Implementing a Fuzzy Prolog

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Seminar für Computerlinguistik

Outline

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Prolog in Artificial Intelligence

Standard Prolog (based on two-valued logic) is widely used in Artificial Intelligence research.

- natural language processing (i.e. parsing)
- database systems
- expert ('knowledge-based') systems
  - medicine
  - finances
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Problem: Sometimes, the data given is not 'crisp':

- *John is 35. Is John young?*
- We want something other than *yes* or *no* (like *fairly* young)
- *'John is young'* has a **degree of truth**!

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A statement is **true to some degree**. The degree of truth marks the degree of membership in the set of true statements.

- fuzzy facts are associated with truth values in the real interval $[0, 1]$
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- common combinations of truth values:
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Example

Our data:

- average temperatures of locations
- average number of hours of sunshine at location

Query:

- How "hot and sunny" is location X?

```
hot_and_sunny_area(X,CHI):-
    av_temp(X,T), hot(T,CHI1),
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- The Prolog interpreter is reimplemented to handle fuzziness
- Reduced notation:

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A Prolog Programming Environment

The Ciao Prolog Development System

- extends Prolog with
  - object-oriented programming
    - modules, classes, inheritance ...
  - constraint programming
    - `X .=. Y+Z, X .=<. 2*Y`
  - alternative computation rules
    - breadth-first, iterative deepening ...
  - external interfaces (C, Java, ...)
  - ...
- includes an emacs interface
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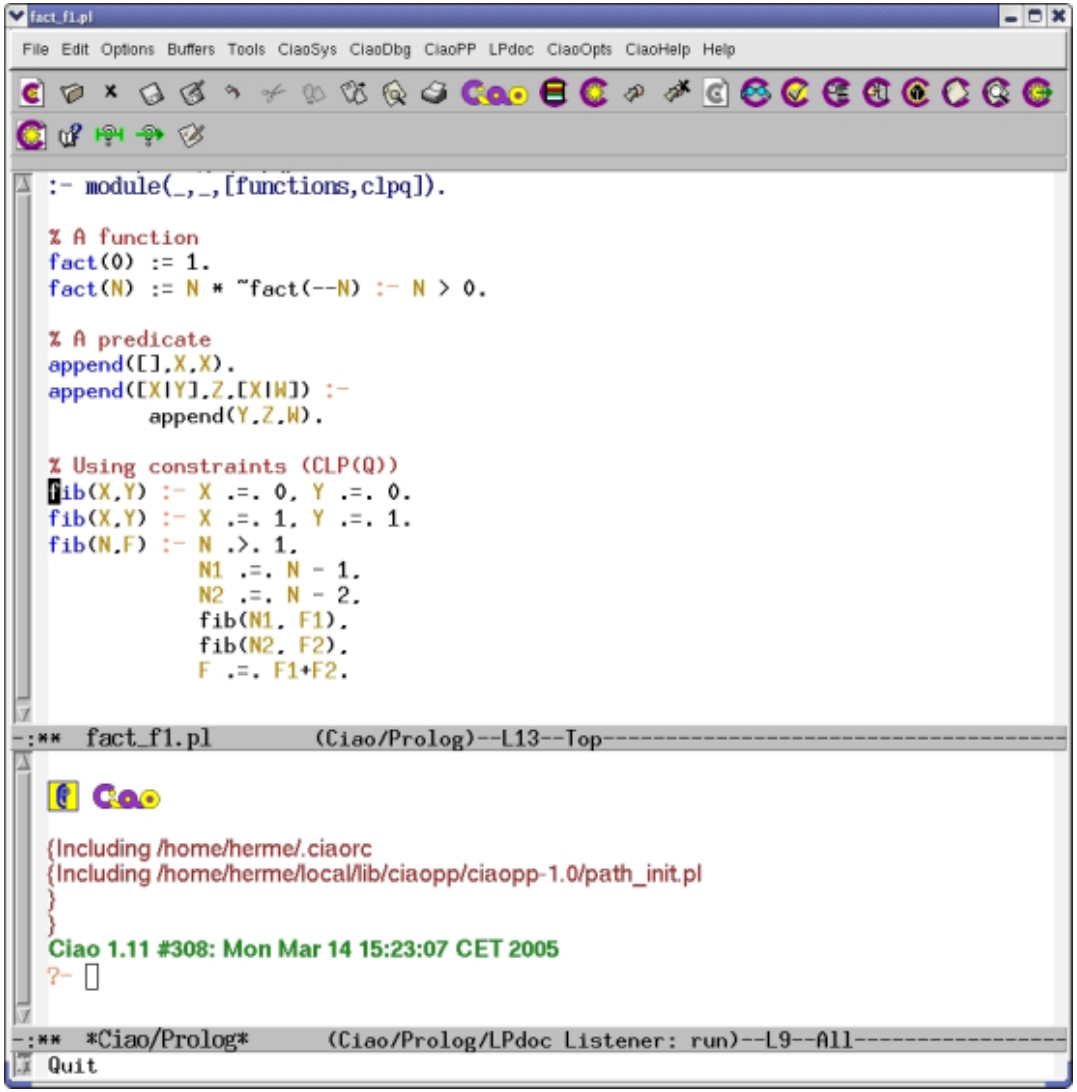
The emacs Interface



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Using the fuzzy Package

Packages can be imported:

- `:- use_package(fuzzy).`

Interface Extensions: New Declaration

- **aggr/1**

```
:- aggr prod.
prod(X,Y,Z):- Z .=. X*Y
```

Aggregators implement the combination of truth values.
Predefined aggregators:

- min
- prod – a × b
- luka – max{0, a + b - 1}
- max
- dprod – a + b - a × b
- dluka – min{a + b, 1}

Interface Extensions: New Predicates

:#/2 and **fuzzy_predicate/1**

- for defining fuzzy predicates by listing a piecewise linear continuous membership function

```
young :\# fuzzy_predicate([(0,1),(35,1),(45,0),(120,0)])
```

:~/2

- for fuzzy clauses:

```
live_long(X,Mu) :~ min
    young(X,X1),
    healthy(X,X2).
```

Interface Extensions: New Operators

- `fnot/1` [1150,fx] - fuzzy negation of a fuzzy predicate
- `:=/2` [1200,xfx]
- `:=/1` [1200,xf]
- `:#/2` [1200,xfx]
- `=>/1` [1175,fx]
- `aggr/1` [1150,fx]
- ...

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```
small :#
    fuzzy_predicate([(1,1),(2,1),(3,0.7),(4,0.3),(5,0),(6,0)]).
large :#
    fuzzy_predicate([(1,0),(2,0),(3,0.3),(4,0.7),(5,1),(6,1)]).

die1(X,M) :~
    small(X,M).
die2(X,M) :~
    large(X,M).

two_dice(X,Y,M):~ prod
    die1(X,M1),
    die2(Y,M2).

sum(2,M) :~
    two_dice(1,1,M1).
sum(5,M) :~ dprod
    two_dice(4,1,M1),
    two_dice(1,4,M2),
    two_dice(3,2,M3),
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-  is one possible solution
- nice IDE for experimenting with fuzziness
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Thanks for Listening

Literature I

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