CSE 307 - Constraint Logic Programming

https://moodle.polytechnique.fr/course/view.php?id=12795

TP1 Initiation to SWI-Prolog

Relational Databases in Datalog

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In all this course, you will use a dialect of Prolog called SWI Prolog. The reference manual of SWI Prolog can be consulted at https://www.swi-prolog.org/pldoc/refman/ but we will not use all features of this programming language originating from the 70's, and will adopt a modern presentation based on constraint programming rather than evaluable predicates for instance.

We recommend you to use

- your favourite editor to edit Prolog files (.pl not to be confused with Perl mode)
- and run the Prolog interpreter in a terminal window.

At each TP session, you will be asked to upload on the Moodle

- a copy of the Prolog file of the session named `tpi.pl`
- completed with your answers to the questions
  - either missing code (i.e. Prolog *facts* and *rules*)
  - or textual answers in the comment blocks created for that
  - or Prolog *queries* with execution traces, similarly copied in the comment blocks

1. Using SWI Prolog

The Prolog file `tp1.pl` contains a small database of family relations defined *in extension* by Prolog facts, and *in intension* by Prolog rules.

```
man(pierre).
man(david).
man(benjamin).

parent(jean, david).
parent(jean, benjamin).

father(X, Y):- parent(X, Y), man(X).

brother(X, Y) :- parent(Z, Y), dif(X, Y), parent(Z, X), man(X).
```

The identifiers stating with a upper case letter or the symbol _ represent a Prolog variable.

Those starting with a lower case letter represent a Prolog constant or a Prolog predicate (or a function but Datalog does not use function symbols).

The SWI-Prolog interpreter is called with the command `swipl` which will bring you in the top level interpreter.

```
prompt% swipl
Welcome to SWI-Prolog (threaded, 64 bits, version 8.2.4)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.

For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?- [tp1].
true.

?- man(pierre).
true.

?- man(catherine).
false.

?- man(xyzzy).
false.

?- parent(X,joel).
X = robert ;
X = lucie.

?- parent(X, joel), dif(X, Y), parent(Y, joel).
X = robert,
Y = lucie ;
X = lucie,
Y = robert ;
false.

?- brother(X,lucie).
X = jean ;
X = michel ;
X = jean ;
X = michel.

?- trace.
true.

[trace]  ?- brother(X,lucie).
   Call: (10) brother(_11284, lucie) ? creep
   Call: (11) parent(_11722, lucie) ? creep
   Exit: (11) parent(pierre, lucie) ? creep
   Call: (11) dif:dif(_11284, lucie) ? creep
   Exit: (11) dif:dif(_11864{dif = ...}, lucie) ? creep
   Call: (11) parent(pierre, _11864{dif = ...}) ? creep
   Exit: (11) parent(pierre, jean) ? creep
   Call: (11) man(jean) ? creep
   Exit: (11) man(jean) ? creep
   Exit: (10) brother(jean, lucie) ? creep
X = jean ;
   Redo: (11) parent(pierre, _11864{dif = ...}) ? creep
   Redo: (11) parent(pierre, _11864{dif = ...}) ? creep
   Exit: (11) parent(pierre, michel) ? creep
   Call: (11) man(michel) ? creep
   Exit: (11) man(michel) ? creep
   Exit: (10) brother(michel, lucie) ? creep
X = michel ;
   Redo: (11) parent(_14182, lucie) ? creep
   Exit: (11) parent(catherine, lucie) ? creep
   Call: (11) dif:dif(_11284, lucie) ? creep
   Exit: (11) dif:dif(_14324{dif = ...}, lucie) ? creep
   Call: (11) parent(catherine, _14324{dif = ...}) ? creep
   Exit: (11) parent(catherine, jean) ? creep
   Call: (11) man(jean) ? creep
   Exit: (11) man(jean) ? creep
   Exit: (10) brother(jean, lucie) ? creep
X = jean ;
   Redo: (11) parent(catherine, _14324{dif = ...}) ? creep
   Redo: (11) parent(catherine, _14324{dif = ...}) ? creep
   Exit: (11) parent(catherine, michel) ? creep
   Call: (11) man(michel) ? creep
   Exit: (11) man(michel) ? creep
   Exit: (10) brother(michel, lucie) ? creep
X = michel.

[trace]  ?- notrace.
true.

[debug]  ?- nodebug.
true.

?-
```

The trace facility allows you to watch the resolution steps (enter Return for the next step).
The variables introduced by the resolution steps are numbered and prefixed with _

The trace is used here to understand why the brothers are found twice in the answers to the query: once through the father relation, Pierre, once through the mother relation, Catherine.

2. Questions on the relational database

Inspect the file `td1.pl` and note that the file contains some more facts and `woman/1` relation.

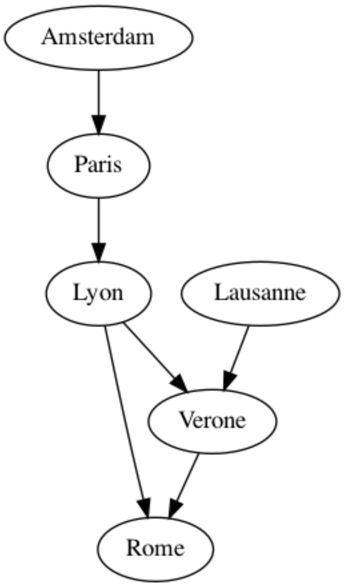
Answer the questions directly in the file tp1.pl either in textual comment blocks or as extra Prolog code you can try by loading the file again.

3. Questions on directed graphs

A directed graph G=(S,A) is composed of a set S of vertices and a set A⊆SxS of couples of vertices called arcs.

A directed graph is acyclic if it contains no circuit.

Let us consider the graph of this simple (but peculiar) route map :



Answer the questions in file `tp1.pl`

Finally, don't forget to upload your file on the Moodle !
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