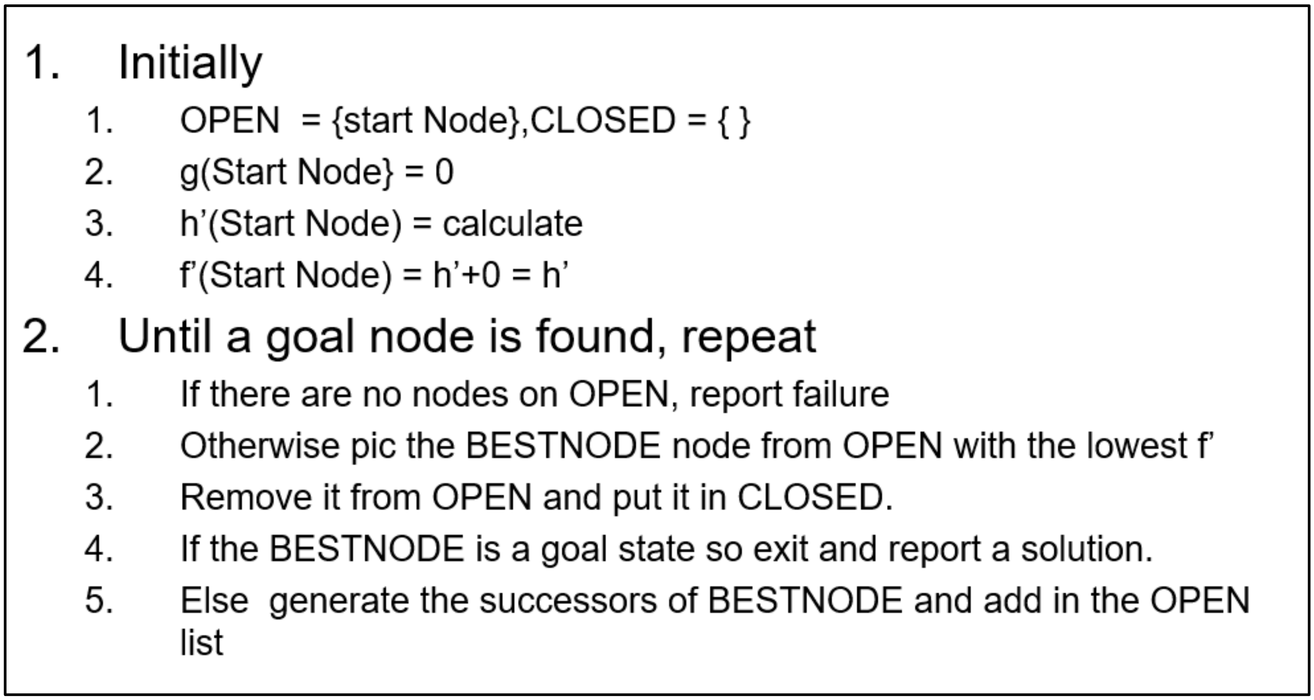
Artificial Intelligence (CS308)

