Artificial Intelligence: Programming 1 (P1)
A* Search

Instructor: Dr. Shengquan Wang

Due Time: 10PM, 7/17/2022

In this programming assignment, we aim to implement the A* search algorithm.

1 Windy 8-Puzzle Problem

We consider a variant of the 8-puzzle problem (`http://tristanpenman.com/demos/n-puzzle`) under a windy condition. The initial state and the goal state are shown as follows: We assume that the wind

1	5	-
6	7	4
2	8	3

Intial state

7	6	5
8	-	4
1	2	3

Goal state

comes from the north. The step cost regarding the agent's moving a non-blank tile to the neighboring blank tile is defined as follows: 1 for moving southward; 2 for moving westward or eastward; 3 for moving northward.

The evaluation function $f(n) = g(n) + h(n)$, where $g(n)$ is the path cost and $h(n)$ is the heuristic function. $g(n)$ is defined as the path cost until the current state n by considering the windy step cost. For $h(n)$, we use a modified total Manhattan distance used in class by considering the windy situation. We define $h(n) = \sum_{i=1}^{8} h_i(n)$, where $h_i(n)$ is for each tile. For example, for the initial node, regarding Tile 6, the agent has to move at least 1-step northward and 1-step eastward in order to reach the goal. Therefore, we have $h_6(n) = 3 * 1 + 2 * 1 = 5$ at the initial state.

In your implementation, please use a priority queue for the frontier and a hash table for the expored set. The priority is based on the evaluation function $f(n)$. The smaller the value, the higher the priority. When adding children to an expansion node, use such order of moving the non-blank tile to the neighboring blank tiles: first the west neighboring non-blank tile; then north one; then the east one; then the south one. To break tie in picking an expansion node, use FIFO order. In your testing output, please print out all expansion states in the sequence as shown on next page: For the printout of each state, the last 2nd row includes $g(n)$ value at the left and $h(n)$ value at the right, and the last row indicates the expansion order.

2 Submission

Form a group on Canvas if you want to work with another student. Specify the contribution made by each member if you work as a group.

1	5	-
6	7	4
2	8	3
0	|	21
#1		

1	-	5
6	7	4
2	8	3
2	|	19
#2		

1	7	5
6	-	4
2	8	3
5	|	16
#3		

1	7	5
-	6	4
2	8	3
7	|	14
#4		

1	7	5
6	8	4
2	-	3
8	|	13
#5		

-	7	5
1	6	4
2	8	3
8	|	13
#6		

1	7	5
6	8	4
-	2	3
10	|	11
#7		

7	-	5
1	6	4
2	8	3
10	|	11
#8		

7	6	5
1	-	4
2	8	3
13	|	8
#9		

7	6	5
1	8	4
2	-	3
16	|	5
#10		

7	6	5
1	8	4
-	2	3
18	|	3
#11		

7	6	5
-	8	4
1	2	3
19	|	2
#12		

7	6	5
8	-	4
1	2	3
21	|	0
#13		

In your report, please provide the screenshots of all outcomes, and the highlighted code segments and the detailed explanation on how you implement the followings:

- Data structure: priority queue for frontier set and hash table for explored set;
- Calculation of $f(n) = g(n) + h(n)$;
- Adding leaves for expansion;
- Picking the smallest $f(n)$.

Each screenshot should include your usernames and the current time, which show that you did it by yourselves. If your output is different from the expected one, provide a reason for the cause. Comment your code in details so that the grader can understand it well.

Your assignment will be graded based on the above guideline and the rubric on Canvas. The report should be written in a ".docx", ".doc", or ".pdf" format. Submit the report and the source code to the assignment folder P1 on Canvas. Any compression file format such as `.zip` is not permitted.