Name : Brijesh Rameshbhai Rohit

Admission number: U19CS009

PINCIPLES OF PROGRAMMING LANGUAGES

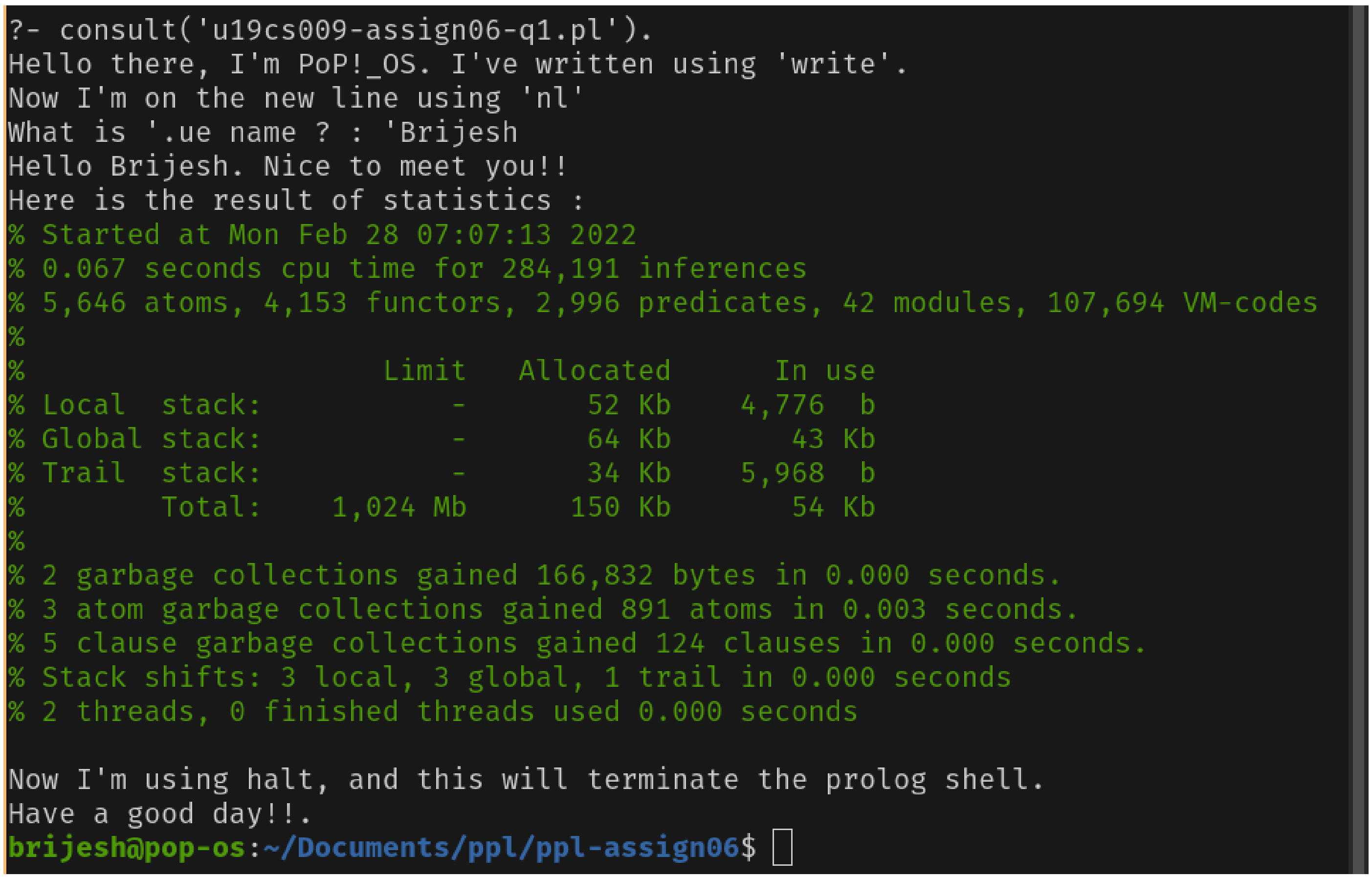
Assignment - 06

1.Write a program in Prolog that uses following predicates
Write, nl, read, consult,halt,statistics.

