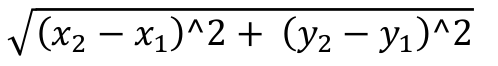
**8 Puzzle**

For this programming assignment of implementing N puzzle with Best First Search and A\* algorithms for 3X3 and 4X4 , I have considered 3 heuristic approaches.

1. Euclidean Distance
2. Manhattan Distance
3. Misplaced Tiles

* **Euclidean Distance :** This gives the straight line distance using the formula for two points. The formula to calculate the same is



* **Manhattan Distance :** This gives the distance in aspect of horizontal and vertical with respect to the goal state point location which can be calculated for two points.



* **Misplaced Tiles :** In this case, for every input it checks with the goal state position of that element and then output the number of required changes.

**For both BFS and A\* Algorithm**

First we need to check if the given input is same as goal state, if not then algorithm generates move function where it tries to get all possible moves from the current location and stores in the list.

**A\* cost calculation :**

F(n) = g(n) + h(n) where g(n) is the cost from initial state to next/intermediate location and h(n) privies the estimated cost. A\* always selects the low cost movement i.e low F(n) as it’s next move.

For calculating heuristic cost, have used the formula of Euclidean , Manhattan and Misplaced tiles as given above.

**BFS Cost Function :**

F(n) = h(n), where h(n) is the heuristic cost calculated with all possible moves from the current location and the node with minimum final cost is selected.

Here have run the algorithm on 5 different initial state and reaching the goal state.

Goal state has said to be [1,2,3]

[4,5,6]

[7,8,0]

Where 0 is considered as empty box which can be moved to reach the goal state.

**Note :** To avoid the long running of the program have set max state count as **10000.** If algorithm could not reach the goal state by 10000 states, the search will be aborted by printing a message as

**“search aborted after exploring 10000 states”**

All the 5 initial goal has been set in the program, when we run the program, Path and total number of steps and total number of states details will be printed in the console, at the end calculating the average for 5 initial states.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*Output \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

A\* Manhattan distance

Initial state is : [[1, 2, 3], [4, 5, 0], [6, 7, 8]]

conda activate base

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Manhattan distance in 13 steps exploring 117 states

A\* with Euclidean distance

Initial state is : [[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Euclidean distance in 13 steps exploring 173 states

A\* with Misplaced tiles

Initial state is : [[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with A\* & Misplaced tiles in 13 steps exploring 143 states

BFS with Manhattan distance

Initial state is : [[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 7, 5], [6, 0, 8]]

[[1, 2, 3], [4, 7, 5], [0, 6, 8]]

[[1, 2, 3], [0, 7, 5], [4, 6, 8]]

[[1, 2, 3], [7, 0, 5], [4, 6, 8]]

[[1, 2, 3], [7, 5, 0], [4, 6, 8]]

[[1, 2, 3], [7, 5, 8], [4, 6, 0]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Manhattan distance in 31 steps exploring 119 states

BFS with Euclidean distance

Initial state is : [[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 7, 5], [6, 0, 8]]

[[1, 2, 3], [4, 7, 5], [0, 6, 8]]

[[1, 2, 3], [0, 7, 5], [4, 6, 8]]

[[1, 2, 3], [7, 0, 5], [4, 6, 8]]

[[1, 2, 3], [7, 5, 0], [4, 6, 8]]

[[1, 2, 3], [7, 5, 8], [4, 6, 0]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Euclidean distance in 31 steps exploring 108 states

BFS with Misplaced tiles

Initial state is : [[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS & Misplaced tiles in 13 steps exploring 152 states

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

A\* Manhatten distance

Initial state is : [[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Manhattan distance in 14 steps exploring 180 states

A\* with Euclidean distance

Initial state is : [[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Euclidean distance in 14 steps exploring 284 states

A\* with Misplaced tiles

Initial state is : [[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with A\* & Misplaced tiles in 14 steps exploring 182 states

BFS with Manhattan distance

Initial state is : [[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 7, 5], [6, 0, 8]]

[[1, 2, 3], [4, 7, 5], [0, 6, 8]]

[[1, 2, 3], [0, 7, 5], [4, 6, 8]]

[[1, 2, 3], [7, 0, 5], [4, 6, 8]]

[[1, 2, 3], [7, 5, 0], [4, 6, 8]]

