

CS561 - ARTIFICIAL INTELLIGENCE LAB

ASSIGNMENT-1: A* Search, BFS

GroupID : 1801cs12_1801cs16_1801cs22

Date : 25/08/2021

1801CS12 : Bablu Kumar

1801CS16 : Mangesh Chandrawanshi

1801CS22 : Hrishabh Raj

Observations

h_1 = number of tiles displaced, h_2 = manhattan distance, b = branching factor, m = depth of solution

BFS : we are not able to say for sure which heuristic is better, there were test cases when h_2 outperformed h_1 and vice versa. BFS can stuck in loops if in queue it keeps on finding state with same heuristic value as it does not consider backward cost to reach current state, therefore it is not complete algorithm

- Time: $O(b^m)$ (in worst case but a good heuristic can improve execution time)
- Space: $O(b^m)$ (stores all nodes in memory)
- Optimal: No (does not guarantee lowest cost solution).
- Complete : No (does not guarantee a solution, can get stuck in loops).

A* : h_2 was better(search time & lesser no of explored states) than using h_1 , and it always finds a solution (this verifies the fact that h_2 dominates h_1)

- Time: $O(b^m)$ (in worst case but a good heuristic can improve execution time)
- Space: $O(b^m)$ (stores all nodes in memory)
- Optimal: Yes (provided heuristic used is admissible (i.e. does not overestimate))
- Complete : Yes (guaranteed to get a solution if it exists).

Conclusion : BFS is not able to find shortest path to goal always since it focuses on the lowest heuristic without considering backward cost where as A* focuses on heuristics and the cost of getting to that state which leads to better results

Test1

StartState
T8 T3 T5
T4 T1 T6
T2 T7 B

GoalState
T1 T2 T3
T8 B T4
T7 T6 T5

Algorithm Name	BFS
Heuristic Function	Displace Cost Heuristics
Total number of states explored	606
Total number of states to optimal path	85
Optimal Path Cost	84
Time Taken For Execution	0.06000041961669922 seconds
Optimal Path	<div> <div>T8 T3 T5</div> <div>T4 T1 T6</div> <div>T2 T7 B</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T1 T3 T5</div> <div>T8 B T4</div> <div>T2 T7 T6</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T1 T2 T3</div> <div>T8 B T4</div> <div>T7 T6 T5</div> </div>

Algorithm Name	Astar
Heuristic Function	Displace Cost Heuristics
Total number of states explored	166
Total number of states to optimal path	15
Optimal Path Cost	14
Time Taken For Execution	0.015999794006347656 seconds
Optimal Path	<div> <div>T8 T3 T5</div> <div>T4 T1 T6</div> <div>T2 T7 B</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T8 T1 T3</div> <div>T2 T4 T5</div> <div>T7 T6 B</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T1 T2 T3</div> <div>T8 B T4</div> <div>T7 T6 T5</div> </div>

Algorithm Name	BFS
Heuristic Function	Manhattan Cost Heuristics
Total number of states explored	16
Total number of states to optimal path	15
Optimal Path Cost	14
Time Taken For Execution	0.0 seconds
Optimal Path	<div> <div>T8 T3 T5</div> <div>T4 T1 T6</div> <div>T2 T7 B</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T8 T1 T3</div> <div>T2 T4 B</div> <div>T7 T6 T5</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T1 T2 T3</div> <div>T8 B T4</div> <div>T7 T6 T5</div> </div>

Algorithm Name	Astar
Heuristic Function	Manhattan Cost Heuristics
Total number of states explored	16
Total number of states to optimal path	15
Optimal Path Cost	14
Time Taken For Execution	0.003999233245849609 seconds
Optimal Path	<div> <div>T8 T3 T5</div> <div>T4 T1 T6</div> <div>T2 T7 B</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T8 T1 T3</div> <div>T2 T4 T5</div> <div>T7 T6 B</div> <div>.....</div> <div>.....</div> <div>.....</div> <div>T1 T2 T3</div> <div>T8 B T4</div> <div>T7 T6 T5</div> </div>

Test2

Start State :
T8 T6 T7
T2 T5 T4
T3 B T1

Goal State :
T1 T2 T3
T4 T5 T6
T7 T8 B

Algorithm Name	BFS
Heuristic Function	Displace Cost Heuristics
Total number of states explored	313
Total number of states to optimal path	76
Optimal Path Cost	75
Time Taken For Execution	0.027999401092529297 seconds
Optimal Path	T8 T6 T7 T2 T5 T4 T3 B T1 T4 T1 T2 B T3 T6 T7 T8 T5 T1 T2 T3 T4 T5 T6 T7 T8 B

Algorithm Name	Astar
Heuristic Function	Displace Cost Heuristics
Total number of states explored	143848
Total number of states to optimal path	32
Optimal Path Cost	31
Time Taken For Execution	15.512041330337524 seconds
Optimal Path	T8 T6 T7 T2 T5 T4 T3 B T1 B T5 T2 T1 T7 T6 T8 T3 T4 T1 T2 T3 T4 T5 T6 T7 T8 B

Algorithm Name	BFS
Heuristic Function	Manhattan Cost Heuristics
Total number of states explored	146
Total number of states to optimal path	46
Optimal Path Cost	45
Time Taken For Execution	0.020000219345092773 seconds
Optimal Path	T8 T6 T7 T2 T5 T4 T3 B T1 T3 T2 B T1 T5 T8 T4 T7 T6 T1 T2 T3 T4 T5 T6 T7 T8 B

Algorithm Name	Astar
Heuristic Function	Manhattan Cost Heuristics
Total number of states explored	21197
Number of states to optimal path	32
Optimal Path Cost	31
Time Taken For Execution	3.3079609870910645 seconds
Optimal Path	T8 T6 T7 T2 T5 T4 T3 B T1 T3 T8 T5 B T2 T6 T1 T4 T7 T1 T2 T3 T4 T5 T6 T7 T8 B