CODE=>

```prolog
%U19CS009
%BRIJESH ROHIT

%start when program is consulted
:-
    write("Hello there, I'm PoP!_OS. I've written using 'write'."),
    nl, write("Now I'm on the new line using 'nl'"),
    write("\nWhat is youe name ? : "), read(Name),
    write("Hello "),write(Name),write(". Nice to meet you!!"),nl,
    write("Here is the result of statistics : "),
    statistics,nl,
    write("Now I'm using halt, and this will terminate the prolog shell.\nHave a
good day!!."),nl,
    halt.
```

OUTPUT=>



```
?- consult('u19cs009-assign06-q1.pl').
Hello there, I'm PoP!_OS. I've written using 'write'.
Now I'm on the new line using 'nl'
What is '.ue name ? : 'Brijesh
Hello Brijesh. Nice to meet you!!
Here is the result of statistics :
% Started at Mon Feb 28 07:07:13 2022
% 0.067 seconds cpu time for 284,191 inferences
% 5,646 atoms, 4,153 functors, 2,996 predicates, 42 modules, 107,694 VM-codes
%
%                     Limit   Allocated      In use
% Local  stack:           -       52 Kb    4,776  b
% Global stack:           -       64 Kb       43 Kb
% Trail  stack:           -       34 Kb    5,968  b
%        Total:    1,024 Mb      150 Kb       54 Kb
%
% 2 garbage collections gained 166,832 bytes in 0.000 seconds.
% 3 atom garbage collections gained 891 atoms in 0.003 seconds.
% 5 clause garbage collections gained 124 clauses in 0.000 seconds.
% Stack shifts: 3 local, 3 global, 1 trail in 0.000 seconds
% 2 threads, 0 finished threads used 0.000 seconds

Now I'm using halt, and this will terminate the prolog shell.
Have a good day!!.
brijesh@pop-os:~/Documents/ppl/ppl-assign06$
```

2. Try to answer the following questions first "by hand" and then verify your answers using a Prolog interpreter.

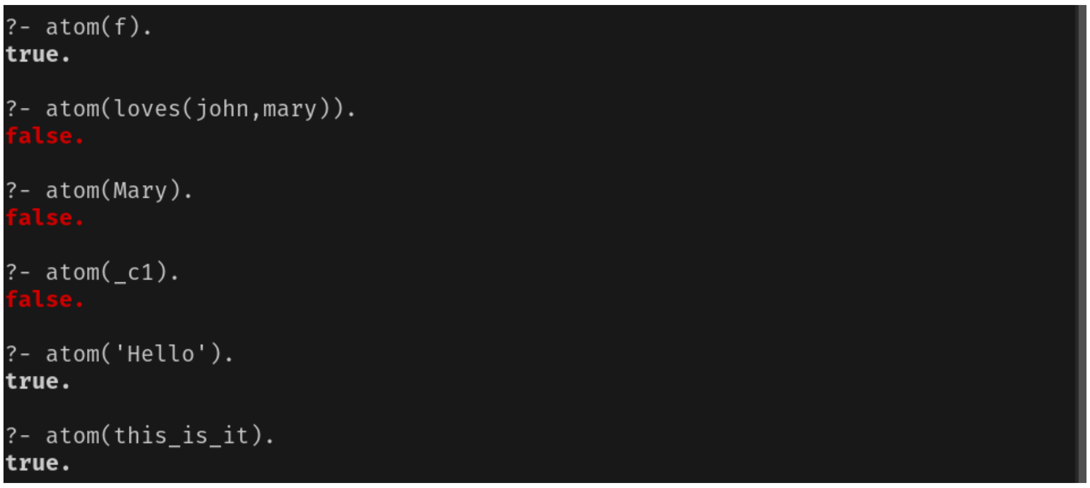
(a) Which of the following are valid Prolog atoms?

f, loves(john,mary), Mary, _c1, 'Hello', this_is_it

Ans: atoms are : f, 'Hello', this_is_it,

loves(john,mary) is fact,

Mary, _c1 are variables.

