CS 520 Advanced Programming Languages
Fall Semester, 2009
Doc 1 Prolog Intro
Sept 2, 2009

Reading

Programming in Prolog

Sept 3 Chapters 1 &2

Sept 8 & 10 - Chapters 3-5

Sept 15 & 17 - Chapters 6-8

Prolog

1972 - Created by Alain Colmerauer

Abbreviation for "programmation en logique"

Logic programming

Prolog, Wikipedia, http://en.wikipedia.org/wiki/Prolog, accessed 2009.9.2

Prolog Data Types

Term

Atom

cat mom 'Roger' 'help me'

Number

12 32

Variable

X WhyMe _WhatIsThis

Compound term

mother_child(sally, tom)

[1, 2, 3]

Prolog Program

Contains

- Set of facts
- Rules about the facts

We ask questions about rules and facts

Hello World

display('Hello World').

display(helloWorld).

Addition

X is 1 + 2.

Running the Examples

```
?- display('Hello World').
Hello World
true.

?- display(helloWorld).
helloWorld
true.
```

```
?- X is 1 + 2.
X = 3.

?-
```

Demo Swi-Prolog

```
Al pro 21->swipl
Welcome to SWI-Prolog (Multi-threaded, 32 bits, Version 5.6.64)
Copyright (c) 1990-2008 University of Amsterdam.
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software,
and you are welcome to redistribute it under certain conditions.
Please visit http://www.swi-prolog.org for details.

For help, use ?- help(Topic). or ?- apropos(Word).

?- display('Hello World').
Hello World
true.

?- display(helloWorld).
helloWorld
true.

?- X is 1 + 2.
X = 3.

?-
```

atoms verses Variables

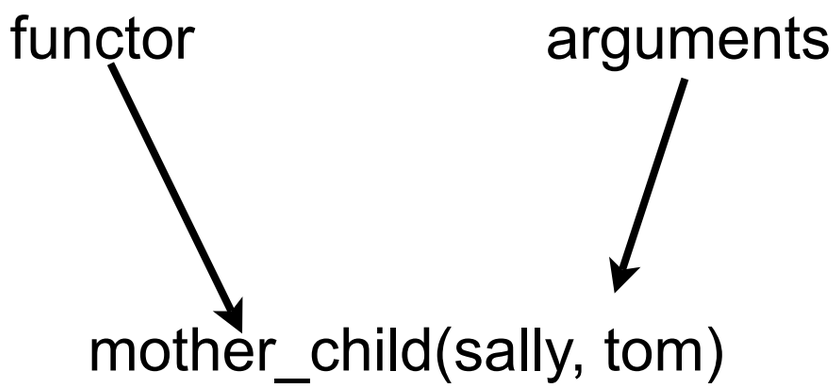
Atoms
- Starts with lower case character
- Surround with single quotes if
  - Contains space
  - Starts with capital letter

Variable
- Starts with capital letter or underscore

What happens here?

?- display(Hello).

More Definitions



functor & arguments are terms

arity - number of arguments

mother_child/2

Prime Number Example

```
% (**) Determine whether a given integer number is prime.

% is_prime(P) :- P is a prime number
%    (integer) (+)

is_prime(2).
is_prime(3).
is_prime(P) :- integer(P), P > 3, P mod 2 =\= 0, \+ has_factor(P,3).

% has_factor(N,L) :- N has an odd factor F >= L.
%    (integer, integer) (+,+)

has_factor(N,L) :- N mod L =:= 0.
has_factor(N,L) :- L * L < N, L2 is L + 2, has_factor(N,L2).
```


Example from https://prof.ti.bfh.ch/hew1/informatik3/prolog/p-99/

Details

Facts

is_prime(2).
is_prime(3).

Rule

is_prime(P) :- integer(P), P > 3, P mod 2 =\= 0, \+ has_factor(P,3).

P is prime if P is an integer and P > 3 and P mod(2) !=0 and
has no factors between P and 3

:- means if
, means and
\+ means not (at least or now)

More Rules

has_factor(N,L) :- N mod L =:= 0.

