Introduction to Prolog

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LOG: PROgramming in LOGic

loped in 1970 in France

arative Language unlike LISP, PASCAL, C, . . . v
procedural languages

ssignment statements

No got

No if-then-else structures

No loops

The user describes the problem in the form
of facts and rules and PROLOG applies

og is a combination of the following key ideas:

then rules with variables

elational databases (w/ terms for data structurin

ackward Chaining to try to prove goals

nification to match goals to rule conclusions.

acktracking to try all possibilities

e are several free PROLOG Compilers available

/I Prolog is a non-commercial product. This is

PCs in Memorial.

nzi! Prolog is available on a 90 day free trial offe

sual Prolog has a student version

rawberry Prolog is a nice light version

OLOG works with facts, relations and rules.

act is a unit of information which is assumed to
ue.

elation combines two or more facts.

ule is a conditional assertion of a fact.

scription of Ann's and Sue's world

Description	PROLOG Version
oll is a toy.	toy(doll).
opy is a toy.	toy(snoopy).
plays with Snoopy.	plays(ann,snoopy).
likes everything Ann likes.	likes(sue,Y) :- likes(ann,Y);
likes the toys she plays with	likes(ann,X) :- toy(X),plays(a

Every PROLO
is a claus

A constant is lower case

A variable is upper c

n the description of Ann's and Sue's world, the
stion might be asked: "What does Sue like?"

PROLOG: |?-likes(sue,X).

X = snoopy

PROCESS: Prolog tries to find a value for all variables in a query so as to make the query true.

Sue likes X if Ann likes X

Ann likes X if X is a toy and Ann plays with X

Snoopy is a toy and Ann plays with Snoopy

So, Sue likes Snoopy

nter a PROLOG program:

|?-consult(user).

<rules/facts/relations>

end-of-file.

or CRTL - D

Alternative: Save the program in a file and use |?-consult(<filename>).

uery returns a single answer, if you want to find ernative answers, respond to a PROLOG result th a “**;**” and PROLOG will seek another way to ake the query true.

ll report the new answer or “**no**” if there are not her solutions.

Query Forms

```
|?- likes(sue,snoopy).
Yes
|?-likes(sue,ann).
no
```

```
|?- toy(X),likes(sue,X)
```

Prolog Programming

DAL: Build a travel database and write PROLOG
uery routines

gin by defining the structure of any relationships

travel(carrier,origin,destination,ty

travel(amtrak, new-york, boston,train).
travel(nj-transit, new-york, boston,train).
travel(amtrak, boston, portland,train).
travel(greyhound, boston, portland,bus).
travel(amtrak, new-york, washington,train)

olog program consists of rules and facts

L: Construct a rule that will identify competitors

is the definition of a competitor
in this small travel world?

Two carriers are competitors if the
travel between the same two cities

variables

if

and

anonymous va

```
competitor(Carrier1,Carrier2) :-
    travel(Carrier1, CityA, CityB, _),
```

DAL: Develop a rule that will determine if it is ossible to travel between two cities

We can travel between A and B if there is a carrier which starts at A and ends at B.

```
can-travel(CityA, CityB) :-
    travel(_, CityA, CityB, _).
```

Don't care about the carrier name

or type

n this travel base and the can-travel rule what is the
onse to the query:

n-travel(new-york,portland).

t correct? If not, what is the problem?

w should a more general can-travel rule be expressed
lish?

travel(amtrak, new-york, boston,tr
travel(nj-transit, new-york, boston,
travel(amtrak, boston, portland,tr
travel(greyhound, boston, portland
travel(amtrak, new-york, washington

n travel from A to B if we can travel
A to C and then from C to B for any
mber of intermediate cities, C.

ore general can-travel rule involves two versions
he can-travel relation:

ROLOG will try this first

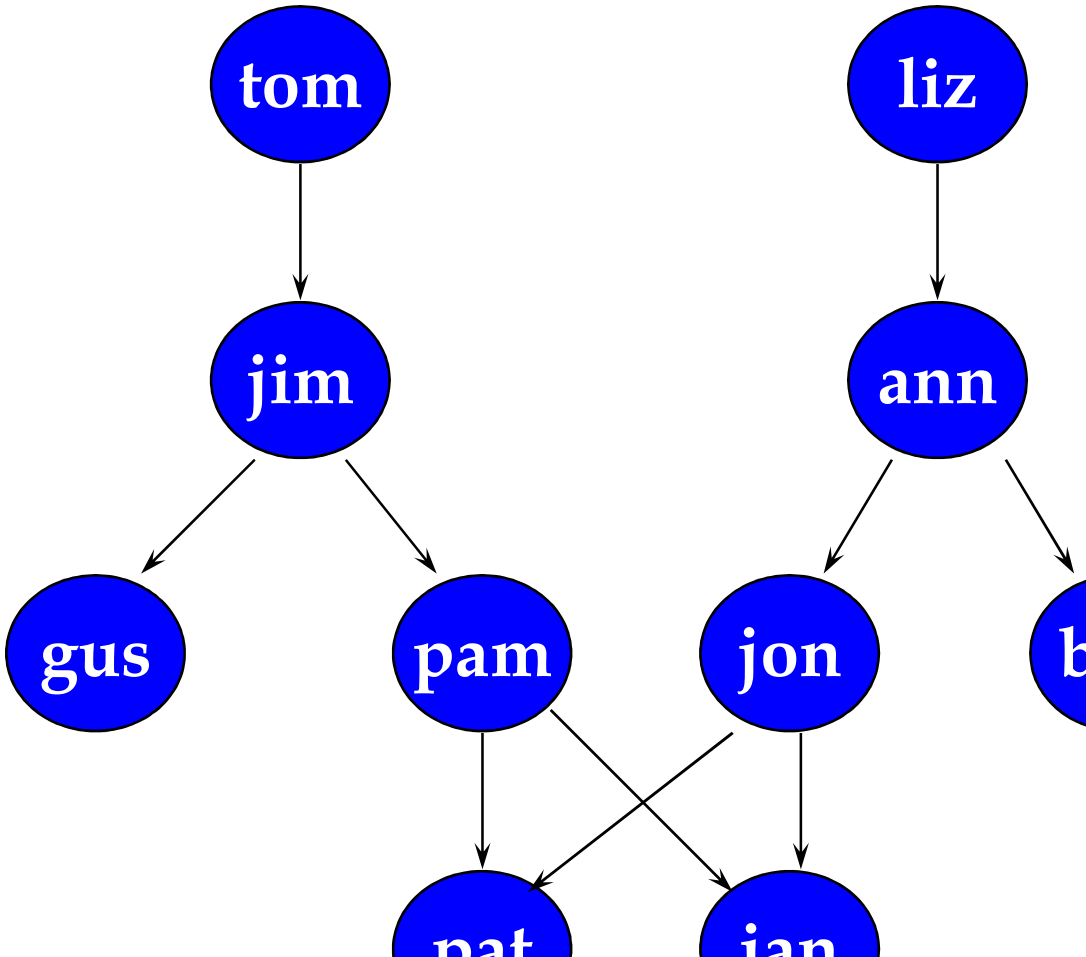
```
can-travel(CityA, CityB) :-
    travel(_, CityA, CityB, _).
```

n this rule if the first fails

```
can-travel(CityA, CityB) :-
    travel(_, CityA, CityC, _),
    can-travel(CityC, CityB).
```

n a family tree – represent it in Prolog:

```
parent(tom, jim).
parent(jim, gus).
parent(jim, pam).
parent(pam, pat).
parent(pam, jan).
parent(liz, ann).
parent(ann, jon).
parent(ann, bob).
parent(jon, pat).
```



can ask several questions about this database:

am a parent of pat?

```
arent(pam, pat).
    yes
```

Is pam a parent of a

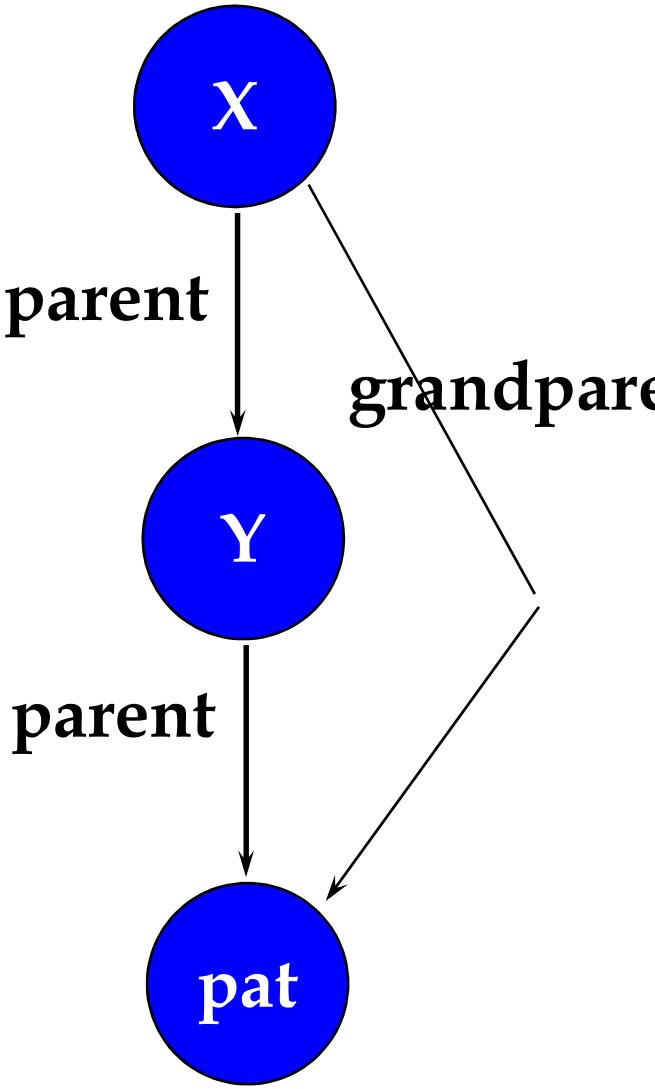
```
?- parent(pam, X)
    X = pat     ;
    X =  jan    ;
        no
```

Do gus and jan share the same parent?

```
?- parent(X, gus), parent(X, jan)
        X = jim
```

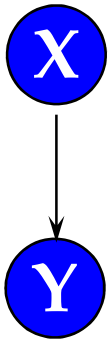
etermine a grandparent:

?- parent(X,Y),parent(Y,pat).
X = jim
Y = pam



For parents

decessor(X, Y) :- parent(X, Y).

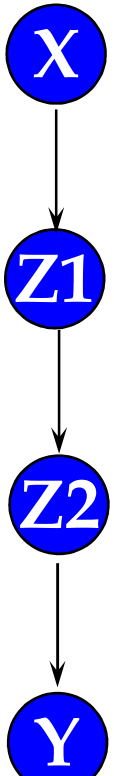


For grandparents

predecessor(X, Y) :-
arent(X, Z1), parent(Z1, Y).