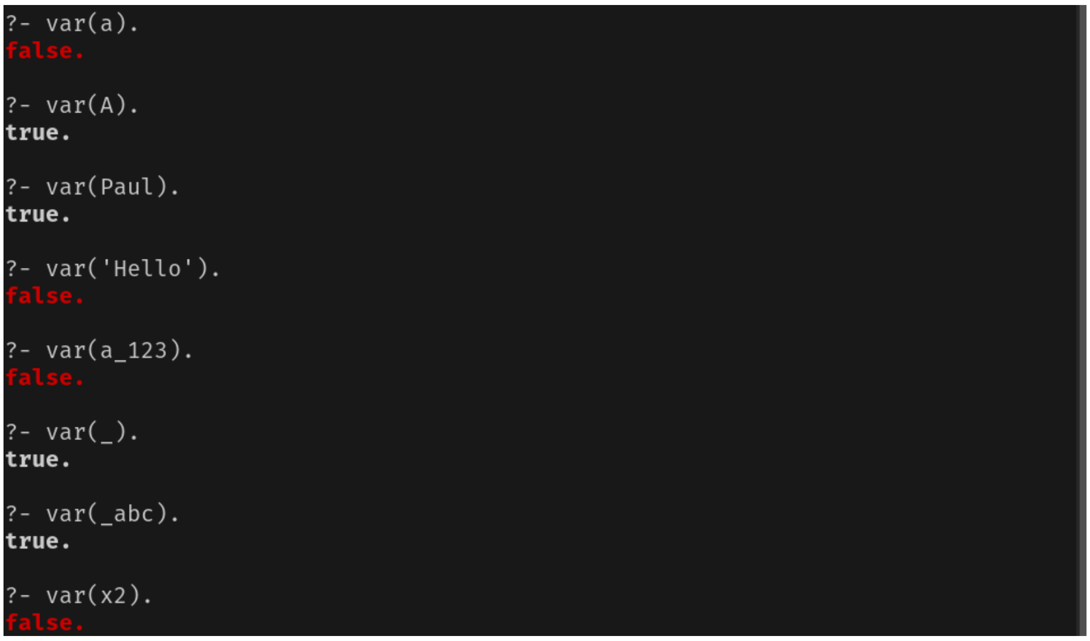


```
?- atom(f).
true.

?- atom(loves(john,mary)).
false.

?- atom(Mary).
false.

?- atom(_c1).
false.

?- atom('Hello').
true.

?- atom(this_is_it).
true.
```

(b) Which of the following are valid names for Prolog variables?

a, A, Paul, 'Hello', a_123, _, _abc, x2

Ans: atoms are : A, Paul, _,_abc,



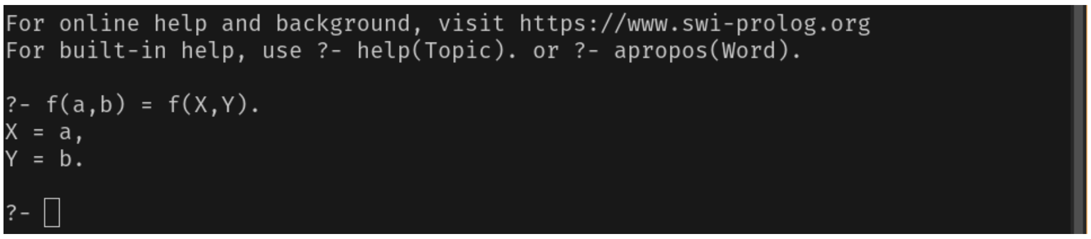
```
?- var(a).
false.

?- var(A).
true.

?- var(Paul).
true.

?- var('Hello').
false.

?- var(a_123).
false.

?- var(_).
true.

?- var(_abc).
true.

?- var(x2).
false.
```

(c) What would a Prolog interpreter reply given the following query?

