AI(2180703)

Tutorial-7

Name : Yogesh Bavishi

Enrollment No.: 170200107003

Division/Batch: E/E1

Q: Write a program to solve 8 puzzle problem using Prolog.

Code(pract7.pl):

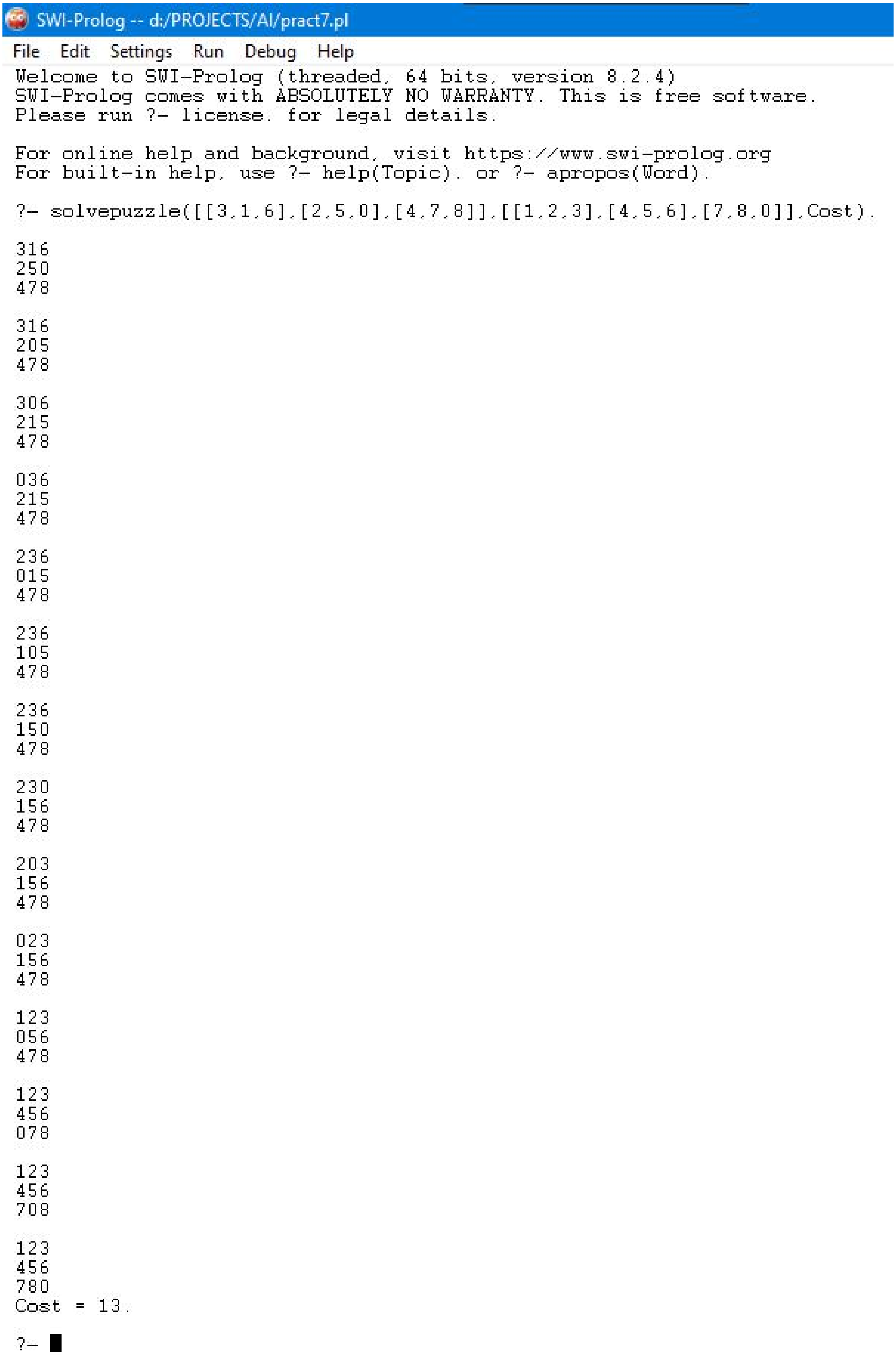
```
can_it_move_left(Left):-
Left >= 0,
Left \= 2,
Left \= 5.

can_it_move_right(Right):-
8 >= Right,
Right \= 3,
Right \= 6.

can_it_move_down(Down):-
Down < 9.

can_it_move_up(Up):-
Up > 0.

countInversions(_,[],Inversions):-
    Inversions is 0.

countInversions(Number,[Head|Tail],Inversions):-
    Number>Head,
    Count is 1,
    countInversions(Number,Tail,Aux_inversions),
    Inversions is Count+Aux_inversions.

countInversions(Number,[Head|Tail],Inversions):-
    Number<Head,
    Count is 0,
    countInversions(Number,Tail,Aux_inversions),
    Inversions is Count+Aux_inversions.

issolvable([],A):-
    A is 0.

issolvable([Head|Tail],Inversions):-
    countInversions(Head,Tail,Aux_inversions),
    issolvable(Tail,Next_inversions),
    Inversions is Next_inversions+Aux_inversions.

iseven(Number):-
    0 is mod(Number,2).

solvepuzzle(Initial_state,Goal_state,Result):-
    flatten(Initial_state, List_initial_state),
    delete(List_initial_state, 0, X),
    issolvable(X,Inversions),
    0 is mod(Inversions,2),
    flatten(Goal_state, List_goal_state),
    delete(List_goal_state, 0, Y),
    issolvable(Y,Inversions_two),
    0 is mod(Inversions_two,2),
    empty_heap(Inital_heap),
    Explored_set = [List_initial_state],
    astar([List_initial_state,0],List_goal_state,Goal_state,Inital_heap,
Explored_set,Iterations),
    copy_term(Iterations, Result),
    !.

solvepuzzle(Initial_state,Goal_state,Result):-
    flatten(Initial_state, List_initial_state),
    delete(List_initial_state, 0, X),
    issolvable(X,Inversions),
    \+0 is mod(Inversions,2),
    flatten(Goal_state, List_goal_state),
    delete(List_goal_state, 0, Y),
    issolvable(Y,Inversions_two),
    \+0 is mod(Inversions_two,2),
    empty_heap(Inital_heap),
    Explored_set = [List_initial_state],
    astar([List_initial_state,0],List_goal_state,Goal_state,Inital_heap,
Explored_set,Iterations),
    copy_term(Iterations, Result),
    !.

solvepuzzle(_,_,Result):-
    Result = 'No solution'.

create_explored_set(Old_Set,Element,X):-
    Aux = [Element],
    append(Old_Set,Aux,X).

divide_list([Head|_],Head).

print_element([],_).

print_element([Head|Tail],I):-
```

```
    0 is mod(I,3),
    Newi=I+1,
    nl,
    print(Head),
    print_element(Tail,Newi).

print_element([Head|Tail],I):-
    Newi=I+1,
    print(Head),
    print_element(Tail,Newi).


print_list([],_).

print_list([Head|Tail],I):-
    number(Head),
    print_list(Tail,I).

print_list([Head|Tail],I):-
    Newi=I+1,
    print_list(Tail,Newi),
    print_element(Head,0),
    nl.


create_list_with_new_cost([],_,_,_).

create_list_with_new_cost([Head|Tail],Iterator,Pos_cost,[New_cost|Tail])
:-
    Iterator == Pos_cost,
    New_iterator is Iterator+1,
    New_cost is Head + 1,
    create_list_with_new_cost(Tail,New_iterator,Pos_cost,Tail).

create_list_with_new_cost([Head|Tail],Iterator,Pos_cost,[Head|Tail2]):-