[[1, 2, 3], [7, 5, 8], [4, 6, 0]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Manhattan distance in 30 steps exploring 119 states

BFS with Euclidean distance

Initial state is : [[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 7, 5], [6, 0, 8]]

[[1, 2, 3], [4, 7, 5], [0, 6, 8]]

[[1, 2, 3], [0, 7, 5], [4, 6, 8]]

[[1, 2, 3], [7, 0, 5], [4, 6, 8]]

[[1, 2, 3], [7, 5, 0], [4, 6, 8]]

[[1, 2, 3], [7, 5, 8], [4, 6, 0]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Euclidean distance in 30 steps exploring 108 states

BFS with Misplaced tiles

Initial state is : [[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS & Misplaced tiles in 14 steps exploring 152 states

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

A\* Manhattan distance

Initial state is : [[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Manhattan distance in 2 steps exploring 3 states

A\* with Euclidean distance

Initial state is : [[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Euclidean distance in 2 steps exploring 3 states

A\* with Misplaced tiles

Initial state is : [[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with A\* & Misplaced tiles in 2 steps exploring 3 states

BFS with Manhattan distance

Initial state is : [[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Manhattan distance in 2 steps exploring 3 states

BFS with Euclidean distance

Initial state is : [[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Euclidean distance in 2 steps exploring 3 states

BFS with Misplaced tiles

Initial state is : [[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS & Misplaced tiles in 2 steps exploring 3 states

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

A\* Manhattan distance

Initial state is : [[1, 2, 3], [0, 4, 5], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Manhattan distance in 15 steps exploring 227 states

A\* with Euclidean distance

Initial state is : [[1, 2, 3], [0, 4, 5], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Euclidean distance in 15 steps exploring 378 states

A\* with Misplaced tiles

Initial state is : [[1, 2, 3], [0, 4, 5], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 5, 0], [6, 7, 8]]

[[1, 2, 3], [4, 5, 8], [6, 7, 0]]

[[1, 2, 3], [4, 5, 8], [6, 0, 7]]

[[1, 2, 3], [4, 5, 8], [0, 6, 7]]

[[1, 2, 3], [0, 5, 8], [4, 6, 7]]

[[1, 2, 3], [5, 0, 8], [4, 6, 7]]

[[1, 2, 3], [5, 6, 8], [4, 0, 7]]

[[1, 2, 3], [5, 6, 8], [4, 7, 0]]

[[1, 2, 3], [5, 6, 0], [4, 7, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with A\* & Misplaced tiles in 15 steps exploring 217 states

BFS with Manhattan distance

Initial state is : [[1, 2, 3], [0, 4, 5], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 7, 5], [6, 0, 8]]

[[1, 2, 3], [4, 7, 5], [0, 6, 8]]

[[1, 2, 3], [0, 7, 5], [4, 6, 8]]

[[1, 2, 3], [7, 0, 5], [4, 6, 8]]

[[1, 2, 3], [7, 5, 0], [4, 6, 8]]

[[1, 2, 3], [7, 5, 8], [4, 6, 0]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Manhattan distance in 31 steps exploring 119 states

BFS with Euclidean distance

Initial state is : [[1, 2, 3], [0, 4, 5], [6, 7, 8]]

[[1, 2, 3], [4, 0, 5], [6, 7, 8]]

[[1, 2, 3], [4, 7, 5], [6, 0, 8]]

[[1, 2, 3], [4, 7, 5], [0, 6, 8]]

[[1, 2, 3], [0, 7, 5], [4, 6, 8]]

[[1, 2, 3], [7, 0, 5], [4, 6, 8]]

[[1, 2, 3], [7, 5, 0], [4, 6, 8]]

[[1, 2, 3], [7, 5, 8], [4, 6, 0]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Euclidean distance in 31 steps exploring 108 states

BFS with Misplaced tiles

Initial state is : [[1, 2, 3], [0, 4, 5], [6, 7, 8]]

[[1, 2, 3], [6, 4, 5], [0, 7, 8]]

[[1, 2, 3], [6, 4, 5], [7, 0, 8]]

[[1, 2, 3], [6, 0, 5], [7, 4, 8]]

[[1, 2, 3], [0, 6, 5], [7, 4, 8]]

[[1, 2, 3], [7, 6, 5], [0, 4, 8]]

[[1, 2, 3], [7, 6, 5], [4, 0, 8]]

[[1, 2, 3], [7, 6, 5], [4, 8, 0]]

