# INDEX

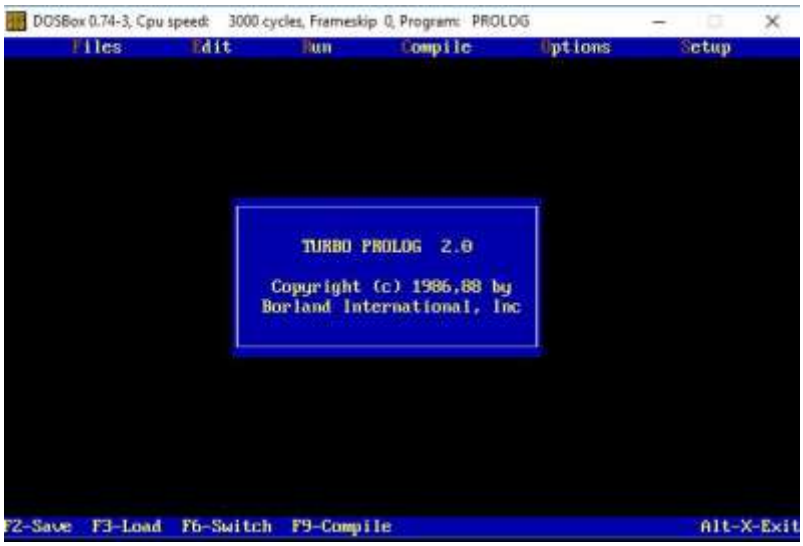
# Practical – 1

## Aim: Study of PROLOG environment with simple programs.

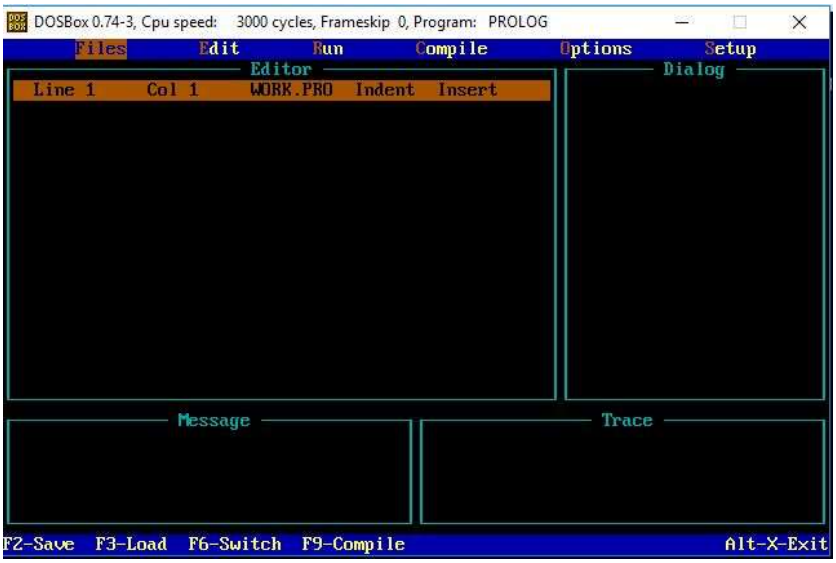
### Prolog Environment: -

Prolog is a very important tool in artificial intelligence applications programming and in the development of expert systems. Several well-known expert system shells are written in Prolog, including APES, ESP/Advisor and Xi.

Once you have a copy of the system on your working disk and you are in the appropriate directory, type PROLOG. You should see the logon message shown in Figure.




Now press the space bar and the Turbo Prolog main menu and four system windows will appear as shown in Figure.



## Sample Programs: -

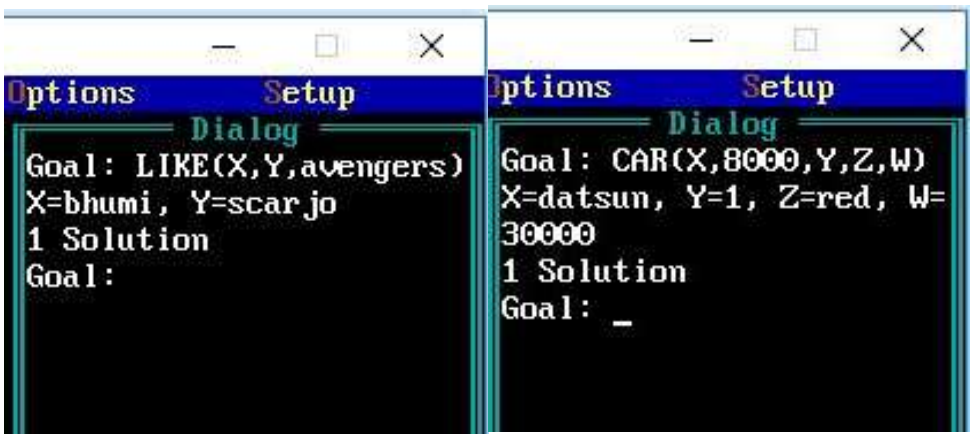
Prac_1_1.pro

```
predicates
        like(symbol,symbol,symbol)
clauses
        like(nidhi,dove,descendents).
        like(bhumi,scarjo,avengers).
```

Prac_1_2.pro

```
domains
        brand, color = symbol
        age = integer
        price, mileage = real
predicates
        car(brand,mileage,age,color,price)
clauses
        car(chrysler,130000,3,red,12000).
        car(ford,90000,4,gray,25000).
        car(datsun,8000,1,red,30000).
```

## Outputs:



# Practical – 2

## Aim: Learn Backtracking and Unification. Implement Medical diagnosis system with PROLOG.

### Program for backtracking: -

```
predicates
        can_buy(symbol,symbol,symbol)
        in_form(symbol,symbol)
        avail(symbol)
clauses
        can_buy(x,y,z):-
                in_form(y,z),
                avail(z),
        can_buy(nidhi,bluray,avengers).
        can_buy(bhumi,dvd,frozenii).
        can_buy(carlos,bluray,frozenii).
        in_form(dvd,frozenii).
        in_form(bluray,avengers).
        avail(avengers).
```

### Output: -

## Program for medical diagnosis: -

```
domains
   disease,indication,name = symbol

predicates
   hypothesis(name,disease)
   symptom(name,indication)

clauses
   symptom(amit,fever).
   symptom(amit,rash).
   symptom(amit,headache).
   symptom(amit,runn_nose).

   symptom(kaushal,chills).
   symptom(kaushal,fever).
   symptom(kaushal,hedache).

   symptom(dipen,runny_nose).
   symptom(dipen,rash).
   symptom(dipen,flu).

   hypothesis(Patient,measels):-
      symptom(Patient,fever),
      symptom(Patient,cough),
      symptom(Patient,conjunctivitis),
      symptom(Patient,rash).
```

```
hypothesis(Patient,german_measles) :-
   symptom(Patient,fever),
   symptom(Patient,headache),
   symptom(Patient,runny_nose),
   symptom(Patient,rash).

hypothesis(Patient,flu) :-
   symptom(Patient,fever),
   symptom(Patient,headache),
   symptom(Patient,body_ache),
   symptom(Patient,chills).

hypothesis(Patient,common_cold) :-
   symptom(Patient,headache),
   symptom(Patient,sneezing),
   symptom(Patient,sore_throat),
   symptom(Patient,chills),
   symptom(Patient,runny_nose).

hypothesis(Patient,mumps) :-
   symptom(Patient,fever),
   symptom(Patient,swollen_glands).

hypothesis(Patient,chicken_pox) :-
   symptom(Patient,fever),
   symptom(Patient,rash),
   symptom(Patient,body_ache),
```

symptom(Patient,chills).