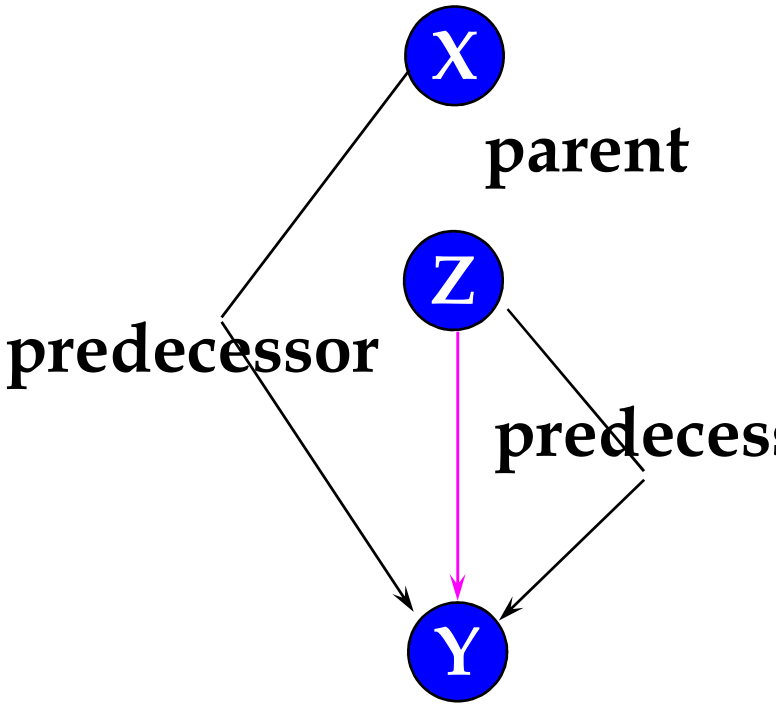
For great grandparents

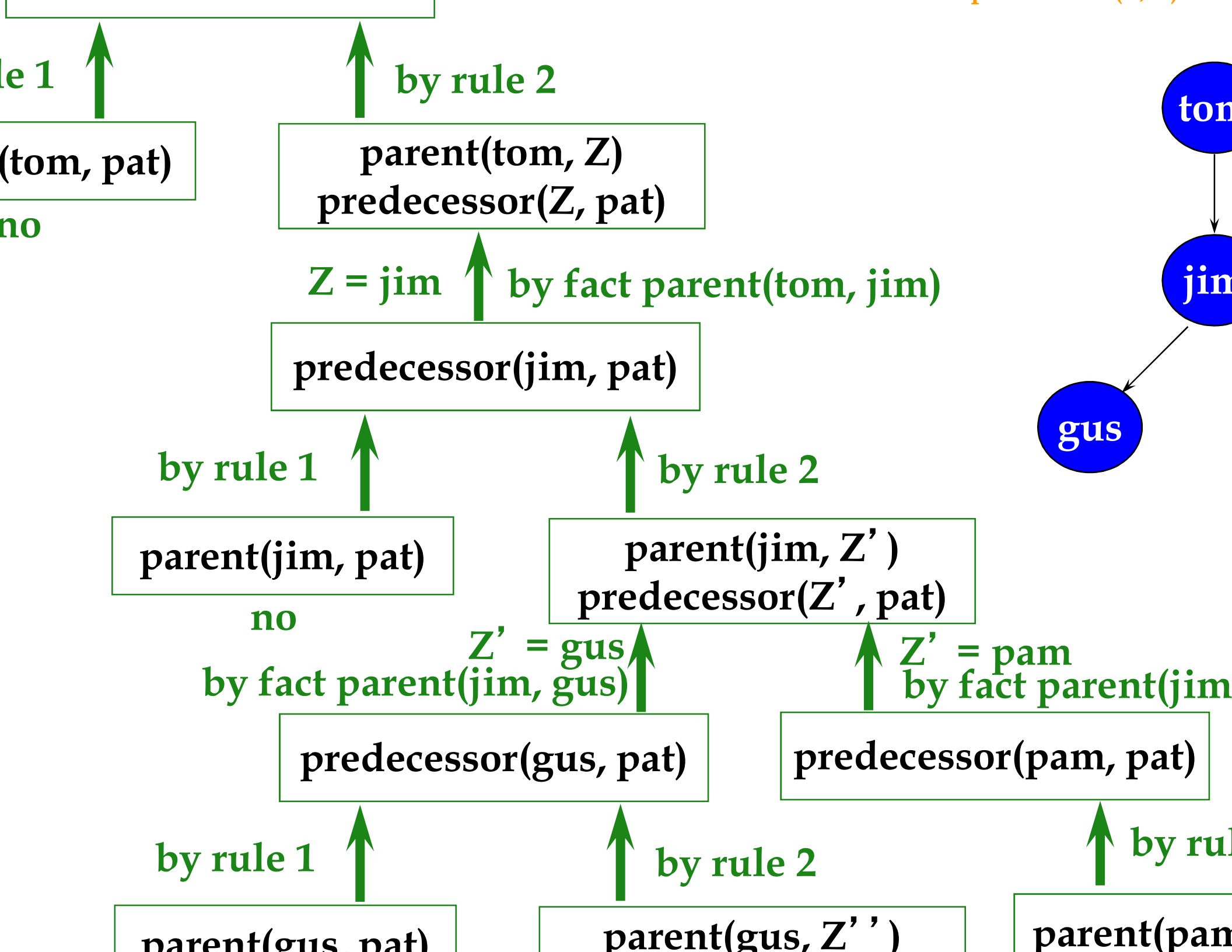
redecessor(X, Y) :- parent(X, Z1),
parent(Z1, Z2),
parent(Z2, Y).



```
redecessor(X, Y) :- parent(X, Y).

edecessor(X, Y) :- parent(X, Z),
                   predecessor(Z, Y).
```




le 1
(tom, pat)
no
by rule 2
parent(tom, Z)
predecessor(Z, pat)
Z = jim
by fact parent(tom, jim)
predecessor(jim, pat)
by rule 1
parent(jim, pat)
no
by rule 2
parent(jim, Z')
predecessor(Z' , pat)
Z' = gus
by fact parent(jim, gus)
Z' = pam
by fact parent(jim
predecessor(gus, pat)
predecessor(pam, pat)
by rule 1
by rule 2
by rul
parent(gus, pat)
parent(gus, Z' ')
parent(pam
tom
jim
gus

g searches for clauses (rules & facts) from top t
tom

g attempts goals from left to right

ood advice

Put simplest clauses first

Put simplest goals on the left

though logically correct, Prolog can’t handle the
ollowing

```
predecessor(X, Y) :- predecessor(Z, Y), paren
Z).
predecessor(X, Y) :- parent(X, Y).
```

Prolog I/O

ere are two I/O commands in PROLOG

te(X). - writes a term X to the current output

d(X). - reads a term X from the current input.