[[1, 2, 3], [7, 6, 0], [4, 8, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS & Misplaced tiles in 27 steps exploring 217 states

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

A\* Manhatten distance

Initial state is : [[0, 1, 2], [3, 4, 5], [6, 7, 8]]

[[1, 0, 2], [3, 4, 5], [6, 7, 8]]

[[1, 4, 2], [3, 0, 5], [6, 7, 8]]

[[1, 4, 2], [0, 3, 5], [6, 7, 8]]

[[1, 4, 2], [6, 3, 5], [0, 7, 8]]

[[1, 4, 2], [6, 3, 5], [7, 0, 8]]

[[1, 4, 2], [6, 3, 5], [7, 8, 0]]

[[1, 4, 2], [6, 3, 0], [7, 8, 5]]

[[1, 4, 2], [6, 0, 3], [7, 8, 5]]

[[1, 4, 2], [0, 6, 3], [7, 8, 5]]

[[1, 4, 2], [7, 6, 3], [0, 8, 5]]

[[1, 4, 2], [7, 6, 3], [8, 0, 5]]

[[1, 4, 2], [7, 0, 3], [8, 6, 5]]

[[1, 0, 2], [7, 4, 3], [8, 6, 5]]

[[1, 2, 0], [7, 4, 3], [8, 6, 5]]

[[1, 2, 3], [7, 4, 0], [8, 6, 5]]

[[1, 2, 3], [7, 4, 5], [8, 6, 0]]

[[1, 2, 3], [7, 4, 5], [8, 0, 6]]

[[1, 2, 3], [7, 4, 5], [0, 8, 6]]

[[1, 2, 3], [0, 4, 5], [7, 8, 6]]

[[1, 2, 3], [4, 0, 5], [7, 8, 6]]

[[1, 2, 3], [4, 5, 0], [7, 8, 6]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Manhattan distance in 22 steps exploring 1719 states

A\* with Euclidean distance

Initial state is : [[0, 1, 2], [3, 4, 5], [6, 7, 8]]

[[1, 0, 2], [3, 4, 5], [6, 7, 8]]

[[1, 4, 2], [3, 0, 5], [6, 7, 8]]

[[1, 4, 2], [0, 3, 5], [6, 7, 8]]

[[1, 4, 2], [6, 3, 5], [0, 7, 8]]

[[1, 4, 2], [6, 3, 5], [7, 0, 8]]

[[1, 4, 2], [6, 3, 5], [7, 8, 0]]

[[1, 4, 2], [6, 3, 0], [7, 8, 5]]

[[1, 4, 2], [6, 0, 3], [7, 8, 5]]

[[1, 4, 2], [0, 6, 3], [7, 8, 5]]

[[1, 4, 2], [7, 6, 3], [0, 8, 5]]

[[1, 4, 2], [7, 6, 3], [8, 0, 5]]

[[1, 4, 2], [7, 0, 3], [8, 6, 5]]

[[1, 0, 2], [7, 4, 3], [8, 6, 5]]

[[1, 2, 0], [7, 4, 3], [8, 6, 5]]

[[1, 2, 3], [7, 4, 0], [8, 6, 5]]

[[1, 2, 3], [7, 4, 5], [8, 6, 0]]

[[1, 2, 3], [7, 4, 5], [8, 0, 6]]

[[1, 2, 3], [7, 4, 5], [0, 8, 6]]

[[1, 2, 3], [0, 4, 5], [7, 8, 6]]

[[1, 2, 3], [4, 0, 5], [7, 8, 6]]

[[1, 2, 3], [4, 5, 0], [7, 8, 6]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

A\* and Euclidean distance in 22 steps exploring 4317 states

A\* with Misplaced tiles

Initial state is : [[0, 1, 2], [3, 4, 5], [6, 7, 8]]

[[1, 0, 2], [3, 4, 5], [6, 7, 8]]

[[1, 4, 2], [3, 0, 5], [6, 7, 8]]

[[1, 4, 2], [0, 3, 5], [6, 7, 8]]

[[1, 4, 2], [6, 3, 5], [0, 7, 8]]

[[1, 4, 2], [6, 3, 5], [7, 0, 8]]

[[1, 4, 2], [6, 3, 5], [7, 8, 0]]

[[1, 4, 2], [6, 3, 0], [7, 8, 5]]

