8 Puzzle Solver

Team Members:-

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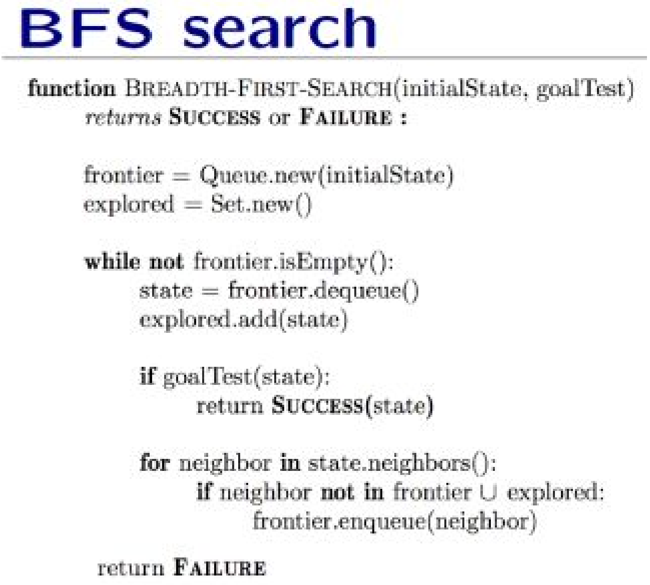
Problem Statement:-

Given an initial state of the board, the search problem is to find a sequence of moves that transitions this state to the goal state. that is, the configuration with all tiles arranged in ascending order 0,1,2,3,4,5,6,7,8.

The Search Algorithms:-

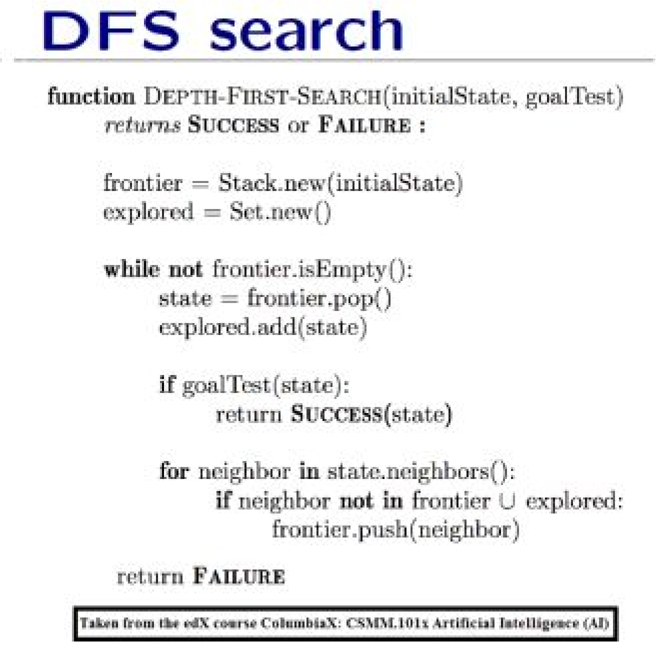
1) BFS:-



BFS search

```
function BREADTH-FIRST-SEARCH(initialState, goalTest)
        returns SUCCESS or FAILURE :

        frontier = Queue.new(initialState)
        explored = Set.new()

        while not frontier.isEmpty():
                state = frontier.dequeue()
                explored.add(state)

                if goalTest(state):
                        return SUCCESS(state)

                for neighbor in state.neighbors():
                        if neighbor not in frontier ∪ explored:
                                frontier.enqueue(neighbor)

        return FAILURE
```