N has a factor between N and L if N mod(L) = 0

has_factor(N,L) :- L * L < N, L2 is L + 2, has_factor(N,L2).

N has a factor between N and L if
L*L < N and has_factor(N, L + 2) is true

Running ?? the Example?

Place source code in a file called "prime.pl"

```
?- consult(prime).
% prime compiled 0.00 sec, 0 bytes
true.

?- is_prime(101).
true.

?-
```

Some Swi Prolog Documentation

?- manpce.

Opens the XPCE Manual

Second Example - Family

Facts and Rules

```
mother_child(susan, sally).
mother_child(susan, matt).

father_child(tom, sally).
father_child(tom, erica).
father_child(tom, pete).
father_child(mike, tom).
```

```
sibling(X, Y)      :- parent_child(Z, X), parent_child(Z, Y).

parent_child(X, Y) :- father_child(X, Y).
parent_child(X, Y) :- mother_child(X, Y).
```


Example from Prolog, Wikipedia, http://en.wikipedia.org/wiki/Prolog

Syntax

mother_child(susan, sally).

What is

mother_child

susan

sally

Semantics

mother_child(susan, sally).

Stating a fact about a relationship between susan & sally

What do we mean when we say

susan is the mother, sally is the child

And Rule

```
sibling(X, Y)      :- parent_child(Z, X), parent_child(Z, Y).
```

Or

```
parent_child(X, Y) :- father_child(X, Y).
parent_child(X, Y) :- mother_child(X, Y).
```


For now we can consider this an or. We will get a more precise definition later and an or operator

Some Questions

?- consult(family).
% family compiled 0.00 sec, 64 bytes
true.

?- father_child(tom,sally).
true .

?- father_child(tom,pete).
true.

Asking for More Answers

?- father_child(tom,X).
X = sally .

?- father_child(tom,X).
X = sally ;
X = erica .

?- father_child(tom,X).
X = sally ;
X = erica ;
X = pete.

?-

The ';' means to continue to look for another answer

Order of the Rules Matters

```
father_child(tom, sally).
father_child(tom, erica).
father_child(tom, pete).
```

```
?- father_child(tom,X).
X = sally .
```

```
father_child(tom, pete).
father_child(tom, sally).
father_child(tom, erica).
```

```
?- father_child(tom,X).
X = pete .
```

More Complex Questions

?- sibling(sally,pete).
true .

?- sibling(sally,matt).
true .

?- sibling(matt,sally).
true .

?- sibling(matt,pete).
false.

Using A Variable

?- sibling(sally,X).
X = sally ;
X = erica ;
X = pete ;
X = sally ;
X = matt .

Using Two Variables

?- sibling(X,Y).
X = sally,
Y = sally ;
X = sally,
Y = erica ;
X = sally,
Y = pete ;
X = erica,
Y = sally ;
X = erica,
Y = erica ;
X = erica,
Y = pete ;
X = pete,
Y = sally ;
X = pete,
Y = erica

trace

Shows what rules/facts are being used

```
?- trace(father_child).
%         father_child/2: [call, redo, exit, fail]
true.

[debug]  ?- sibling(sally,pete).
sibling
 T Call: (10) father_child(_L176, sally)
 T Exit: (10) father_child(tom, sally)
 T Call: (10) father_child(tom, pete)
 T Exit: (10) father_child(tom, pete)
true .
```

More Trace

```
?- trace(father_child).
%        father_child/2: [call, redo, exit, fail]
true.

[debug]  ?- trace(parent_child).
%        parent_child/2: [call, redo, exit, fail]
true.

[debug]  ?- sibling(sally,pete).
sibling
 T Call: (9) parent_child(_L176, sally)
 T Call: (10) father_child(_L176, sally)
 T Exit: (10) father_child(tom, sally)
 T Exit: (9) parent_child(tom, sally)
 T Call: (9) parent_child(tom, pete)
 T Call: (10) father_child(tom, pete)
 T Exit: (10) father_child(tom, pete)
 T Exit: (9) parent_child(tom, pete)
true
```