# Large-scale Grammar Development: Ambiguity in Analysis and Generation

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## Overview

- Facing the ambiguity problem in large-scale grammar development
- Structural, syntactic and lexical ambiguities
- Ambiguities in parsing and generation
- A constraint ranking mechanism for filtering ambiguities: "Optimality Theory-style constraint ranking" (Frank, King, Kuhn and Maxwell 1998)

# Facing the ambiguity problem in large-scale grammar development
# – Examples –

## Object Drop

- Transitive verbs may undergo object drop (pervasive in French)

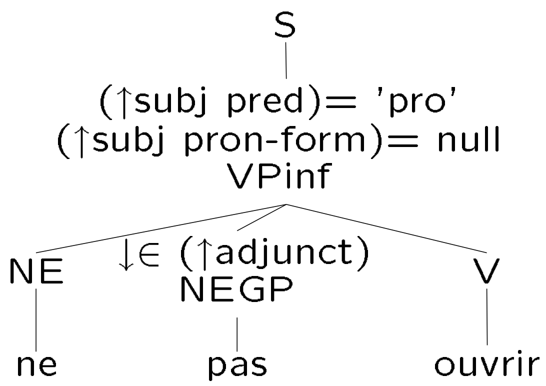
  (1)a. *Ne pas ouvrir le couvercle.*
  ‘(do) not open the cover’

  b. *Ne pas ouvrir.*
  ‘(do) not open’

- Modelling object drop

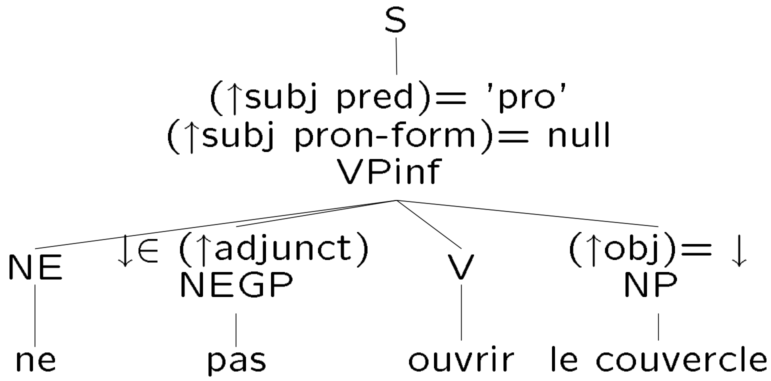
$$\text{trans} = \quad \begin{array}{l} (\uparrow\text{pred}) = \text{'\%stem}\langle(\uparrow\text{subj})(\uparrow\text{obj})\rangle\text{'} \\ \{\ (\uparrow\text{obj pred}) = \text{'pro'} \\ \quad (\uparrow\text{obj pron-type}) = \text{null}\}. \end{array}$$

- *Ne pas ouvrir.*




$$\begin{bmatrix} \text{pred} = \text{'ouvrir}\langle(\uparrow\text{subj})(\uparrow\text{obj})\rangle\text{'} \\ \text{subj} \begin{bmatrix} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{null} \end{bmatrix} \\ \text{obj} \begin{bmatrix} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{null} \end{bmatrix} \\ \text{adjunct}\{\begin{bmatrix} \text{pred} = \text{ne pas} \end{bmatrix}\} \\ \text{ne} = + \\ \text{vform} = \text{inf} \\ \text{stmt-type} = \text{imperative} \end{bmatrix}$$

- *Ne pas ouvrir le couvercle.*




$$\left[\begin{array}{l} \text{pred} = \text{'ouvrir}\langle(\uparrow\text{subj})(\uparrow\text{obj})\rangle\text{'} \\ \text{subj} \left[\begin{array}{l} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{null} \end{array}\right] \\ \text{obj} \left[\begin{array}{l} \text{pred} = \text{'couvercle'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc} \\ \text{spec} = \text{def} \end{array}\right] \\ \text{adjunct}\{\left[\text{pred} = \text{ne pas}\right]\} \\ \text{ne} = + \\ \text{vform} = \text{inf} \\ \text{stmt-type} = \text{imperative} \end{array}\right]$$

- Ambiguities with object drop

  (2) Cela indique si le moteur tourne.
  'This indicates whether the motor runs'

$$
\begin{array}{lll}
\text{indiquer V} & \{ & \text{@trans} \\
 & | & (\uparrow\text{pred}) = \text{'\%stem}\langle(\uparrow\text{subj})(\uparrow\text{comp})\rangle\text{'} \\
 & & (\uparrow\text{comp compl-form}) = \text{si} \\
 & & (\uparrow\text{stmt-type}) = \text{interrogative } \}.
\end{array}
$$

The appropriate analysis:

*Cela indique si le moteur tourne.*
'This indicates whether the motor runs'

$$
\begin{bmatrix}
\text{pred} = \text{'indiquer}\langle(\uparrow\text{subj})(\uparrow\text{comp})\rangle\text{'} \\
\text{subj} \begin{bmatrix} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{demon} \\ \text{pron-form} = \text{cela} \end{bmatrix} \\
\text{comp} \begin{bmatrix} \text{pred} = \text{'tourner'}\langle(\uparrow\text{subj})\rangle\text{'} \\ \text{compl-form} = \text{si} \\ \text{subj} \begin{bmatrix} \text{pred} = \text{'moteur'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc} \end{bmatrix} \\ \text{stmt-type} = \text{interrogative} \end{bmatrix} \\
\text{stmt-type} = \text{declarative}
\end{bmatrix}
$$

The unwarranted analysis:

*Cela indique (obj) si le moteur tourne.*
‘This indicates (obj) if the motor runs’

$$\left[\begin{array}{ll}
\multicolumn{2}{l}{\text{pred} = \text{'indiquer}\langle(\uparrow\text{subj})(\uparrow\text{obj})\rangle\text{'}} \\
\text{subj} & \left[\begin{array}{l} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{demon} \\ \text{pron-form} = \text{cela} \end{array}\right] \\
\text{obj} & \left[\begin{array}{l} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{null} \end{array}\right] \\
\text{adjunct} & \left\{ \left[\begin{array}{ll} \multicolumn{2}{l}{\text{pred} = \text{'tourner'}\langle(\uparrow\text{subj})\rangle\text{'}} \\ \multicolumn{2}{l}{\text{compl-form} = \text{si}} \\ \text{subj} & \left[\begin{array}{l} \text{pred} = \text{'moteur'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc} \end{array}\right] \\ \multicolumn{2}{l}{\text{stmt-type} = \text{declarative}} \\ \multicolumn{2}{l}{\text{adjunct-type} = \text{conditional}} \end{array}\right] \right\} \\
\multicolumn{2}{l}{\text{stmt-type} = \text{declarative}}
\end{array}\right]$$

- Cases of real ambiguity:

(3) *Tu me diras si ça marche.*
‘You tell me whether this works”
‘You tell me (obj) if this works’.

a. *??? Si ça marche, tu me diras.*
‘whether this works, you tell me’

b. *Si ça marche, tu me diras.*
‘if this works, you tell me (obj)’

# Headless Noun Phrases

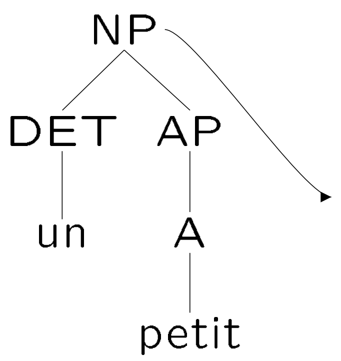
- German and French allow for headless noun phrases

  (4)a. *Take a small one.* (E)
  
  b. *Nimm ein kleines.* (G)
  
  c. *Prends-en un petit.* (F)

- An analysis for headless noun phrases

$$
\begin{array}{llccc}
\text{NP} \rightarrow & \{ & \text{(DET)} & \text{AP*} & \text{N} \\
 & & (\uparrow\text{spec}){=}\downarrow & \downarrow\in(\uparrow\text{adjunct}) & \\
 & & & & \\
 & | & \text{(DET)} & \text{AP} & \\
 & & (\uparrow\text{spec}){=}\downarrow & \downarrow\in(\uparrow\text{adjunct}) & \\
 & & & (\uparrow\text{pred}){=}\ \text{'pro'} & \\
 & & & (\uparrow\text{pron-type}){=}\ \text{null} & \\
 & \}. & & &
\end{array}
$$