?- f(a, b) = f(X, Y).

Ans: X=a,

Y=b.



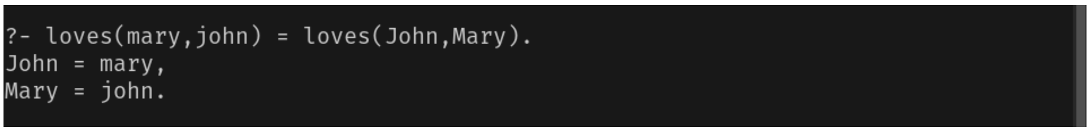
```
For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).

?- f(a,b) = f(X,Y).
X = a,
Y = b.

?- 
```

(d) Would the following query succeed?

?- loves(mary, john) = loves(John, Mary).

Ans: John=mary,

Mary=john.



```
?- loves(mary,john) = loves(John,Mary).
John = mary,
Mary = john.
```

Why?

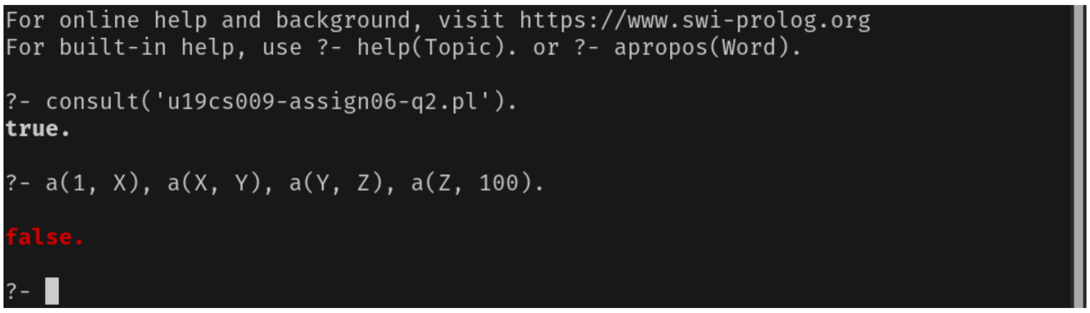
Ans: This is because initially John and Mary are variables which do not hold any value. Thus, the first '=' would act as assignment rather than comparison and John would store mary, Mary will store john.

(e) Assume a program consisting only of the fact

a(B, B).

has been consulted by Prolog. How will the system react to the following query? ?- a(1, X), a(X, Y), a(Y, Z), a(Z, 100).

Ans: False.



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

?- consult('u19cs009-assign06-q2.pl').
true.

?- a(1, X), a(X, Y), a(Y, Z), a(Z, 100).

false.

