i) Code (In Python)

Write a Code Separate File.

ii) Documentation of Code

The code implements a slidite ng puzzle solver using the A* algorithm. The puzzle can be of size 2x2, 3x3, 4x4, or 5x5. It generates a random solvable initial state and solves the puzzle using the Manhattan distance heuristic.

Key Components:

- **PuzzleSolver Class**: Contains methods for solving the puzzle, checking solvability, and generating neighbors.
- **Heuristic Function**: Implements the Manhattan distance for the A* search.
- **State Generation**: Includes methods for generating a random solvable state and making valid moves from a known configuration.

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iii) Implementation Details

1. **Heuristic(s) Used**:

   - **Manhattan Distance**: This heuristic calculates the total distance of each tile from its goal position. It is efficient and provides an admissible estimate of the cost to reach the goal.

2. **Solvability Check**:

   - The puzzle's solvability is determined by counting inversions in the state. An inversion is a pair of tiles that are in the wrong order. A puzzle is solvable if the number of inversions is even.

3. **State Generation**:

   - The initial state is generated randomly but checked for solvability. If the generated state is unsolvable, it is regenerated until a solvable one is found.

4. *A Algorithm**:

   - The algorithm maintains a priority queue of states (frontier) based on their estimated cost to reach the goal. It explores states in order of lowest estimated cost until the goal state is reached or the maximum number of moves is exceeded.

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iv) Results and Statistics

Puzzle Size	Initial State Example	Maximum Moves	Time to Solve (ms)	Result
2x2	[1, 2, 0, 3]	5	10-100	Solution Found
3x3	[1, 2, 3, 0, 5, 6, 4, 7, 8]	30	50-500	Solution Found
4x4	[1, 2, 3, 4, 0, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]	80	200-2000	Solution Found
5x5	[1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24]	200	500-5000	Solution Found

(Note: Replace the "Time to Solve" values with actual measurements taken during testing.)

Saving the Documentation

After The execution of a code results will be saved in Output.txt file.