    New_iterator is Iterator+1,
    create_list_with_new_cost(Tail,New_iterator,Pos_cost,Tail2).

astar([Head|Tail],Head,_,_,_,Result):-
    append([Head],Tail,Fathers),
    print_list(Fathers,0),
    length(Tail,Aux),
    Result is Aux-1.

astar(State,Goal_state,Grid_goal_state,Priority_queue,Explored_set,Resu
lt):-
    divide_list(State,State_to_esplore),
    nth0(Position_blank_tile,State_to_esplore, 0),
    length(State,Pos_cost),
    nth1(Pos_cost, State, Cost),
    New_cost is Cost + 1,
    create_list_with_new_cost(State,1,Pos_cost,New_state),
    findcombinations(New_state,Grid_goal_state,Position_blank_tile,0,Priority_queue,New_cost,Explored_set,New_priority_queue),
    get_from_heap(New_priority_queue, _, P, Next_priority_queue),
    divide_list(P,Explored),
    create_explored_set(Explored_set,Explored,New_explored_set),
    astar(P,Goal_state,Grid_goal_state,Next_priority_queue,New_explored_set,Result).

astar(_,_,_,Priority_queue,_,Result):-
    empty_heap(Priority_queue),
    Result = 'No solution'.

findcost([],_,_,Nextcost):-
    Nextcost is 0.

findcost([Head|Tail],Matrixinitialstate ,Matrixgoalstate, Cost):-
    Head == 0,
    findcost(Tail,Matrixinitialstate ,Matrixgoalstate, Nextcost),
    Cost is 0 + Nextcost.

findcost([Head|Tail], Matrixinitialstate ,Matrixgoalstate, Cost):-
    matrix(Matrixgoalstate,K,L,Head),
    matrix(Matrixinitialstate,I,J,Head),
    Manhattan_distance is abs(I-K) + abs(J-L),
    findcost(Tail,Matrixinitialstate,Matrixgoalstate,Nextcost),
    Cost is Manhattan_distance + Nextcost.


convert_to_matrix(Lista,Nueva_lista):-
    aux_convert_to_matrix(Lista,1,N1,T1),
    aux_convert_to_matrix(T1,1,N2,T2),
    aux_convert_to_matrix(T2,1,N3,_),
    append([N1],[N2],Aux),
    append(Aux,[N3],Nueva_lista),
    !.

aux_convert_to_matrix([Head|Tail], Iterator, [Head|Tail2], Sobra):-
    Iterator < 3,
    Nuevoi is Iterator+1,
    aux_convert_to_matrix(Tail,Nuevoi,Tail2, Sobra).


aux_convert_to_matrix([Head|Tail], Iterator, [Head], Tail):-
    0 is mod(Iterator,3).


create_list_of_explored_states(List,Element,New_list):-
    Aux = [Element],
    append(Aux,List,New_list).
```

```
findcombinations(State,Matrix_goal_state,Position_blank_tile,0,Old_priority_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    divide_list(State,State_to_esplore),
    Left is Position_blank_tile - 1,
    can_it_move_left(Left),
    swap_tiles(State_to_esplore, Position_blank_tile, Left, Permutation_left),
    \+member(Permutation_left,Explored_set),
    convert_to_matrix(Permutation_left,Matrix_per_left),
    findcost(Permutation_left,Matrix_per_left,Matrix_goal_state,Cost),
    create_list_of_explored_states(State,Permutation_left,State_with_fathers),
    New_cost is Cost_move_grid + Cost,
    add_to_heap(Old_priority_queue,New_cost,State_with_fathers,Aux_priority_queue),
    findcombinations(State,Matrix_goal_state,Position_blank_tile,1,Aux_priority_queue,Cost_move_grid,Explored_set,New_priority_queue).