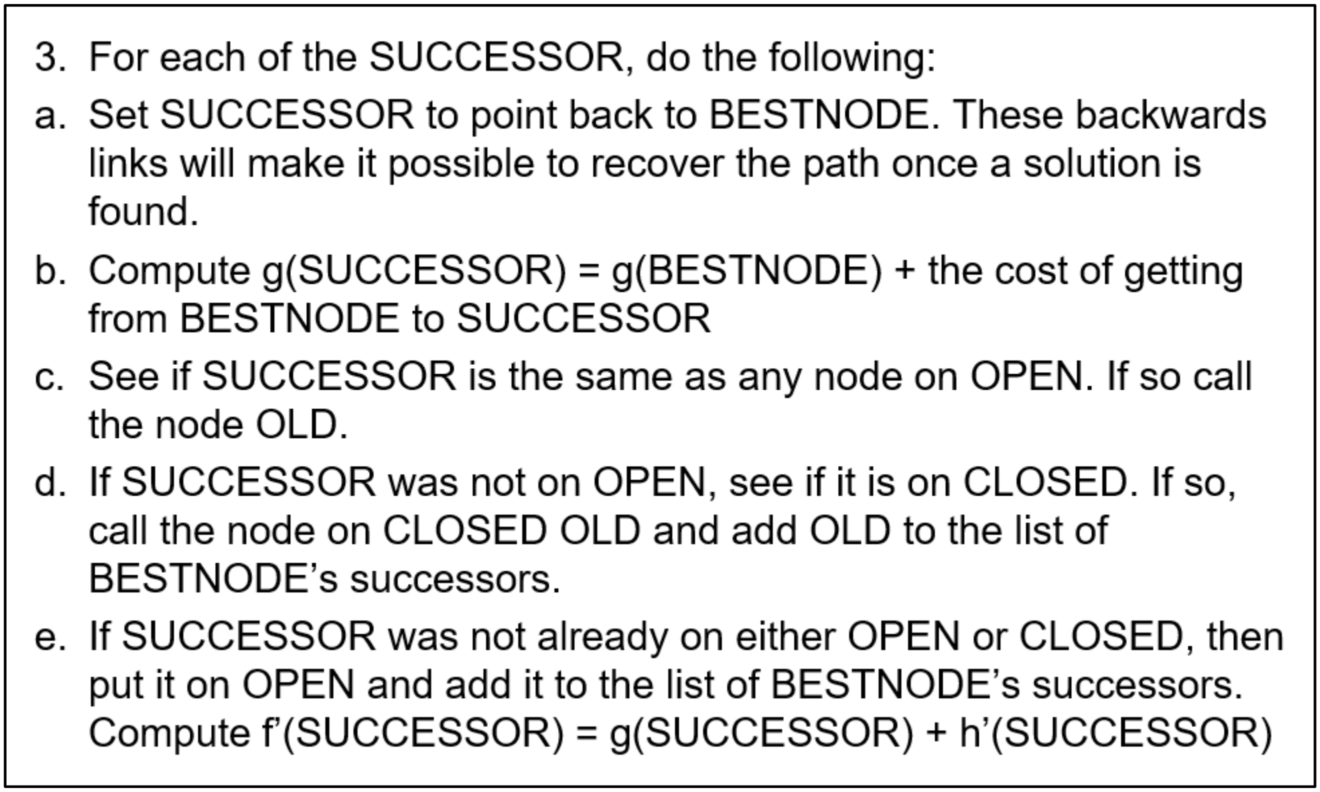
Lab Test

U19CS012

Q.) Implement **8 Puzzle** problem with **Heuristic Algorithms** in PROLOG.



1. Initially
    1. OPEN = {start Node},CLOSED = { }
    2. g(Start Node} = 0
    3. h'(Start Node) = calculate
    4. f'(Start Node) = h'+0 = h'
2. Until a goal node is found, repeat
    1. If there are no nodes on OPEN, report failure
    2. Otherwise pic the BESTNODE node from OPEN with the lowest f'
    3. Remove it from OPEN and put it in CLOSED.
    4. If the BESTNODE is a goal state so exit and report a solution.
    5. Else generate the successors of BESTNODE and add in the OPEN list



3. For each of the SUCCESSOR, do the following:

a. Set SUCCESSOR to point back to BESTNODE. These backwards links will make it possible to recover the path once a solution is found.

