Assignment: A* to solve the modified n-puzzle problem

Suppose the standard n-puzzle problem is modified so that there are two empty locations (instead of one) allowing you to pick any one tile adjacent to any one of the two empty locations and move it to the adjacent empty location. You are given a starting configuration and are supposed to rearrange the tiles by move them into the empty locations as necessary to end up in a given goal configuration. Figure 1 shows an example of a starting and a goal configuration.

1	4	-	7
9	2	3	5
6	-	10	13
8	11	14	12

1	4	7	5
9	2	3	-
-	11	10	13
6	8	14	12

Starting configuration   Goal configuration

Figure 1: Sample starting/goal configurations. Two '-'s are the empty locations.

Q1)

Implement the A* algorithm in any programming language of your choice to solve this modified *n*-puzzle problem. Your program should be able to accept as command line input, two tab delimited files of the form provided together with this assignment as sample starting configuration and goal configuration. The output should be a *text* file containing a sequence of moves of the form [(tile_number, move)]. E.g., see the sample output file provided. (1,up), (2,down), (3,left) …. (8, right).

a) Experiment with the two heuristics "number of misplaced tiles" and "total Manhattan distance" and compare their efficiency in terms of the number of moves to reach the goal. Is one better than the other?

To find the answer, generate at least 100 randomly generated start/goal configuration pairs comprising of different puzzle sizes (*n*) ranging from 5 - 20. Then for each of them, run the A* algorithm, first with "number of misplaced tiles" heuristic and then with the "total Manhattan distance" heuristic. For each start/goal pair, compute the difference in the number of moves required to go from start to goal for the two heuristics. E.g., if you tested with 100 start/goal pairs, you would have computed 100 differences. Then, compute the mean of these difference values and assess whether the mean difference is significantly different from 0. Based on this, you can conclude whether there is a significant difference between the performance of the two heuristics and which one is better. You may refer to this link for help on paired t-test, which you can use to assess the statistical significance of the differences mentioned earlier. Submit a report including the results of your experiments (difference in moves) and your analysis of the results (statistical significance testing).

Please submit it in one zipped folder along with the deliverables mentioned on part b) below.

b) Submit your program as an executable file that can be run from the windows command line by providing the input as mentioned above in Q1. Submit the source code as well. Please submit everything in one zipped folder.