findcombinations(State,Matrix_goal_state,Position_blank_tile,0,Old_priority_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    findcombinations(State,Matrix_goal_state,Position_blank_tile,1,Old_priority_queue,Cost_move_grid,Explored_set,New_priority_queue).

findcombinations(State,Matrix_goal_state,Position_blank_tile,1,Old_priority_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    divide_list(State,State_to_esplore),
    Right is Position_blank_tile + 1,
    can_it_move_right(Right),
    swap_tiles(State_to_esplore, Position_blank_tile, Right, Permutation_right),
    \+member(Permutation_right,Explored_set),
    convert_to_matrix(Permutation_right,Matrix_per_right),
    findcost(Permutation_right,Matrix_per_right,Matrix_goal_state,Cost),
    create_list_of_explored_states(State,Permutation_right,State_with_fathers),
    New_cost is Cost_move_grid + Cost,
    add_to_heap(Old_priority_queue,New_cost,State_with_fathers,Aux_priority_queue),
    findcombinations(State,Matrix_goal_state,Position_blank_tile,2,Aux_priority_queue,Cost_move_grid,Explored_set,New_priority_queue).

findcombinations(State,Matrix_goal_state,Position_blank_tile,1,Old_priority_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    findcombinations(State,Matrix_goal_state,Position_blank_tile,2,Old_priority_queue,Cost_move_grid,Explored_set,New_priority_queue).
findcombinations(State,Matrix_goal_state,Position_blank_tile,2,Old_prio
rity_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    divide_list(State,State_to_esplore),
    Down is Position_blank_tile + 3,
    can_it_move_down(Down),
    swap_tiles(State_to_esplore, Position_blank_tile, Down, Permutation
_down),
    \+member(Permutation_down,Explored_set),
    convert_to_matrix(Permutation_down,Matrix_per_down),
    findcost(Permutation_down,Matrix_per_down,Matrix_goal_state,Cost),
    create_list_of_explored_states(State,Permutation_down,State_with_fa
thers),
    New_cost is Cost_move_grid + Cost,
    add_to_heap(Old_priority_queue,New_cost,State_with_fathers,Aux_prio
rity_queue),
    findcombinations(State,Matrix_goal_state,Position_blank_tile,3,Aux_
priority_queue,Cost_move_grid,Explored_set,New_priority_queue).

findcombinations(State,Matrix_goal_state,Position_blank_tile,2,Old_prio
rity_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    findcombinations(State,Matrix_goal_state,Position_blank_tile,3,Old_
priority_queue,Cost_move_grid,Explored_set,New_priority_queue).


findcombinations(State,Matrix_goal_state,Position_blank_tile,3,Old_prio
rity_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    divide_list(State,State_to_esplore),
    Up is Position_blank_tile -3,
    can_it_move_up(Up),
    swap_tiles(State_to_esplore, Position_blank_tile, Up, Permutation_u
p),
    \+member(Permutation_up,Explored_set),
    convert_to_matrix(Permutation_up,Matrix_per_up),
    findcost(Permutation_up,Matrix_per_up,Matrix_goal_state,Cost),
    create_list_of_explored_states(State,Permutation_up,State_with_fath
ers),
    New_cost is Cost_move_grid + Cost,
    add_to_heap(Old_priority_queue,New_cost,State_with_fathers,Aux_prio
rity_queue),