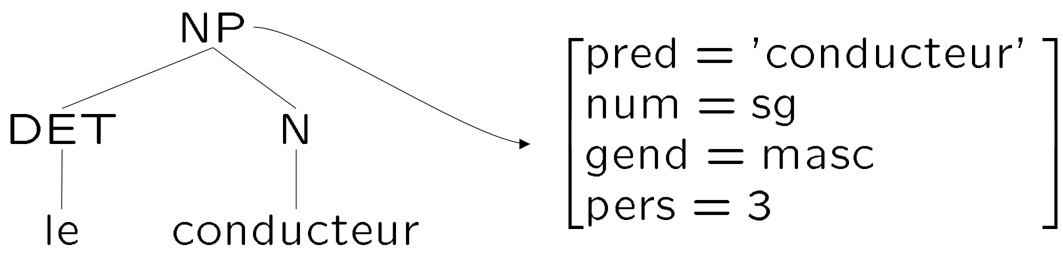
*un petit*



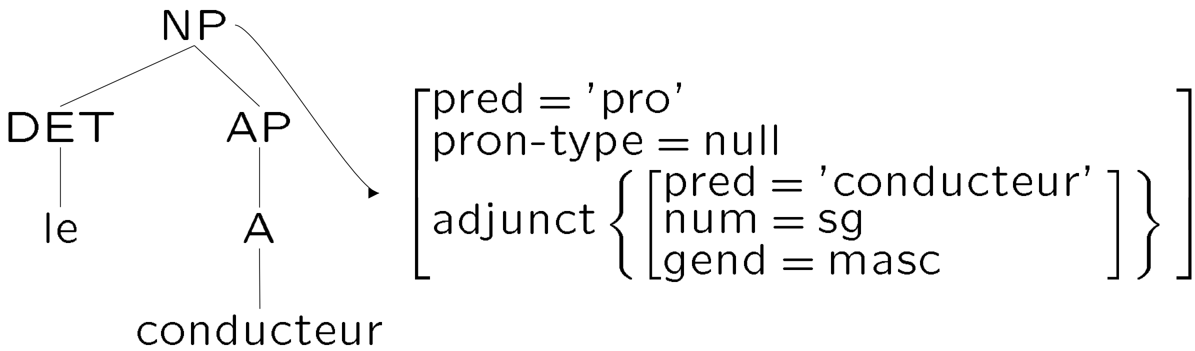

$$
\begin{bmatrix}
\text{pred} = \text{'pro'} \\
\text{pron-type} = \text{null} \\
\text{spec} \begin{bmatrix} \text{spec-form} = \text{un} \\ \text{spec-type} = \text{indef} \end{bmatrix} \\
\text{adjunct} \left\{ \begin{bmatrix} \text{pred} = \text{'petit'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc} \end{bmatrix} \right\}
\end{bmatrix}
$$

- Ambiguities arising . . .

(5) *le conducteur* ('the driver')

a. 


b. unwarranted:




(*le fil conducteur* – 'the guiding/main theme')

(6) *Nachts fallen helle Farben auf.*

a. *Nachts fallen* [$_{NPnom}$ *helle Farben*] *auf.*
'At night, [bright colors] stand out'

b. *Nachts fallen* [$_{NPnom}$ *helle*] [$_{NPdat}$*Farben*] *auf.*
'At night, (the) colors notice [bright ones]'

- Cases of real ambiguity:

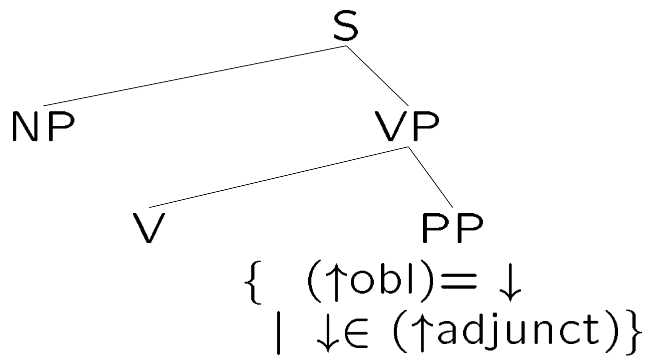
(7) *Il aime le rouge*
a. 'he loves red'
b. 'he loves the red one'

# Argument- vs. Adjunct Ambiguities with Prepositional Phrases

- The grammars provide annotations for PPs as OBLique arguments or adjuncts

(8)a. *He thinks of Mary.* (E)
b. *Il pense à Marie.* (F)
c. *Er denkt an Maria.* (G)

(9)a. *He is singing in the park.* (E)
b. *Il chante dans le parc.* (F)
c. *Er singt im Park.* (G)



- Ambiguities arising ...
  with optionally OBLique-subcategorizing verbs:

  $$\text{renoncer V XLE} \quad \{\ (\uparrow\text{pred}) = \text{renoncer}\langle(\uparrow\text{subj})(\uparrow\text{obl})\rangle\text{'} \quad (\uparrow\text{obl obj pcase}) = \text{à} \ \mid\ (\uparrow\text{pred}) = \text{renoncer}\langle(\uparrow\text{subj})\rangle\text{'}\ \}.$$

  *Il renonce à ce voyage.*
  'He abandons this journey'

$$\left[\begin{array}{ll}
\multicolumn{2}{l}{\text{pred} = \text{'renoncer}\langle(\uparrow\text{subj})(\uparrow\text{obl})\rangle\text{'}} \\
\text{subj} & \left[\begin{array}{l} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{pers} \\ \text{pron-form} = \text{il} \end{array}\right] \\
\text{obl} & \left[\begin{array}{ll} \multicolumn{2}{l}{\text{pred} = \text{à}\langle(\uparrow\text{obj})\rangle\text{'}} \\ \text{obj} & \left[\begin{array}{l} \text{pcase} = \text{à} \\ \text{pred} = \text{'voyage'} \\ \text{gend} = \text{masc} \\ \text{num} = \text{sg} \end{array}\right] \end{array}\right] \\
\multicolumn{2}{l}{\text{tense} = \text{present}} \\
\multicolumn{2}{l}{\text{stmt-type} = \text{declarative}}
\end{array}\right]$$

$$\left[\begin{array}{ll}
\multicolumn{2}{l}{\text{pred} = \text{'renoncer}\langle(\uparrow\text{subj})\rangle\text{'}} \\
\text{subj} & \left[\begin{array}{l} \text{pred} = \text{'pro'} \\ \text{pron-type} = \text{pers} \\ \text{pron-form} = \text{il} \end{array}\right] \\
\text{adjunct} & \left\{\left[\begin{array}{ll} \multicolumn{2}{l}{\text{pred} = \text{à}\langle(\uparrow\text{obj})\rangle\text{'}} \\ \text{obj} & \left[\begin{array}{l} \text{pcase} = \text{à} \\ \text{pred} = \text{'voyage'} \\ \text{gend} = \text{masc} \\ \text{num} = \text{sg} \end{array}\right] \end{array}\right]\right. \\
\multicolumn{2}{l}{\text{tense} = \text{present}} \\
\multicolumn{2}{l}{\text{stmt-type} = \text{declarative}}
\end{array}\right]$$