2)DFS:-

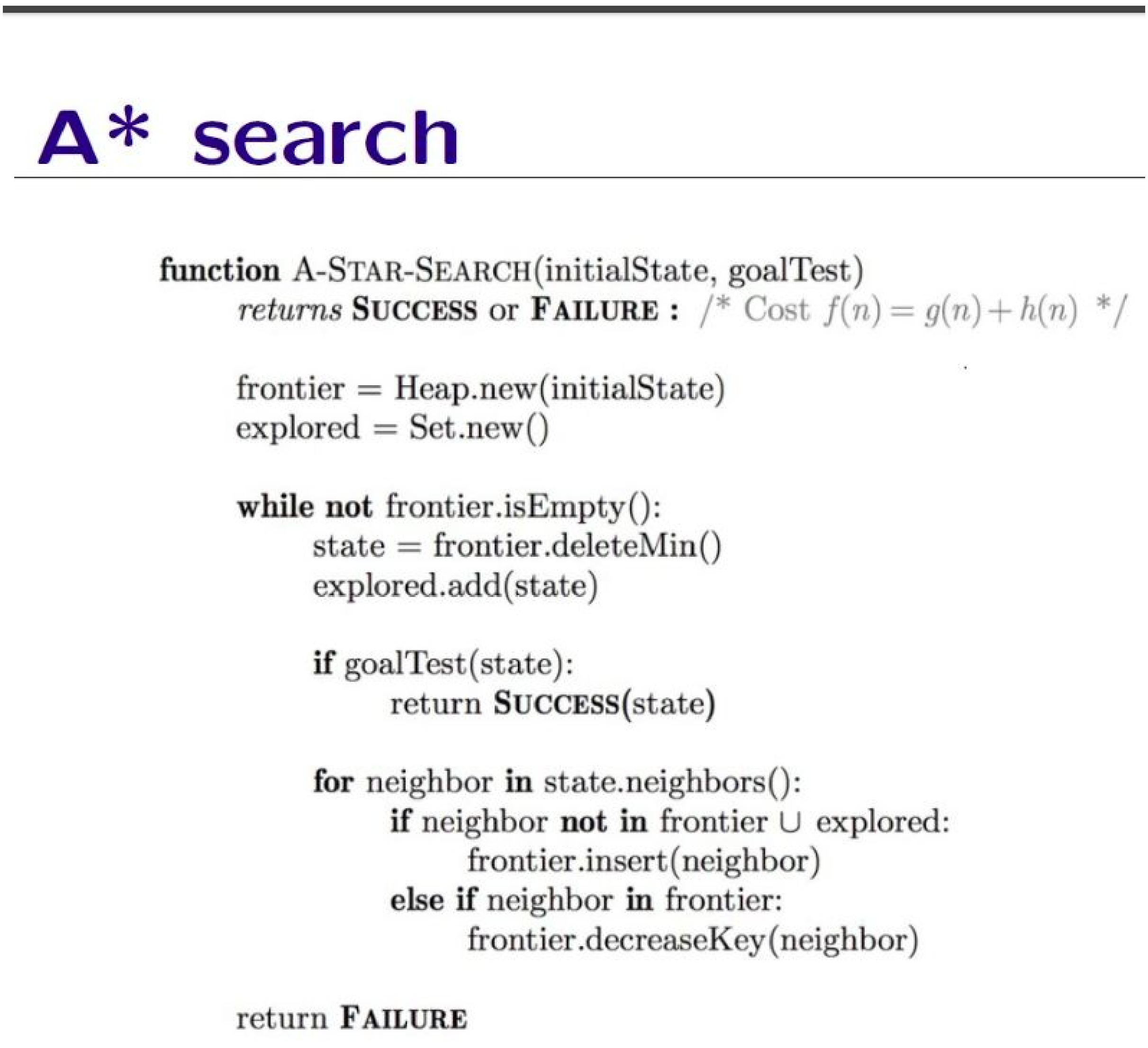


DFS search

```
function DEPTH-FIRST-SEARCH(initialState, goalTest)
    returns SUCCESS or FAILURE :

    frontier = Stack.new(initialState)
    explored = Set.new()

    while not frontier.isEmpty():
        state = frontier.pop()
        explored.add(state)

        if goalTest(state):
            return SUCCESS(state)

        for neighbor in state.neighbors():
            if neighbor not in frontier ∪ explored:
                frontier.push(neighbor)

     return FAILURE
```

Taken from the edX course ColumbiaX: CSMM.101x Artificial Intelligence (AI)

3)A*:-



A* search

```
function A-STAR-SEARCH(initialState, goalTest)
    returns SUCCESS or FAILURE :  /* Cost $f(n) = g(n) + h(n)$ */

    frontier = Heap.new(initialState)
    explored = Set.new()

    while not frontier.isEmpty():
        state = frontier.deleteMin()
        explored.add(state)

        if goalTest(state):
            return SUCCESS(state)

        for neighbor in state.neighbors():
            if neighbor not in frontier ∪ explored:
                frontier.insert(neighbor)
            else if neighbor in frontier:
                frontier.decreaseKey(neighbor)

    return FAILURE
```