    findcombinations(State,Matrix_goal_state,Position_blank_tile,4,Aux_
priority_queue,Cost_move_grid,Explored_set,New_priority_queue).

findcombinations(State,Matrix_goal_state,Position_blank_tile,3,Old_prio
rity_queue,Cost_move_grid,Explored_set,New_priority_queue):-
    findcombinations(State,Matrix_goal_state,Position_blank_tile,4,Old_
priority_queue,Cost_move_grid,Explored_set,New_priority_queue).

findcombinations(_,_,_,4,Old_priority_queue,_,_,New_priority_queue):-
    copy_term(Old_priority_queue,New_priority_queue).
```

```
matrix(M, X, Y, Element) :-
    nth0(X, M, R),
    nth0(Y, R, Element).

swap_tiles(List,Zero,Move,Nl):-
    Ayuda is Move+1,
    Zero==Ayuda,
    nth0(Move,List, Number_to_find),
    aux_swap_tiles(List,Move,0,New_list,_,List_to_explore_more),
    append(New_list,[0],Nl_aux),
    append(Nl_aux,[Number_to_find],Nl_aux2),
    delete(List_to_explore_more, 0, X),
    append(Nl_aux2,X,Nl),
    !.

swap_tiles(List,Zero,Move,Nl):-
    Ayuda is Move-1,
    Zero==Ayuda,
    nth0(Move,List,Number_to_find),
    aux_swap_tiles(List,Zero,0,New_list,_,List_to_explore_more),
    append(New_list,[Number_to_find],Nl_aux),
    append(Nl_aux,[0],Nl_aux2),
    delete(List_to_explore_more, Number_to_find, X),
    append(Nl_aux2,X,Nl),
    !.

swap_tiles(List,Zero,Move,Nl):-
    Ayuda is Move+1,
    Ayuda_dos is Move-1,
    Zero<Move,
    \+Zero==Ayuda,
    \+Zero==Ayuda_dos,
    nth0(Move,List, Number_to_find),
    aux_swap_tiles(List,Zero,0,New_list,Current_iterator,List_to_explore_more),
    append(New_list,[Number_to_find],Nl_aux),
    aux_swap_tiles(List_to_explore_more,Move,Current_iterator+1,New_list_two,_,List_to_explore_more_two),
    append(Nl_aux,New_list_two,Nl_aux_two),
    append(Nl_aux_two,[0],Nl_aux_three),
    append(Nl_aux_three,List_to_explore_more_two,Nl),
    !.

swap_tiles(List,Zero,Move,Nl):-
    Ayuda is Move+1,
    Ayuda_dos is Move-1,
    Zero>Move,
    \+Zero==Ayuda,
    \+Zero==Ayuda_dos,
    nth0(Move,List, Number_to_find),
    aux_swap_tiles(List,Move,0,New_list,Current_iterator,List_to_explore_more),
    append(New_list,[0],Nl_aux),
    aux_swap_tiles(List_to_explore_more,Zero,Current_iterator+1,New_list_two,_,List_to_explore_more_two),
    append(Nl_aux,New_list_two,Nl_aux_two),
    append(Nl_aux_two,[Number_to_find],Nl_aux_three),
    append(Nl_aux_three,List_to_explore_more_two,Nl),
    !.

aux_swap_tiles([_|Tail],Limit,Iterator,[],X,Tail):-
    Iterator==Limit,
    copy_term(Iterator,X).

aux_swap_tiles([Head|Tail],Limit,Iterator,[Head|Tail2],X,List_to_explore_more):-
    Iterator<Limit,
    New_iterator is Iterator+1,
    aux_swap_tiles(Tail,Limit,New_iterator,Tail2,X,List_to_explore_more).
```

Output :


SWI-Prolog -- d:/PROJECTS/AI/pract7.pl
File Edit Settings Run Debug Help

```
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).

?- solvepuzzle([[3,1,6],[2,5,0],[4,7,8]],[[1,2,3],[4,5,6],[7,8,0]],Cost).

316
250
478

316
205
478

306
215
478

036
215
478

236
015
478

236
105
478

236
150
478

230
156
478

203
156
478

023
156
478

123
056
478

123
456
078

123
456
708

123
456
780
Cost = 13.

?-
```