \text{bird(x)}\end{array}} \Rightarrow \text{G}'' :: \text{G}' + \boxed{\text{can-fly(x)}}}$

I :: H* + $\boxed{\text{I}' :: \text{H}^* + \boxed{\begin{array}{l}\text{x}\\ \text{penguin(x)}\end{array}} \Rightarrow \text{I}'' :: \text{I}' + \boxed{\neg\ \text{can-fly(x)}}}$

J :: I + $\boxed{\text{penguin(t)}}$

L :: J + $\boxed{\text{L}' :: \text{J} + \boxed{\quad} \Rightarrow \text{L}'' :: \text{L}' + \boxed{\neg\ \text{can-fly(t)}}}$

M :: L + $\boxed{\text{M}' :: \text{L} + \boxed{\quad} \not\Rightarrow \text{M}'' :: \text{M}' + \boxed{\text{can-fly(t)}}}$

Interpretation of the first sentence constrains the set of worlds in the context set $cs(e(G))$ to satisfy that for every individual that is a penguin we also have that it is a bird. By the second sentence the normalcy assumptions for birds, $*(w'', h(G + K'))$, $K' = [x : bird(x)]$, for $\langle w'', h\rangle \in e(H)$ are such that every normal bird can fly. And this normalcy assumption defeasibly carries over, by SPECIFICITY, to the normalcy assumptions for penguins, which are a specific class of birds: $\forall\langle w'', h\rangle \in e(H) : *(w'', h(G + K'')) \subseteq [\![can - fly(x)]\!]$, for $K'' = [x : penguin(x)]$.

Now the third sentence, if true, explicitly constrains the normalcy assumptions for penguins, $*(w''', i(H + K''))$, for $\langle w''', i\rangle \in e(I)$ to be such that penguins do *not* fly: $\forall\langle w''', i\rangle \in e(I) : *(w''', i(H + K'')) \subseteq [\![\neg can - fly(x)]\!]$.

This is in conflict with the normality assumptions for penguins, which were defeasibly derived, by SPECIFICITY, within the preceding context H, and we see that we are driven into the very same kind of conflicting defaults that we were confronted with, in Section 5.3.1, when investigating sequences of *increasingly strict conflicting conditionals.*

For a coherent interpretation of the third (conflicting) premise relative to the antecedent context, we must assume minimal revision of the underlying evaluation context: While we were earlier going with the oversimplifying assumption that *any* bird can be assumed to be a "normal" bird, and thus, to be able to fly, we now have to adjust the evaluation context, to introduce enough background information about penguins, which then *justifies* the refined normality assumption for penguins, and also for birds. Assuming *minimal* revision, we argued, these refined normalcy assumptions are as defined by VARIABILITY I:

The normality assumptions for birds, $*(w''', i(H^* + K'))$, within the minimally revised context $e(I)$ are such that for every $\langle w''', i\rangle \in e(I)$ there is some $\langle w'', h^*\rangle \in e(H^*)$ such that $*(w''', i(H^* + K')) \subseteq *(w'', h^*(G + K')) \backslash (*(w'', h^*(G + K')) \cap cs([\![K'']\!]))$. In other words, the normalcy assumptions for birds are refined to be such that among the normal birds, which are assumed to be able to fly, we do not find penguins. Penguins no longer qualify as normal birds. By the third premise itself we have, of course that normal penguins do not fly: for all $\langle w''', i\rangle \in e(I)$: $*(w''', i(H^* + K'')) \subseteq [\![\neg can - fly(x)]\!]$, and by SPECIFICITY this carries over to any specific individual that is a penguin.

Learning next that Tweety is a penguin, $K_t'' = [t : penguin(t)]$, introduces new information that is stricter than both K' and K'', but does not introduce conflicting information. The normality assumptions that were (re)defined in context I for both K' and K'' carry over to the extended context J without modification, via VARIABILITY III.

It is therefore predicted that the normality assumptions for the penguin Tweety license the defeasible conclusion, under normalcy assumptions, that *Tweety cannot fly*, just like any other normal penguin, while it is not possible to assume Tweety (or any other penguin) to be a normal bird, und thus to be *able to fly*.

On the other hand, if, as in (185) – relative to the otherwise identical context I – Tweety is asserted to be a bird, he qualifies as one of the specific individuals for which it is assumed that – under normality assumptions – they are able to fly.

(185) Penguins are birds.
Birds can fly.
Penguins cannot fly.
Tweety is a bird.
$\mid\!\approx$ Tweety can fly.
$\mid\!\not\approx$ Tweety cannot fly.

Λ F G H H* I J L M	
F :: Λ +	$\boxed{\text{t; Tweety(t)}}$
G :: F +	$\boxed{\boxed{\text{x; penguin(x)}} \rightarrow \boxed{\text{bird(x)}}}$
H :: G +	$\boxed{\text{G}' :: \text{F} + \boxed{\text{x; bird(x)}} \Rightarrow \text{G}'' :: \text{G}' + \boxed{\text{can-fly(x)}}}$
I :: H* +	$\boxed{\text{I}' :: \text{H}^* + \boxed{\text{x; penguin(x)}} \Rightarrow \text{I}'' :: \text{I}' + \boxed{\neg\ \text{can-fly(x)}}}$
J :: I +	$\boxed{\text{bird(t)}}$
L :: J +	$\boxed{\text{L}' :: \text{J} + \boxed{} \Rightarrow \text{L}'' :: \text{L}' + \boxed{\text{can-fly(t)}}}$
M :: L +	$\boxed{\text{M}' :: \text{L} + \boxed{} \not\Rightarrow \text{M}'' :: \text{M}' + \boxed{\neg\ \text{can-fly(t)}}}$

In virtue of SPECIFICITY we have, in context J, that for $K' = [x : bird(x)]$ and $K_t' = [t : bird(t)]$ $*(w'''', j(I + K_t')) \subseteq *(w'''', j(I + K'))$, or – equivalently – the specific normalcy assumptions for birds, computed within context I, carry over to the extended context J by VARIABILITY III. Due to the refined normalcy assumptions for birds, in context I – which restricts "normal worlds" where birds are assumed to fly to worlds where there are no penguins – the assumption that Tweety is a normal bird comes down, in terms of the one but last conditional structure in (185), to assuming him to be a non–penguin, and thus, to be able to fly. Since, in contrast to (184), (185) does not state that Tweety is a penguin, he does now not qualify as a specific instance of the class of penguins: $cs([\![K'_t]\!]) \not\subseteq cs([\![K'']\!])$. Tweety *cannot*, therefore, be assumed to be a normal penguin (while abnormal bird) in virtue of SPECIFICITY.