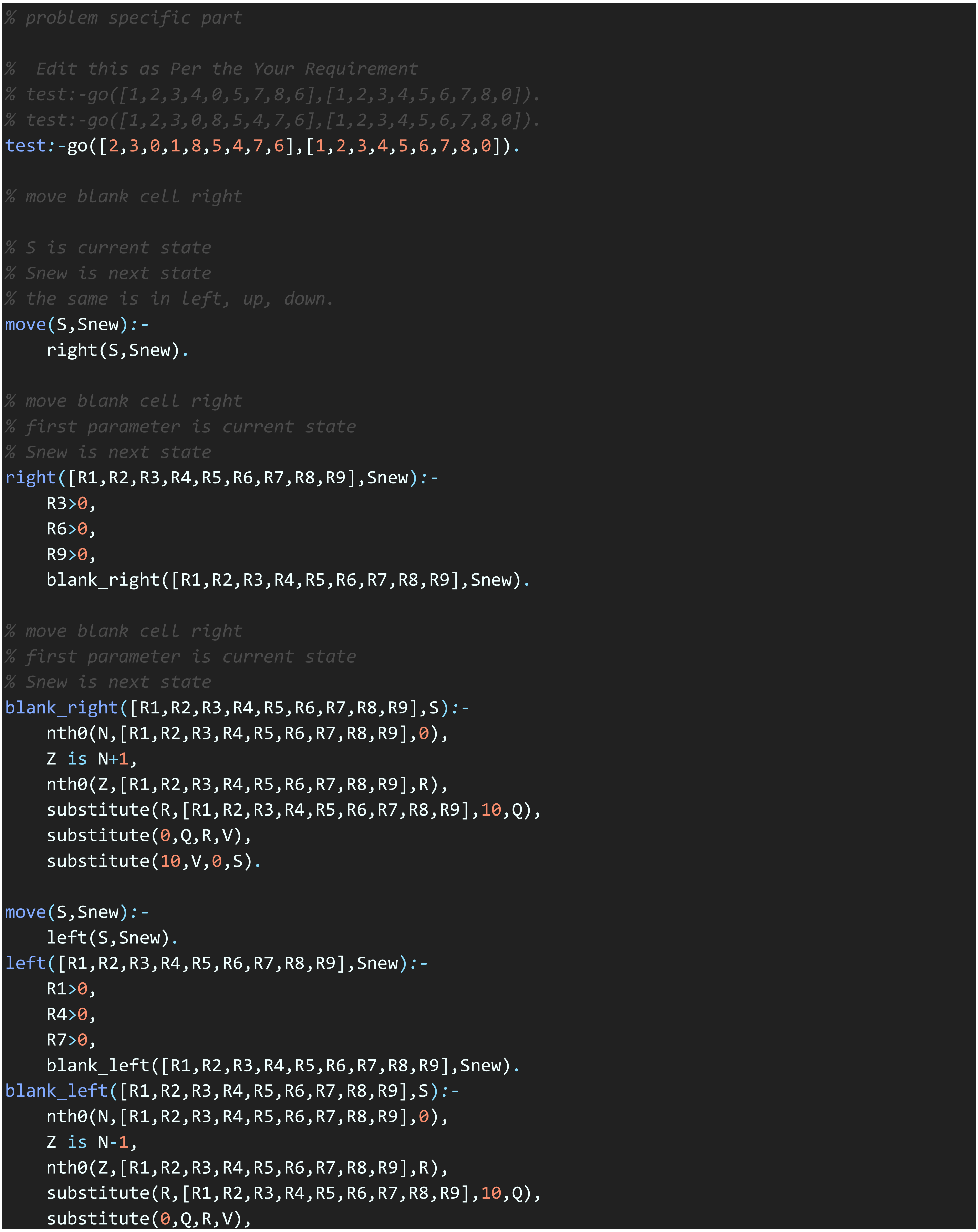
b. Compute g(SUCCESSOR) = g(BESTNODE) + the cost of getting from BESTNODE to SUCCESSOR

c. See if SUCCESSOR is the same as any node on OPEN. If so call the node OLD.

d. If SUCCESSOR was not on OPEN, see if it is on CLOSED. If so, call the node on CLOSED OLD and add OLD to the list of BESTNODE's successors.

e. If SUCCESSOR was not already on either OPEN or CLOSED, then put it on OPEN and add it to the list of BESTNODE's successors. Compute f'(SUCCESSOR) = g(SUCCESSOR) + h'(SUCCESSOR)

Code



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% problem specific part

%  Edit this as Per the Your Requirement
% test:-go([1,2,3,4,0,5,7,8,6],[1,2,3,4,5,6,7,8,0]).
% test:-go([1,2,3,0,8,5,4,7,6],[1,2,3,4,5,6,7,8,0]).
test:-go([2,3,0,1,8,5,4,7,6],[1,2,3,4,5,6,7,8,0]).

% move blank cell right

% S is current state
% Snew is next state
% the same is in left, up, down.
move(S,Snew):-
    right(S,Snew).