?- 
```

Why?

Ans: As a(B,B). is the only fact in the knowledge base, it will return true only when Both the variables store same value.

When we use a(1, X), a(X, Y), a(Y, Z), a(Z, 100). as command,

Because of 1st call X would hold value 1,

And Y will also hold value 1 because of call 2,

And Z will also hold value 1 because of call 3,

Now since Z is not empty variable anymore, a(Z,100) would now perform comparison rather than assignment thus it would check if a(Z,100) exist in the knowledge base or not.

a(Z,100) is now same as a(1,100) which would never exist in the knowledge base due a(B,B) being the only fact.

3. Read the section on matching again and try to understand what's happening when you submit the following queries to Prolog.

(a) ?- myFunctor(1, 2) = X, X = myFunctor(Y, Y).

Ans: X would hold myFunctor(1,2) as value but when we write X= myFuntor(Y,Y) next instead of assignment comparison happens and because the two parameters inside myFunctor should be different and not the same (Y,Y) for X we get false as result.

If we replace the query X=myFunctor(Y,Y) with X=myFunctor(Y,Z)

then Y would hold value 1 and Z would hold value 2. Hence the result would be :

Y=1,

Z=2.

(b) ?- f(a, _, c, d) = f(a, X, Y, _).

Ans: The result would be Y=c. Since comparison is taking place, each parameter will be compared.

1. 1st parameter is same in both the predicates.

2. 2nd parameter of LHS is '_'meaning any value thus does not matter what parameter is there in RHS.

3. 3rd parameter in LHS is 'c' which would be assigned to variable 'Y'.

4. 4th parameter of RHS is '_'again ignored.

Hence output would be:

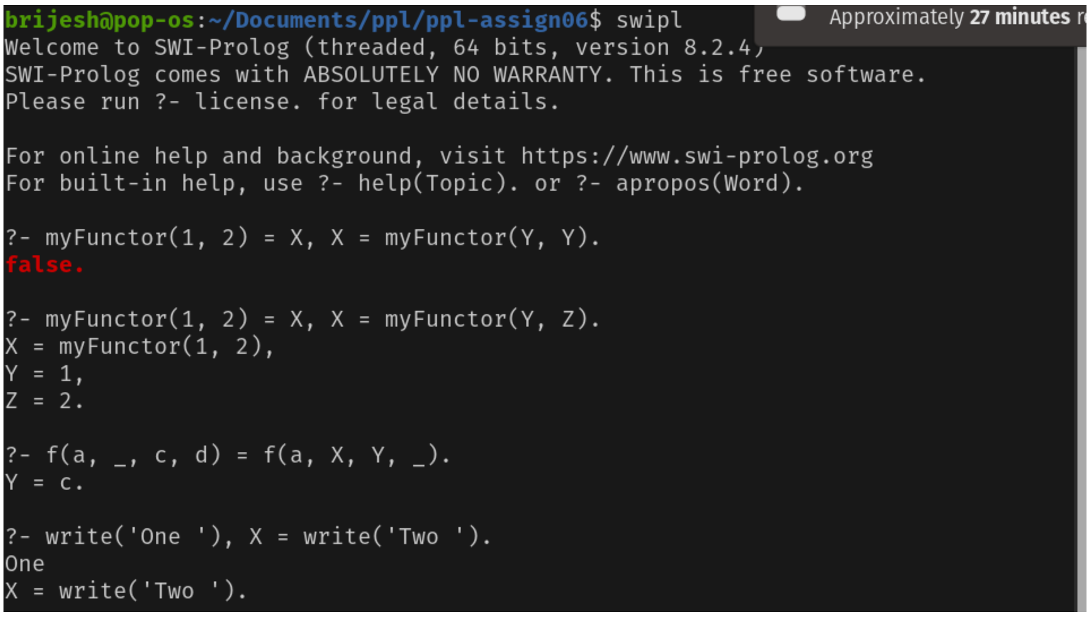
Y = c.

(c) ?- write('One '), X = write('Two ').

Ans: The write('two') would be assigned to X instead of being executed. Hence the result would be :

One

X=write('Two').



```
brijesh@pop-os:~/Documents/ppl/ppl-assign06$ 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).

?- myFunctor(1, 2) = X, X = myFunctor(Y, Y).
false.

?- myFunctor(1, 2) = X, X = myFunctor(Y, Z).
X = myFunctor(1, 2),
Y = 1,
Z = 2.

?- f(a, _, c, d) = f(a, X, Y, _).
Y = c.

?- write('One '), X = write('Two ').
One
X = write('Two ').
```

4. Draw the family tree corresponding to the following Prolog program:female(mary).

```
female(sandra).
female(juliet).
female(lisa).
male(peter).
male(paul).
male(dick).
male(bob).
male(harry).
parent(bob, lisa).
parent(bob, paul).
parent(bob, mary).
parent(juliet, lisa).
parent(juliet, paul).
parent(juliet, mary).


parent(peter, harry).
parent(lisa, harry).
parent(mary, dick).
parent(mary, sandra).
```

After having copied the given program, define new predicates (in terms of rules using male/1, female/1 and parent/2) for the following family relations:

(a) father
(b) sister
(c) grandmother
(d) cousin

You may want to use the operator \=, which is the opposite of =. A goal like X \= Y succeeds, if the two terms X and Y cannot be matched.

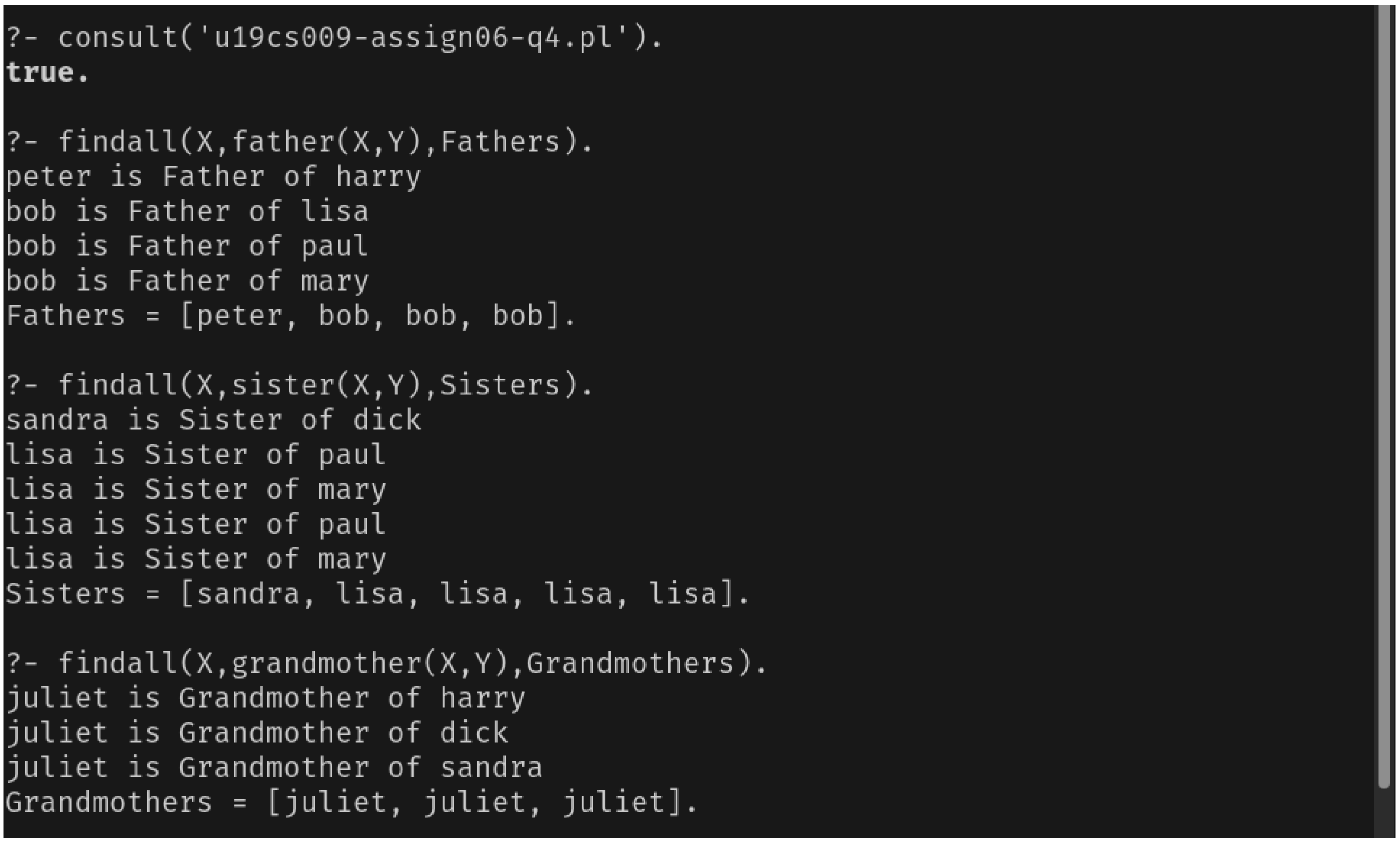
Example: X is the brother of Y, if they have a parent Z in common and if X is male and if X and Y don't represent the same person. In Prolog this can be expressed through the following rule:

```
brother(X, Y) :-
parent(Z, X),
parent(Z, Y),
male(X),
X \= Y.
```

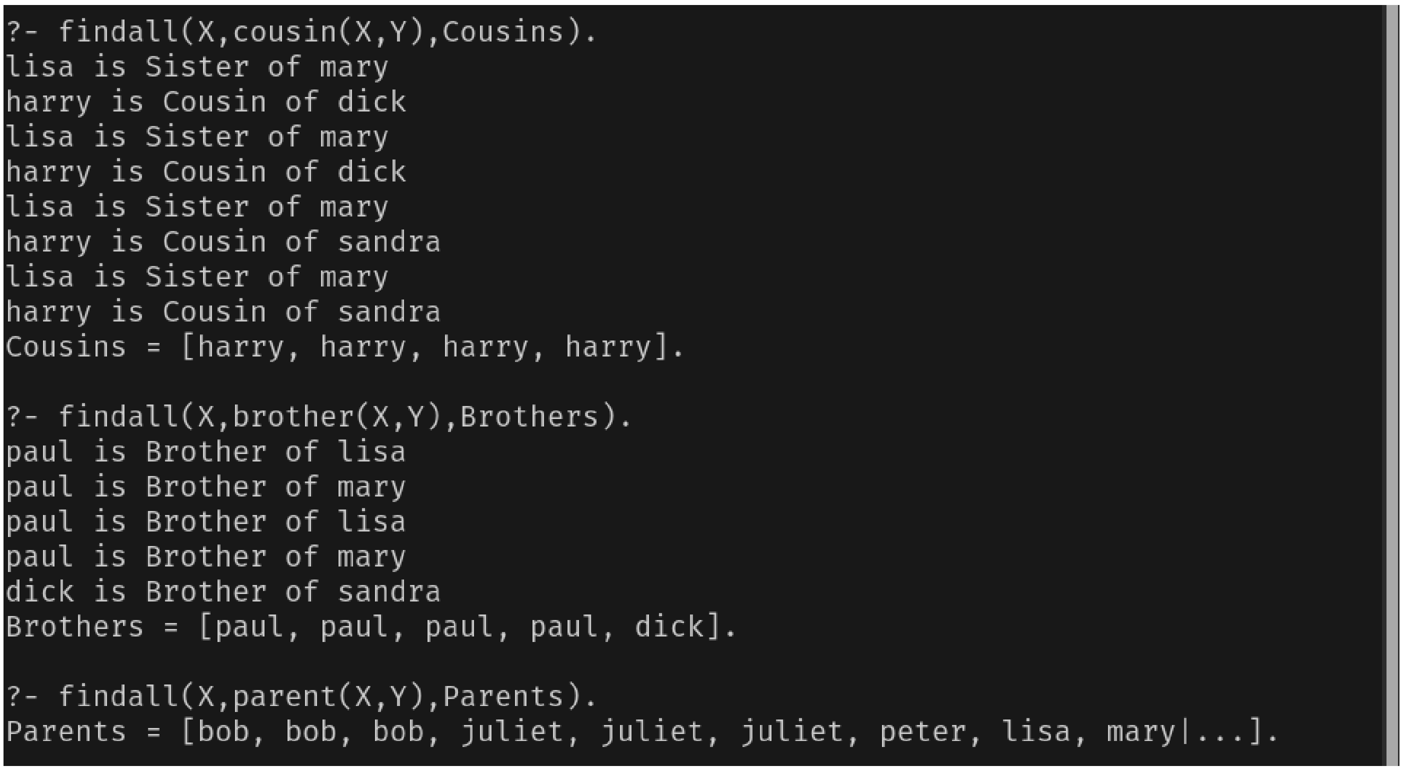
CODE=>