[[1, 4, 2], [6, 0, 3], [7, 8, 5]]

[[1, 0, 2], [6, 4, 3], [7, 8, 5]]

[[1, 2, 0], [6, 4, 3], [7, 8, 5]]

[[1, 2, 3], [6, 4, 0], [7, 8, 5]]

[[1, 2, 3], [6, 0, 4], [7, 8, 5]]

[[1, 2, 3], [0, 6, 4], [7, 8, 5]]

[[1, 2, 3], [7, 6, 4], [0, 8, 5]]

[[1, 2, 3], [7, 6, 4], [8, 0, 5]]

[[1, 2, 3], [7, 0, 4], [8, 6, 5]]

[[1, 2, 3], [7, 4, 0], [8, 6, 5]]

[[1, 2, 3], [7, 4, 5], [8, 6, 0]]

[[1, 2, 3], [7, 4, 5], [8, 0, 6]]

[[1, 2, 3], [7, 4, 5], [0, 8, 6]]

[[1, 2, 3], [0, 4, 5], [7, 8, 6]]

[[1, 2, 3], [4, 0, 5], [7, 8, 6]]

[[1, 2, 3], [4, 5, 0], [7, 8, 6]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with A\* & Misplaced tiles in 24 steps exploring 604 states

BFS with Manhattan distance

Initial state is : [[0, 1, 2], [3, 4, 5], [6, 7, 8]]

[[1, 0, 2], [3, 4, 5], [6, 7, 8]]

[[1, 4, 2], [3, 0, 5], [6, 7, 8]]

[[1, 4, 2], [0, 3, 5], [6, 7, 8]]

[[1, 4, 2], [6, 3, 5], [0, 7, 8]]

[[1, 4, 2], [6, 3, 5], [7, 0, 8]]

[[1, 4, 2], [6, 3, 5], [7, 8, 0]]

[[1, 4, 2], [6, 3, 0], [7, 8, 5]]

[[1, 4, 2], [6, 0, 3], [7, 8, 5]]

[[1, 4, 2], [0, 6, 3], [7, 8, 5]]

[[0, 4, 2], [1, 6, 3], [7, 8, 5]]

[[4, 0, 2], [1, 6, 3], [7, 8, 5]]

[[4, 2, 0], [1, 6, 3], [7, 8, 5]]

[[4, 2, 3], [1, 6, 0], [7, 8, 5]]

[[4, 2, 3], [1, 0, 6], [7, 8, 5]]

[[4, 2, 3], [1, 8, 6], [7, 0, 5]]

[[4, 2, 3], [1, 8, 6], [7, 5, 0]]

[[4, 2, 3], [1, 8, 0], [7, 5, 6]]

[[4, 2, 0], [1, 8, 3], [7, 5, 6]]

[[4, 0, 2], [1, 8, 3], [7, 5, 6]]

[[0, 4, 2], [1, 8, 3], [7, 5, 6]]

[[1, 4, 2], [0, 8, 3], [7, 5, 6]]

[[1, 4, 2], [8, 0, 3], [7, 5, 6]]

[[1, 0, 2], [8, 4, 3], [7, 5, 6]]

[[1, 2, 0], [8, 4, 3], [7, 5, 6]]

[[1, 2, 3], [8, 4, 0], [7, 5, 6]]

[[1, 2, 3], [8, 0, 4], [7, 5, 6]]

[[1, 2, 3], [0, 8, 4], [7, 5, 6]]

[[1, 2, 3], [7, 8, 4], [0, 5, 6]]

[[1, 2, 3], [7, 8, 4], [5, 0, 6]]

[[1, 2, 3], [7, 0, 4], [5, 8, 6]]

[[1, 2, 3], [7, 4, 0], [5, 8, 6]]

[[1, 2, 3], [7, 4, 6], [5, 8, 0]]

[[1, 2, 3], [7, 4, 6], [5, 0, 8]]

[[1, 2, 3], [7, 4, 6], [0, 5, 8]]

[[1, 2, 3], [0, 4, 6], [7, 5, 8]]

[[1, 2, 3], [4, 0, 6], [7, 5, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Manhattan distance in 38 steps exploring 141 states

BFS with Euclidean distance

Initial state is : [[0, 1, 2], [3, 4, 5], [6, 7, 8]]

[[1, 0, 2], [3, 4, 5], [6, 7, 8]]