EXAMPLE: given color(blue) color(red) the

```
|?- color(X), write(X), nl.
blue   ;
```

```
|?- read(X), write(X).
test.
```

s useful to provide a prompt for a read operation

Define a rule input(X)

Write the prompt

Read the value

```
input(X) :-
    write( '>' ),
    read(X).
```

Running Prolog

n SWI and a Prolog window opens

t a session

r the code

er a query

```
SWI-Prolog (version 3.1.0)

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

?- consult(user).
|: parent(tom, jim).
|: parent(jim, gus).
|: parent(jim, pam).
|: parent(pam, pat).
|: parent(pam, jan).
|: parent(liz, ann).
|: parent(ann, jon).
|: parent(ann, bob).
|: parent(jon, pat).
|: parent(jon, jan).
|:
user compiled, 89.41 sec, 952 bytes.

Yes
?- parent(X, jim).

X = tom ;

No
?-
```

save a program and run it at a later me

reate the program as a set of rules and facts in a SCII file

ave it with a .pl extension

art SWI Prolog and enter

consult(<filename>).

he file will be read into Prolog and you are now ady to enter queries

eate a text file with the following set of rules and
cts:

```
arent(tom, jim).
arent(jim, gus).
arent(jim, pam).
arent(pam, pat).
arent(pam, jan).
arent(liz, ann).
arent(ann, jon).
arent(ann, bob).
arent(jon, pat).
```

New Facts

```
female(pam).
female(pat).
female(liz).
female(ann).
female(jan).
male(tom).
male(jim).
male(gus).
male(jon).
male(bob).
```

Mother Rule:

X is the mother of
X is a parent of Y a
X is a female.

```
mother(X,Y):-
parent(X,Y),female
```

SWI and consult your program file:

e a query

```
SWI-Prolog (version 4.0.9)
Copyright (c) 1990-2000 University of Amsterdam.
Copy policy: GPL-2 (see www.gnu.org)

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

?- consult(\family).
% \family compiled 0.00 sec, 2,412 bytes

Yes
?- mother(X, pat).

X = pam

Yes
?-
```

Prolog Examples

g the family tree data base consider the rule:

```
ster(X, Y) :- parent(Z, X), parent(Z, Y),
male(X).
```

nfortunately Prolog succeeds on

```
sister(ann, ann).
```

olution

```
sister(X, Y) :- parent(Z, X), parent(Z, Y), female(X
X\=Y.
```

assignment like statement is in the form:

X is E .

The arithmetic expression **E** is evaluated and the
ariable **X** is instantiated to the result.

```
?- N is 3 *
4.

N = 12

yes
```

```
?- X is 3 +
4/5.

X = 3.8
```

BLEM: Find the factorial of a nonnegative integ

= is a test, not an assignment

```
torial(N,F) :- N=0, F=1.

torial(N,F) :- N>0,
               N1 is N - 1,
               factorial(N1,F1),
               F is N*F1.
```

ENGLISH: F is t
factorial of N if eit
N=0 and F = 1 or N
and F=N*F1 whe
F1 is the factorial o
1.

e a rule to find the maximum of two numbers X
Y

Relation: **max(X,Y,Max)**

sh: X is the max if X > Y

Max(X,Y,X) :- X > Y

sh: Y is the max if Y >= X

Max(X,Y,Y) :- Y >= X

oblem: Find the square of a number

```
quares :-write( 'Next item please: '),
read(X),
process(X).

cess(stop) :- !.

process(N) :-C is N * N,
e( 'Square of '),write(N),write( ' is '),
write(C), nl,
dosquares.
```

```
?- dosquares.
Next item please: 5.
Square of 5 is 25.
Next item please: 12
Square of 12 is 144
Next item please:
stop
yes
```