% move blank cell right
% first parameter is current state
% Snew is next state
right([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew):-
    R3>0,
    R6>0,
    R9>0,
    blank_right([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew).

% move blank cell right
% first parameter is current state
% Snew is next state
blank_right([R1,R2,R3,R4,R5,R6,R7,R8,R9],S):-
    nth0(N,[R1,R2,R3,R4,R5,R6,R7,R8,R9],0),
    Z is N+1,
    nth0(Z,[R1,R2,R3,R4,R5,R6,R7,R8,R9],R),
    substitute(R,[R1,R2,R3,R4,R5,R6,R7,R8,R9],10,Q),
    substitute(0,Q,R,V),
    substitute(10,V,0,S).

move(S,Snew):-
    left(S,Snew).
left([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew):-
    R1>0,
    R4>0,
    R7>0,
    blank_left([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew).
blank_left([R1,R2,R3,R4,R5,R6,R7,R8,R9],S):-
    nth0(N,[R1,R2,R3,R4,R5,R6,R7,R8,R9],0),
    Z is N-1,
    nth0(Z,[R1,R2,R3,R4,R5,R6,R7,R8,R9],R),
    substitute(R,[R1,R2,R3,R4,R5,R6,R7,R8,R9],10,Q),
    substitute(0,Q,R,V),
    substitute(10,V,0,S).

move(S,Snew):-
    down(S,Snew).
down([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew):-
    R7>0,
    R8>0,
    R9>0,
    blank_down([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew).
blank_down([R1,R2,R3,R4,R5,R6,R7,R8,R9],S):-
    nth0(N,[R1,R2,R3,R4,R5,R6,R7,R8,R9],0),
    Z is N+3,
    nth0(Z,[R1,R2,R3,R4,R5,R6,R7,R8,R9],R),
    substitute(R,[R1,R2,R3,R4,R5,R6,R7,R8,R9],10,Q),
    substitute(0,Q,R,V),
    substitute(10,V,0,S).

move(S,Snew):-
    up(S,Snew).
up([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew):-
    R1>0,
    R2>0,
    R3>0,
    blank_up([R1,R2,R3,R4,R5,R6,R7,R8,R9],Snew).
blank_up([R1,R2,R3,R4,R5,R6,R7,R8,R9],S):-
    %  get position of blank cell
    nth0(N,[R1,R2,R3,R4,R5,R6,R7,R8,R9],0),
    Z is N-3,
    %  get element in pos Z
    nth0(Z,[R1,R2,R3,R4,R5,R6,R7,R8,R9],R),
    % substitute element of pos Z with blank cell “0”
    substitute(R,[R1,R2,R3,R4,R5,R6,R7,R8,R9],10,Q),
    substitute(0,Q,R,V),
    substitute(10,V,0,S).

%  substitutes the first parameter with the third parameter and the third parameter with the
first parameter in the second parameter (list) and produces a new list (forth parameter).

% e.g. substitute(1, [1,2,3,1,4], 4, X) will make X=[4,2,3,4,1]

% first parameter is value to be substituted by third parameter or replaces it.
% second parameter is the given list to be substituted.
% third parameter is the value that will replace the first parameter or will be substituted
by the first parameter
% forth parameter is the new list after substitution.

substitute(_, [], _, []):-!.
substitute(X, [X|T], Y, [Y|T1]):-
  substitute(X, T, Y, T1),!.
substitute(X, [Y|T], Y, [X|T1]):-
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  substitute(X, T, Y, T1),!.
substitute(X, [H|T], Y, [H|T1]):-
  substitute(X, T, Y, T1).

%  end of specific part

% General Algorithm to Solve the 8 Queens using Heusteric Search

% query of user and takes start state and next state
go(Start,Goal):-
      getHeuristic(Start, H, Goal),
      path([[Start,null, 0, H, H]],[],Goal).% open, closed, goal, path_cost, heuristic, total
cost

% main predicate that takes open list, closed list and goal state
path([], _, _):-
      write('No solution'),nl,!.
path(Open, Closed, Goal):-
      getBestChild(Open, [Goal, Parent, PC, H, TC], RestOfOpen),
      write('A solution is found'),  nl ,
      printsolution([Goal,Parent, PC, H, TC], Closed),!.
path(Open, Closed, Goal):-
      getBestChild(Open, [State, Parent, PC, H, TC], RestOfOpen),
      getchildren(State, Open, Closed, Children, PC, Goal),
      addListToOpen(Children , RestOfOpen, NewOpen),
      path(NewOpen, [[State, Parent, PC, H, TC] | Closed], Goal).

