USJ-ESIB

Eight Puzzle Project

Artificial Intelligence

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Our video's link: eight_puzzle_video

Key Ideas:

State Space: A state is a unique arrangement of 8 tiles (1 to 8) and one blank (0).
Number of States: Number of permutations of the tiles (9!) divided by 2 (not all are solvable).
Solvability Rule: If the number of inversions is odd (resp. even): The blank tile should be on an odd (resp. even) row.
Possible Actions: We can only move the blank tile (up, down, left, right) in the grid, and swap it with another tile.
Goal Test: Compare the current state with goal state ([[1,2,3], [4,5,6], [7,8,0]])

Solving the puzzle with A* using different heuristics:

I. Misplaced Tiles
Misplaced Tiles Heuristic = Number of misplaced tiles in the puzzle
\+ : Easy and fast heuristic to compute
− : Very optimistic and far from reality
− : Combined with an A* search, too many nodes are explored →Slow resolution of the puzzle when the tiles are very shuffled.

II. Manhattan distance
Manhattan distance=$\sum |x_{now} - x_{goal}| + |y_{now} - y_{goal}|$ for all tiles.
\+ : Great Heuristic, optimistic and realistic

III. Linear Conflict (Enhanced Manhattan Distance)
Linear Conflict = Manhattan Distance + 2*number of conflicts
What is a conflict?
\+ : The most realistic heuristic in our project
− : Increases Complexity → Requires more calculation than Manhattan distance.

Conclusion:

Test Case	Initial State	BFS (Explored Nodes)	Manhattan (Explored Nodes)	Misplaced Tiles (Explored Nodes)	Linear Conflict (Explored Nodes)	Uniform Cost Search (Explored Nodes)
Test Case 1	[[8,0,6], [5,4,7], [2,3,1]]	174373	6900	58465	3594	174373
Test Case 2	[[0,1,8], [3,6,2], [5,7,4]]	134409	2052	19124	1150	134409
Test Case 3	[[8,7,6],[5,4,3],[2,1,0]]	181392	17125	117086	9932	181392
Test Case 4	[[1,2,3],[4,5,6],[7,0,8]]	3	1	1	1	3

For very slightly shuffled puzzles, **Misplaced Tiles** can be a good choice since it is simple to compute. The more the puzzle is shuffled, the worse this heuristic becomes. **Manhattan Distance** is a good heuristic because the computation of this heuristic resembles the possible moves of the tiles. We can take into consideration **conflicts** in the puzzle to decrease the number of explored nodes, though this increases the complexity.

When we set the heuristic to zero, **A*** becomes **UCS**, and in this case, it becomes **BFS** because the cost of each move is constant.