Output: -

# Practical – 3

## Aim: Learn Different Predicates. And implement revised medical diagnosis system.

### Program for medical diagnosis (revised): -

```
domains
    disease,indication = symbol
    Patient,name = string

predicates
    hypothesis(string,disease)
    symptom(name,indication)
    response(char)
    go
clauses
    go :-
        write("What is the patient's name?"),
        readln(Patient),
        hypothesis(Patient,Disease),
        write(Patient,"probably has ",Disease,"."),nl.

    go :-
        write("Sorry, I do not seem to be able to"),nl,
        write("diagnose the disease."),nl.

    symptom(Patient,fever) :-
        write("Does ",Patient," have a fever (y/n) ?"),
        response(Reply),
        Reply='y'.
```

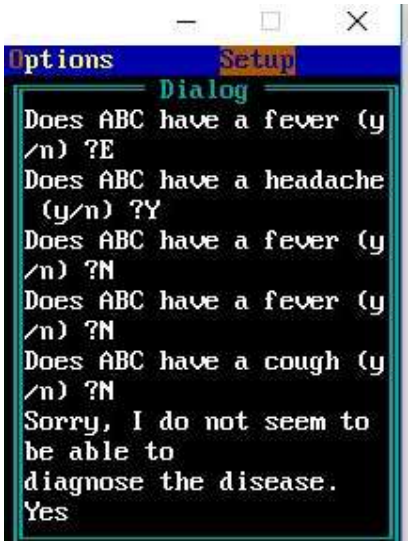
```
symptom(Patient,rash) :-
   write("Does ",Patient," have a rash (y/n) ?"),
   response(Reply),
   Reply='y'.

symptom(Patient,headache) :-
   write("Does ",Patient," have a headache (y/n) ?"),
   response(Reply),
   Reply='y'.

symptom(Patient,runny_nose) :-
   write("Does ",Patient," have a runny_nose (y/n) ?"),
   response(Reply),
   Reply='y'.

symptom(Patient,conjunctivitis) :-
   write("Does ",Patient," have a conjunctivitis (y/n) ?"),
   response(Reply),
   Reply='y'.

symptom(Patient,cough) :-
   write("Does ",Patient," have a cough (y/n) ?"),
   response(Reply),
   Reply='y'.

symptom(Patient,body_ache) :-
   write("Does ",Patient," have a body_ache (y/n) ?"),
```

```
    response(Reply),
    Reply='y'.

symptom(Patient,chills) :-
    write("Does ",Patient," have a chills (y/n) ?"),
    response(Reply),
    Reply='y'.

symptom(Patient,sore_throat) :-
    write("Does ",Patient," have a sore_throat (y/n) ?"),
    response(Reply),
    Reply='y'.

symptom(Patient,sneezing) :-
    write("Does ",Patient," have a sneezing (y/n) ?"),
    response(Reply),
    Reply='y'.

symptom(Patient,swollen_glands) :-
    write("Does ",Patient," have a swollen_glands (y/n) ?"),
    response(Reply),
    Reply='y'.

hypothesis(Patient,measles) :-
    symptom(Patient,fever),
    symptom(Patient,cough),
    symptom(Patient,conjunctivitis),
```

```
    symptom(Patient,runny_nose),
    symptom(Patient,rash).

hypothesis(Patient,german_measles) :-
    symptom(Patient,fever),
    symptom(Patient,headache),
    symptom(Patient,runny_nose),
    symptom(Patient,rash).

hypothesis(Patient,flu) :-
    symptom(Patient,fever),
    symptom(Patient,headache),
    symptom(Patient,body_ache),
    symptom(Patient,conjunctivitis),
    symptom(Patient,chills),
    symptom(Patient,sore_throat),
    symptom(Patient,runny_nose),
    symptom(Patient,cough).

hypothesis(Patient,common_cold) :-
    symptom(Patient,headache),
    symptom(Patient,sneezing),
    symptom(Patient,sore_throat),
    symptom(Patient,runny_nose),
    symptom(Patient,chills).

hypothesis(Patient,mumps) :-
```

```
    symptom(Patient,fever),
    symptom(Patient,swollen_glands).

hypothesis(Patient,chicken_pox) :-
    symptom(Patient,fever),
    symptom(Patient,chills),
    symptom(Patient,body_ache),
    symptom(Patient,rash).

hypothesis(Patient,measles) :-
    symptom(Patient,cough),
    symptom(Patient,sneezing),
    symptom(Patient,runny_nose).

response(Reply) :-
    readchar(Reply),
    write(Reply),nl.
```

Output: -



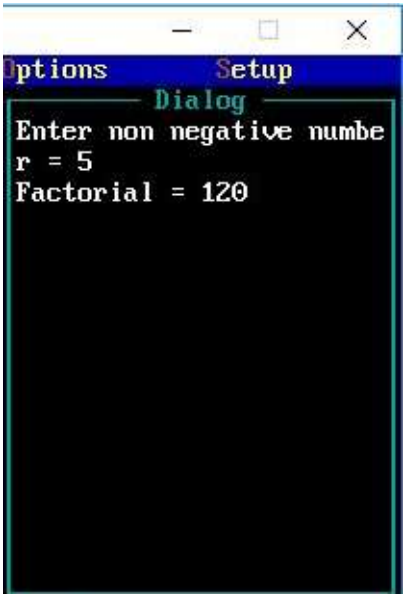
# Practical – 4

## Aim: Learn Recursion and Implement it with examples.

### Program for finding factorial of number using recursion: -

```
predicates
   start
   find_factorial(real,real)

goal
   clearwindow,
   start.

clauses
   start:-
      write("Enter non negative number = "),
      readreal(Num),
      Result = 1.0,
      find_factorial(Num,Result).
   find_factorial(Num,Result):-
      Num <> 0,
      NewResult = Num * Result,
      NewNum = Num - 1,
      find_factorial(NewNum,NewResult).

   find_factorial(_,Result):-
      write("Factorial = ",Result),nl.
```

Output: -


Options Setup
Dialog
Enter non negative numbe
r = 5
Factorial = 120

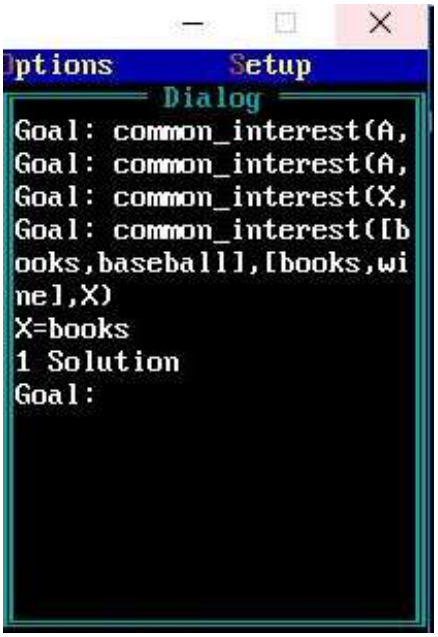
# Practical – 5

## Aim: Learn CUT predicate, Arithmetic predicates and implement with examples.

### Program for CUT predicate: -

```
domains
        name,sex,interest = symbol
        interests = interest*
predicates
        findpairs
        person(name,sex,interests)
        member(interest,interests)
        common_interest(interests, interests, interest)
clauses
        findpairs if person(Man, m, ILIST1 ) and
                person( Woman, f, ILIST2 ) and
                common_interest( ILIST1, ILIST2,_) and
                write( Man, "might like",Woman) and nl and
                fail.
        findpairs:- write ("----------end of the 1ist---" ).
        common_interest( IL1, IL2, X ) if
                member(X, IL1 ) and member(X, IL2) and !.
        person(tom,m,[travel,books,baseball]).
        person(mary,f,[wine,books,swimming]).

        member(X,[X|_]).
        member(X,[_|L]) if member(X,L).
```

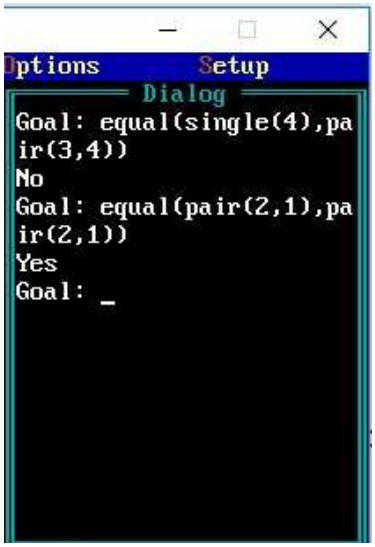
## Output: -




## Program for arithmetic predicates: -

```
domains
        d = pair(integer,integer) ; single(integer);none
predicates
        equal(d,d)
clauses
        equal(X,X).
```