Weak Penguin Principle

In Section 5.2.3 we argued that the *Weak Penguin Principle*, given its close correspondence to the *Penguin Principle*, should be accounted for by way of a constraint that can be considered as a generalization of the one that captures the simple *Penguin Principle.*

In (178) we slightly modified our original version of VARIABILITY I in such a way that it applies not only to conflicting generics with antecedents K' and K'' where K'' *implies* K', i.e. where K' is true whenever K'' is, but also in cases where K' is true in all "normal" cases where K'' holds true, i.e. in case the normality assumptions for K'' are such that K' holds true: $*(w, \mathbf{X_1} +^\bullet \mathbf{K''}) \subseteq cs(\mathbf{K'})$. This extension of VARIABILITY I predicts the defeasible conclusion in the *Weak Penguin Principle* (186).

(186) Adults are employed.
Students are adults.
Students are not employed.
Sam is a student.
$|\approx$ Sam is not employed.

Λ F G H H* I J L
F :: Λ + $\boxed{\begin{array}{l} \text{s} \\ \text{Sam(s)} \end{array}}$
G :: F + $\boxed{\text{G}' :: \text{F} + \boxed{\begin{array}{l} \text{x} \\ \text{adult(x)} \end{array}} \Rightarrow \text{G}'' :: \text{G}' + \boxed{\text{employed(x)}}}$
H :: G + $\boxed{\text{H}' :: \text{G} + \boxed{\begin{array}{l} \text{x} \\ \text{student(x)} \end{array}} \Rightarrow \text{H}'' :: \text{H}' + \boxed{\text{adult(x)}}}$
I :: H* + $\boxed{\text{I}' :: \text{H}^* + \boxed{\begin{array}{l} \text{x} \\ \text{student(x)} \end{array}} \Rightarrow \text{I}'' :: \text{I}' + \boxed{\neg\ \text{employed(x)}}}$
J :: I + $\boxed{\text{student(s)}}$
L :: J + $\boxed{\text{L}' :: \text{I} + \boxed{} \Rightarrow \text{L}'' :: \text{L}' + \boxed{\neg\ \text{employed(s)}}}$

According to the first generic sentence the normality assumptions for adults, $*(w', g(F + K'))$, for $\langle w', g\rangle \in e(G)$ and $K' = [x : adult(x)]$, are such that all normal adults are employed. By SPECIFICITY we assume this normality assumption to carry over to any specific individual that is an adult. The second generic sentence constrains the normality assumptions for students,$*(w'', h(G + K''))$, for $\langle w'', h\rangle \in e(H)$ and $K'' = [x : student(x)]$ to be such that normal students are adults. Since this does not introduce any conflicting information, the normality assumptions for adults just carry over to this extended context via VARIABILITY III.

Now the third generic sentence further constrains the normality assumptions for students in such a way that $*(w''', i(H + K''))$, for $\langle w''', i\rangle \in e(I)$ not only supports that students are adults, but also that they are normally not employed. This follows from the CLOSURE constraint in Section 5.2.4. p. 349. This, however, is not consistent with what was assumed, by SPECIFICITY, within contexts G and H, to be normally the case for any individual that is an adult, namely that it is normally employed: $*(w'', h(G + K')) \subseteq [\![employed(x)]\!]$, for every $\langle w'', h\rangle \in e(H)$. We now have, for certain individuals, namely "normal" students, the information that they are both adults and not employed.

In the by now familiar way, this will induce minimal revision of the underlying evaluation context H, to allow for consistent update with this new incoming conflicing information. The refined normalcy assumptions that are consistent with this minimal revision are constrained by the VARIABILITY I constraint, which no longer only applies in the configuration of the *Penguin Principle*, but also in cases of conflicting defaults for $*(w''', i(H^* + K''))$ and $*(w'', h(G + K'))$, and where $*(w'', h(G + K'') \subseteq cs([\![K']\!])$. By VARIABILITY I the normalcy assumptions for adults are now refined in such a way that the set of "normal" worlds, where adults are assumed to be employed, may no longer contain worlds where adults are also students: $\forall\langle w''', i\rangle \in e(I)\ \exists\langle w'', h\rangle \in e(H)$: $*(w''', i(H^* + K')) \subseteq (*(w'', h(G+K')) \setminus *(w'', h(G+K')) \cap cs([\![K'']\!]))$. That is, given these revised normalcy assumptions in context I, students cannot any longer be assumed to be among the "normal adults".

All these (revised) normality assumptions carry over to J, where we learn that Sam is a student. By SPECIFICITY the normalcy assumptions for students in general carry over to those for Sam, such that we can defeasibly infer – under assumption of maximal normality – that Sam will be (an adult, yet) non–employed student. And, as in the *Penguin Principle*, given that we know Sam to be a student – due to the refined normalcy assumptions for adults which are "revised" to exclude "abnormal" adults that are students – he cannot be assumed to be a normal adult (via SPECIFICITY). If, by normality assumptions for students he is (defeasibly) inferred to be an adult, he will be considered an abnormal adult.

Defeasible Transitivity

In Section 5.2.3 we argued that the *Nixon Diamond* is a special case of the pattern of *Defeasible Transitivity* (189). We therefore proposed the constraint TRANSITIVE NIXON DIAMOND (see p. 336) to capture both inference patterns. One way to carry over this solution to the present framework is to impose on * the TRANSITIVITY constraint (187). It applies to contexts where a generic statement *ϕ's are ψ's* is followed by a generic statement *ψ's are χ's*. For such contexts (187) predicts that the normality assumptions for ϕ's *defeasibly* also support those for ψ's, that is, that ϕ's are also defeasibly assumed to be χ's.

Since (187) is stronger than the original TRANSITIVITY constraint, repeated as (188), (187) now replaces (188) as a general constraint on *. The adoption of TRANSITIVITY (187) allows us to capture the defeasible inference patterns of what we will now call *Transitive Nixon Diamond* (189) and *Defeasible transitive modus ponens* in (191) and (192).

(187) Let boldface capital letters $\mathbf{G}$,$\mathbf{H}$, and $\mathbf{I}$ stand for sets of world–function pairs.
TRANSITIVITY:
If $*(w,\mathbf{G}) \subseteq cs(\mathbf{H})$ and $*(w,\mathbf{H}) \subseteq cs(\mathbf{I})$ then $*(w,\mathbf{G}) \subseteq cs(\mathbf{I})$.
By this, we also have, for the specific case where $\mathbf{H} = [\![K'']\!]$ and $\mathbf{I} = [\![K''']\!]$:
If $*(w,\mathbf{G}) \subseteq cs([\![K'']\!])$ & $*(w,[\![K'']\!]) \subseteq cs([\![K''']\!])$ then $*(w,\mathbf{G}) \subseteq cs([\![K''']\!])$.