[[1, 4, 2], [3, 0, 5], [6, 7, 8]]

[[1, 4, 2], [0, 3, 5], [6, 7, 8]]

[[1, 4, 2], [6, 3, 5], [0, 7, 8]]

[[1, 4, 2], [6, 3, 5], [7, 0, 8]]

[[1, 4, 2], [6, 3, 5], [7, 8, 0]]

[[1, 4, 2], [6, 3, 0], [7, 8, 5]]

[[1, 4, 2], [6, 0, 3], [7, 8, 5]]

[[1, 4, 2], [0, 6, 3], [7, 8, 5]]

[[0, 4, 2], [1, 6, 3], [7, 8, 5]]

[[4, 0, 2], [1, 6, 3], [7, 8, 5]]

[[4, 2, 0], [1, 6, 3], [7, 8, 5]]

[[4, 2, 3], [1, 6, 0], [7, 8, 5]]

[[4, 2, 3], [1, 0, 6], [7, 8, 5]]

[[4, 2, 3], [0, 1, 6], [7, 8, 5]]

[[0, 2, 3], [4, 1, 6], [7, 8, 5]]

[[2, 0, 3], [4, 1, 6], [7, 8, 5]]

[[2, 1, 3], [4, 0, 6], [7, 8, 5]]

[[2, 1, 3], [4, 8, 6], [7, 0, 5]]

[[2, 1, 3], [4, 8, 6], [7, 5, 0]]

[[2, 1, 3], [4, 8, 0], [7, 5, 6]]

[[2, 1, 3], [4, 0, 8], [7, 5, 6]]

[[2, 0, 3], [4, 1, 8], [7, 5, 6]]

[[0, 2, 3], [4, 1, 8], [7, 5, 6]]

[[4, 2, 3], [0, 1, 8], [7, 5, 6]]

[[4, 2, 3], [1, 0, 8], [7, 5, 6]]

[[4, 2, 3], [1, 5, 8], [7, 0, 6]]

[[4, 2, 3], [1, 5, 8], [7, 6, 0]]

[[4, 2, 3], [1, 5, 0], [7, 6, 8]]

[[4, 2, 0], [1, 5, 3], [7, 6, 8]]

[[4, 0, 2], [1, 5, 3], [7, 6, 8]]

[[0, 4, 2], [1, 5, 3], [7, 6, 8]]

[[1, 4, 2], [0, 5, 3], [7, 6, 8]]

[[1, 4, 2], [5, 0, 3], [7, 6, 8]]

[[1, 0, 2], [5, 4, 3], [7, 6, 8]]

[[1, 2, 0], [5, 4, 3], [7, 6, 8]]

[[1, 2, 3], [5, 4, 0], [7, 6, 8]]

[[1, 2, 3], [5, 4, 8], [7, 6, 0]]

[[1, 2, 3], [5, 4, 8], [7, 0, 6]]

[[1, 2, 3], [5, 0, 8], [7, 4, 6]]

[[1, 2, 3], [0, 5, 8], [7, 4, 6]]

[[1, 2, 3], [7, 5, 8], [0, 4, 6]]

[[1, 2, 3], [7, 5, 8], [4, 0, 6]]

[[1, 2, 3], [7, 0, 8], [4, 5, 6]]

[[1, 2, 3], [7, 8, 0], [4, 5, 6]]

[[1, 2, 3], [7, 8, 6], [4, 5, 0]]

[[1, 2, 3], [7, 8, 6], [4, 0, 5]]

[[1, 2, 3], [7, 0, 6], [4, 8, 5]]

[[1, 2, 3], [0, 7, 6], [4, 8, 5]]

[[1, 2, 3], [4, 7, 6], [0, 8, 5]]

[[1, 2, 3], [4, 7, 6], [8, 0, 5]]

[[1, 2, 3], [4, 7, 6], [8, 5, 0]]

[[1, 2, 3], [4, 7, 0], [8, 5, 6]]

[[1, 2, 3], [4, 0, 7], [8, 5, 6]]

[[1, 2, 3], [4, 5, 7], [8, 0, 6]]

[[1, 2, 3], [4, 5, 7], [0, 8, 6]]

[[1, 2, 3], [0, 5, 7], [4, 8, 6]]

[[1, 2, 3], [5, 0, 7], [4, 8, 6]]

[[1, 2, 3], [5, 7, 0], [4, 8, 6]]

[[1, 2, 3], [5, 7, 6], [4, 8, 0]]

[[1, 2, 3], [5, 7, 6], [4, 0, 8]]

[[1, 2, 3], [5, 0, 6], [4, 7, 8]]

[[1, 2, 3], [0, 5, 6], [4, 7, 8]]

[[1, 2, 3], [4, 5, 6], [0, 7, 8]]

[[1, 2, 3], [4, 5, 6], [7, 0, 8]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS with Euclidean distance in 66 steps exploring 197 states

BFS with Misplaced tiles

Initial state is : [[0, 1, 2], [3, 4, 5], [6, 7, 8]]

[[1, 0, 2], [3, 4, 5], [6, 7, 8]]

[[1, 2, 0], [3, 4, 5], [6, 7, 8]]

[[1, 2, 5], [3, 4, 0], [6, 7, 8]]

[[1, 2, 5], [3, 0, 4], [6, 7, 8]]

[[1, 2, 5], [0, 3, 4], [6, 7, 8]]

[[1, 2, 5], [6, 3, 4], [0, 7, 8]]

[[1, 2, 5], [6, 3, 4], [7, 0, 8]]

[[1, 2, 5], [6, 3, 4], [7, 8, 0]]

[[1, 2, 5], [6, 3, 0], [7, 8, 4]]

[[1, 2, 5], [6, 0, 3], [7, 8, 4]]

[[1, 2, 5], [0, 6, 3], [7, 8, 4]]

[[0, 2, 5], [1, 6, 3], [7, 8, 4]]

[[2, 0, 5], [1, 6, 3], [7, 8, 4]]

[[2, 5, 0], [1, 6, 3], [7, 8, 4]]

[[2, 5, 3], [1, 6, 0], [7, 8, 4]]

[[2, 5, 3], [1, 0, 6], [7, 8, 4]]

[[2, 0, 3], [1, 5, 6], [7, 8, 4]]

[[0, 2, 3], [1, 5, 6], [7, 8, 4]]

[[1, 2, 3], [0, 5, 6], [7, 8, 4]]

[[1, 2, 3], [7, 5, 6], [0, 8, 4]]

[[1, 2, 3], [7, 5, 6], [8, 0, 4]]

[[1, 2, 3], [7, 5, 6], [8, 4, 0]]

[[1, 2, 3], [7, 5, 0], [8, 4, 6]]

[[1, 2, 3], [7, 0, 5], [8, 4, 6]]

[[1, 2, 3], [7, 4, 5], [8, 0, 6]]

[[1, 2, 3], [7, 4, 5], [0, 8, 6]]

[[1, 2, 3], [0, 4, 5], [7, 8, 6]]

[[1, 2, 3], [4, 0, 5], [7, 8, 6]]

[[1, 2, 3], [4, 5, 0], [7, 8, 6]]

[[1, 2, 3], [4, 5, 6], [7, 8, 0]]

Solved with BFS & Misplaced tiles in 30 steps exploring 783 states

**Average Count**

**A\* & Manhattan distance: 215.6**

**A\* & Euclidean distance: 215.6**

**A\* & Misplaced tiles: 234.0**

**BFS & Manhattan distance: 854.0**

**BFS & Euclidean distance: 1436.4**

**BFS & Misplaced tiles: 399.6**

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Summary :** On comparing the above outputs, we can say that A\* provides an optimal solution when compared to Best First Search.

Also, BFS Euclidean gives the most optimal path with less steps and more number of states where as A\* with Manhattan and Euclidean gives almost the same number of steps but different number of states because of the approach used to calculate the distance and then select the less cost efficient intermediate state.

**15 Puzzle**

**Note : BFS is implemented using Breadth First Search**

**For running different Heuristic, need to change the heuristic\_1 value in the code at line number 37**

**Heuristic : Misplaced tiles**

Average steps of A \*

[3, 29, 4, 5, 3]

8.8

Average steps of BFS

[2, 12, 3, 4, 2]

4.6

**Heuristic : Euclidean Distance**

Average steps of A \*

[3, 29, 4, 5, 3]

8.8

Average steps of BFS

[2, 12, 3, 4, 2]

4.6

**Heuristic : Manhattan Distance**

Average steps of A \*

[3, 21, 4, 5, 3]

7.2

Average steps of BFS

[2, 12, 3, 4, 2]

4.6