

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.

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Loop Revisited

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

Also called *generate-and-test*.

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= 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.

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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

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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

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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.
```

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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	

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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 `` ... ''.

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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>*.

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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.

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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.
```

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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).
```

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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.

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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].
```

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Natural Language Parsing

(example rewritten using DCG)

```
sentence --> article, noun, verb, article, noun.
article --> [a] | [every].
noun --> [criminal] | ['big kahuna burger'].
verb --> [eats] | [likes].
```

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Exercises

12. How would you translate DCG rules into Prolog rules?
13. PLP Exercise 11.26 (pg 655).
14. *PLP Exercise 11.30 (pg 655).

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