(188) Let boldface capital letters $\mathbf{G}$,$\mathbf{H}$, and $\mathbf{I}$ stand for sets of world–function pairs.
TRANSITIVITY (= CUT in CE) (see p. 349)
If $*(w,\mathbf{G}) \subseteq cs(\mathbf{H})$ and $*(w,\mathbf{G} +^{\bullet} \mathbf{H}) \subseteq cs(\mathbf{I})$ then $*(w,\mathbf{G}) \subseteq cs(\mathbf{I})$.
By this, we also have, for the specific case where $\mathbf{H} = [\![K'']\!]$ and $\mathbf{I} = [\![K''']\!]$:
If $*(w,\mathbf{G}) \subseteq cs([\![K'']\!])$ & $*(w,\mathbf{G} +^{\bullet} [\![K'']\!]) \subseteq cs([\![K''']\!])$ then $*(w,\mathbf{G}) \subseteq cs([\![K''']\!])$.

For (189) we get the following picture: The normalcy assumption imported into G, viz. that quakers are pacifists (formally, $\forall\langle w',g\rangle \in e(G)$: $*(w',g(F+K')) \subseteq [\![pacifist(x)]\!]$ where $K' = [x' : quaker(x)]$), carry over to the extended context H by VARIABILITY III, and so do those derived by SPECIFICITY for specific individuals that are quakers. By the second generic we get normalcy assumptions for pacifists, $*(w'',h(G+K''))$, for $K'' = [x : pacifist(x)]$ and $\langle w'',h\rangle \in e(H)$, according to which they normally are vegetarians.

By TRANSITIVITY (187), since $*(w'',h(G+K')) \subseteq cs([\![K'']\!])$ and $*(w'',h(G+K'')) \subseteq cs([\![K''']\!])$, for $K''' = [x : vegetarian(x)]$ we also have $*(w'',h(G+K')) \subseteq cs([\![K''']\!])$. That is, normal quakers are assumed to be vegetarians. And again this carries over to specific individuals that are quakers.

The third generic premise reveals the normality assumptions for republicans to be such that they normally are not vegetarian: $*(w''',i(H+K'''') \subseteq cs([\![\neg K''']\!])$, for $K'''' = [x : republican(x)]$ and $\langle w''',i\rangle \in e(I)$. Just as in the pattern of *Nixon Diamond*, this yields conflicting normalcy assumptions for specific individuals that are *both* republicans and quakers or pacifists. Thus, by VARIABILITY II we define refined normalcy assumptions, relative to a slightly revised context H^*, for republicans, quakers and pacifists, in such a way that normal republicans cannot be assumed to be also quakers or pacifists, and normal quakers and pacifists may not be republicans. And corresponding refined normalcy assumptions are defined for specific individuals that are both republicans and quakers, or republicans and pacifists, such that these cannot be assumed to satisfy the normalcy assumptions for republicans, quakers or vegetarians.

As in the *Nixon Diamond* then, Dick is first asserted to be a quaker. The thus extended context J does not conflict with any of the generic normalcy assumptions introduced earlier, which are therefore defined to carry over to J by VARIABILITY III. As for Dick, we can further derive, by SPECIFICITY, that if he is a *normal* quaker, he cannot be a republican: $\forall\langle w'''',j\rangle \in e(J) : *(w'''',j(I+K'_d)) \not\subseteq cs([\![K'''']\!])$, while we can consistently assume him to be a pacifist and vegetarian. The next assertion states Dick to be a republican: $K''''_d = [: republican(d)]$. And, as in the *Nixon Diamond*, this leads to the defeat of the SPECIFICITY assumptions for Dick as a normal quaker. These will have to be refined, by VARIABILITY II, relative to a minimally revised evaluation context J^* of J in such a way that Dick cannot be assumed to be a normal quaker, nor a normal republican. As in the ordinary *Nixon Diamond*, then, we cannot infer, by way of the two final conditional structures, that either Dick is a vegetarian or that he is not: since he cannot be consistently assumed to be a normal quaker, nor a normal republican, the final conditionals in (189) cannot be (non–vacuously) true.

(189) Quakers are pacifists.
Pacifists are vegetarians.
Republicans are not vegetarians.
Dick is a quaker.
Dick is a republican.
$|\not\approx$ Dick is a vegetarian.
$|\not\approx$ Dick is not a vegetarian.

$$\begin{array}{|l|}\hline
\Lambda\ F\ G\ H\ H^*\ I\ J\ J^*\ L\ M\ N \\
F :: \Lambda + \boxed{\begin{array}{l} \mathrm{d} \\ \mathrm{Dick(d)} \end{array}} \\
G :: F + \boxed{G' :: F + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{quaker(x)} \end{array}} \Rightarrow G'' :: G' + \boxed{\mathrm{pacifist(x)}}} \\
H :: G + \boxed{H' :: G + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{pacifist(x)} \end{array}} \Rightarrow H'' :: H' + \boxed{\mathrm{vegetarian(x)}}} \\
I :: H^* + \boxed{I' :: H^* + \boxed{\begin{array}{l} \mathrm{x} \\ \mathrm{rebublican(x)} \end{array}} \Rightarrow I'' :: I' + \boxed{\neg\ \mathrm{vegetarian(x)}}} \\
J :: I + \boxed{\mathrm{quaker(d)}} \\
L :: J^* + \boxed{\mathrm{republican(d)}} \\
M :: L + \boxed{M' :: L + \boxed{} \not\Rightarrow M'' :: M' + \boxed{\mathrm{vegetarian(d)}}} \\
N :: M + \boxed{N' :: M + \boxed{} \not\Rightarrow N'' :: N' + \boxed{\neg\ \mathrm{vegetarian(d)}}} \\
\hline\end{array}$$

By adoption of TRANSITIVITY (187) as a general constraint on the normalcy selection function *, we do not only account for the defeasible inference pattern *Transitive Nixon Diamond*, but also for "transitive" versions of *Defeasible modus ponens* (190) and (191).

Having discussed (189) in detail, it is obvious how (190) is accounted for: the first two generics lead to a configuration where the default assumptions for quakers are such that they are assumed, by TRANSITIVITY, to be normally both pacifists and vegetarians. Relative to such a context, learning that Bill is a quaker is consistent with the SPECIFICITY assumption, and thus licenses the conclusion that – under assumption of maximal normality – Bill can be (defeasibly) inferred to be both a pacifist and a vegetarian.

(190) Quakers are pacifists.
Pacifists are vegetarians.
Bill is a quaker.
$|\approx$ Bill is a pacifist.
$|\approx$ Bill is a vegetarian.

(191) is explained as follows: Again the generic statements generate a context where normal quakers are assumed, by TRANSITIVITY, to be both pacifists and vegetarians. And as before we learn that Bill is a quaker, such that by SPECIFICITY he can be assumed to be a normal quaker, thus a pacifist and a vegetarian. But next we learn that Bill is not a pacifist. This induces a refinement of the normality assumptions for Dick via VARIABILITY I: since normal quakers are pacifists, he can no longer be consistently assumed to be among the normal quakers, since these are pacifists. Moreover, given the new information that Bill is not a pacifist, he also not be assumed to be a vegetarian in virtue of the second generic. There is still, of course, the valid conclusion that Bill is a quaker, but an abnormal one.

