ARTIFICIAL INTELLIGENCE ASSIGNMENT-1

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Readme:

Commands to run the program:

For q1.1 : python3 q1.py
For q1.2 : python3 q2.py
For q1.5 : python3 q5.py

Input Format :

White block='w'
Black block='b'
Empty block='_'

For q1 and q2:

Output:

- The first line consists of the minimum cost of solving the puzzle.
- The minimum cost path from input state to goal state will be printed from the second line along with the serial number of each step.

For q5:

Output:

- The first line consists of the minimum cost of solving the puzzle.
- All the possible goal states and their corresponding costs will be printed from the second line.

Question 1.1:

The programme is implemented in python and it accepts all the valid configurations of the tiles and the empty space as input and outputs the puzzle solution with the total cost of the shortest path and the total number of nodes expanded in solving the puzzle.

Idea of implementation : Implemented a BFS search algorithm.

Question 1.2 :

Heuristic function considered here is : h(s)=number of 'w's after first b + number of 'b's before last w.

The programme is implemented in python and it accepts all the valid configurations of the tiles and the empty space as input and outputs a measure of how far the current configuration is, from any of the goal states. This is added to the edge weight in the previous BFS implementation.

Question 1.3 :

Let's say

c1 as the cost to solve an input configuration without using heuristic function,

c2 as the cost to solve an input configuration with heuristic function.

Then, c1 is always greater than equal to c2 for the same input. Following are some examples to demonstrate it. (c1 >= c2)

Example Input 1: bbbw_ww

Without Heuristic:

Enter the start configuration:
bbbw_ww

Cost= 14
b_bwbww 1
_bbwbww 2
wbb_bww 3
wb_bbww 4
wbwbb_w 5
wbw_bbw 6
wbwwbb_ 7
wbww_bb 8
w_wwbbb 9

With heuristic:

Enter the start configuration:
bbbw_ww

Cost= 13
bb_wbww 1
_bbwbww 2
wbb_bww 3
wbbwbw_ 4
wbbw_wb 5
w_bwbwb 6
wwb_bwb 7
wwbwb_b 8
ww_wbbb 9

Example Input 2 : bbb_www

Without Heuristic:

Enter the start configuration:
bbb_www

Cost= 14
b_bbwww 1
bwbb_ww 2
bw_bbww 3
bwwbb_w 4
bwwbbw_ 5
bww_bwb 6
_wwbbwb 7
ww_bbwb 8
wwwbb_b 9

With heuristic:

Enter the start configuration:
bbb_www

Cost= 14
b_bbwww 1
bwbb_ww 2
bwbbww_ 3
bwb_wwb 4
_wbbwwb 5
w_bbwwb 6
wwbb_wb 7
ww_bbwb 8
wwwbb_b 9

Question 1.4 :

Lowest cost path of above two methods:(left side ones are the configurations of each node and right side one is the serial number of it in the path).

Ex1:

Without Heuristic:

Enter the start configuration:
bbbw_ww

Cost= 14
b_bwbww 1
_bbwbww 2
wbb_bww 3
wb_bbww 4
wbwbb_w 5
wbw_bbw 6
wbwwbb_ 7
wbww_bb 8
w_wwbbb 9

With heuristic:

Enter the start configuration:
bbbw_ww

Cost= 13
bb_wbww 1
_bbwbww 2
wbb_bww 3
wbbwbw_ 4
wbbw_wb 5
w_bwbwb 6
wwb_bwb 7
wwbwb_b 8
ww_wbbb 9

Ex2:

Without Heuristic:

Enter the start configuration:
bbb_www

Cost= 14
b_bbwww 1
bwbb_ww 2
bw_bbww 3
bwwbb_w 4
bwwbbw_ 5
bww_bwb 6
_wwbbwb 7
ww_bbwb 8
wwwbb_b 9

With heuristic:

Enter the start configuration:
bbb_www

Cost= 14
b_bbwww 1
bwbb_ww 2
bwbbww_ 3
bwb_wwb 4
_wbbwwb 5
w_bbwwb 6
wwbb_wb 7
ww_bbwb 8
wwwbb_b 9

Question 1.5 :

Empty space position affects the cost by either 1 or 2 values, we can infer that when the input configuration has empty block in second half then cost of reaching a goal state with empty block in first half is lesser cost than that of the second half, vice versa for the empty block being in first half. From this we can conclude that when we start off with a configuration we are more likely to end up having the empty block in the opposite half. If the empty block is in the middle the costs are evenly distributed and we will end up in any of the halfs depending on the implementation.

(Left side ones are the goal configurations and right side are their corresponding costs)

Enter the start configuration:
bbb_www

_wwwbbb 15
w_wwbbb 14
ww_wbbb 14
www_bbb 15
wwwb_bb 14
wwwbb_b 14
wwwbbb_ 15

Enter the start configuration:
bbbw_ww

_wwwbbb 14
w_wwbbb 13
ww_wbbb 13
www_bbb 14
wwwb_bb 14
wwwbb_b 13
wwwbbb_ 14

Enter the start configuration:
wwbwbb_

_wwwbbb 3
w_wwbbb 3
ww_wbbb 3
www_bbb 3
wwwb_bb 4
wwwbb_b 4
wwwbbb_ 5

Enter the start configuration:
bwww_bb

_wwwbbb 8
w_wwbbb 7
ww_wbbb 6
www_bbb 6
wwwb_bb 5
wwwbb_b 6
wwwbbb_ 6