LAB - 3 8/9/25

Implement A* search algorithm on 8-puzzle problem

Algorithm

Step 1 : Initialize
→ 1) Input : start state, goal state
→ Compute :
- g(start) = 0 (cost so far = 0 moves)
- h(start) = number of misplaced tiles (ignore blank)
- f(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 neighbor :
  g(neighbor) = g(current + 1)
  h(neighbor) = misplaced tiles
  f(neighbor) = 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 → sucess (path found)
- If open list becomes empty → no solution exists.

Output:-

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

Goal state   start state

TRACING $h(n)$ - misplaced tiles.

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

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

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

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

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

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

$\downarrow$

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

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

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

Goal reached!

Tracing For h(n) Manhattan Distance

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

$f(n) = g(n) + h(n)$

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

D | L | R

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

$f(n) = g(n) + h(n)$

$= 1 + (1+1+0+0+0+0+0+2)$

$= 5$

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

$f(n) = 1 + (1+1+0+0+0+1+1+2)$

$= 7$

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

$f(n) = 1 + (1+1+0+0+1+1+0+2)$

$= 7$

D | L | R

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

$f(n) = 2 + (1+1+0+0+0+0+0+1)$

$= 5$

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

$f(n) = 2 + (1+2+0+0+0+0+0+2)$

$= 7$

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

$f(n) = 2 + (1+1+0+1+0+1+2)$

$= 7$

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

L	R

L

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

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

$= 5$

R

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

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

$= 7$

D (from L)

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

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

$= 5$

R

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

$f(n) = 5 + 0$

$f(n) = 5$

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