(191) Quakers are pacifists.
Pacifists are vegetarians.
Bill is a quaker.
Bill is not a pacifist.
$\not\approx$ Bill is a vegetarian.

Finally, we should also be able to account for (192), where we get the information that Bill is a quaker, but not a vegetarian. By TRANSITIVITY and SPECIFICITY the normalcy assumptions for Bill as a quaker are such that he is assumed to be both a pacifist and a vegetarian. Thus, learning that he is *not* a vegerarian leads to revision of the normalcy assumptions for Bill in terms of VARIABILITY I, such that Bill can no longer be assumed a normal quaker (and therefore cannot be assumed to be a pacifist and vegetarian).

(192) Quakers are pacifists.
Pacifists are vegetarian.
Bill is a quaker.
Bill is not a vegetarian.
?? $|\approx$ Bill is a pacifist.
$\not\approx$ Bill is a vegetarian.

Yet, intuitively, in such cases we still might want to draw the defeasible conclusion that – assuming Bill to be a normal quaker – *Bill is a pacifist*, while he might well not be a *normal* pacifist (and therefore not a vegetarian). This is not predicted by our analysis. The reason is closely connected to the problem of *Graded Normality*, to which we turn now.

Graded Normality

When discussing patterns of nonmonotonic reasoning involving transitivity, we encountered a problem that is identical to the one that shows up in the pattern of *Graded Normality*: In cases where the normality assumptions for some K' are such that $*(w, g(F + K'))$ implies both K'' and K''', if the SPECIFICITY assumption fails, e.g., for some specific instance K'_x of K' – because K'_x is inconsistent with K'' – then the specificity assumption for K'_x will also be defeated for K''': K'_x can no longer be assumed to be "normal" with respect to K'''.

Yet, the inference pattern of *Graded Normality* in (193) shows that this is not correct:

If the normality assumptions for dogs are such that normal dogs are both dangerous and hairy, and if we learn that Fido is a dog that is abnormal in being not dangerous, we may still assume that he patterns with normal dogs in being hairy.

(193) Dogs are dangerous.
Dogs are hairy.
Fido is a dog.
Fido is not dangerous.
$\not\approx$ Fido is dangerous.
$|\approx$ Fido is hairy.

$$
\boxed{\begin{array}{l}
\Lambda\ \mathrm{F}\ \mathrm{G}\ \mathrm{H}\ \mathrm{I}\ \mathrm{I}^*\ \mathrm{J}\ \mathrm{L}\ \mathrm{M} \\
\mathrm{F} :: \Lambda + \boxed{\begin{array}{l}\mathrm{f}\\ \mathrm{fido(f)}\end{array}} \\
\mathrm{G} :: \mathrm{F} + \boxed{\mathrm{G}' :: \mathrm{F} + \boxed{\begin{array}{l}\mathrm{x}\\ \mathrm{dog(x)}\end{array}} \Rightarrow \mathrm{G}'' :: \mathrm{G}' + \boxed{\mathrm{dangerous(x)}}} \\
\mathrm{H} :: \mathrm{G} + \boxed{\mathrm{H}' :: \mathrm{G} + \boxed{\begin{array}{l}\mathrm{x}\\ \mathrm{dog(x)}\end{array}} \Rightarrow \mathrm{H}'' :: \mathrm{H}' + \boxed{\mathrm{hairy(x)}}} \\
\mathrm{I} :: \mathrm{H} + \boxed{\mathrm{dog(f)}} \\
\mathrm{J} :: \mathrm{I}^* + \boxed{\neg\ \mathrm{dangerous(f)}} \\
\mathrm{L} :: \mathrm{J} + \boxed{\mathrm{J}' :: \mathrm{J} + \boxed{\quad} \not\Rightarrow \mathrm{L}'' :: \mathrm{L}' + \boxed{\mathrm{dangerous(f)}}} \\
\mathrm{M} :: \mathrm{L} + \boxed{\mathrm{M}' :: \mathrm{L} + \boxed{\quad} \Rightarrow \mathrm{M}'' :: \mathrm{M}' + \boxed{\mathrm{hairy(f)}}}
\end{array}}
$$

Our analysis predicts, however, that, once we get the conflicting information that Fido is not dangerous, – by application of VARIABILITY I – the specific normalcy assumptions for dog Fido will be refined to support neither that he is dangerous, nor that he is hairy: According to VARIABILITY I the refined normality assumptions for dogs, $*(w'''', j(I^* + K')$, for $\langle w'''', j\rangle \in e(J)$ will be such that the worlds where dog Fido is among the "normal dogs" are kicked out: Dog Fido cannot be assumed to be a normal dog any longer. This leads to failure of SPECIFICITY for dog Fido K'_f, and, in turn, not only to the defeat of the conclusion that *Fido is dangerous*, but also that *Fido is hairy*.

In Section 5.2.3 we argued that the problem of *Graded Normality* in Commonsense Entailment is essentially a consequence of its particular definition of the *normalcy selection function*, which implements a notion of *absolute normality*. So, in taking over this notion of *normalcy* we also imported the problem of *Graded Normality*.

We do not have a solution for this problem, and thus can only refer to Asher&Morreau (1995), who hint at a solution in terms of a *graded notion* of normality.

Nonmonotonic inferences with non–epistemic generics

Finally, we will briefly return to the special kind of generic sentences which – in analogy to conditionals – we called non–epistemic. In Section 5.2.2 we argued that the generics in

(194) and (195) differ from the ones we discussed throughout this Section, in that they allow for a *deontic* reading. We also noticed that – in accordance with the general analogy between generics and conditionals – such *deontic* generics are best analyzed in terms of an embedded deontic modal operator, located within the scope of an epistemically based modal operator which takes the indefinite NP as its restrictor argument.

Further observations, in Section 5.1.1, brought out that non–epistemic modals differ from epistemically based modal operators in not being subject to the *vagueness* that is so typical for (epistemically based) conditionals. Since we have drawn this clear line of demarcation between non–epistemic modal quantification and *exclusively* epistemically based conditionals, our *conditional* approach to nonmonotonic inference is well equipped to account for the specific nonmonotonic inferences that are licensed in contexts involving non–epistemic generics. In particular, from the premises in (195) we *cannot* derive the (defeasible) conclusion that *Bill declares his full income*, but only that *Bill* **must** *declare his full income.*

