8 puzzle problem:

5	4	
6	1	8
7	3	2

Initial state

	1	2
3	4	5
6	7	8

Goal state

① misplaced tiles
② manhattan distance

Algorithm :

```
function a_star (start, goal) :
    pq = Minheap()
    push (pq, (h(start, goal), start, [], 0)).
    visited = set()

    while pq is not empty :
        f_n, current_state, path, g_n = pop(pq).
        if current_state == goal.
            return path + [current_state].
        add current_state to visited.
        for neighbor in generated_moves (current_state)
            if neighbor not in to visited
            g_neighbor = g_n + 1
            f_neighbor = g_neighbor + h(neighbor, goal)
            push (pq, (f_neighbour, neighbour, path +
                            [current_state], g_neighbour)

    return None
```

function generate-moves (state):
 // Generate neighbors by moving blank tiles
 in 4 direction (up, down, left, right)
 // Swap the blank (0) with adjacent tile
 within bounds.

function h(state, goal)
  d = 0
  for each tile in state
   if tile != 0.
   distance += abs (current_row - goal_row).
        + abs(current_col - goal_col)

  return distance.

Initial state :-

2	8	3
1	6	4
	7	5

h = 6   g = 0.
$f = 6$

2	8	3
	6	4
1	7	5

h = 7
$f = 8$

2	8	3
1	6	4
	7	5

h = 5
$f = 6$

h = 4
$f = 6$

2	8	
1		4
7	6	5

h = 6
$f = 8$

2	8	3
1	6	4
	7	5

h = 6
$f = 8$

2	8	3
1	6	4
7		5

h = 3
$f = 6$

2		3
1	8	4
7	6	5

h = 5

2	8	3
	1	4
7	6	5

h = 5

2	8	3
1		4
7	6	5

h = 5
$f = 8$

2		3
1	6	4
7		5

$f = 8$

2	3	
1	8	4
7	6	5

$f = 6$

2	3	
1	8	4
7	6	5

$f = 7$.

	2	3
1	8	4
7	6	5

b=6

f=6 | 1 | 2 | 3 |
      | 8 | 4 |
      | 7 | 6 | 5 |

| 2 | 3 |
| 1 | 8 | 4 | f=8
| 7 | 6 | 5 |

f=8 | 2 | 3 |
      | 1 | 8 | 4 |
      | 7 | 6 | 5 |

f=6 | 1 | 2 | 3 |
      | 8 | |
      | 7 | 6 | 5 |

f=8 | 1 | 2 | 3 |
      | 7 | 8 | 4 |
      | 6 | 5 |

↓

final = ['right', 'up', 'up', 'left', 'down', 'right'].
state
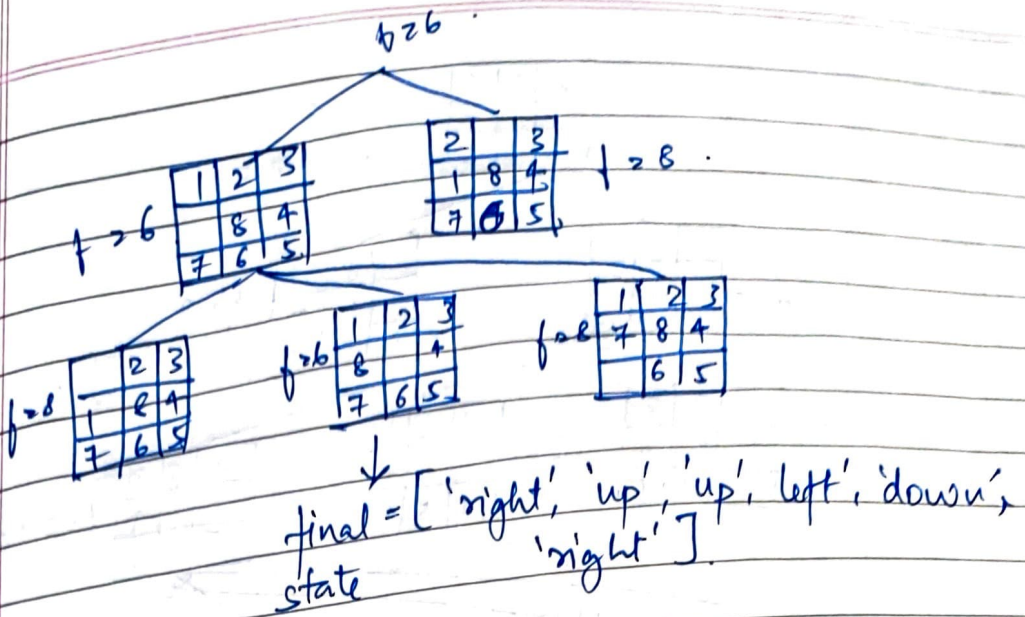
Misplaced Tiles:-