% gets Children of State that aren't in Open or Close
getchildren(State, Open ,Closed , Children, PC, Goal):-
      bagof(X, moves( State, Open, Closed, X, PC, Goal), Children).
getchildren(_,_,_, [],_,_).

% adds children to open list (without best child) to form new open list
addListToOpen(Children, [], Children).
addListToOpen(Children, [H|Open], [H|NewOpen]):-
      addListToOpen(Children, Open, NewOpen).

% gets the best state of the open list and another list without this best state
% first parameter is the open list
% second parameter is the best child
% third parameter is the open list without the best child
getBestChild([Child], Child, []).
getBestChild(Open, Best, RestOpen):-
  getBestChild1(Open, Best),
  removeFromList(Best, Open, RestOpen).

% gets the best state of the open list
getBestChild1([State], State).
getBestChild1([State|Rest], Best):-
  getBestChild1(Rest, Temp),
  getBest(State, Temp, Best).

% compares two states with each other (according to their Total cost) and returns the state
with lower total cost TC
getBest([State, Parent, PC, H, TC], [_, _, _, _, TC1], [State, Parent, PC, H, TC]):-
  TC < TC1, !.
getBest([_, _, _, _, _], [State1, Parent1, PC1, H1, TC1], [State1, Parent1, PC1, H1, TC1]).

% removes an element (usually the best state) from a list (open list) and returns a new list
removeFromList(_, [], []).
removeFromList(H, [H|T], V):-
  !, removeFromList(H, T, V).
removeFromList(H, [H1|T], [H1|T1]):-
  removeFromList(H, T, T1).

% gets next state given the current state
moves( State, Open, Closed,[Next,State, NPC, H, TC], PC, Goal):-
      move(State,Next),
      \+ member([Next, _, _, _, _],Open),
      \+ member([Next, _, _, _, _],Closed),
      NPC is PC + 1,
      getHeuristic(Next, H, Goal),
      TC is NPC + H.

% calculate heuristic of some state
% here it is calculated as number of misplaced numbers
getHeuristic([], 0, []):-!.
getHeuristic([H|T1],V,[H|T2]):-!,
  getHeuristic(T1,V, T2).
getHeuristic([_|T1],H,[_|T2]):-
  getHeuristic(T1,TH, T2),
  H is TH + 1.

% prints the path from start state to goal state
printsolution([State, null, PC, H, TC],_):-
      write(State), write(' PC: '), write(PC), write(' H:'), write(H), write(' TC: '),
write(TC), nl.

printsolution([State, Parent, PC, H, TC], Closed):-
      member([Parent, GrandParent, PC1, H1, TC1], Closed),
      printsolution([Parent, GrandParent, PC1, H1, TC1], Closed),
      write(Parent),    write(State), write(' !!PC: '), write(PC), write(' H:'), write(H),
write(' TC: '), write(TC), nl.
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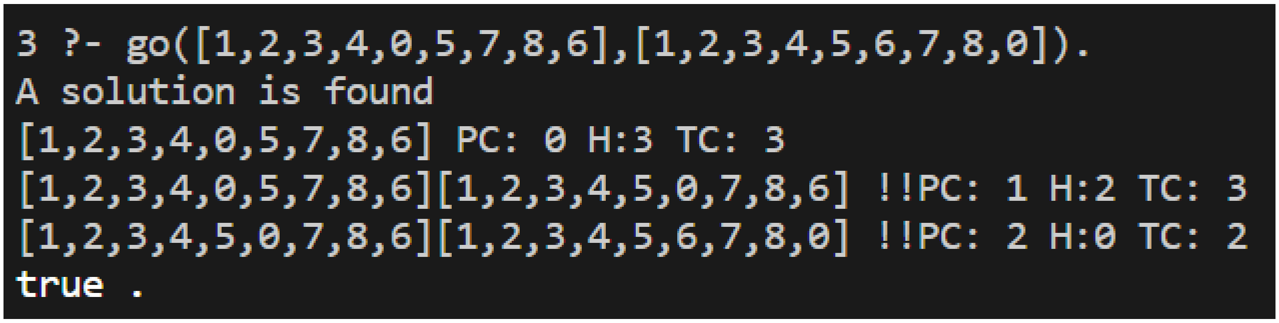
Output

Easy: puzzle(state(1,2,3,4,*,5,7,8,6)).



