Question 5: Compare Algorithm

Data

Initial State	Misplaced Tile Heuristic	Manhattan Heuristic	Gaschnig Heuristic
1 2 3 7 0 6 5 4 8	Nodes Expanded: 21 Total Run Time: 0.0 Length of Solution:6	Nodes Expanded: 15 Total Run Time: 0.0 Length of Solution: 6	Nodes Expanded:19 Total Run Time:0.000997 Length of Solution:6
1 3 8 5 7 2 6 0 4	Nodes Expanded: 1273 Total Run Time: 0.213429 Length of Solution:17	Nodes Expanded: 189 Total Run Time: 0.0089762 Length of Solution:17	Nodes Expanded: 749 Total Run Time: 0.1107 Length of Solution:17
4 1 3 0 6 8 2 7 5	Nodes Expanded: 123 Total Run Time: 0.00399 Length of Solution:11	Nodes Expanded: 29 Total Run Time: 0.000997 Length of Solution:11	Nodes Expanded: 95 Total Run Time: 0.003989 Length of Solution:11
4 1 2 6 8 0 5 7 3	Nodes Expanded: 663 Total Run Time: 0.091754 Length of Solution: 15	Nodes Expanded: 161 Total Run Time: 0.00798 Length of Solution:15	Nodes Expanded: 487 Total Run Time: 0.05388 Length of Solution:15
1 2 3 5 7 6 0 4 8	Nodes Expanded: 17 Total Run Time: 0.0 Length of Solution:6	Nodes Expanded: 15 Total Run Time: 0.0 Length of Solution:6	Nodes Expanded: 15 Total Run Time: 0.0 Length of Solution:6
0 1 3 4 7 6 5 2 8	Nodes Expanded: 83 Total Run Time: 0.002021 Length of Solution:10	Nodes Expanded: 10 Total Run Time: 0.00199 Length of Solution:10	Nodes Expanded: 10 Total Run Time: 0.00197 Length of Solution:10
1 2 3 4 6 5 8 7 0	Nodes Expanded: 969 Total Run Time: 0.15558 Length of Solution:16	Nodes Expanded: 469 Total Run Time:0.0508 Length of Solution:16	Nodes Expanded: 601 Total Run Time: 0.08975 Length of Solution:16
2 6 8 7 1 3 0 4 5	Nodes Expanded: 903 Total Run Time: 0.1426 Length of Solution:16	Nodes Expanded: 187 Total Run Time:0.00797 Length of Solution:16	Nodes Expanded: 531 Total Run Time: 0.0548 Length of Solution:16
1 5 2 0 3 6 7 8 4	Nodes Expanded: 313 Total Run Time: 0.0199 Length of Solution:13	Nodes Expanded: 117 Total Run Time: 0.00598 Length of Solution:13	Nodes Expanded: 243 Total Run Time: 0.0169 Length of Solution:13
2 0 4 1 5 3 7 8 6	Nodes Expanded: 57 Total Run Time: 0.00299 Length of Solution:9	Nodes Expanded: 49 Total Run Time: 0.00398 Length of Solution:11	Nodes Expanded: 43 Total Run Time: 0.00299 Length of Solution:11

Table 1: Summarizes the data in this table where total run is measured in seconds.

Statistics

Misplaced Tile Heuristic	Length of Solution	Nodes Expanded	Total Run Time
Maximum	17	1273	0.213429
Minimum	6	17	0
Mean	11.9	442.2	0.063226
Median	12	313	0.011945

Manhattan Heuristic	Length of Solution	Nodes Expanded	Total Run Time
Maximum	17	469	0.0508
Minimum	6	10	0
Mean	11.9	124.1	0.008867
Median	12	83	0.00498

Gaschnig Heuristic	Length of Solution	Nodes Expanded	Total Run Time
Maximum	17	1273	0.213429
Minimum	6	17	0
Mean	11.9	309	0.033579
Median	12	169	0.010345

This section shows each heuristic functions' respective statistics

Questions

(1) Based on your data, can you give a recommendation for what you think is the best algorithm? Explain how you came to your conclusion

Based on my data, Manhattan heuristic is the best algorithm out of the 3 because in all of the 10 cases, it had the least number of nodes expanded (except sometimes when the length of the solution was less than 6 and gaschnig has performed equally to Manhattan). Overall, as shown in my table of data, as the length of the solution grew larger, the Manhattan algorithm expanded the least number of nodes out of the 3 algorithms.

(2) Is it possible to rule out one of the heuristic functions without looking at experimental data, but purely based on theoretical consideration? Hint: We say that an admissible heuristic h1 is at least as accurate as another admissible heuristic h2 iff for every n, $h1(n) \geq h2(n)$.

We can rule out the misplaced tile heuristic based on theoretical consideration and admissible Gaschnig heuristic is at least as accurate as misplaced tile heuristic. Misplaced tiles can only count the number of tiles that are not in position in one move while Gaschnig will always take at least one move to its goal state position. In addition, Gaschnig also requires two moves for the blank location if the state does not have the blank it in goal state position. Therefore, Gaschnig will return either more or equal numbers compared to the misplaced tile heuristic. This means that Gaschnig will always be closer to the true shortest path cost compared to misplace tile heuristic and also, Gaschnig dominates misplaced tile heuristic.

(3) Can you suggest a heuristic that is always at least as accurate as all 3 heuristic functions discussed here?

$$h(n) = \max(gaschnig(n), manhattan(n))$$

This h(n) uses whichever function is most accurate on the node n in question. Because the component heuristics are admissible, h(n) is also admissible. h(n) dominates all the heuristic functions that it is composed of.