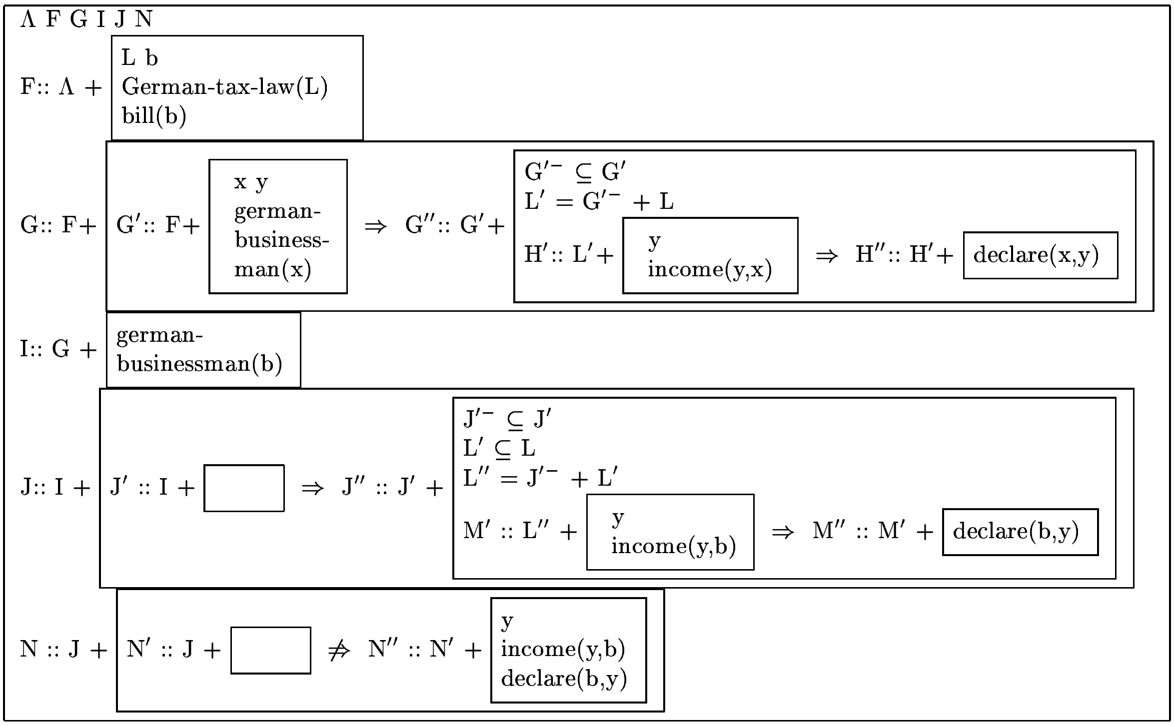
(194) A boy doesn't cry.
Fred is a boy.
$|\approx$ Fred mustn't cry.
$|\not\approx$ Fred doesn't cry.

In (195) the generic sentence about German businessmen is not purely epistemic in nature, but *deontic.* Thus, the sentence can be paraphrased as *A German businessman (normally) must (according to German tax law) declare his full income.* That this sentence is still to be represented as epistemically quantified and vague can be seen from a possible continuation such as *But if his official domicile is located outside of Germany, he needn't.*

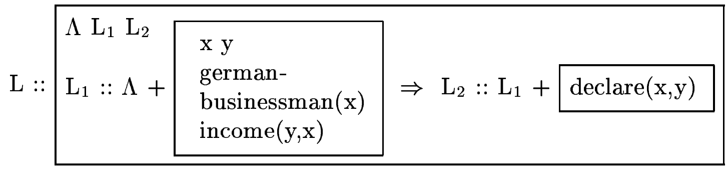
Following our analysis of deontic conditionals the DRS representation for the first generic involves a vague conditional structure, anaphorically dependent upon an antecedent context F, and which, in its scope argument, hosts an embedded deontic quantificational structure, which is dependent on a "complex" modal base consisting of the union of the (reduced) context G'^{-} determined by the antecedent's context referent G'[87] and the context referent L that stands proxy for the prescriptions defined by German tax law (see (196)). For a correct representation of this deontic generic sentence we also have to assume accommodation of the condition *income(y,x)*, either into the restrictor of the embedded, or else in that of the higher quantificational structure. The embedded deontic quantificational structure can only be verified if the legal context referred to by the context referent L is such that it satisfies a conditional structure as displayed in (196) (see Section 4.1.4).

(195) A German businessman declares his full income.
Bill is a German businessman.
$|\approx$ Bill must declare his full income.
$|\not\approx$ Bill declares his full income.

[87] We do not state the full reduction relation in (195). See Sections 4.1.3 and 4.1.4 for the missing details.



(196)



Thus, the normalcy assumptions for German businessmen ($*(w', g(F+K')$, for $\langle w', g\rangle \in e(G)$) will be such that if they have an income, they are obliged to declare it. Having learnt that Bill is a German businessman, we can then conclude (by SPECIFICITY) that *according to German tax law, if Bill has an income, he must declare his income.* I.e. the defeasible conclusion that is licensed in (195) corresponds to the scope argument of the prefinal (vague) conditional in the DRS representation. By contrast, as displayed by the final conditional structure, it is not possible to derive, from the premises in (195), the (defeasible) conclusion that under normalcy assumptions *(if Bill has income) he will declare his income.*

By the same token – and it may be worthwhile to say this explicitly – if *Bill has an income* and *Bill hasn't declared his income* are among the premises, this does *not* defeat the first conclusion of (195) (see Sections 4.1.3, 4.1.4).

5.4 Summary of Chapter 5

The main interest of Chapter 5 was to investigate the *vagueness* and *variability* of indicative and counterfactual conditionals.

In particular, we had to substantiate our criticism, raised in Section 2.2.2, that it is not necessary and quite misleading to resort to a *system of spheres* in order to account for sequences of variably strict conflicting conditionals. Further, we had questioned the adequacy of the notion of *similarity* to capture the inherent vagueness of conditionals.

As a starting point we brought up some data to support that *vagueness* is not only a characteristic of conditional, but also of non–restricted modal sentences, yet only of *epistemically* modalized sentences, as opposed to non–epistemic (e.g. deontic) modality. While non–restricted epistemic modal sentences can be shown to be *vague*, they do not easily allow for *variability*, i.e. for sequences with conflicting consequents. Also, we argued that the phenomenon of *conditional variability* is essentially based on the *vagueness* of epistemic modal quantification, yet strongly interacts with dynamic interpretation in discourse.

Section 5.1 was mainly concerned with the basic notion of *vagueness*. We reconsidered well–established arguments against the *(maximal) similarity* account of conditional vagueness, and investigated in some detail Ginzberg's(1986) implementation of the maximal similarity approach. The results of this discussion substantiated our claim of Section 2.2.2, that the notion of vagueness is to be reduced to three distinct concepts: *context dependent relevance*, *context dependent normalcy*, and the notion of *historical necessity*.