function h(state, goal)
  n=0.
  for i from 0 → 8:
    if state[0]! =0 and state[i]!=goal[i].
      n+=1.
  return n.

State space diagram:-

1	2	3
8		4
7	6	5

2	8	3
1	6	4
	7	5

Goal   Initial State.

Top node:
$$\begin{array}{|c|c|c|}\hline 2&8&5\\\hline &6&4\\\hline 1&7&5\\\hline\end{array}$$
$h=5$
$f=0+5=5$

$$\begin{array}{|c|c|c|}\hline 2&8&3\\\hline &6&4\\\hline 1&7&5\\\hline\end{array}$$
$h=5$
$f=1+5=6$

$h=t$
$f=1+4=5$
$$\begin{array}{|c|c|c|}\hline 2&8&5\\\hline 1&6&4\\\hline &7&5\\\hline\end{array}$$

$f=2+5=7$
$$\begin{array}{|c|c|c|}\hline 2&8&3\\\hline 1&6&4\\\hline &7&5\\\hline\end{array}$$

$f=7$
$$\begin{array}{|c|c|c|}\hline 2&8&3\\\hline 1&6&4\\\hline &7&5\\\hline\end{array}$$

$f=2+3=5$
$$\begin{array}{|c|c|c|}\hline 2&8&3\\\hline 1&&4\\\hline 7&6&5\\\hline\end{array}$$

$f=3+3=6$
$$\begin{array}{|c|c|c|}\hline 2&8&3\\\hline 1&&4\\\hline 7&6&5\\\hline\end{array}$$

$f=7$
$$\begin{array}{|c|c|c|}\hline 2&8&2\\\hline 1&6&4\\\hline 7&&\\\hline\end{array}$$

$f=6$
$$\begin{array}{|c|c|c|}\hline 2&&3\\\hline 1&8&4\\\hline 7&6&5\\\hline\end{array}$$

$f=7$
$$\begin{array}{|c|c|c|}\hline 2&8&3\\\hline 1&&4\\\hline 7&6&5\\\hline\end{array}$$

$f=7$
$$\begin{array}{|c|c|c|}\hline &8&3\\\hline 2&1&4\\\hline 7&6&5\\\hline\end{array}$$

$f=8$
$$\begin{array}{|c|c|c|}\hline 2&8&2\\\hline 7&1&4\\\hline &6&5\\\hline\end{array}$$

$f=6$
$$\begin{array}{|c|c|c|}\hline &2&3\\\hline 1&8&4\\\hline 7&6&5\\\hline\end{array}$$

$f=8$
$$\begin{array}{|c|c|c|}\hline &2&3\\\hline 1&8&4\\\hline 7&6&5\\\hline\end{array}$$

$f=5+1=6$
$$\begin{array}{|c|c|c|}\hline 1&2&3\\\hline &8&4\\\hline 7&6&5\\\hline\end{array}$$

$f=5+3=8$
$$\begin{array}{|c|c|c|}\hline 2&&3\\\hline 1&8&4\\\hline 7&6&5\\\hline\end{array}$$

$f=8$
$$\begin{array}{|c|c|c|}\hline 1&2&3\\\hline 7&8&4\\\hline &6&5\\\hline\end{array}$$

$$\begin{array}{|c|c|c|}\hline 1&2&3\\\hline &8&4\\\hline 7&6&5\\\hline\end{array}$$

$$\begin{array}{|c|c|c|}\hline &2&3\\\hline 1&8&4\\\hline 7&6&5\\\hline\end{array}$$

$f=6$

final state = ['right', 'up', 'up', 'left', 'down', 'right']