- Unwarranted and real ambiguities

(10)a. *He waited for Mary.* (oblique)

b. but: *He waited for 3 hours.* (adjunct)

(11)a. *The bird was shot by a hunter.* (oblique agent)

b. but: *The bird was shot by chance.* (adjunct)

(12)a. *Il renonce au voyage.* (oblique)
'He abandons the journey.'

b. *Il renonce au premier essai.* (oblique/adjunct)
'He abandons (at) the first attempt.'

# Reflexive Constructions: Inherently reflexive verbs vs. 'semantic' reflexivization

- Inherently reflexive verbs: no reflexive semantics

(13)a. *Hans beruhigt sich.* ('Hans calms down')

b. *Marie s'évanouit.* ('Marie faints')

$$\left[\begin{array}{ll} \text{pred} = \text{évanouir}\langle(\uparrow\text{subj})\rangle\text{'} & \\ \text{subj} & \left[\begin{array}{l} \text{pred} = \text{'Marie'} \\ \text{ntype} = \text{proper} \\ \text{num} = \text{sg} \\ \text{pers} = 3 \end{array}\right] \\ \text{vtype} = \text{reflexive} & \\ \text{refl} = \text{-} & \\ \text{vmorph} = \text{cl} & \\ \text{stmt-type} = \text{declarative} & \end{array}\right]$$

| | |
|---|---|
| v_inhrefl = | (↑pred)= '%stem⟨(↑subj)⟩'<br>(↑vtype)= reflexive<br>(↑refl)= -<br>(↑vmorph)=c cl. |
| se CL_refl XLE | (↑subj pers)= 3<br>(↑vtype)=c reflexive<br>(↑vmorph)= cl. |

- ‘Semantic’ reflexivization:
  Many transitive verbs allow for reflexive/reciprocal readings

(14) *John saw Mary in the mirror.*

a. *John saw himself in the mirror.* (E)
b. *Hans betrachtete sich im Spiegel.* (G)
b. *Jean se regarde dans le miroir.* (F)

$$\begin{bmatrix} \text{pred} = \text{'regarder}\langle(\uparrow\text{subj})\ \text{NULL}\rangle\text{'} \\ \text{subj} \begin{bmatrix} \text{pred} = \text{'Jean'} \\ \text{ntype} = \text{proper} \\ \text{num} = \text{sg} \\ \text{pers} = 3 \end{bmatrix} \\ \text{vtype} = \text{reflexive} \\ \text{refl} = + \\ \text{vmorph} = \text{cl} \\ \text{stmt-type} = \text{declarative} \end{bmatrix}$$

| | |
|---|---|
| v_refl = | (↑pred)= '%stem⟨(↑subj) NULL⟩'<br>(↑vtype)= reflexive<br>(↑refl)= +<br>(↑vmorph)=c cl. |
| se CL_refl XLE | (↑subj pers)= 3<br>(↑vtype)=c reflexive<br>(↑vmorph)= cl. |

- Ambiguities arising...

(15)a. *Le feu s'allume.* ('the fire lights up/breaks out')

b. *Das Feuer entzündet sich.*

allumer V XLE { @v_inhrefl
| @v_trans }.

$$\begin{bmatrix} \text{pred} = \text{'allumer}\langle(\uparrow\text{subj})\rangle\text{'} & \\ \text{subj} & \begin{bmatrix} \text{pred} = \text{'feu'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc} \\ \text{pers} = 3 \end{bmatrix} \\ \text{vtype} = \text{reflexive} & \\ \text{refl} = \text{-} & \\ \text{vmorph} = \text{cl} & \\ \text{stmt-type} = \text{declarative} & \end{bmatrix}$$

unwarranted:

$$\begin{bmatrix} \text{pred} = \text{'allumer}\langle(\uparrow\text{subj})\ \text{NULL}\rangle\text{'} & \\ \text{subj} & \begin{bmatrix} \text{pred} = \text{'feu'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc} \\ \text{pers} = 3 \end{bmatrix} \\ \text{vtype} = \text{reflexive} & \\ \text{refl} = + & \\ \text{vmorph} = \text{cl} & \\ \text{stmt-type} = \text{declarative} & \end{bmatrix}$$

(16)a. *Les verres se sont cassés.* (inherently reflexive)
'The glasses broke'

b. *Jean a cassé la fenêtre.* (transitive)
'John broke the window'

*Les verres se sont cassés.* (unwarranted: semantic reflexivization)

- Cases of real ambiguity:

(17)a. *Les enfants se sont réveillés.*
'The children woke up' (inherently reflexive)

b. *Les enfants se sont réveillés (mutuellement).*
'The children woke (each other) up'
(semantic reflexivization)

# Broad-coverage Lexica and Lexical Ambiguities

Access to broad-coverage lexica is a prerequisite for large-scale grammar development. However, rich lexica constitute a significant source of lexical ambiguity.

