

Logic Programming (PLP 11.3)

Prolog: Arithmetic, Equalities, Operators, I/O,
Natural Language Parsing

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Arithmetic Goals

$N > M$

$N < M$

$N = < M$

$N > = M$

- N and M must be bound to numbers for these tests to *succeed* or *fail*.
- X **is** $1+2$ is used to *assign* numeric value of right-hand-side to variable in left-hand-side.

Loop Revisited

```
natural(1).  
natural(N) :- natural(M), N is M+1.  
my_loop(N) :- N>0,  
              natural(I),  
              write(I), nl,  
              I=N,  
              !.  
  
my_loop(_).
```

Also called *generate-and-test*.

= is not equal to == or ::=

$X=Y$

$X\backslash=Y$

test whether X and Y **can be** or **cannot be** *unified*.

$X==Y$

$X\backslash==Y$

test whether X and Y are currently *co-bound*, i.e., have been bound to, or share the same value.

$X>::=Y$

$X=\backslash=Y$

test *arithmetic* equality and inequality.

More equalities

$X=@=Y$

$X\backslash=@=Y$

test whether X and Y are *structurally identical*.

- $=@=$ is weaker than $==$ but stronger than $=$.
- Examples:

$a=@=A$

false

$A=@=B$

true

$x(A, A) =@= x(B, C)$

false

$x(A, A) =@= x(B, B)$

true

$x(A, B) =@= x(C, D)$

true

More on equalities

$$X==Y \Rightarrow X=@=Y \Rightarrow X=Y$$

but not the other way (\Leftarrow).

- If two terms are currently **co-bound**, they are **structurally identical**, and therefore they can **unify**.
- Examples:

$a=@=A$	false
$A=@=B$	true
$x(A,A)=@=x(B,C)$	false
$x(A,A)=@=x(B,B)$	true
$x(A,B)=@=x(C,D)$	true

Prolog Operators

```
:- op(P, T, O)
```

declares an operator symbol O with precedence P and type T .

- Example:

```
:- op(500, xfx, 'has_color')
```

```
a has_color red.
```

```
b has_color blue.
```

then:

```
?- b has_color C.
```

```
C = blue.
```

```
?- What has_color red.
```

```
What = a.
```

Operator precedence/type

- Precedence **P** is an integer: the larger the number, the less the precedence (*ability to group*).
- Type **T** is one of:

T	Position	Associativity	Examples
xfx	Infix	Non-associative	<code>is</code>
xfy	Infix	Right-associative	<code>,</code> <code>;</code>
yfx	Infix	Left-associative	<code>+</code> <code>-</code> <code>*</code> <code>/</code>
fx	Prefix	Non-associative	<code>?-</code>
fy	Prefix	Right-associative	
xf	Postfix	Non-associative	
yf	Postfix	Left-associative	

Testing types

atom(X)

tests whether X is an *atom*, e.g., 'foo', bar.

integer(X)

tests whether X is an *integer*; it does not test for complex terms, e.g., `integer(4/2)` fails.

float(X)

tests whether X is a *float*; it matches exact type.

string(X)

tests whether X is a *string*, enclosed in `` ... ``.

Prolog Input

seeing (X)

succeeds if X is (or can be) bound to *current read port*.

X = `user` is keyboard (standard input.)

see (X)

opens port for input file bound to X, and makes it *current*.

seen

closes current port for input file, and makes `user` *current*.

read (X)

reads Prolog type expression from *current* port, storing value in X.

end-of-file

is returned by **read** at *<end-of-file>*.

Prolog Output

telling (X)

succeeds if X is (or can be) bound to *current output port*.

X = user is screen (standard output.)

tell (X)

opens port for output file bound to X, and makes it *current*.

told

closes current output port, and reverses to screen output
(makes user *current*.)

write (X)

writes Prolog expression bound to X into *current* output port.

nl

new line (line feed).

tab (N)

writes N spaces to current output port.

I/O Example

```
browse(File) :-
    seeing(Old),          /* save for later */
    see(File),           /* open this file */
    repeat,
    read(Data),          /* read from File */
    process(Data),
    seen,                /* close File */
    see(Old),           /* prev read source */
    !.                  /* stop now */

process(end_of_file) :- !.
process(Data) :- write(Data), nl, fail.
```

First-Class Terms Revisited

<code>call(P)</code>	Invoke predicate as a goal.
<code>assert(P)</code>	Adds predicate to database.
<code>retract(P)</code>	Removes predicate from database.
<code>functor(T, F, A)</code>	Succeeds if T is a <i>term</i> with <i>functor</i> F and <i>arity</i> A.
<code>findall(F, P, L)</code>	Returns a list L with all elements F satisfying predicate P
<code>clause(H, B)</code>	Succeeds if the clause <code>H :- B</code> can be found in the database.

Natural Language Parsing

(Example from "Learn Prolog Now!" Online Tutorial)

```
word(article,a) .
```

```
word(article,every) .
```

```
word(noun,criminal) .
```

```
word(noun,'big kahuna burger') .
```

```
word(verb,eats) .
```

```
word(verb,likes) .
```

```
sentence(Word1,Word2,Word3,Word4,Word5) :-
```

```
    word(article,Word1) ,
```

```
    word(noun,Word2) ,
```

```
    word(verb,Word3) ,
```

```
    word(article,Word4) ,
```

```
    word(noun,Word5) .
```

Parsing natural language

- *Definite Clause Grammars (DCG)* are useful for natural language parsing.
- Prolog can load DCG rules and convert them automatically to Prolog parsing rules.

DCG Syntax

-->

DCG *operator*, e.g.,

sentence-->subject, verb, object.

Each goal is assumed to refer to the *head* of a DCG rule.

{prolog_code}

Include Prolog code in generated parser, e.g.,

subject-->modifier, noun, {write('subject') }.

[terminal_symbol]

Terminal symbols of the grammar, e.g.,

noun-->[cat].

Natural Language Parsing

(example rewritten using DCG)

sentence --> article, noun, verb, article, noun.

article --> [a] | [every].

noun --> [criminal] | ['big kahuna burger'].

verb --> [eats] | [likes].

Exercises

12. How would you translate DCG rules into Prolog rules?
13. PLP Exercise 11.8 (pg 571).
14. PLP Exercise 11.14 (pg 572).