Output: -


Options Setup
Dialog
Goal: equal(single(4),pa
ir(3,4))
No
Goal: equal(pair(2,1),pa
ir(2,1))
Yes
Goal:

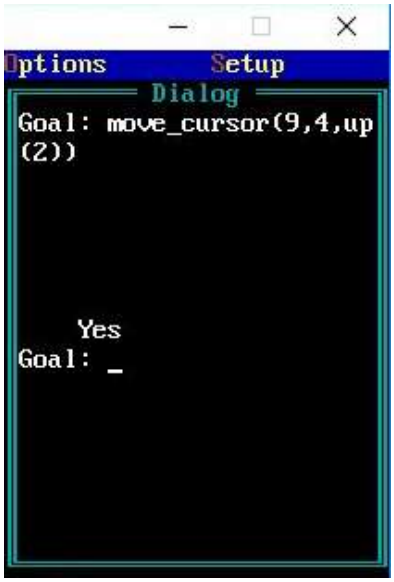
# Practical – 6

## Aim: Study and implementation of compound Objects and dynamic database.

### Program for compound objects: -

```
domains
        row, column, step = integer
        movement = up(step); down(step);
                   left(step) ; right(step)
predicates
        move_cursor(row,column,movement)
clauses
        move_cursor(R,C,up(Step)) :-
                Rl= R-Step,cursor(Rl,C).
        move_cursor(R,C,down(Step)) :-
                Rl= R+Step,cursor(Rl,C).
        move_cursor(R,C,left(_)) :-
                Cl= C-1,cursor(R,Cl).
        move_cursor(R,C,right(_)):-
                Cl= C+1,cursor(R,Cl).
```

## Output: -




## Program for dynamic database: -

```
domains
        name,addr = string
        one_data_record = p(name,addr)
        file = file_of_data_records
predicates
        person(name,addr)
        moredata(file)
clauses
        person(Name,Addr):-
                openread(file_of_data_records,"dd.dat") ,
                readdevice(file_of_data_records),
                moredata(file_of_data_records),
                readterl(one_data_record,p(Name,Addr)).
        moredata(_) .
        moredata(File):- not(eof(File)),moredata(File).
```

Provided the file dd.dat contains facts belonging to the description domain, such as

p("Peter" ,"28th Street" )

p("Curt","Wall Street" )

Output: -

Goal: person("Peter",Address).

Address="28th Street"

1 Solution

Goal: person("Peter","Not an address").

False

Goal : ...

# Practical – 7

## Aim: Study and implementation of Lists and strings.

### Program for lists: -

List Membership

```
list_member(X, [X|_]).

list_member(X, [_|Tail]):-
                        list_member(X,Tail).
```

Concatenation

```
concatenation([],L,L).

concatenation([X1|L1],L2,[X1|L3]):-
                                concatenation(L1,L2,L3).
```

Append

```
list_member(X,[X|_]).

list_member(X,[_|Tail]):-
                        list_member(X,Tail).

list_append(A,T,T):-
                        list_member(A,T),!.

list_append(A,Tail,[A|Tail]).
```

### Program:

```
list_member(b,[a,b,c]).

list_member([b,c],[a,[b,c]]).

list_member(X,[a,b,c,d,e,f]).

concatenation([a,b,c],[d,e,f,g],L).

L= [a,b,c,d,e,f,g]

concatenation([a,b,c],L,[a,b,c,d,e,f,g,h]).

concatenation([],L,[a,b,c,d,e,f,g,h]).
```

concatenation([a,b,c],[],L).

concatenation([],[],L).

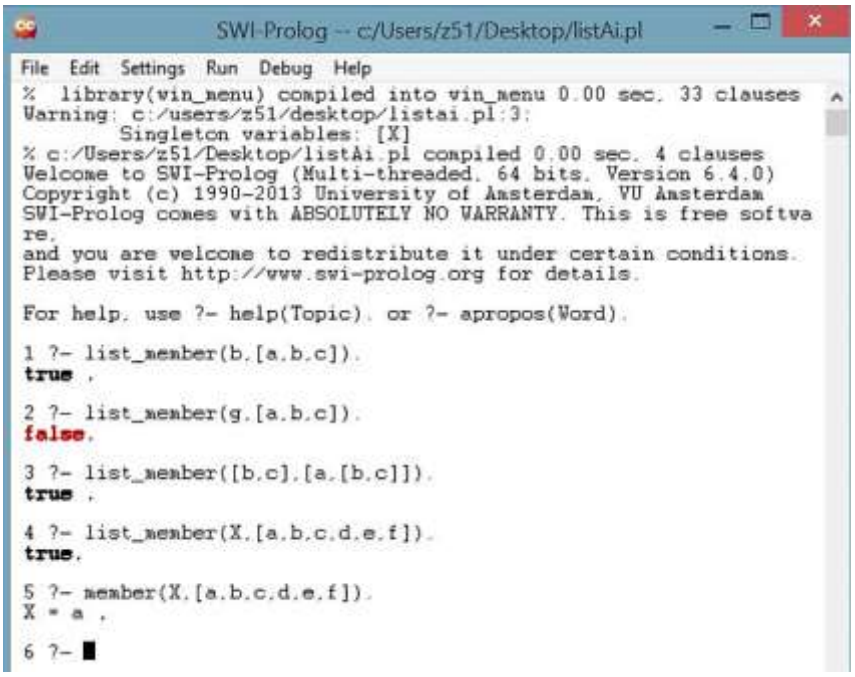
list_append([1,2,3],[4,5,6],X).

X=[[1,2,3],4,5,6]

list_append(3,[4,5,6],X).

X=[3,4,5,6]

## Output: -




## Program for strings: -

domains

charlist=char*

predicates

string_chlist(string,charlist)

clauses

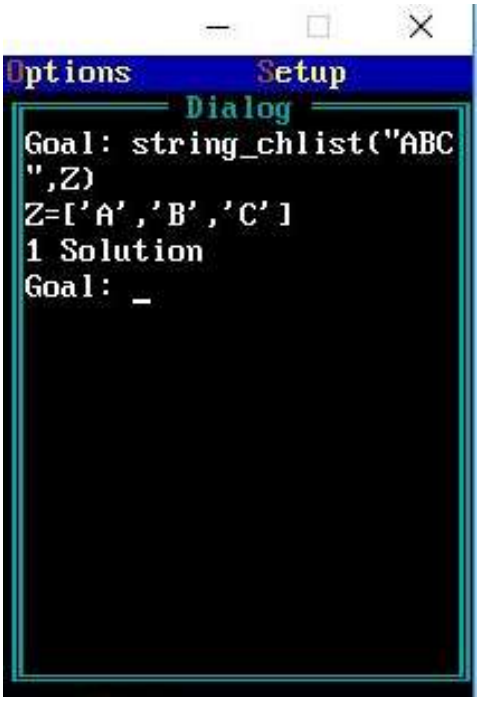
string_chlist("", []).

string_chlist(S,[H|T]):-

frontchar(S,H,Sl),

string_chlist(Sl,T).

