

Implement A* search algorithm on 8-puzzle problem

Algorithm

Step 1 : Initialize

- Input : start state, goal state
- Compute :
 - $g(\text{start}) = 0$ (cost so far) = 0 moves
 - $h(\text{start}) = \text{number of misplaced tiles}$ (ignore blank)
 - $f(\text{start}) = g + h$
- Put the start state into the open list (priority queue ordered by f)
- Keep an empty parent map to reconstruct path

Step 2 : Main Loop

While the open list is not empty

- Select state from open list with the smallest f
- Print its g, h, f values (for clarity)
- If this state = goal, stop → solution found
- Otherwise expand it:
 - Generate all possible neighbours by sliding the blank tile
 - For each neighbour :
 - $g(\text{neighbour}) = g(\text{current} + 1)$
 - $h(\text{neighbour}) = \text{misplaced tiles}$
 - $f(\text{neighbour}) = g + h$
 - If the neighbour is new (or has a better g value than before):
 - Record its parent
 - Add it to the open list with priority f
 - Print its g, h, f

Step 3: End

- If the goal state is popped from open list → success (path found)
- If open list becomes empty → no solution exists.

Output:-

$$\begin{bmatrix} 1 & 0 & 3 \\ 8 & 0 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$

Goal state

$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 6 & 4 \\ 0 & 7 & 5 \end{bmatrix}$$

Start state

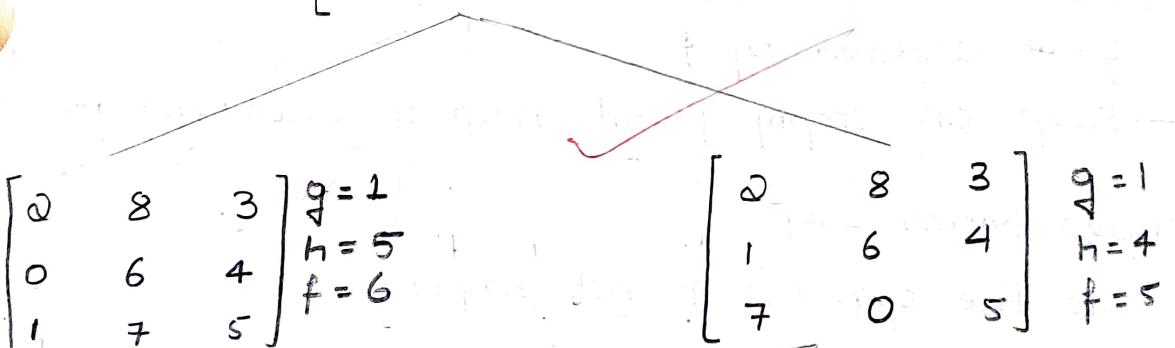
TRACING $h(n)$ = misplaced tiles.

$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 6 & 4 \\ 0 & 7 & 5 \end{bmatrix}$$

$$g=0$$

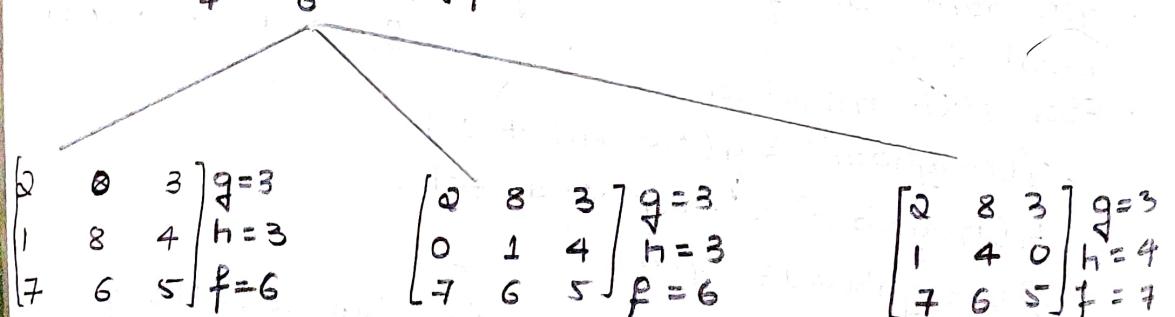
$$h=5$$

$$f=0+5=5$$



$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 0 & 4 \\ 7 & 6 & 5 \end{bmatrix} g=2 \\ h=3 \\ f=2+3=5$$