In Section 5.1.3 we investigated the asymmetry of counterfactual dependence, discussed by Lewis(1979). We argued that Lewis' analysis of counterfactual asymmetry in terms of the notion of "overall similarity" can be replaced by the simpler *analysis–by–fiat*, which in certain respects must even be preferred over the maximal similarity approach. Section 5.1.4 comes up with a reimplementation of Kamp's notion of *historical necessity* into our DRT framework, and a refinement of the reduction relation $\subseteq$ to *respect the notion of historical necessity* and otherwise to mimic the *analysis–by–fiat* for counterfactual conditionals. We could show that not only this analysis accounts for the asymmetry of counterfactual dependence, but more importantly, improves over Lewis' analysis in that it explains the difference between "ordinary" *odd* backtracking conditionals and *perfectly wellformed* (apparently) backtracking conditionals with an embedded modal *have to.* The final analysis of this type of counterfactual turned out to be fully analogous to the analysis of deontic *if*–conditionals developed in Section 4.1.4, which thereby receives additional support. Finally, the data were shown to be in accordance with the assumption that the selection of the (reduced) modal base is subject to the notion of *relevance.*

Section 5.2 is devoted to the notion of *normality* which was built into our analysis of conditionals in Section 3.3, and which was essential for the analysis of modal subordination relative to *negation* and *graded* modal operators.

In Section 5.2.1 we established that the *normalcy restriction* must be clearly distinguished from the notion of *relevance.* In Section 5.2.2 we summarize long–observed parallels between generic and conditional sentences, which strongly suggest an investigation of the notion of *normalcy* that is to be found in theories of genericity and nonmonotonic reasoning. Interestingly, we find that the notion of *relative modality* not only is an important feature of generic sentences, but also affects the adequacy of nonmonotonic inferences. We then investigated two selected *modal* theories of nonmonotonic reasoning, Commonsense Entailment and Conditional Default Reasoning. The main results of a detailed comparison brought out that by refinement of the formal constraints on the normalcy selection function * of Commonsense Entailment the normalization process can in principle be reduced to yield a single "fixed point of normalization", which is important for our discussion in Section 5.3.3. We argued that although the *normalcy selection function* * of Commonsense Entailment does not make it possible to capture the inference pattern of *Graded Normality*, it is to be preferred, since it accounts for counterfacual–like generic sentences. On the other hand, by reconsidering generic sentences with a *deontic* reading, we argued that an analysis of nonmonotonic reasoning that is based on the semantics of the vague conditional, as is Delgrande's theory of Conditional Default Reasoning, – and on the basis of a more refined analysis of deontic generic sentences along the lines of Section 4.1.4 – could explain their "unexceptional" behaviour in nonmonotonic inferencing. In Section 5.2.4 we then stated the basic formal constraints on our the normalcy selection function *, which differs from the one defined in Commonsense Entailment in that the function is *context dependent*, by taking, as its second parameter a context–type argument, which for the interpretation of a conditional is instantiated by the context determined by the modal base, updated with the conditional's antecedent DRS.

Section 5.3 finally investigates the phenomenon of *conditional variability*, i.e. of the context dependent notion of *normalcy* in a dynamically evolving discourse. In the spirit of Commonsense Entailment, we introduced a VARIABILITY constraint on * that accounts for the nonmonotonic behaviour of variably strict and *conflicting* conditionals in discourse, in conjunction with a (defeasible) SPECIFICITY constraint: As we saw, in contexts involving conflicting conditionals, along with the underlying evaluation context the normalcy assumptions for each one of the conflicting conditionals must be "revised", or rather *refined in light of new, conflicting information.* This refinement of normalcy assumptions we implemented by way of the VARIABILITY constraint on *. Our analysis enabled us to explain the contrast between wellformed sequences of *increasingly* strict conflicting conditionals, as opposed to the oddity of sequences with *decreasingly* strict conditionals.

For sake of completeness, we briefly digressed on Lewis' arguments against the transitivity of counterfactuals, and showed that in our analysis of conditionals as contextually dependent on a modal base, the data can be explained without further ado.

Finally, in order to give some additional motivation for the VARIABILITY constraint we imposed on the normalcy selection function *, in the final Section 5.3.3 we adapted the definition of COMMONSENSE ENTAILMENT to our present DRT framework. It turned out that what is carried through in terms of a separate *normalization* process in Commonsense Entailment is reflected, in our analysis, by the joint effects of a stepwise, dynamic interpretation of the set of premises, possibly involving conflicting defaults, the accompanying refinement of normalcy assumptions, and – finally – a *conditional* account of defeasible inference in terms of the vague, or *normalcy–restricted* conditional. We went through some of the most important patterns of nonmonotonic inference, and showed that – to the exception of *Graded Normality* – they can be accounted for on the basis of the VARIABILITY and SPECIFICITY constraints. We finally illustrated that on the basis of an analysis of deontic generic sentences along the lines of deontic *if*–conditionals this analysis accounts for the special inferences that are licensed by these *prescriptive* generics, and which to our knowledge are not explained by current theories of nonmonotonic reasoning.

6 Conclusion

A conclusion is simply the place
where someone got tired of thinking.

Whoever is expecting this final chapter to give a summary of this dissertation is invited to (re)read the introduction, and the summaries of Chapters 3 to 5, where we outline the main topics of our investigations, the basic line(s) of argumentation and our main results.

Instead of restating what has already been said at these various places, we will finally come to address a very important issue – which we only briefly touched, in passing, in Sections 3.2 and 3.3 – viz. the question whether the kind of denotation we assigned to *context referents*, sets of world–function pairs, is in fact appropriate for the use we make of them in our analysis of contextual dynamics and of modal subordination.

It is all to evident that an analysis such as ours, where context dependence is mediated via anaphoric reference to context referents, intended to "stand proxy" for contexts, stands or falls with the answer to this question. We therefore beg for the reader's indulgence for not being in a position to give this important question enough attention, besides the following very brief remarks. Also, since in recent work many semanticists have treated this issue in much detail, and based on their profound knowledge, we feel it is not a loss if instead we refer the reader to these thorough investigations – i.a. Asher(1993), Groenendijk&Stokhof&Veltman(1996), Kamp&Reyle(1996) and Kamp(1996) – and restrict ourselves to the following general concluding remarks.

First of all, we believe to have provided good evidence that Kratzer's notion of (multiple) *relative* modality is to be treated in terms of *anaphoric* dependency, which in DRT is to be treated at the level of the DRS. This necessitated the introduction of an appropriate type of discourse referents, our *context referents*, or *propositional referents* in Geurts' terminology. And, just as in Geurts' analysis, we decided to let these context referents denote sets of world–function pairs. This type of denotation has also been chosen, for the analysis of attitudinal contexts, in Geurts(1995) and Kamp&Reyle(1996), while Asher(1993) designes a theory where propositional referents are defined to denote DRSes in the model.

As shown, e.g. in Kamp(1996), the notion of an *information state* (i.e. of sets of world–function pairs, or states) gives us a much richer notion of context than is the traditional concept of a *context set*, i.e. a set of worlds. This he illustrates by use of Partee's balls–example (1a–b), where the respective first sentences determine the same context set, namely those worlds where nine balls are in the bag and one is outside. By contrast, the notion of an information state determines two different sets of states that verify the first sentences of (1a–b): For (1a) the function argument g_1 in each verifying state $\langle w', g_1 \rangle$ is such that besides a group referent X for the set of ten balls it has a referent x for the missing ball in its domain. For (1b), however, the functions g_2 in verifying states $\langle w', g_2 \rangle$ for the first sentence, do *not* have a discourse referent for the missing ball in their domain: here we have again X for the set of ten balls, and a referent Y for a subset of nine balls out of the set of ten. This difference is – in consequence of the DRT treatment of anaphora – decisive for the wellformedness vs. oddity of the respective second sentences of (1a–b).

(1) a. One of the ten balls is not in the bag. It is under the sofa.

b. Nine of the ten balls are in the bag. # It is under the sofa.

In Section 3.3 we stated verification conditions for *updates* $G :: F + K'$ on context referents, which – roughly – define the "output" context referent G to denote *every state* $\langle w', g\rangle$ for which we find a state $\langle w', f\rangle$ in the denotation of the "input referent" F such that $\langle w', f\rangle$ and $\langle w', g\rangle$ constitute correct input and output states in the relational semantics of the DRS K' that "extends" the input context F. Thus, the notion of context dependence that we modeled in terms of anaphoric reference to context referents is built on the notion of an *information state.*

For Partee's example (1) this means that for (1a) the context referent G_1, defined in terms of an update condition for the first sentence's DRS K_1', will carry exactly the information that is considered decisive for the wellformedness of the second sentence, where the anaphoric referent for *it* is to be bound to an antecedent referent that denotes the missing ball: Each state denoted by G_1 will contain a function parameter g_1 that has a referent x for the missing ball in its domain, and this information (state) is carried over to the evaluation of the second sentence, where the referent G_1 instantiates the "input referent" for the new update condition for the second sentence's DRS K_1''. So, each input state $\langle w', g_1\rangle$ in the relational meaning ${}_{\langle w', g_1\rangle}[\![K_1'']\!]_{\langle w', h_1\rangle}$ will have x in its domain, and thus – based on a semantic definition of accessibility – provides an antecedent for the anaphoric referent for the pronoun *it* in the second sentence. This will not be possible in (1b), since the information state defined by the first sentence will not carry any information about the missing ball in terms of the function–type arguments of states. So, at least for the example just considered, we could conclude that anaphoric reference to a context referent that denotes the set of verifying states for a preceding sentence's DRS K' *uniquely* identifies this sentence's DRS.

Yet, it is evident that information states do *not*, in fact, give us a sufficiently rich notion of a context, if we take into account the wellknown problem of substitution of equivalents. In (2a–b) we give DRSs for Frege's classical example, where we indicated, outside of the DRSs, that for both sentences the verifying states must be such that the discourse referents x and y are mapped onto the same individual $\mathbf{v}$, Venus, in the model. The information states determined by the DRSs in (2a–b) will thus be identical, i.e., carry the *meaning*, or *nominatum* ("Bedeutung") of the two sentences, which is identical, while not capturing their distinct *sense* ("Art des Gegebenseins").[1]

(2) a. The morning star is the evening star.

x y morning_star(x) evening_star(y) x = y	$\{\langle x,\mathbf{v}\rangle,\langle y,\mathbf{v}\rangle\}$

b. The morning star is the morning star.

x y morning_star(x) morning_star(y) x = y	$\{\langle x,\mathbf{v}\rangle,\langle y,\mathbf{v}\rangle\}$

So it seems as if, in our analysis of modality and modal subordination, we are confronted with two (related) problems. For one, in modelling context dependence in terms of anaphoric

[1] See also Kamp(1996) for detailed discussion of further classes of examples that support the importance of a *representational level* for semantic analysis.

reference to context referents that denote information states, we lose an important aspect of meaning, corresponding to the distinction between *meaning* and *sense*, where the latter is captured, in DRT, in terms of the representational level (see (2a) vs. (2b)).

Also, one might think that in consequence of our new representation format for DRSs the loss is even greater: Let us consider, in (3), two representational schemata: one for sentential disjunction (3a), and one for sentential negation (3b).[2]

In (3a) and (3b) the denotations of the referents G_1 and G_2 will be identical, and thus, one might conclude that – similar to the case presented in (2) – the semantic distinction between (3a) and (3b) is only captured in terms of their distinct *representations*, while not in virtue of the denotation of the respective referents G of (3a–b), which will both denote a set of states where the function arguments will have the referents G_1 and G_2 in their domain, to which they assign identical denotations. Yet, our analysis in fact predicts that (3a–b) are distinguished in terms of the information states they denote: The verification conditions for disjunction and negation guarantee that the *context set(s)* $cs(e(G))$ for (3a) and (3b) are distinct: In (3a) $cs(e(G))$ is determined to contain only those worlds where either K_1 or K_2, or both K_1 and K_2 are true, while no worlds where both of them are false. For (3b), by contrast, $cs(e(G))$ determines a set of worlds where *both* K_1 and K_2 are false.

(3) a.

$$\begin{array}{|l|}\hline \mathrm{F\ G\ H} \\ \mathrm{F} :: \boxed{\mathrm{K}_0} \\ \mathrm{G} :: \mathrm{F} + \begin{array}{|l|}\hline \mathrm{G}_1\ \mathrm{G}_2 \\ \mathrm{G}_1 :: \mathrm{F} + \boxed{\mathrm{K}_1} \vee \mathrm{G}_2 :: \mathrm{F} + \boxed{\mathrm{K}_2} \\ \hline \end{array} \\ \mathrm{H} :: \mathrm{G} + \boxed{\mathrm{K}_3} \\ \hline \end{array}$$

b.

$$\begin{array}{|l|}\hline \mathrm{F\ G\ H} \\ \mathrm{F} :: \boxed{\mathrm{K}_0} \\ \mathrm{G} :: \mathrm{F} + \begin{array}{|l|}\hline \mathrm{G}_1\ \mathrm{G}_2 \\ \neg\ \mathrm{G}_1 :: \mathrm{F} + \boxed{\mathrm{K}_1} \\ \neg\ \mathrm{G}_2 :: \mathrm{F} + \boxed{\mathrm{K}_2} \\ \hline \end{array} \\ \mathrm{H} :: \mathrm{G} + \boxed{\mathrm{K}_3} \\ \hline \end{array}$$

Similarly, for the representational schemata for modally quantified structures (4a–b), which differ with respect to the quantificational force of the modal generalized quantifier (*every* vs. *no*), one could argue that this semantic distinction is not captured in terms of the respective annotating referents G, and thus cannot be "carried over" to the subsequent context in terms of the "input" referent G. For recall that we defined the annotating context referents of the restrictor and scope arguments of the modal generalized quantifier to denote the (context dependent) *intension* of the antecedent and scope DRSs, in order to account

[2]For sake of the argument, we have given a slightly modified representation for the negation case, which introduces a parallelism between disjunction and negation that is in fact not present in our analysis, where we defined sentential negation to introduce for each newly asserted negated sentence a new update condition $H :: G + K''$, with K'' the DRS for this sentence. This yields an important structural difference between disjunction and negation, and thus also results in a difference between disjunction and negation as regards the information states they determine.

both for modal subordination relative to a modal structure which hosts the quantifier *no*, and also to account for variably strict conditionals with conflicting antecedents.

But again, the verification conditions for modally quantified structures will determine distinct denotations of the context referent(s) G in (4a–b), respectively: Due to the *normalcy restriction*, the worlds w' in the context set $cs(e(G))$ in (4a) must be such that they license the selection of "normal K_1–worlds" that *all* support the truth of K_2, while in (4b) the worlds w' in the context set $cs(e(G))$ must be such that they license the selection of "normal K_1–worlds" that all do *not* support the truth of K_2. While carrying identical function–type parameters, the denotation of G in (4a–b) will thus crucially differ with regard to the *context set* that is determined by G.

(4) a.
$$\begin{array}{|l|}\hline \mathrm{F\ G\ H} \\ \mathrm{F} :: \boxed{\mathrm{K}_0} \\ \mathrm{G} :: \mathrm{F} + \begin{array}{|l|}\hline \mathrm{G}_1\ \mathrm{G}_2 \\ \mathrm{G}_1 :: \mathrm{F} + \boxed{\mathrm{K}_1} \langle \text{every} \rangle\ \mathrm{G}_2 :: \mathrm{G}_2 + \boxed{\mathrm{K}_2} \\ \hline \end{array} \\ \mathrm{H} :: \mathrm{G} + \boxed{\mathrm{K}_3} \\ \hline \end{array}$$

b.
$$\begin{array}{|l|}\hline \mathrm{F\ G\ H} \\ \mathrm{F} :: \boxed{\mathrm{K}_0} \\ \mathrm{G} :: \mathrm{F} + \begin{array}{|l|}\hline \mathrm{G}_1\ \mathrm{G}_2 \\ \mathrm{G}_1 :: \mathrm{F} + \boxed{\mathrm{K}_1} \langle \text{no} \rangle\ \mathrm{G}_2 :: \mathrm{G}_2 + \boxed{\mathrm{K}_2} \\ \hline \end{array} \\ \mathrm{H} :: \mathrm{G} + \boxed{\mathrm{K}_3} \\ \hline \end{array}$$

While this refutes an objection that would have been damaging for our overall account, we are still confronted with the first problem mentioned, viz. that the notion of context dependence in terms of anaphoric reference to context referents fails to capture differences such as the one between (2a) and (2b), which, we saw, are only distinguished in terms of their representational structures. To put it clearly, it seems as if by modelling context dependence in terms of anaphoric reference to context referents we somehow "demolished" DRT's representational characteristic!

Two answers may be given as a response to this objection. The first is that as long as DRSs are defined to denote information states, i.e. sets of world–function pairs – as they are in most intensional frameworks of DRT – there is, in the first place, no reflection of the semantic distinction between, e.g., (2a–b) in terms of the semantic value that is assigned to these structures, even though in DRT they can be distinguished in structural terms.

The second answer is that we do not think that the loss of representational distinctions is an unavoidable consequence of our analysis. Even if sort of "hidden" within the subordinated DRSs that figure in subsequent update conditions, the distinguishing representational structures are still present in the overall representation of the discourse, and are defined to be accessible in terms of a revised definition of accessibility. So what we ended up with is a kind of two–dimensional analysis, that – we think – can be modified, or extended in a way that allows us to regain what we seem to have lost, the representational impact of DRT.

What we have in mind, as a remedy, is inspired by Reyle's(1993) theory of UDRT,[3] in particular, recent work in Reyle(1995), where the "annotating" labels of UDRS components, i.e. partial DRSs, are defined to denote the sets of verifying embedding functions for the respective UDRS components. Modulo the difference between an extensional and intensional framework,[4] the labels of UDRS components thus closely correspond to what we have introduced into the DRS language in terms of (annotating) context referents of update conditions.

So let us conclude with some speculations, to sketch an idea of how, as an alternative to the syntactic definition of accessibility, we could try to proceed in order to make "accessible" representational structures that are "hidden" within subordinated DRSs resulting from update conditions for some discourse.

Recall that in Section 3.3 we have defined a partial order $\ll$ on the set of context referents which reflects the increase of informational content that is determined by these referents. For the DRS (5a) this relation determines an ordering of Λ, F, G, and H as indicated. The basic idea is then to define a function $\Longrightarrow$ that – on the basis of this partial order for the context referents that occur in the universe of the main DRS K – effects "substitution" of the "input" referent C_i in an update condition $C_{i+1} :: C_i + K_i$ with the update $C_{i-1} + K_{i-1}$ that defines this referent C_i in virtue of the update condition $C_i :: C_{i-1} + K_{i-1}$ just in case C_i minimally precedes C_{i+1} relative to partial order defined by $\ll$.[5] In a way, this construal corresponds to what is done, in UDRT, in order to derive a fully disambiguated DRS from an underspecifed structure, by strenghtening the subordination relation $\leq$ (which defines a partial order on UDRS labels) to equality whenever possible.

(5) a.
$$\boxed{\begin{array}{l} \lambda\ \mathrm{F}\ \mathrm{G}\ \mathrm{H} \\ \mathrm{F} :: \Lambda + \boxed{K'} \\ \mathrm{G} :: \mathrm{F} + \boxed{K''} \\ \mathrm{H} :: \mathrm{G} + \boxed{K''} \end{array}} \qquad \Lambda \ll \mathrm{F} \ll \mathrm{G} \ll \mathrm{H}$$

b.
$$\begin{array}{lclcl} \Lambda & & & & \\ \mathrm{F} :: \Lambda + K' & & & & \\ \mathrm{G} :: \mathrm{F} + K'' & \Longrightarrow & \mathrm{G} :: \Lambda + K' + K'' & & \\ \mathrm{H} :: \mathrm{G} + K''' & & \mathrm{H} :: \mathrm{G} + K''' & \Longrightarrow & \mathrm{H} :: \Lambda + K' + K'' + K''' \end{array}$$

Although these final remarks cannot but be considered as speculative ideas on how to restitute, in our analysis, the representational impact of DRT, we believe that this is a promising direction for future research.

Finally, it should have become evident, by the above observations, that there are interesting connections to be drawn, for our analysis, to the theory of UDRT in Reyle(1995), as well as to Asher's(1993) theory of SDRT in that rethorical relations for discourse structure could be defined to apply to context referents.

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[3]For applications of UDRT within the HPSG framework see Frank&Reyle(1992,1995), Keller(1995a, 1995b), and Richter&Sailer(1996).

[4]and, of course, the issue of underspecification

[5]Unfortunately we have to make use of an alternative sign, "", in lack of a vertical variant of $\ll$.

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