Output: -



# Practical – 8

## Aim: Write a program to implement Tic-tac-toe game problem.

### Program: -

```
% A Tic-Tac-Toe program in Prolog.   S. Tanimoto, May 11, 2003.

% To play a game with the computer, type

% playo.

% To watch the computer play a game with itself, type

% selfgame.


% Predicates that define the winning conditions:

win(Board, Player) :- rowwin(Board, Player).

win(Board, Player) :- colwin(Board, Player).

win(Board, Player) :- diagwin(Board, Player).


rowwin(Board, Player) :- Board = [Player,Player,Player,_,_,_,_,_,_].

rowwin(Board, Player) :- Board = [_,_,_,Player,Player,Player,_,_,_].

rowwin(Board, Player) :- Board = [_,_,_,_,_,_,Player,Player,Player].


colwin(Board, Player) :- Board = [Player,_,_,Player,_,_,Player,_,_].

colwin(Board, Player) :- Board = [_,Player,_,_,Player,_,_,Player,_].

colwin(Board, Player) :- Board = [_,_,Player,_,_,Player,_,_,Player].


diagwin(Board, Player) :- Board = [Player,_,_,_,Player,_,_,_,Player].

diagwin(Board, Player) :- Board = [_,_,Player,_,Player,_,Player,_,_].


% Helping predicate for alternating play in a "self" game:
```

```
other(x,o).
other(o,x).

game(Board, Player) :- win(Board, Player), !, write([player, Player, wins]).
game(Board, Player) :-
  other(Player,Otherplayer),
  move(Board,Player,Newboard),
  !,
  display(Newboard),
  game(Newboard,Otherplayer).

move([b,B,C,D,E,F,G,H,I], Player, [Player,B,C,D,E,F,G,H,I]).
move([A,b,C,D,E,F,G,H,I], Player, [A,Player,C,D,E,F,G,H,I]).
move([A,B,b,D,E,F,G,H,I], Player, [A,B,Player,D,E,F,G,H,I]).
move([A,B,C,b,E,F,G,H,I], Player, [A,B,C,Player,E,F,G,H,I]).
move([A,B,C,D,b,F,G,H,I], Player, [A,B,C,D,Player,F,G,H,I]).
move([A,B,C,D,E,b,G,H,I], Player, [A,B,C,D,E,Player,G,H,I]).
move([A,B,C,D,E,F,b,H,I], Player, [A,B,C,D,E,F,Player,H,I]).
move([A,B,C,D,E,F,G,b,I], Player, [A,B,C,D,E,F,G,Player,I]).
move([A,B,C,D,E,F,G,H,b], Player, [A,B,C,D,E,F,G,H,Player]).

display([A,B,C,D,E,F,G,H,I]) :- write([A,B,C]),nl,write([D,E,F]),nl,
 write([G,H,I]),nl,nl.
selfgame :- game([b,b,b,b,b,b,b,b,b],x).
% Predicates to support playing a game with the user:
x_can_win_in_one(Board) :- move(Board, x, Newboard), win(Newboard, x).
% The predicate orespond generates the computer's (playing o) reponse
```

```
% from the current Board.

orespond(Board,Newboard) :-
  move(Board, o, Newboard),
  win(Newboard, o),
  !.
orespond(Board,Newboard) :-
  move(Board, o, Newboard),
  not(x_can_win_in_one(Newboard)).
orespond(Board,Newboard) :-
  move(Board, o, Newboard).
orespond(Board,Newboard) :-
  not(member(b,Board)),
  !,
  write('Cats game!'), nl,
  Newboard = Board.

% The following translates from an integer description
% of x's move to a board transformation.

xmove([b,B,C,D,E,F,G,H,I], 1, [x,B,C,D,E,F,G,H,I]).
xmove([A,b,C,D,E,F,G,H,I], 2, [A,x,C,D,E,F,G,H,I]).
xmove([A,B,b,D,E,F,G,H,I], 3, [A,B,x,D,E,F,G,H,I]).
xmove([A,B,C,b,E,F,G,H,I], 4, [A,B,C,x,E,F,G,H,I]).
xmove([A,B,C,D,b,F,G,H,I], 5, [A,B,C,D,x,F,G,H,I]).
xmove([A,B,C,D,E,b,G,H,I], 6, [A,B,C,D,E,x,G,H,I]).
xmove([A,B,C,D,E,F,b,H,I], 7, [A,B,C,D,E,F,x,H,I]).
```

```
xmove([A,B,C,D,E,F,G,b,I], 8, [A,B,C,D,E,F,G,x,I]).
xmove([A,B,C,D,E,F,G,H,b], 9, [A,B,C,D,E,F,G,H,x]).
xmove(Board, N, Board) :- write('Illegal move.'), nl.

% The 0-place predicate playo starts a game with the user.

playo :- explain, playfrom([b,b,b,b,b,b,b,b,b]).

explain :-
  write('You play X by entering integer positions followed by a period.'),
  nl,
  display([1,2,3,4,5,6,7,8,9]).

playfrom(Board) :- win(Board, x), write('You win!').
playfrom(Board) :- win(Board, o), write('I win!').
playfrom(Board) :- read(N),
  xmove(Board, N, Newboard),
  display(Newboard),
  orespond(Newboard, Newnewboard),
  display(Newnewboard),
  playfrom(Newnewboard).
```

## Output: -

```
?- s.              % show the board
    # # #
    # # #
    # # #

Yes
?- h(2,1).         % Human marks x at 2,1 (not best)
    # x #
    # # #
    # # #

Yes
?- c.              % computer thinks, moves to 2,2
    # x #
    # o #
    # # #

Yes
?- h(1,1).         %  Human moves to 1,1
    x x #
    # o #
    # # #

Yes
?- c.              % computer's move. SEE ANALYSIS BELOW
    x x o
    # o #
    # # #

... etc.
```

# Practical – 9

## Aim: Write a program to implement BFS and DFS.

### Prolog program to solve the water-jug puzzle using BFS: -

```
database
    visited_state(integer,integer)

predicates
   state(integer,integer)

clauses
state(2,0).

   state(X,Y):- X < 4,
         not(visited_state(4,Y)),
         assert(visited_state(X,Y)),
write("Fill the 4-Gallon Jug: (",X,",",Y,") --> (", 4,",",Y,")\n"),
         state(4,Y).

   state(X,Y):- Y < 3,
         not(visited_state(X,3)),
         assert(visited_state(X,Y)),
write("Fill the 3-Gallon Jug: (", X,",",Y,") --> (", X,",",3,")\n"),
         state(X,3).

   state(X,Y):- X > 0,
         not(visited_state(0,Y)),
         assert(visited_state(X,Y)),
```

```
write("Empty the 4-Gallon jug on ground: (", X,",",Y,") --> (", 0,",",Y,")\n"),
        state(0,Y).


   state(X,Y):- Y > 0,
        not(visited_state(X,0)),
        assert(visited_state(X,0)),
write("Empty the 3-Gallon jug on ground: (", X,",",Y,") --> (", X,",",0,")\n"),
        state(X,0).


   state(X,Y):- X + Y >= 4,
        Y > 0,
        NEW_Y = Y - (4 - X),
        not(visited_state(4,NEW_Y)),
        assert(visited_state(X,Y)),
write("Pour water from 3-Gallon jug to 4-gallon until it is full: (", X,",",Y,") --> (",
4,",",NEW_Y,")\n"),
        state(4,NEW_Y).


   state(X,Y):- X + Y >=3,
        X > 0,
        NEW_X = X - (3 - Y),
        not(visited_state(X,3)),
        assert(visited_state(X,Y)),
write("Pour water from 4-Gallon jug to 3-gallon until it is full: (", X,",",Y,") --> (",
NEW_X,",",3,")\n"),
        state(NEW_X,3).


   state(X,Y):- X + Y <=4,
```

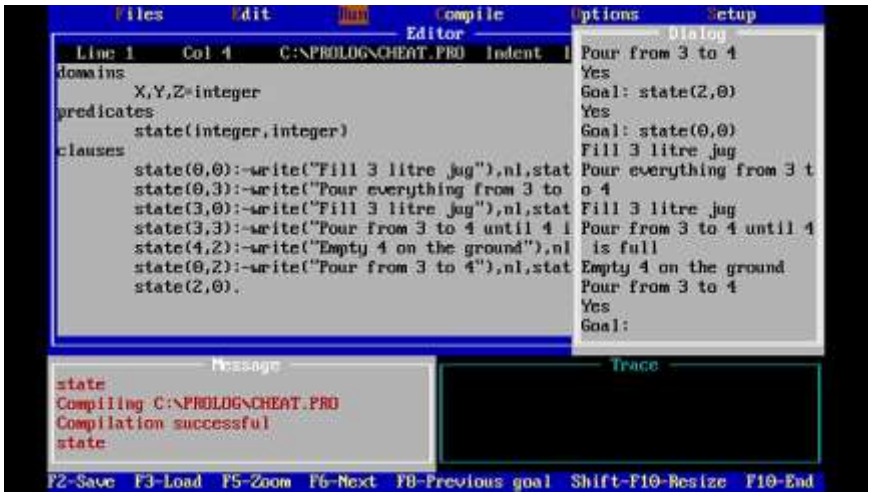
```
        Y > 0,
        NEW_X = X + Y,
        not(visited_state(NEW_X,0)),
        assert(visited_state(X,Y)),
write("Pour all the water from 3-Gallon jug to 4-gallon: (", X,",",Y,") --> (", NEW_X,",",0,")\n"),
        state(NEW_X,0).

   state(X,Y):- X+Y<=3,
        X > 0,
        NEW_Y = X + Y,
        not(visited_state(0,NEW_Y)),
        assert(visited_state(X,Y)),
write("Pour all the water from 4-Gallon jug to 3-gallon: (", X,",",Y,") --> (", 0,",",NEW_Y,")\n"),
        state(0,NEW_Y).

state(0,2):- not(visited_state(2,0)),
        assert(visited_state(0,2)),
write("Pour 2 gallons from 3-Gallon jug to 4-gallon: (", 0,",",2,") --> (", 2,",",0,")\n"),
state(2,0).

   state(2,Y):- not(visited_state(0,Y)),
        assert(visited_state(2,Y)),
write("Empty 2 gallons from 4-Gallon jug on the ground: (", 2,",",Y,") --> (", 0,",",Y,")\n"),
        state(0,Y).
```