```
female(sandra).
female(juliet).
female(lisa).
male(peter).
male(paul).
male(dick).
male(bob).
male(harry).
```

```prolog
parent(bob, lisa).
parent(bob, paul).
parent(bob, mary).
parent(juliet, lisa).
parent(juliet, paul).
parent(juliet, mary).
parent(peter, harry).
parent(lisa, harry).
parent(mary, dick).
parent(mary, sandra).

%New Predicates
%father predicate (X is father of Y)
father(X,Y):-
    male(X),
    parent(X,Y),
    write(X), write(" is Father of "),write(Y),nl.

%sister predicate (X is sister of Y)
sister(X,Y):-
    female(X),
    parent(Z,X),
    parent(Z,Y),
    X\==Y,
    write(X),write(" is Sister of "),write(Y),nl.

%grandmother predicate (X is grandmother of Y)
grandmother(X,Y):-
    female(X),
    parent(X,Z),
    parent(Z,Y),
    write(X), write(" is Grandmother of "),write(Y),nl.

%brother predicate (X is brother of Y)
brother(X,Y):-
    male(X),
    parent(Z,X),
    parent(Z,Y),
    X\==Y,
    write(X), write(" is Brother of "),write(Y),nl.

%sibling predicate (X is sibling of Y)
sibling(X,Y):-
    sister(X,Y);
    brother(X,Y),
    write(X), write(" is Sibling of "),write(Y),nl.

%cousin predicate (X is cousin of Y)
cousin(X,Y):-
    parent(Z,X),
    parent(W,Y),
    sibling(Z,W),
    write(X), write(" is Cousin of "),write(Y),nl.
```



```
?- consult('u19cs009-assign06-q4.pl').
true.

?- findall(X,father(X,Y),Fathers).
peter is Father of harry
bob is Father of lisa
bob is Father of paul
bob is Father of mary
Fathers = [peter, bob, bob, bob].

?- findall(X,sister(X,Y),Sisters).
sandra is Sister of dick
lisa is Sister of paul
lisa is Sister of mary
lisa is Sister of paul
lisa is Sister of mary
Sisters = [sandra, lisa, lisa, lisa, lisa].

?- findall(X,grandmother(X,Y),Grandmothers).
juliet is Grandmother of harry
juliet is Grandmother of dick
juliet is Grandmother of sandra
Grandmothers = [juliet, juliet, juliet].
```



```
?- findall(X,cousin(X,Y),Cousins).
lisa is Sister of mary
harry is Cousin of dick
lisa is Sister of mary
harry is Cousin of dick
lisa is Sister of mary
harry is Cousin of sandra
lisa is Sister of mary
harry is Cousin of sandra
Cousins = [harry, harry, harry, harry].

?- findall(X,brother(X,Y),Brothers).
paul is Brother of lisa
paul is Brother of mary
paul is Brother of lisa
paul is Brother of mary
dick is Brother of sandra
Brothers = [paul, paul, paul, paul, dick].

?- findall(X,parent(X,Y),Parents).
Parents = [bob, bob, bob, juliet, juliet, juliet, peter, lisa, mary|...].
```