In the A* Search we used 2 heuristics:-

1. Manhattan Distance:

$$h = abs(current\_cell.x - goal.x) + abs(current\_cell.y - goal.y)$$

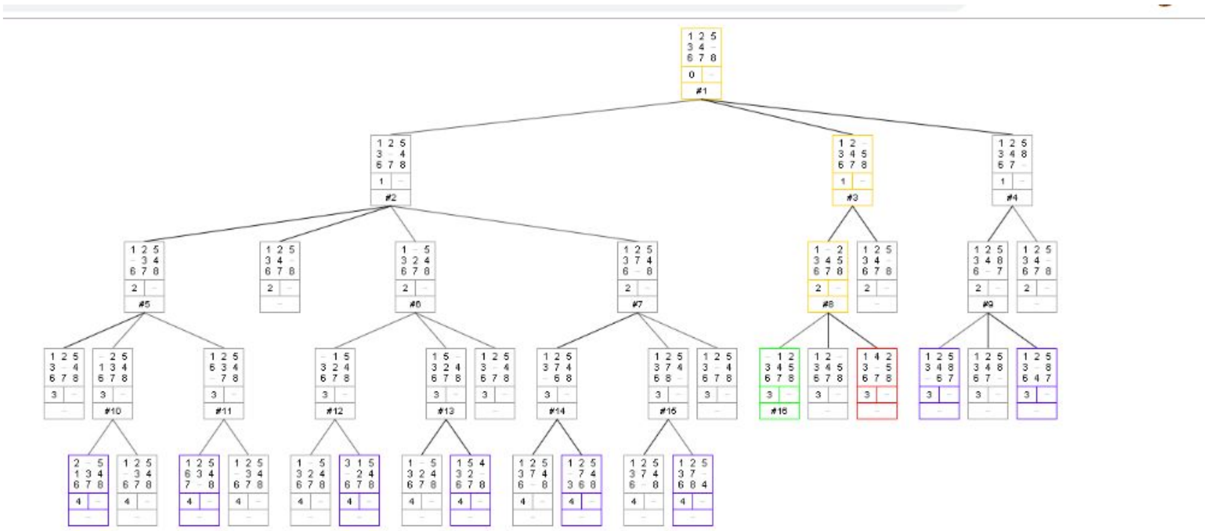
2. Euclidean Distance:

$$h = sqrt((current\_cell.x - goal.x)^2 + (current\_cell.y - goal.y)^2)$$

8 Puzzle problem sample:-

Initial State: 1,2,5,3,4,0,6,7,8

1. Applying BFS:-
   a. Path to goal And Nodes Expanded:-



   b. Cost of Path:-

   Cost = 3 : number of changed configurations (depth).

   c. Search Depth:-

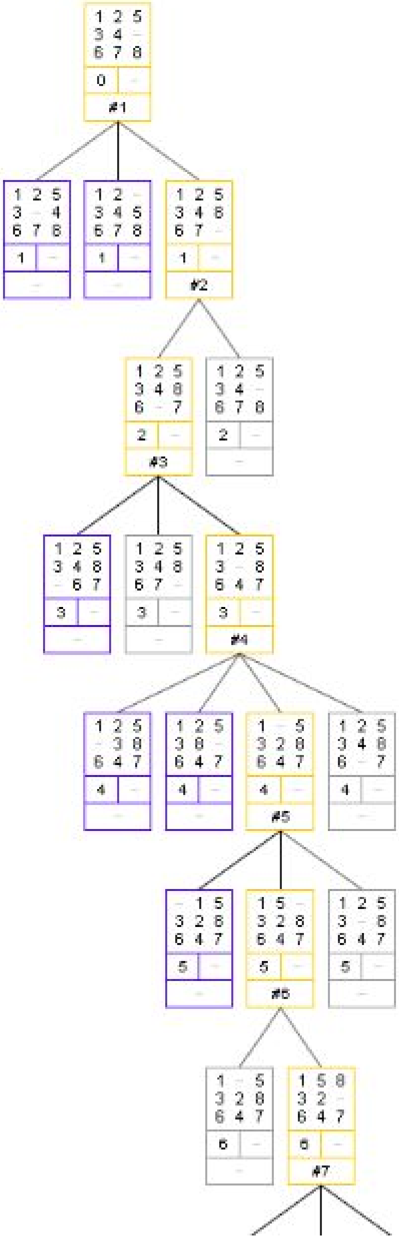
   Depth = 3 (root depth = 0)

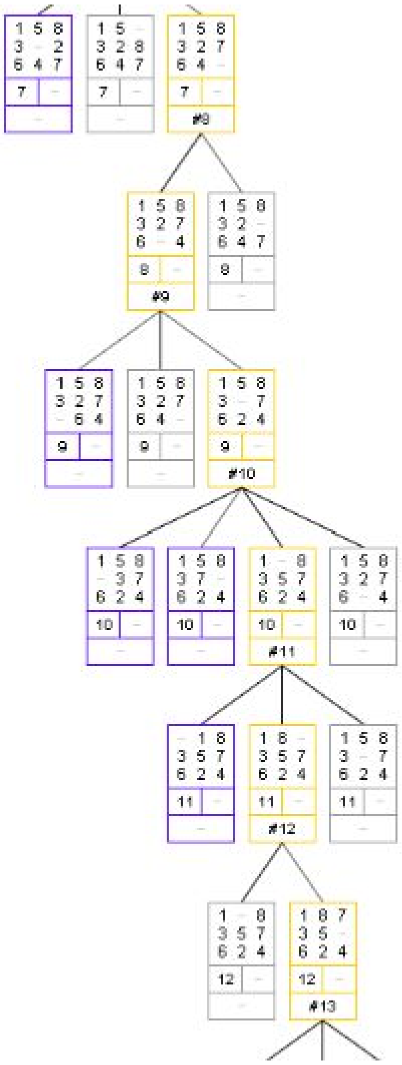
   d. Running Time:-

   BFS time 2.0 milliseconds

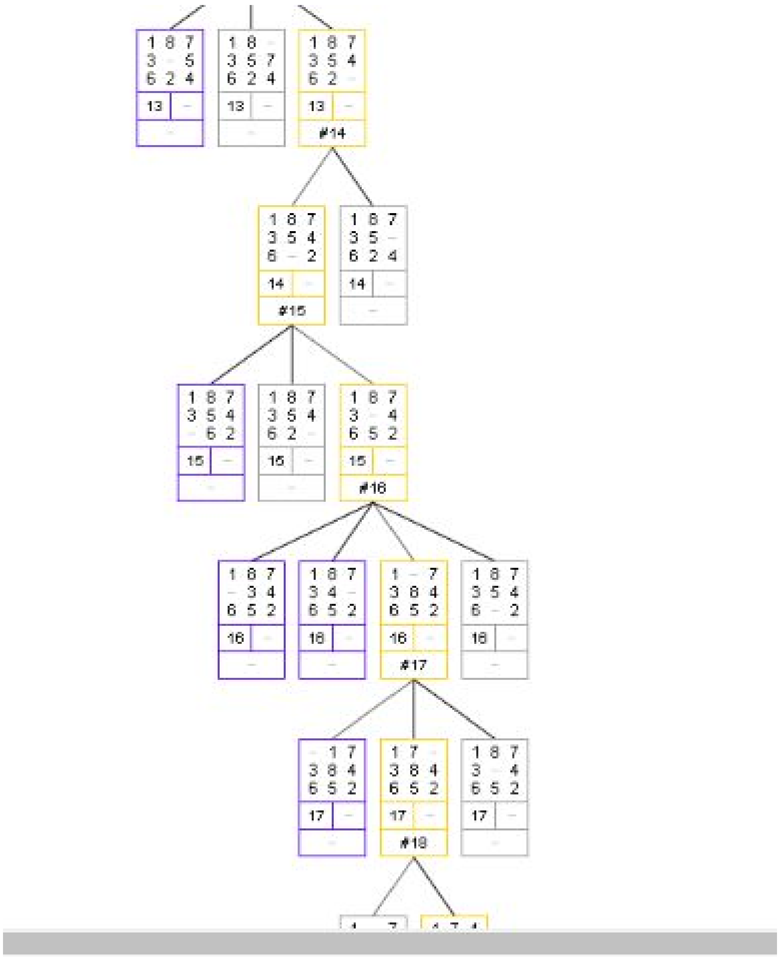
2. Applying DFS:-

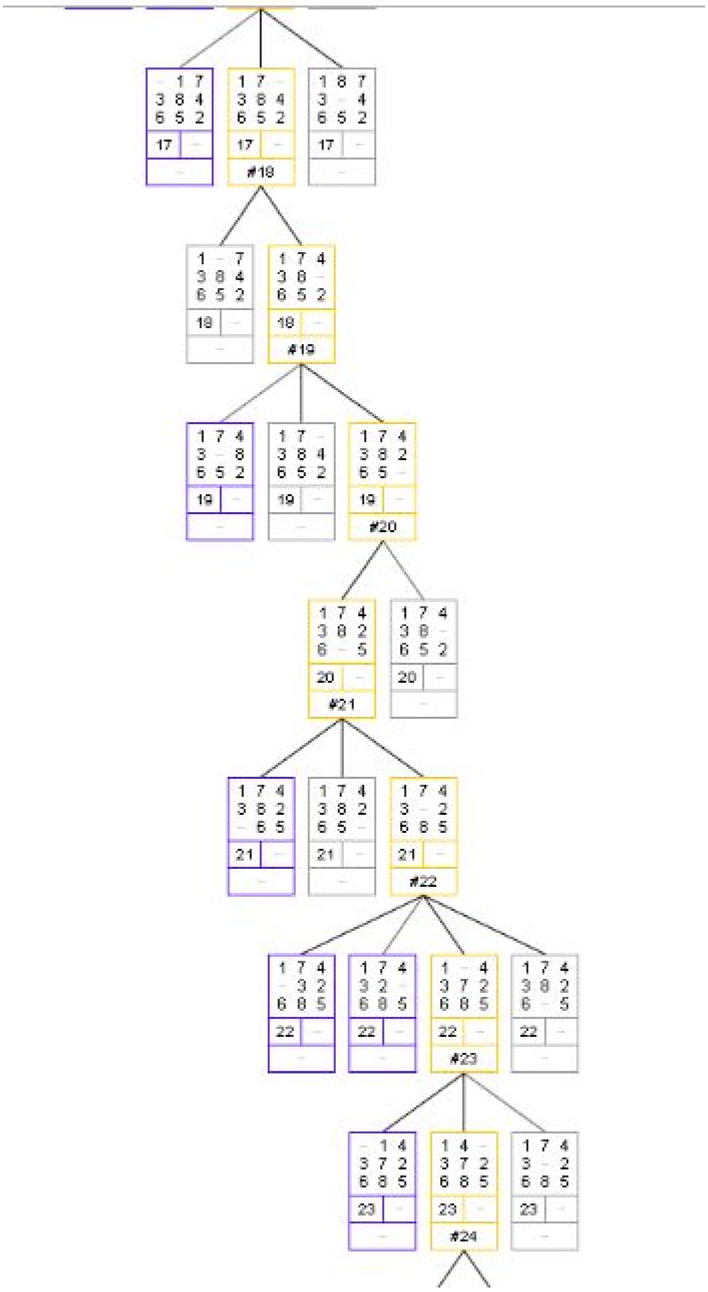
a. Path to goal And Nodes Expanded:-

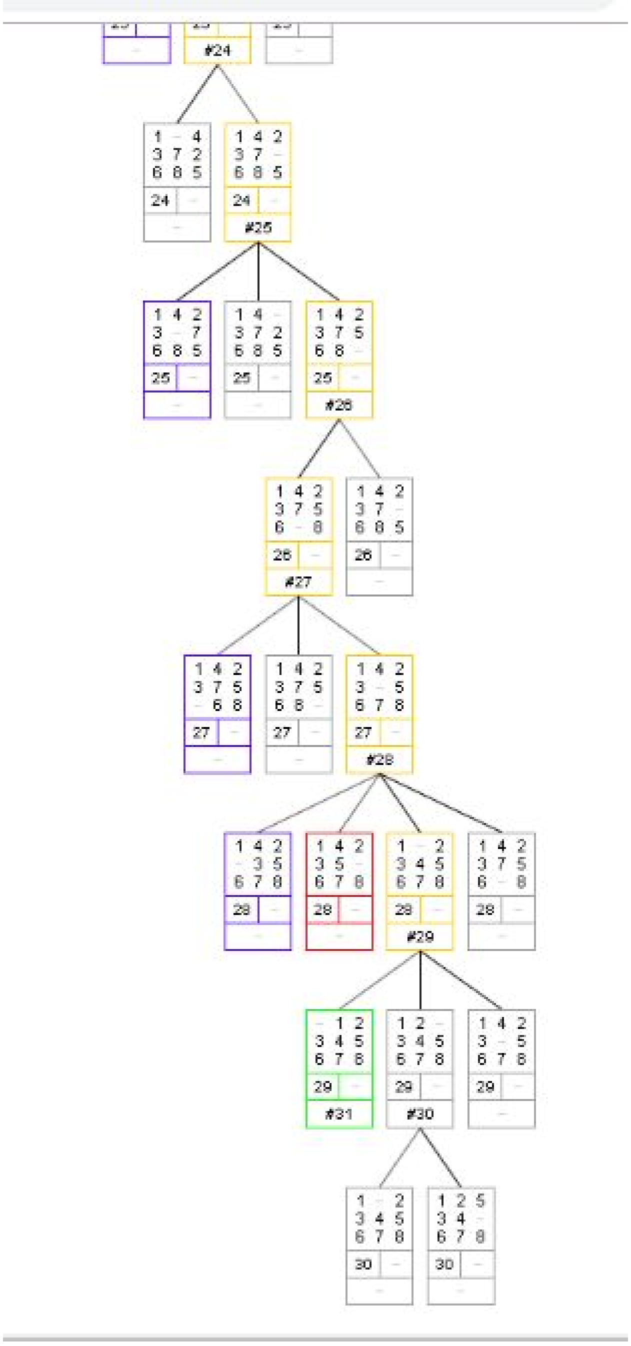




1 5 8 3 – 2 6 4 7 7 – –
1 5 – 3 2 8 6 4 7 7 – –
1 5 8 3 2 7 6 4 – 7 – #8
1 5 8 3 2 7 6 – 4 8 – #9
1 5 8 3 2 – 6 4 7 8 – –
1 5 8 3 2 7 – 6 4 9 – –
1 5 8 3 2 7 6 4 – 9 – –
1 5 8 3 – 7 6 2 4 9 – #10
1 5 8 – 3 7 6 2 4 10 – –
1 5 8 3 7 – 6 2 4 10 – –
1 – 8 3 5 7 6 2 4 10 – #11
1 5 8 3 2 7 6 – 4 10 – –
– 1 8 3 5 7 6 2 4 11 – –
1 8 – 3 5 7 6 2 4 11 – #12
1 5 8 3 – 7 6 2 4 11 – –
1 – 8 3 5 7 6 2 4 12 – –
1 8 7 3 5 – 6 2 4 12 – #13


#14
#15
#16
#17
#18


- 1 7
3 8 4
6 5 2
17 -
-
1 7 -
3 8 4
6 5 2
17 -
#18
1 8 7
3 - 4
6 5 2
17 -
-
1 - 7
3 8 4
6 5 2
18 -
-
1 7 4
3 8 -
6 5 2
18 -
#19
1 7 4
3 - 8
6 5 2
19 -
-
1 7 -
3 8 4
6 5 2
19 -
-
1 7 4
3 8 2
6 5 -
19 -
#20
1 7 4
3 8 2
6 - 5
20 -
#21
1 7 4
3 8 -
6 5 2
20 -
-
1 7 4
3 8 2
- 6 5
21 -
-
1 7 4
3 8 2
6 5 -
21 -
-
1 7 4
3 - 2
6 8 5
21 -
#22
1 7 4
- 3 2
6 8 5
22 -
-
1 7 4
3 2 -
6 8 5
22 -
-
1 - 4
3 7 2
6 8 5
22 -
#23
1 7 4
3 8 2
6 - 5
22 -
-
- 1 4
3 7 2
6 8 5
23 -
-
1 4 -
3 7 2
6 8 5
23 -
#24
1 7 4
3 - 2
6 8 5
23 -
-



b. Cost of Path:-

Cost = 30 : number of changed configurations (depth).

After setting maxDepth:-

Cost = 3 (depth)

c. Search Depth:-

Depth = 30 (root depth = 0)

After setting maxDepth:-

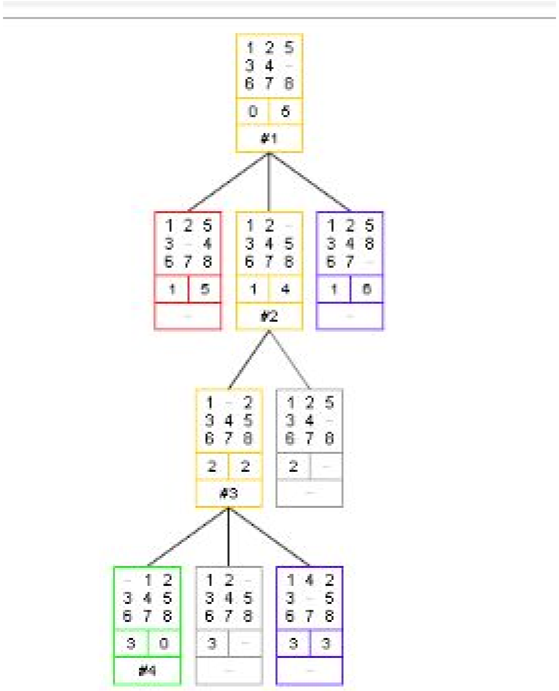
Depth = 3 (depth)

d. Running Time:-

DFS time 102.0 milliseconds

3. Applying A* with Euclidean Search:-

a. Path to goal And Nodes Expanded:-



b. Cost of Path:-

Cost = 17 : number of changed configurations.

c. Search Depth:-

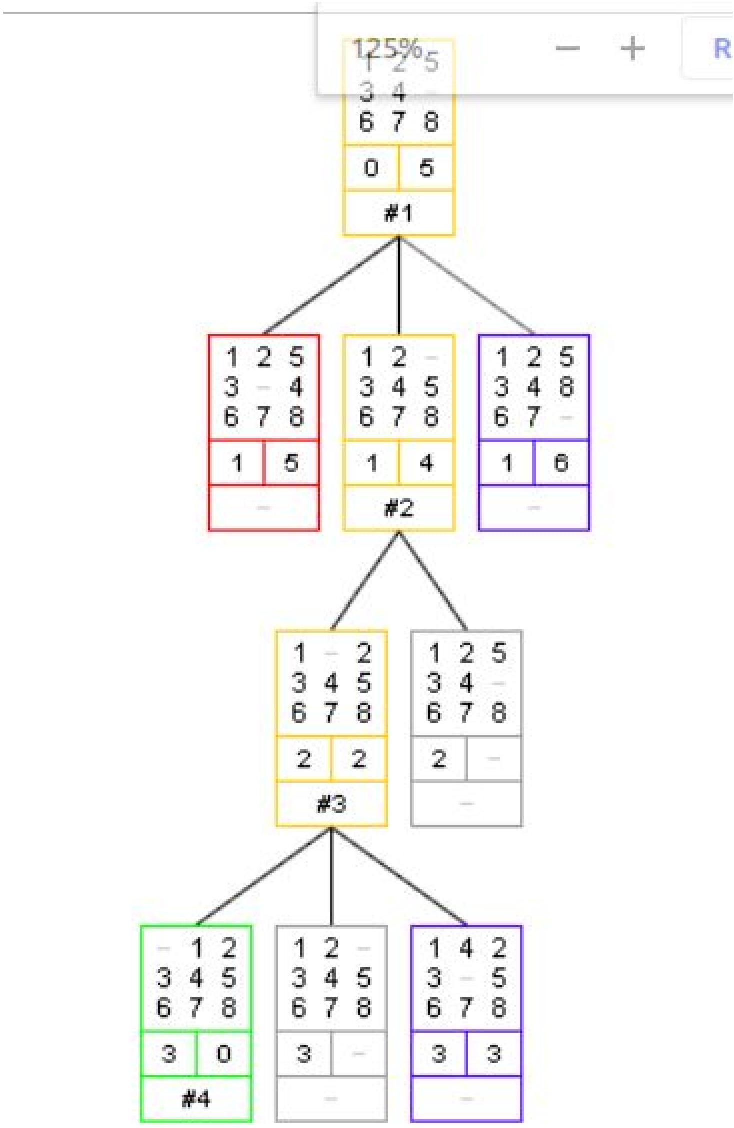
Depth = 3 (root depth = 0)

d. Running Time:-

Euclidean time 3.0 milliseconds

4. Applying A* with Manhattan Search:-

a. Path to goal And Nodes Expanded:-



b. Cost of Path:-

Cost = 18 : number of changed configurations (depth).

c. Search Depth:-

Depth = 3 (root depth = 0)

d. Running Time:-

Manhattan time 3.0 milliseconds