## Output: -


## Prolog program to solve the water-jug puzzle using DFS: -

```
domains

        X,Y,Z=integer

predicates

        state(integer,integer)

clauses

        state(0,0):-write("Fill 3 litre jug"),nl,state(0,3).

        state(0,3):-write("Pour everything from 3 to 4"),nl,state(3,0).

        state(3,0):-write("Fill 3 litre jug"),nl,state(3,3).

        state(3,3):-write("Pour from 3 to 4 until 4 is full"),nl,state(4,2).

        state(4,2):-write("Empty 4 on the ground"),nl,state(0,2).

        state(0,2):-write("Pour from 3 to 4"),nl,state(2,0).

        state(2,0).
```

Output: -


Files Edit Run Compile Options Setup
Editor
Line 1 Col 4 C:\PROLOG\CHEAT.PRO Indent
domains
X,Y,Z=integer
predicates
state(integer,integer)
clauses
state(0,0):-write("Fill 3 litre jug"),nl,stat
state(0,3):-write("Pour everything from 3 to
state(3,0):-write("Fill 3 litre jug"),nl,stat
state(3,3):-write("Pour from 3 to 4 until 4 i
state(4,2):-write("Empty 4 on the ground"),nl
state(0,2):-write("Pour from 3 to 4"),nl,stat
state(2,0).
Dialog
Pour from 3 to 4
Yes
Goal: state(2,0)
Yes
Goal: state(0,0)
Fill 3 litre jug
Pour everything from 3 t
o 4
Fill 3 litre jug
Pour from 3 to 4 until 4
is full
Empty 4 on the ground
Pour from 3 to 4
Yes
Goal:
Message
state
Compiling C:\PROLOG\CHEAT.PRO
Compilation successful
state
Trace
F2-Save F3-Load F5-Zoom F6-Next F8-Previous goal Shift-F10-Resize F10-End

# Practical – 10

## Aim: Write a program to implement Single Player Game (Using Heuristic Function).

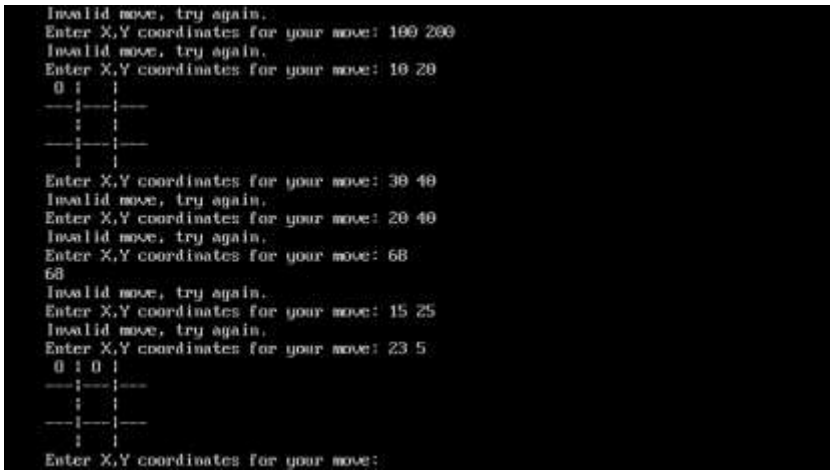
```
#include <stdio.h>
#include <stdlib.h>
char matrix[3][3]; char check(void);
void init_matrix(void);
void get_player_move(void);
void get_computer_move(void);

void disp_matrix(void);
int main(void)
{
char done;
printf("This is the game of Tic Tac Toe.\n");
printf("You will be playing against the computer.\n");
done = ' ';
init_matrix();
do {
disp_matrix();
get_player_move();
done = check(); /* see if winner */
if(done!= ' ') break; /* winner!*/
get_computer_move();
done = check(); /* see if winner */
} while(done== ' ');
if(done=='X') printf("You won!\n");
else printf("I won!!!!\n");
```

```
disp_matrix(); /* show final positions */
return 0;
}
/* Initialize the matrix. */
void init_matrix(void)
{
int i, j;

for(i=0; i<3; i++)
for(j=0; j<3; j++) matrix[i][j] = ' ';
}
/* Get a player's move. */
void get_player_move(void)
{
int x, y;

printf("Enter X,Y coordinates for your move: "); scanf("%d%*c%d", &x, &y); x--; y--;

if(matrix[x][y]!= ' '){

printf("Invalid move, try again.\n");
get_player_move();
}
else matrix[x][y] = 'X';
}
/* Get a move from the computer. */
void get_computer_move(void)
```

```
{
int i, j;
for(i=0; i<3; i++){
for(j=0; j<3; j++)
if(matrix[i][j]==' ') break;
if(matrix[i][j]==' ') break;

}

if(i*j==9) {
printf("draw\n");
exit(0);
}
else
matrix[i][j] = 'O';
}

/* Display the matrix on the screen. */
void disp_matrix(void)
{
int t;
for(t=0; t<3; t++) {
printf(" %c | %c | %c ",matrix[t][0],
matrix[t][1], matrix [t][2]);
if(t!=2) printf("\n---|---|---\n");
}
printf("\n");
```

```
}

/* See if there is a winner. */
char check(void)
{
int i;

for(i=0; i<3; i++) /* check rows */
if(matrix[i][0]==matrix[i][1] &&
matrix[i][0]==matrix[i][2]) return matrix[i][0];
for(i=0; i<3; i++) /* check columns */
if(matrix[0][i]==matrix[1][i] &&
matrix[0][i]==matrix[2][i]) return matrix[0][i];
/* test diagonals */
if(matrix[0][0]==matrix[1][1] &&
matrix[1][1]==matrix[2][2])
return matrix[0][0];
if(matrix[0][2]==matrix[1][1] && matrix[1][1]==matrix[2][0])
return matrix[0][2];
return ' ';
}
```

Output: -


Invalid move, try again.
Enter X,Y coordinates for your move: 100 200
Invalid move, try again.
Enter X,Y coordinates for your move: 10 20
Enter X,Y coordinates for your move: 30 40
Invalid move, try again.
Enter X,Y coordinates for your move: 20 40
Invalid move, try again.
Enter X,Y coordinates for your move: 68
68
Invalid move, try again.
Enter X,Y coordinates for your move: 15 25
Invalid move, try again.
Enter X,Y coordinates for your move: 23 5
Enter X,Y coordinates for your move:

# Practical – 11

## Aim: Write a program to implement A* algorithm.

### Python program to implement A* algorithm: -

```
from __future__ import print_function

import matplotlib.pyplot as plt


class AStarGraph(object):

    # Define a class board like grid with two barriers


    def __init__(self):

        self.barriers = []

        self.barriers.append([(2, 4), (2, 5), (2, 6), (3, 6), (4, 6),

                              (5, 6), (5, 5), (5, 4), (5, 3), (5, 2), (4, 2), (3, 2)])


    def heuristic(self, start, goal):

        # Use Chebyshev distance heuristic if we can move one square either

        #adjacent or diagonal

        D = 1

        D2 = 1

        dx = abs(start[0] - goal[0])

        dy = abs(start[1] - goal[1])

        return D * (dx + dy) + (D2 - 2 * D) * min(dx, dy)


    def get_vertex_neighbours(self, pos):

        n = []

        # Moves allow link a chess king

        for dx, dy in [(1, 0), (-1, 0), (0, 1), (0, -1), (1, 1), (-1, 1), (1, -1), (-1, -1)]:
```

```
            x2 = pos[0] + dx
            y2 = pos[1] + dy
            if x2 < 0 or x2 > 7 or y2 < 0 or y2 > 7:
                continue
            n.append((x2, y2))
        return n

    def move_cost(self, a, b):
        for barrier in self.barriers:
            if b in barrier:
                return 100  # Extremely high cost to enter barrier squares
        return 1  # Normal movement cost


def AStarSearch(start, end, graph):

    G = {}  # Actual movement cost to each position from the start position
    F = {}  # Estimated movement cost of start to end going via this position

    # Initialize starting values
    G[start] = 0
    F[start] = graph.heuristic(start, end)

    closedVertices = set()
    openVertices = set([start])
    cameFrom = {}
```

```
while len(openVertices) > 0:
    # Get the vertex in the open list with the lowest F score
    current = None
    currentFscore = None
    for pos in openVertices:
        if current is None or F[pos] < currentFscore:
            currentFscore = F[pos]
            current = pos

    # Check if we have reached the goal
    if current == end:
        # Retrace our route backward
        path = [current]
        while current in cameFrom:
            current = cameFrom[current]
            path.append(current)
        path.reverse()
        return path, F[end]  # Done!

    # Mark the current vertex as closed
    openVertices.remove(current)
    closedVertices.add(current)

    # Update scores for vertices near the current position
    for neighbour in graph.get_vertex_neighbours(current):
        if neighbour in closedVertices:
            continue  # We have already processed this node exhaustively
```

```
            candidateG = G[current] + graph.move_cost(current, neighbour)

            if neighbour not in openVertices:
                openVertices.add(neighbour)  # Discovered a new vertex
            elif candidateG >= G[neighbour]:
                continue  # This G score is worse than previously found

            # Adopt this G score
            cameFrom[neighbour] = current
            G[neighbour] = candidateG
            H = graph.heuristic(neighbour, end)
            F[neighbour] = G[neighbour] + H
    raise RuntimeError("A* failed to find a solution")
if __name__ == "__main__":
    graph = AStarGraph()
    result, cost = AStarSearch((0, 0), (7, 7), graph)
    print("route", result)
    print("cost", cost)
    plt.plot([v[0] for v in result], [v[1] for v in result])
    for barrier in graph.barriers:
        plt.plot([v[0] for v in barrier], [v[1] for v in barrier])
    plt.xlim(-1, 8)
    plt.ylim(-1, 8)
    plt.show()
```

## Output: -

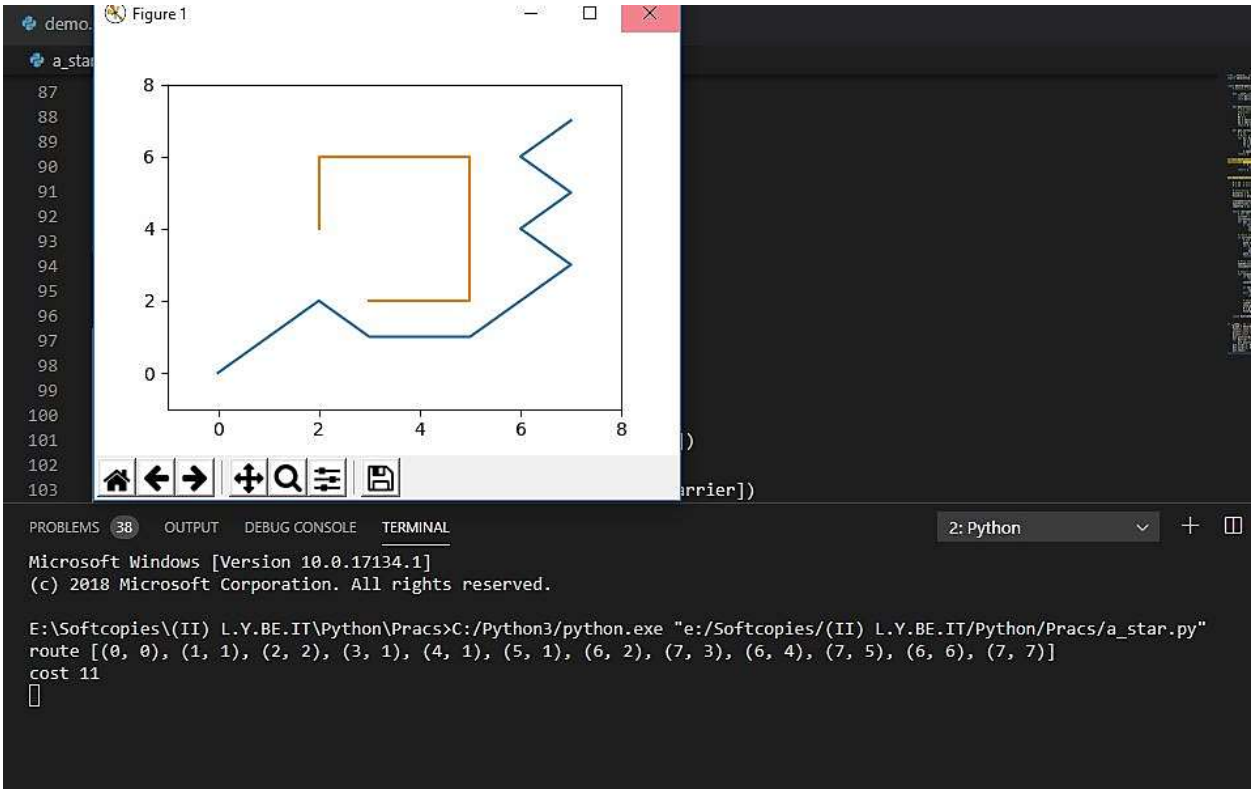


Figure 1
8
6
4
2
0
0
2
4
6
8
PROBLEMS 38
OUTPUT
DEBUG CONSOLE
TERMINAL
2: Python
Microsoft Windows [Version 10.0.17134.1]
(c) 2018 Microsoft Corporation. All rights reserved.
E:\Softcopies\(II) L.Y.BE.IT\Python\Pracs>C:/Python3/python.exe "e:/Softcopies/(II) L.Y.BE.IT/Python/Pracs/a_star.py"
route [(0, 0), (1, 1), (2, 2), (3, 1), (4, 1), (5, 1), (6, 2), (7, 3), (6, 4), (7, 5), (6, 6), (7, 7)]
cost 11

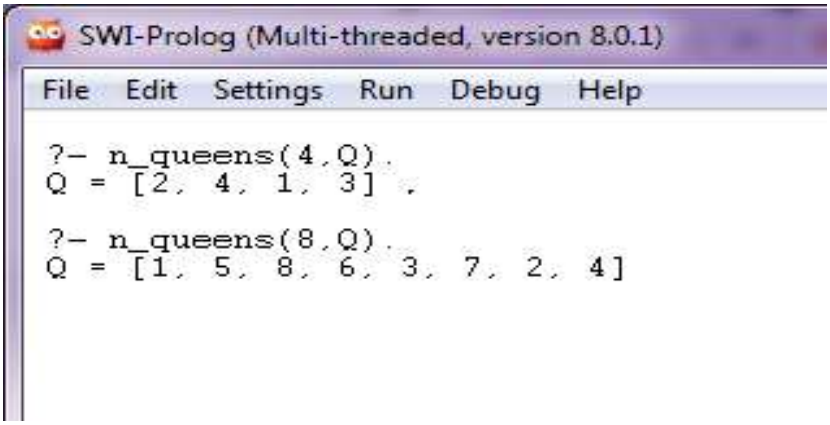
# Practical – 12

## Aim: N-Queens problem.

### Program for N-queens problem: -

```
n_queens(N,Q) :-
        length(Q,N),
        board(Q,Board,0,N, _, _),
        queens(Board,0,Q).
        board([], [], N, N, _, _).
        board([_|Queens],
        [Col-Vars|Board],
        Col0, N, [_|VR], VC) :-
        Col is Col0+1,
        functor(Vars, f, N),
        constraints(N, Vars, VR, VC),
         board(Queens, Board, Col, N, VR, [_|VC]).


constraints(0, _, _, _) :- !.
constraints(N, Row, [R|Rs], [C|Cs]) :-
        arg(N, Row, R-C),
        M is N-1,
        constraints(M, Row, Rs, Cs).


queens([], _, []).
queens([C|Cs], Row0, [Col|Solution]) :-
        Row is Row0+1,
        select(Col-Vars, [C|Cs], Board),
        arg(Row, Vars, Row-Row),
        queens(Board, Row, Solution).
```