$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 6 & 4 \\ 7 & 5 & 0 \end{bmatrix} g=2 \\ h=5 \\ f=7$$



$$\begin{bmatrix} 0 & 2 & 3 \\ 1 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix} g=4 \\ h=2 \\ f=6$$

$$\begin{bmatrix} 0 & 3 & 0 \\ 1 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix} g=4 \\ h=4 \\ f=8$$

$$\begin{bmatrix} 0 & 2 & 3 \\ 1 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$



$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix} \quad g = 5 \\ h = 1 \\ f = 6$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 7 & 8 & 4 \\ 0 & 6 & 5 \end{bmatrix} \quad g = 6 \\ h = 2 \\ f = 8$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 8 & 0 & 4 \\ 7 & 6 & 5 \end{bmatrix} \quad g = 6 \\ h = 0 \\ f = 6$$

Goal reached!

Tracing For $h(n)$ Manhattan Distance

$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 6 & 4 \\ 7 & 0 & 5 \end{bmatrix} \quad f(n) = g(n) + h(n) \\ f(n) = 0 + 5 = 5$$



$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 0 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$

$$f(n) = g(n) + h(n) \\ = 1 + (1+1+0+0+0+0+2) \\ = 5$$

$$\begin{bmatrix} 2 & 8 & 3 \\ 0 & 6 & 4 \\ 7 & 5 & 5 \end{bmatrix} \quad f(n) = 1 + (1+1+0+1+1+0) \\ = 7$$

$$f(n) = 1 + (1+1+0+1+0+1+0) \\ = 7$$

$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 6 & 4 \\ 7 & 5 & 0 \end{bmatrix}$$

$$f(n) = 1 + (1+1+0+1+0+1+0+1+0) \\ = 7$$

D

L

R

$$\begin{bmatrix} 0 & 8 & 3 \\ 1 & 6 & 4 \\ 7 & 0 & 5 \end{bmatrix}$$

$$f(n) = 0 + (1+1+0+0+0+0+0+1) \\ = 5$$

$$\begin{bmatrix} 2 & 8 & 3 \\ 0 & 1 & 4 \\ 7 & 6 & 5 \end{bmatrix} \quad f(n) = 0 + (1+0+1+0+0+0+0+0) \\ = 7$$

$$f(n) = 0 + (1+0+1+0+0+0+0+0) \\ = 7$$

$$\begin{bmatrix} 2 & 8 & 3 \\ 1 & 4 & 0 \\ 7 & 6 & 5 \end{bmatrix} \quad f(n) = 0 + (1+1+0+1+0+1+1+0) \\ = 7$$

$$f(n) = 0 + (1+1+0+1+0+1+1+0+0) \\ = 7$$

$$\begin{bmatrix} 0 & 0 & 3 \\ 1 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix} \quad f(n) = 5$$

L

R

$$\begin{bmatrix} 0 & 2 & 3 \\ 1 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 3 & 0 \\ 1 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$

$$f(n) = 3 + (1 + 0 + 0 + 0 + 0 + 0 + 0 + 1) \\ = 5$$

$$f(n) = 3 + (1 + 1 + 1 + 0 + 0 + 0 + 1) \\ = 7$$

|D

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 8 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$

$$f(n) = 4 + (0 + 0 + 0 + 0 + 0 + 0 + 1) \\ = 5$$

|R

$$\begin{bmatrix} 1 & 2 & 3 \\ 8 & 0 & 4 \\ 7 & 6 & 5 \end{bmatrix}$$

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$$f(n) = 5 + 0 \\ f(n) = 5$$