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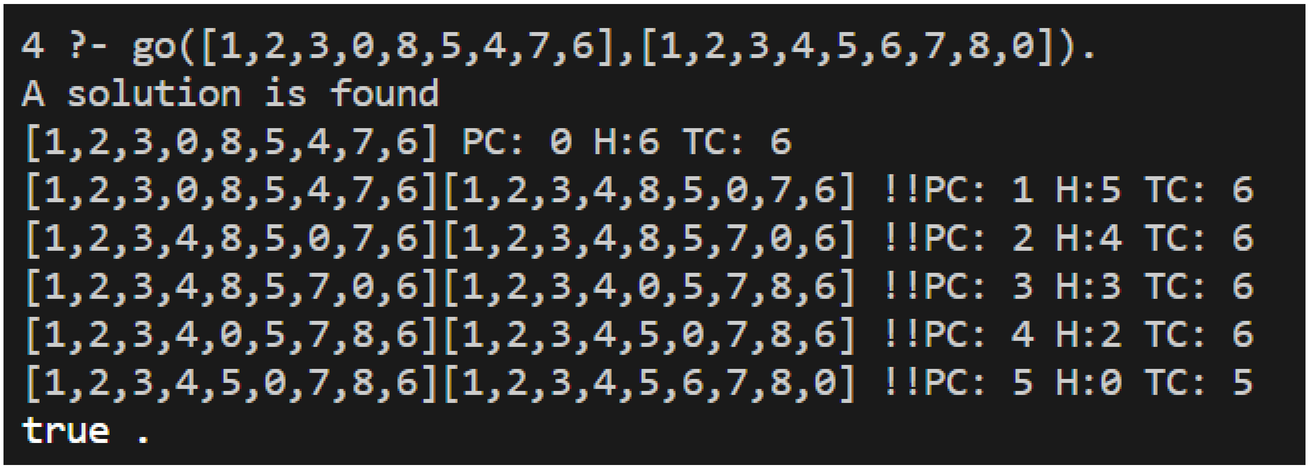
3 ?- go([1,2,3,4,0,5,7,8,6],[1,2,3,4,5,6,7,8,0]).
A solution is found
[1,2,3,4,0,5,7,8,6] PC: 0 H:3 TC: 3
[1,2,3,4,0,5,7,8,6][1,2,3,4,5,0,7,8,6] !!PC: 1 H:2 TC: 3
[1,2,3,4,5,0,7,8,6][1,2,3,4,5,6,7,8,0] !!PC: 2 H:0 TC: 2
true .
```

Medium: puzzle(state(1,2,3,*,8,5,4,7,6)).



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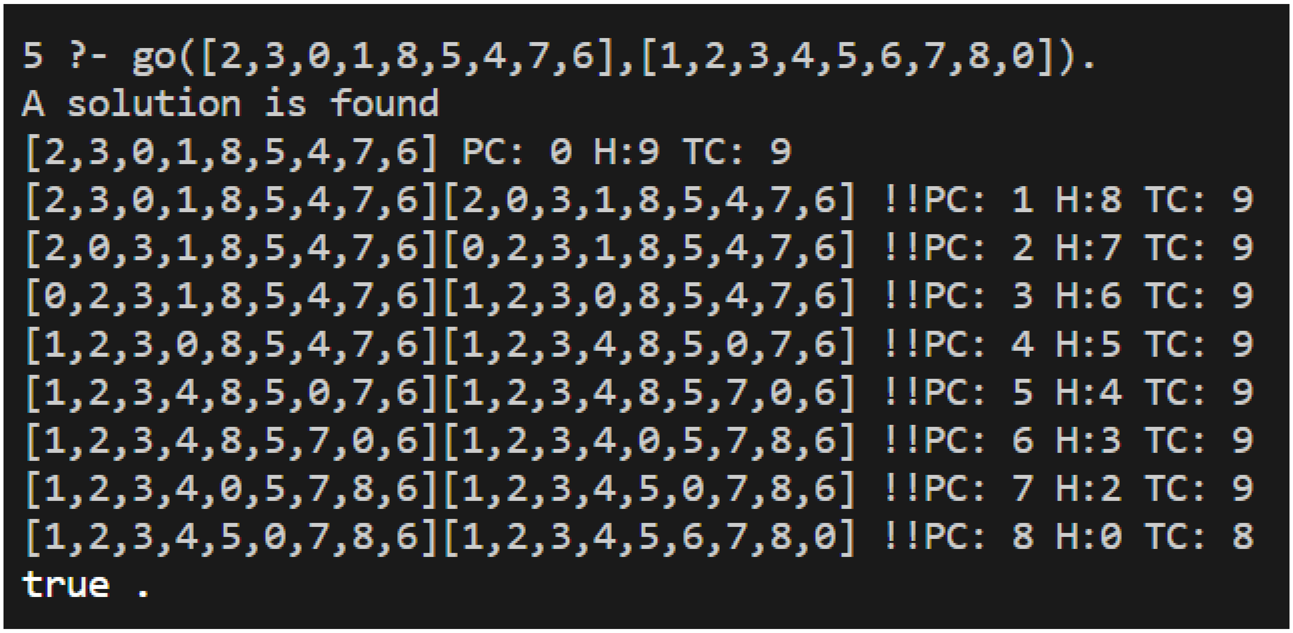
4 ?- go([1,2,3,0,8,5,4,7,6],[1,2,3,4,5,6,7,8,0]).
A solution is found
[1,2,3,0,8,5,4,7,6] PC: 0 H:6 TC: 6
[1,2,3,0,8,5,4,7,6][1,2,3,4,8,5,0,7,6] !!PC: 1 H:5 TC: 6
[1,2,3,4,8,5,0,7,6][1,2,3,4,8,5,7,0,6] !!PC: 2 H:4 TC: 6
[1,2,3,4,8,5,7,0,6][1,2,3,4,0,5,7,8,6] !!PC: 3 H:3 TC: 6
[1,2,3,4,0,5,7,8,6][1,2,3,4,5,0,7,8,6] !!PC: 4 H:2 TC: 6
[1,2,3,4,5,0,7,8,6][1,2,3,4,5,6,7,8,0] !!PC: 5 H:0 TC: 5
true .
```

Hard: puzzle(state(2,3,*,1,8,5,4,7,6)).



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5 ?- go([2,3,0,1,8,5,4,7,6],[1,2,3,4,5,6,7,8,0]).
A solution is found
[2,3,0,1,8,5,4,7,6] PC: 0 H:9 TC: 9
[2,3,0,1,8,5,4,7,6][2,0,3,1,8,5,4,7,6] !!PC: 1 H:8 TC: 9
[2,0,3,1,8,5,4,7,6][0,2,3,1,8,5,4,7,6] !!PC: 2 H:7 TC: 9
[0,2,3,1,8,5,4,7,6][1,2,3,0,8,5,4,7,6] !!PC: 3 H:6 TC: 9
[1,2,3,0,8,5,4,7,6][1,2,3,4,8,5,0,7,6] !!PC: 4 H:5 TC: 9
[1,2,3,4,8,5,0,7,6][1,2,3,4,8,5,7,0,6] !!PC: 5 H:4 TC: 9
[1,2,3,4,8,5,7,0,6][1,2,3,4,0,5,7,8,6] !!PC: 6 H:3 TC: 9
[1,2,3,4,0,5,7,8,6][1,2,3,4,5,0,7,8,6] !!PC: 7 H:2 TC: 9
[1,2,3,4,5,0,7,8,6][1,2,3,4,5,6,7,8,0] !!PC: 8 H:0 TC: 8
true .
```

SUBMITTED BY: U19CS012

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