Output: -


SWI-Prolog (Multi-threaded, version 8.0.1)
File Edit Settings Run Debug Help
?- n_queens(4,Q).
Q = [2, 4, 1, 3] .
?- n_queens(8,Q).
Q = [1, 5, 8, 6, 3, 7, 2, 4]

# Practical – 13

## Aim: 8-puzzle problem.

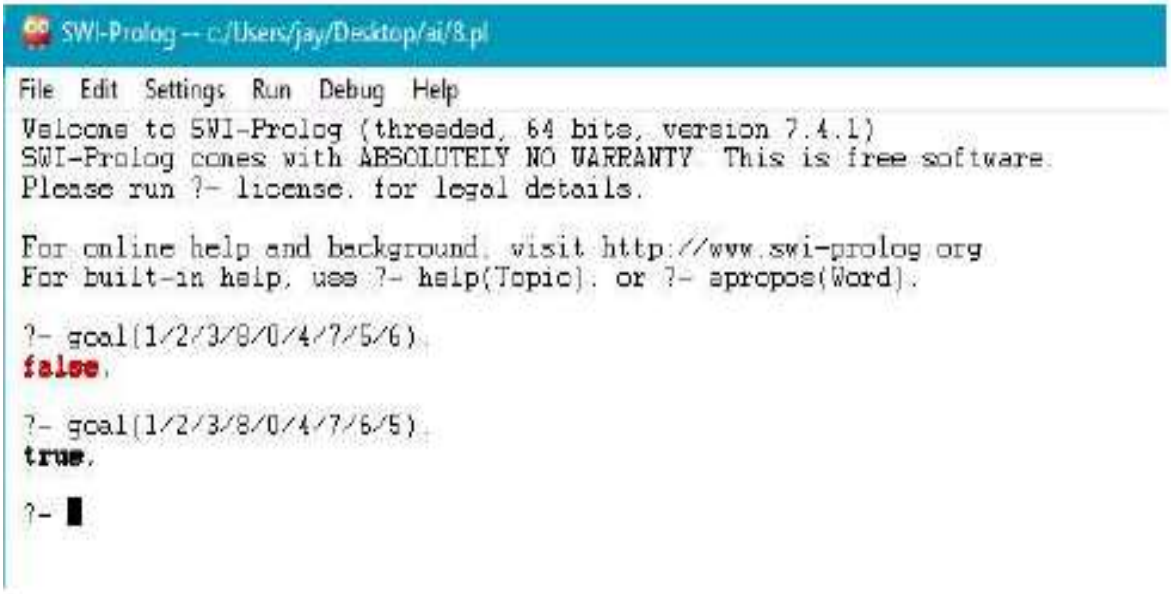
### Program to solve 8-puzzle problem: -

```
goal(1/2/3/8/0/4/7/6/5).

left( A/0/C/D/E/F/H/I/J , 0/A/C/D/E/F/H/I/J ).

left( A/B/C/D/0/F/H/I/J , A/B/C/0/D/F/H/I/J ).

left( A/B/C/D/E/F/H/0/J , A/B/C/D/E/F/0/H/J ).

left( A/B/0/D/E/F/H/I/J , A/0/B/D/E/F/H/I/J ).

left( A/B/C/D/E/0/H/I/J , A/B/C/D/0/E/H/I/J ).

left( A/B/C/D/E/F/H/I/0 , A/B/C/D/E/F/H/0/I ).


up( A/B/C/0/E/F/H/I/J , 0/B/C/A/E/F/H/I/J ).

up( A/B/C/D/0/F/H/I/J , A/0/C/D/B/F/H/I/J ).

up( A/B/C/D/E/0/H/I/J , A/B/0/D/E/C/H/I/J ).

up( A/B/C/D/E/F/0/I/J , A/B/C/0/E/F/D/I/J ).

up( A/B/C/D/E/F/H/0/J , A/B/C/D/0/F/H/E/J ).

up( A/B/C/D/E/F/H/I/0 , A/B/C/D/E/0/H/I/F ).


right( A/0/C/D/E/F/H/I/J , A/C/0/D/E/F/H/I/J ).

right( A/B/C/D/0/F/H/I/J , A/B/C/D/F/0/H/I/J ).

right( A/B/C/D/E/F/H/0/J , A/B/C/D/E/F/H/J/0 ).

right( 0/B/C/D/E/F/H/I/J , B/0/C/D/E/F/H/I/J ).

right( A/B/C/0/E/F/H/I/J , A/B/C/E/0/F/H/I/J ).

right( A/B/C/D/E/F/0/I/J , A/B/C/D/E/F/I/0/J ).


down( A/B/C/0/E/F/H/I/J , A/B/C/H/E/F/0/I/J ).

down( A/B/C/D/0/F/H/I/J , A/B/C/D/I/F/H/0/J ).
```

```
down( A/B/C/D/E/0/H/I/J , A/B/C/D/E/J/H/I/0 ).
down( 0/B/C/D/E/F/H/I/J , D/B/C/0/E/F/H/I/J ).
down( A/0/C/D/E/F/H/I/J , A/E/C/D/0/F/H/I/J ).
down( A/B/0/D/E/F/H/I/J , A/B/F/D/E/0/H/I/J ).

h_function(Puzz,H) :- p_fcn(Puzz,P),
s_fcn(Puzz,S),
H is P + 3*S.
move(P,C,left) :- left(P,C).
move(P,C,up) :- up(P,C).
move(P,C,right) :- right(P,C).
move(P,C,down) :- down(P,C).
%%% Manhattan distance

p_fcn(A/B/C/D/E/F/G/H/I, P) :-
a(A,Pa), b(B,Pb), c(C,Pc),
d(D,Pd), e(E,Pe), f(F,Pf),
g(G,Pg), h(H,Ph), i(I,Pi),
P is Pa+Pb+Pc+Pd+Pe+Pf+Pg+Ph+Pg+Pi.

a(0,0). a(1,0). a(2,1). a(3,2). a(4,3). a(5,4). a(6,3). a(7,2). a(8,1).
b(0,0). b(1,0). b(2,0). b(3,1). b(4,2). b(5,3). b(6,2). b(7,3). b(8,2).
c(0,0). c(1,2). c(2,1). c(3,0). c(4,1). c(5,2). c(6,3). c(7,4). c(8,3).
d(0,0). d(1,1). d(2,2). d(3,3). d(4,2). d(5,3). d(6,2). d(7,2). d(8,0).
e(0,0). e(1,2). e(2,1). e(3,2). e(4,1). e(5,2). e(6,1). e(7,2). e(8,1).
f(0,0). f(1,3). f(2,2). f(3,1). f(4,0). f(5,1). f(6,2). f(7,3). f(8,2).
g(0,0). g(1,2). g(2,3). g(3,4). g(4,3). g(5,2). g(6,2). g(7,0). g(8,1).
```

```
h(0,0). h(1,3). h(2,3). h(3,3). h(4,2). h(5,1). h(6,0). h(7,1). h(8,2).

i(0,0). i(1,4). i(2,3). i(3,2). i(4,1). i(5,0). i(6,1). i(7,2). i(8,3).


%%% the out-of-cycle function

s_fcn(A/B/C/D/E/F/G/H/I, S) :-

s_aux(A,B,S1), s_aux(B,C,S2), s_aux(C,F,S3),

s_aux(F,I,S4), s_aux(I,H,S5), s_aux(H,G,S6),

s_aux(G,D,S7), s_aux(D,A,S8), s_aux(E,S9),

S is S1+S2+S3+S4+S5+S6+S7+S8+S9.


s_aux(0,0) :- !.

s_aux(_,1).

s_aux(X,Y,0) :- Y is X+1, !.

s_aux(8,1,0) :- !.

s_aux(_,_,2).
```