- N

  | n_stem | gend_tag | nbr_tag | n_tag |
  |---|---|---|---|
  | utilisation | +Fem | +Sg | +Noun |

- | | | |
  |---|---|---|
  | +Fem | gend_tag | (↑gend)= fem. |
  | +Sg | nbr_tag | (↑num)= sg. |
  | +Noun | n_tag | (↑pers)= 3. |

- +Lunknown n_stem (↑pred)= '%stem'.

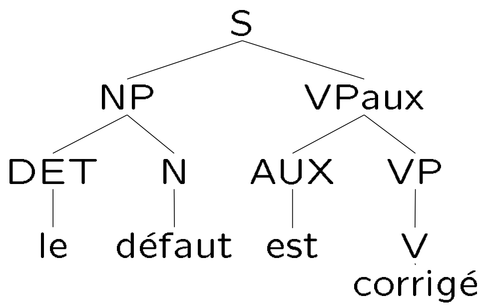
- $\begin{bmatrix} \text{pred= 'utilisation'} \\ \text{gend= fem} \\ \text{num= sg} \\ \text{pers= 3} \end{bmatrix}$

- Ambiguities arising from homonyms (French)

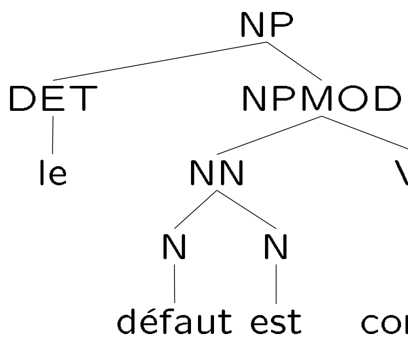
  | | | |
  |---|---|---|
  | *est* | est+Pres+Sg+3P+V | 'is' |
  | | est+Masc+Sg+Noun | 'east' |
  | *si* | si+Conj | 'if/whether' |
  | | si+Masc+Sg+Noun | 'B' (in music) |
  | *la* | le+Fem+Sg+Def+Det | 'the' (fem.) |
  | | le+Acc+Fem+Sg+3P+PC | 'it' (fem.) |
  | | la+Masc+Sg+Noun | 'A' (in music) |
  | *a* | avoir+Pres+Sg+3P+V | 'has' |
  | | a+Masc+Sg+Noun | 'A' (letter) |
  | *été* | être+Part+InvNum+InvPers+V | 'been' |
  | | été+Masc+Sg+Noun | 'summer' |
  | *être* | être+Inf+V | 'be' |
  | | être+Masc+Sg+Noun | '(human) being' |

- Ambiguities arising...

(18) *Le défaut est corrigé*
'the error is corrected'



'the error is corrected'



'the corrected east error'

But:

(19) *Il faut orienter l'imprimante vers l'est.*
'You must orient the printer towords east.'

# Ambiguities in Analysis and Generation

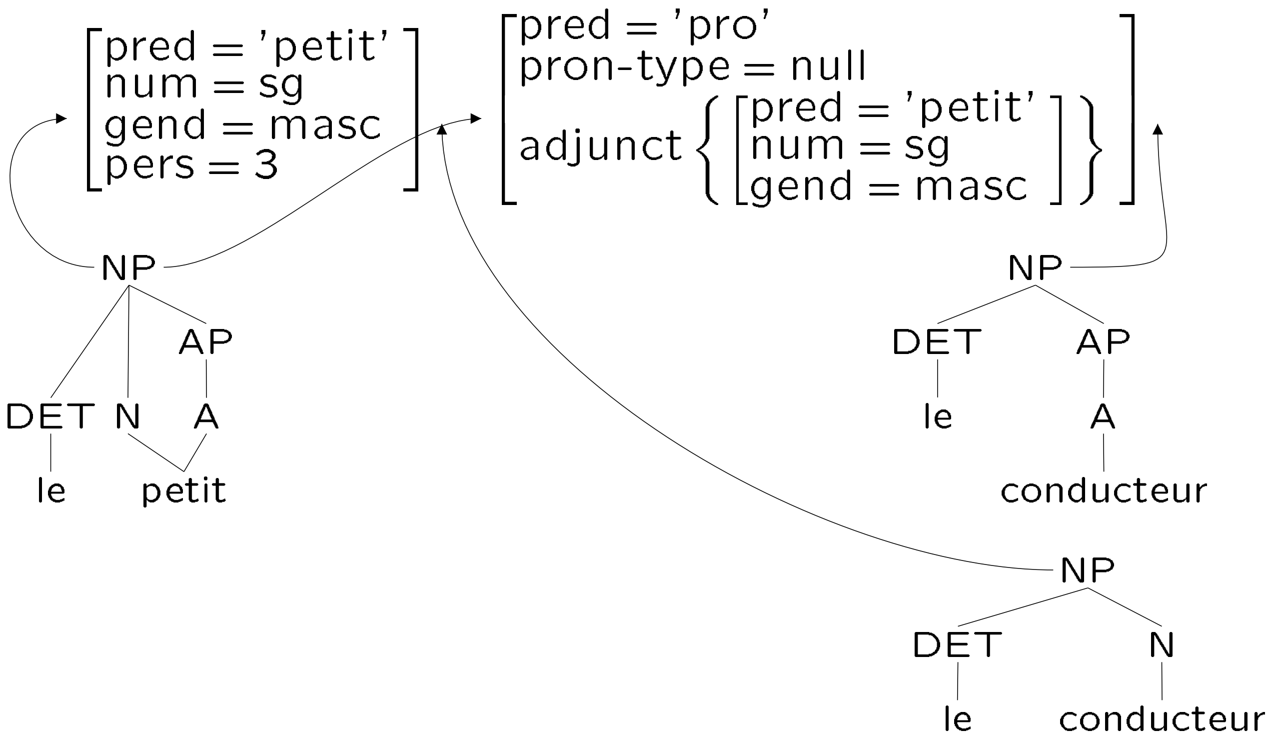
A special case:

Analysis:

| | |
|---|---|
| string – c-structure | 1 : 1 |
| c-structure – f-structure | 1 : 1 |

Generation:

| | |
|---|---|
| f-structure – c-structure | 1 : 1 |
| c–structure – string | 1 : 1 |

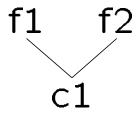


General case: string – c-structure – f-structure: n : m : r

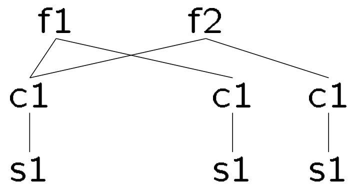
| | | |
|---|---|---|
| Analysis: | string – c-structure | 1 : n |
| | c-structure – f-structure | 1 : n |

| | | |
|---|---|---|
| Generation: | f-structure – c-structure | 1 : n |
| | c–structure – string | 1 : n |

I. c-structure : f-structure
1 : n

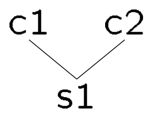



⇒ ambiguity in parsing

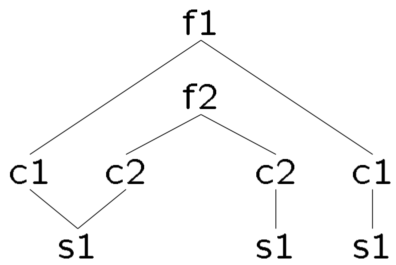



– PP oblique/adjunct ambiguities
– ± object drop: *Tu me diras si ça marche.*

II. string : c-structure
1 : n

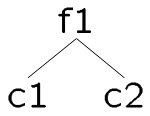



⇒ ambiguity in parsing

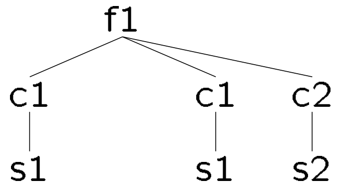



– headed/headess noun phrases: *un petit*
– inherently/semantic reflexives: *La branche se casse.*
– lexical ambiguities: *le défaut est corrigé*

III. c-structure f-structure
n : 1

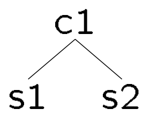



⇒ ambiguity in generation

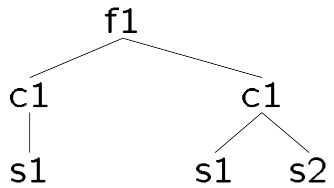



– order variation in coordination
– order variation with adjuncts

IV. string c-structure
n : 1




⇒ ambiguity in generation




– Contraction phenomena:

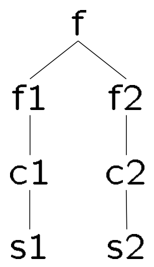
*Il pense aux/*à les enfants*
He thinks of the children.

*Er ißt im/?in dem Garten.*
'He is eating in the garden.'

*Er ißt ?im/in dem Garten, den er selbst pflegt.*
'He is eating in the garden which he takes care of himself'

*He is/He's eating in the garden.*
*There is/There's a cat in the garden.*

V. Generation from underspecified structures:




⇒ ambiguity in generation

Examples:
feature underspecification:
*Jean les voit. – Jean les a vus/vues.*

# Ambiguities in Generation

## c-structure – f-structure ambiguities

- Relative order between adjunct(s) and head

(20)a. *If the motor stops, turn the lever.*
b. *Turn the lever if the motor stops.*

$$\left[\begin{array}{l}
\text{pred} = \text{'turn}\langle(\uparrow\text{subj})(\uparrow\text{obj})\rangle\text{'} \\
\text{subj} \left[\begin{array}{l}\text{pred} = \text{'pro'} \\ \text{pron-type} = \text{null}\end{array}\right] \\
\text{obj} \left[\text{pred} = \text{'lever'}\right] \\
\text{adjunct} \left\{ \left[\begin{array}{l}
\text{pred} = \text{'stop'}\langle(\uparrow\text{subj})\rangle\text{'} \\
\text{compl-form} = \text{if} \\
\text{subj} \left[\begin{array}{l}\text{pred} = \text{'motor'} \\ \text{num} = \text{sg} \\ \text{gend} = \text{masc}\end{array}\right] \\
\text{stmt-type} = \text{declarative} \\
\text{adjunct-type} = \text{conditional}
\end{array}\right] \right\} \\
\text{stmt-type} = \text{imperative}
\end{array}\right]$$

- Relative order of adjuncts

(21)a. John danced in the park after sunrise.

b. John danced after sunrise in the park.

$$\begin{bmatrix} \text{pred} = \text{'dance}\langle(\uparrow\text{subj})\rangle\text{'} \\ \text{subj} \begin{bmatrix}\text{pred} = \text{'John'}\end{bmatrix} \\ \text{adjunct} \left\{ \begin{matrix} \begin{bmatrix} \text{pred} = \text{'in}\langle(\uparrow\text{obj})\rangle\text{'} \\ \text{obj} = \begin{bmatrix} \text{pred} = \text{'park'} \\ \text{pcase} = \text{in} \end{bmatrix} \end{bmatrix} \\ \begin{bmatrix} \text{pred} = \text{'after}\langle(\uparrow\text{obj})\rangle\text{'} \\ \text{obj} = \begin{bmatrix} \text{pred} = \text{'sunrise'} \\ \text{pcase} = \text{after} \end{bmatrix} \end{bmatrix} \end{matrix} \right\} \\ \text{stmt-type} = \text{declarative} \end{bmatrix}$$

- The order of conjuncts in coordination

(22)a. *John and Mary danced.*

b. *Mary and John danced.*

$$\begin{bmatrix} \text{pred} = \text{'dance}\langle(\uparrow\text{subj})\rangle\text{'} \\ \text{subj} \begin{bmatrix} \text{conj-form} = \text{and} \\ \left\{ \begin{matrix} \begin{bmatrix}\text{pred} = \text{'John'}\end{bmatrix} \\ \begin{bmatrix}\text{pred} = \text{'Mary'}\end{bmatrix} \end{matrix} \right\} \end{bmatrix} \\ \text{tense} = \text{past} \\ \text{stmt-type} = \text{declarative} \end{bmatrix}$$

# Ambiguities multiply

|   |   |
|---|---|
|   | PP attachment ambiguities |
| x | oblique - adjunct PP-ambiguities |
| x | headed/non-headed noun phrase ambiguities |
| x | reflexive verb ambiguities |
| x | coordination attachment ambiguities |
| x | conjunct order ambiguities (in generation) |
| x | adjunct order ambiguities (in generation) |
| x | ... |

*Si le conducteur s'approche d'un tracteur sur la route ou le trottoir, le motor s'arrête et se casse.*

'If the driver comes near a tractor on the street or the sidewalk, the motor stops and breaks.'

|   |   |
|---|---|
| 2 | *s'approcher de*: oblique vs. adjunct |
| 2 | *un tracteur sur la route*: PP attachment ambiguity |
| 2 | *s'approcher + de-adjunct*: oblique/adjunct ambiguity |
| 2 | *se casser*: reflexive ambiguity |
| 2 | *s'arrêter*: reflexive ambiguity |
| 2 | *le conducteur*: headed/non-headed np |
| 2 | *le moteur*: headed/non-headed np |
| 2 | *si ..., S*: adjunct order (in generation) |
| 2 | *[la route] ou [le trottoir]*: conjunct order (in generation) |
| 2 | *[un tracteur sur la route] ou [le trottoir]*: conjunct order (in generation) |
| 2 | *s'arrête et se casse*: conjunct order (in generation) |

$2^8 = 256$ in analysis
$2^{11} = 2048$ in generation

## ⇒ Efficient processing of ambiguities in packed structures

Maxwell III J.T. and Kaplan R.M. (1991): A method for disjunctive constraint satisfaction. In: Tomita,M. (ed): *Current Issues in Parsing Technology*, Kluwer Academic Publishers.

Maxwell III J.T. and Kaplan R.M. (1996): Unification-based parsers that automatically take advantage of context freeness. Paper presented at the LFG96 Conference, Grenoble, France, Ms Xerox Parc.

Shemtov, H. (1997): Ambiguity Management in Natural Language Generation. PhD dissertation, Stanford.

## ⇒ Constraint ranking mechanism for filtering ambiguities

Frank, A., King, T.H., Kuhn, J., Maxwell, III J.T (1998): Optimality Theory stype constraint ranking in large-scale LFG grammars. In: Butt, M. and King, T.H. (ed): *Proceedings of the LFG98 Conference*, Brisbane. CSLI Online Publications.
`http:/www-csli.stanford.edu/publications/LFG3/lfg98.html.`

## ⇒ Defining surface order constraints in f-structure

Zaenen, A. and Kaplan, R.M. (1995): Formal Devices for Linguistic Generalizations: West Germanic Word Order in LFG. In: Dalrymple et al (1995).

# Defining surface order constraints in f-structure

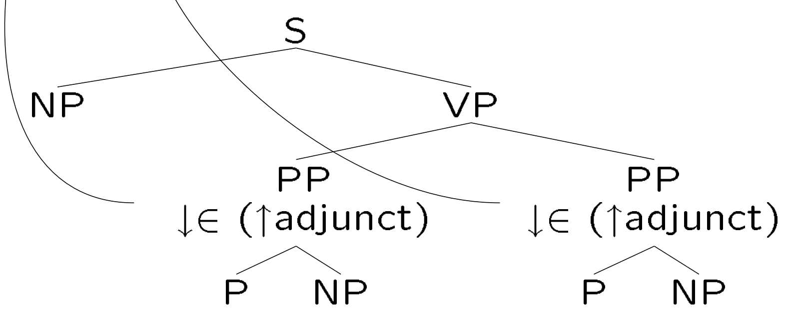
- F-precedence (Zaenen and Kaplan 1995)

  For two f-structure elements $f_1$ and $f_2$,
  $f_1$ *f-precedes* $f_2$ ($f_1 <_f f_2$) if and only if
  all the nodes that map onto $f_1$ c-precede all the nodes that map onto $f_2$:

  $f_1 <_f f_2$ iff
  for all $n_1 \in \phi^{-1}(f_1)$ and for all $n_2 \in \phi^{-1}(f_2)$, $n_1 <_c n_2$

  *John danced in the park after sunrise.*

$$\begin{bmatrix} \text{pred} = \text{'dance}\langle(\uparrow\text{subj})\rangle\text{'} \\ \text{subj} \begin{bmatrix}\text{pred} = \text{'John'}\end{bmatrix} \\ \text{adjunct} \left\{ \begin{array}{l} f1\text{:} \begin{bmatrix} \text{pred} = \text{'in}\langle(\uparrow\text{obj})\rangle\text{'} \\ \text{obj} = \begin{bmatrix} \text{pred} = \text{'park'} \\ \text{pcase} = \text{in} \end{bmatrix} \end{bmatrix} \\ \text{f1 ¡}_f f\text{2} \\ f2\text{:} \begin{bmatrix} \text{pred} = \text{'after}\langle(\uparrow\text{obj})\rangle\text{'} \\ \text{obj} = \begin{bmatrix} \text{pred} = \text{'sunrise'} \\ \text{pcase} = \text{after} \end{bmatrix} \end{bmatrix} \end{array} \right\} \\ \text{stmt-type} = \text{declarative} \end{bmatrix}$$



- Head precedence in XLE: $f_1$ <h $f_2$ or $f_1$ >h $f_2$

  $f_1$ <h $f_2$ is true if and only if
  $f_1$ and $f_2$ have heads and the head of $f_1$ precedes the head of $f_2$ in the c-structure.

- Scope constraints in XLE: $f_1$ <s $f_2$ or $f_2$ <s $f_1$

  $f_1$ <s $f_2$ asserts that $f_1$ is in the scope of $f_2$.
  The scoping relation is transitive and antisymmetric.

  Example:
  The subject takes scope over the object if it precedes it in c-structure, otherwise the object will outscope the subject.

  { (↑subj) <h (↑obj)
  (↑subj) >s (↑obj)
  | (↑subj) ¡$h$(↑obj)
  (↑obj) >s (↑subj) }

- Surface adjunct scope: $f_1$ $<h<s $f_2$ or $f_1$ $<h>s $f_2$

  $f_1$ $<h<s $f_2$ $=_{\text{def}}$
  $f_1$ \$ $f_2$ and
  for all $x$ in the set $f_2$,
  if $x$ $<h<s $f_2$ and $f_1$ <h $x$ then $f_1$ <s $x$.

  $f_1$ $<h>s $f_2$ $=_{\text{def}}$
  $f_1$ \$ $f_2$ and
  for all $x$ in the set $f_2$,
  if $x$ $<h>s $f_2$ and $f_1$ <h $x$ then $f_1$ >s $x$.

Example: conjunct/adjunct order in sets

| | | | |
|---|---|---|---|
| VP → | V | | PP* |
| | | | ↓∈<h>s (↑adjunct) |

*John danced in the park after sunrise.*

$$\left[\begin{array}{l}
\text{pred} = \text{'dance}\langle(\uparrow\text{subj})\rangle\text{'} \\
\text{subj} \left[\text{pred} = \text{'John'}\right] \\
\text{adjunct} \left\{\begin{array}{l}
f1\text{:} \left[\begin{array}{l}\text{pred} = \text{'in}\langle(\uparrow\text{obj})\rangle\text{'} \\ \text{obj} = \left[\begin{array}{l}\text{pred} = \text{'park'} \\ \text{pcase} = \text{in}\end{array}\right]\end{array}\right] \\
\text{f1 ¿s f2} \\
f2\text{:} \left[\begin{array}{l}\text{pred} = \text{'after}\langle(\uparrow\text{obj})\rangle\text{'} \\ \text{obj} = \left[\begin{array}{l}\text{pred} = \text{'sunrise'} \\ \text{pcase} = \text{after}\end{array}\right]\end{array}\right]
\end{array}\right\} \\
\text{stmt-type} = \text{declarative}
\end{array}\right]$$