## Output:



# Practical – 14

## Aim: Travelling salesman problem.

### Program to solve travelling salesman problem: -

```
data(1,[1,2,3],[1-1-2,2-5-1,2-2-3,3-1-2,1-4-3,3-3-1]).

data(2,[1,2,3,4,5],[1-4-2,2-1-1,1-4-3,3-1-1,2-5-3,3-2-2,1-2-4,4-2-1,2-5-4,4-4-2,3-4-4,4-1-3,1-1-5,5-1-1,2-3-5,5-2-2,3-0-5,5-1-3,4-9-5,5-8-4]).


tsp(V,E,Route,Sum):-
setof(ARoute-ASum,route(V,E,ARoute,ASum),Routes),        %compute
all routes
min(Routes,Route-Sum).                                   %find minimal route
min([H|T],X):-
min0(T,H,X).                                             %H is minimum of List without tail T.
min0([],H,H).                                            %actual minimum is overall minimum
min0([H-Hs|T],_-As,X):-                                  %actual minimum is greater than new head:
As >= Hs,
min0(T,H-Hs,X).                                          %new head becomes actual minimum
min0([_-Hs|T],A-As,X):-                                  %other case
As =< Hs,
min0(T,A-As,X).                                          %keep actual minimum
route(V,E,Route,Sum):-
select(V,1,V1),                                          %remove start node
visit_all(1,V1,E,[1],Route0,0,Sum0),                     %visit all other nodes
Route0=[H|_],
member(H-D-1,E),                                         %return to node 1
Route=[1|Route0],
Sum is D+Sum0.
```

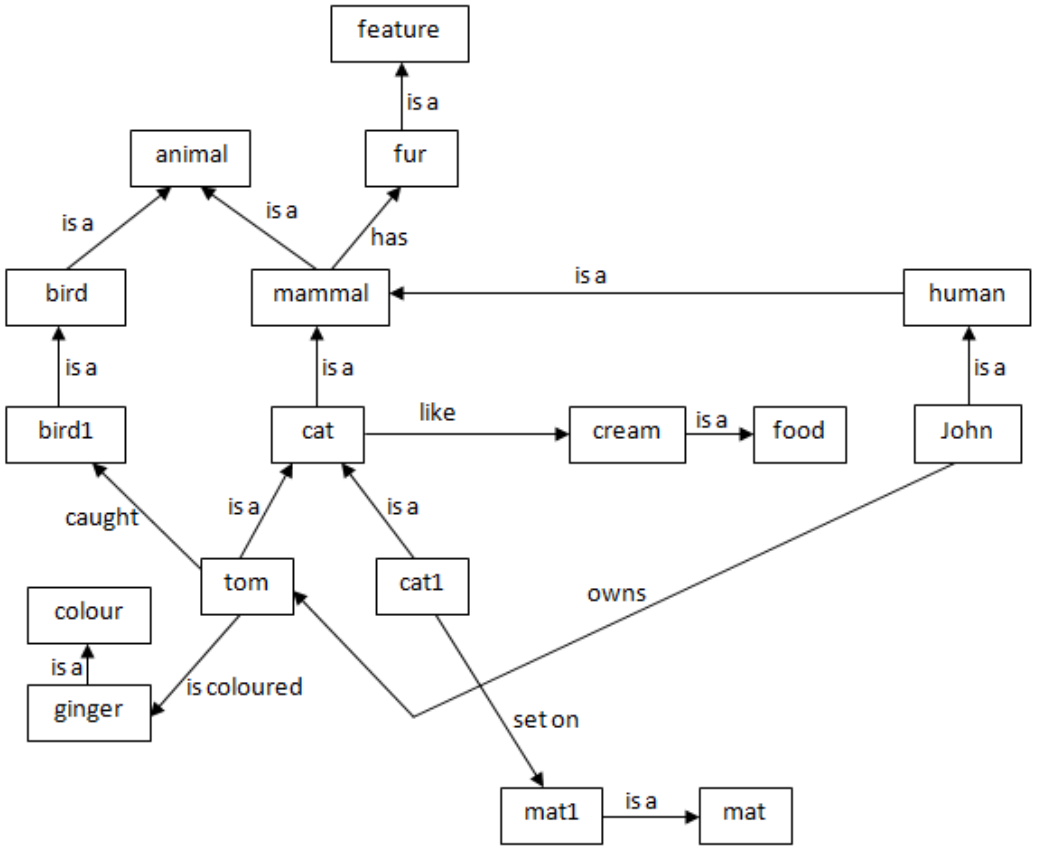
```
visit_all(_,[],_,R,R,Sum,Sum).                    %base case: no vertices left
visit_all(N,V,E,Rin,Rout,Sumin,Sumout):-
select(V,N1,V1),                                  %select a vertice
member(N-D-N1,E),                                 %find edge (get distance)
Sumout0 is Sumin+D,                               %update distance-sum
visit_all(N1,V1,E,[N1|Rin],Rout,Sumout0,Sumout).  %keep going
```

## Output:-

# Practical – 15

## Aim: Convert following Prolog predicates into Semantic Net.

```
cat(tom).

cat(cat1).

mat(mat1).

sat_on(cat1,mat1).

bird(bird1).

caught(tom,bird1).

like(X,cream) :– cat(X).

mammal(X) :– cat(X).

has(X,fur) :– mammal(X).

animal(X) :– mammal(X).

animal(X) :– bird(X).

owns(john,tom).

is_coloured(tom,ginger).
```


feature
is a
animal
fur
is a
is a
has
bird
mammal
is a
human
is a
is a
is a
bird1
cat
like
cream
is a
food
John
caught
is a
is a
tom
cat1
owns
colour
is a
ginger
is coloured
set on
mat1
is a
mat

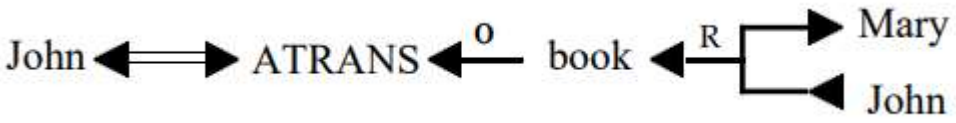
# Practical – 16

## Aim: Write the Conceptual Dependency for following statements.

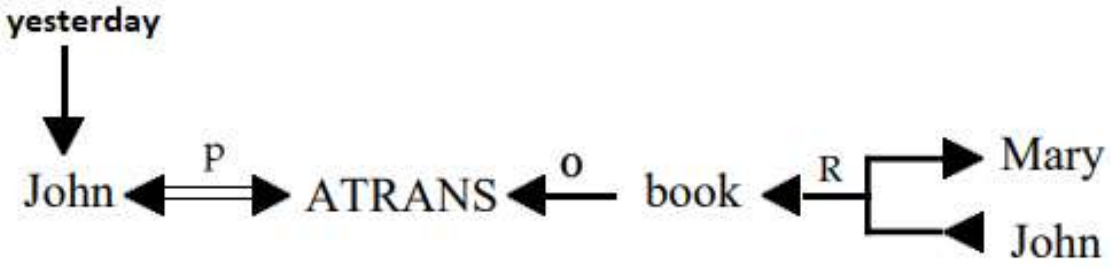
*(a)* John gives Mary a book.

*(b)* John gave Mary the book yesterday.

*(a)* John gives Mary a book.




*(b)* John gave Mary the book yesterday.



# Beyond Syllabus Practical

## Aim: Write a PROLOG program to solve tower of Hanoi problem.

### Program:

```
domains
        loc =right;middle;left
predicates
        hanoi(integer)
        move(integer,loc,loc,loc)
        inform(loc,loc)
clauses
        hanoi(N):- move(N,left,middle,right).
        move(1,A,_,C):- inform(A,C),!.
        move(N,A,B,C):-
                N1=N-1, move(N1,A,C,B),
                inform(A,C),move(N1,B,A,C).
        inform(Loc1, Loc2):-nl,
                write("Move a disk from ", Loc1, " to ", Loc2).
```

### Output: