8 Puzzle using DFS and BFS

i) DFS :

```
 cnt = 0;
def print_state(in_array):
    global cnt
    cnt += 1
    for row in in_array:
        print(' '.join(str(num) for num in row))
    print() # Print a blank line for better readability

def helper(goal, in_array, row, col, vis):
    # Mark the current position as visited
    vis[row][col] = 1
    drow = [-1, 0, 1, 0] # Directions for row movements: up, right, down, left
    dcol = [0, 1, 0, -1] # Directions for column movements
    dchange = ['U', 'R', 'D', 'L']

    # Print the current state print("Current
    state:") print_state(in_array)

    # Check if the current state is the goal state
    if in_array == goal:
        print_state(in_array)
        print(f"Number of states : {cnt}")
        return True

    # Explore all possible directions
    for i in range(4):
        nrow = row + drow[i]
        ncol = col + dcol[i]

        # Check if the new position is within bounds and not visited
        if 0 <= nrow < len(in_array) and 0 <= ncol < len(in_array[0]) and not
            vis[nrow][ncol]: # Make the move (swap the empty space with the adjacent tile)
            print(f"Took a {dchange[i]} move")
            in_array[row][col], in_array[nrow][ncol] = in_array[nrow][ncol], in_array[row][col]

            # Recursive call
            if helper(goal, in_array, nrow, ncol, vis):
                return True

            # Backtrack (undo the move)
            in_array[row][col], in_array[nrow][ncol] = in_array[nrow][ncol], in_array[row][col]
```

```
    # Mark the position as unvisited before returning
    vis[row][col] = 0
    return False

# Example usage
initial_state = [[1, 2, 3], [0, 4, 6], [7, 5, 8]]  # 0 represents the empty space
goal_state = [[1, 2, 3], [4, 5, 6], [7, 8, 0]]
visited = [[0] * 3 for _ in range(3)]  # 3x3 visited matrix
empty_row, empty_col = 1, 0 # Initial position of the empty space

found_solution = helper(goal_state, initial_state, empty_row, empty_col, visited)
print("Solution found:", found_solution)
```

Output :

```
Took a L move
Current state:
1 2 3
4 6 8
0 7 5

Took a D move
Current state:
1 2 3
4 5 6
7 0 8

Took a R move
Current state:
1 2 3
4 5 6
7 8 0

1 2 3
4 5 6
7 8 0

Number of states : 42
Solution found: True
```

i) BFS :

```
from collections import deque

GOAL_STATE = (1, 2, 3, 4, 5, 6, 7, 8,

0)

 def find_empty(state):
     return state.index(0)

def get_neighbors(state):
   neighbors = []
   empty_index = find_empty(state)
   row, col = divmod(empty_index, 3)
   directions = [(-1, 0), (1, 0), (0, -1), (0, 1)]
   for dr, dc in directions:
      new_row, new_col = row + dr, col + dc
      if 0 <= new_row < 3 and 0 <= new_col < 3:
         new_index = new_row * 3 + new_col
         new_state = list(state)
         new_state[empty_index], new_state[new_index] = new_state[new_index],
new_state[empty_index]
         neighbors.append(tuple(new_state))
   return neighbors

def bfs(initial_state):
   queue = deque([(initial_state, [])])
   visited = set()
   visited.add(initial_state)
   visited_count = 1 # Initialize visited count
   while queue:
      current_state, path = queue.popleft() if
      current_state == GOAL_STATE:
         return path, visited_count # Return path and count
      for neighbor in get_neighbors(current_state):
         if neighbor not in visited:
            visited.add(neighbor) queue.append((neighbor,
            path + [neighbor])) visited_count += 1  #
            Increment visited count
   return None, visited_count  # Return count if no solution found

def input_start_state():
   print("Enter the starting state as 9 numbers (0 for the empty space):")
   input_state = input("Format: 1 2 3 4 5 6 7 8 0\n")
   numbers = list(map(int, input_state.split()))
   if len(numbers) != 9 or set(numbers) != set(range(9)):
      print("Invalid input. Please enter numbers from 0 to 8 with no duplicates.") return
      input_start_state()
   return tuple(numbers)
```

```
def print_matrix(state):
    for i in range(0, 9, 3):
        print(state[i:i+3])

if _name_ == "_main_":
    initial_state = input_start_state()
    print("Initial state:")
    print_matrix(initial_state)
    solution, visited_count = bfs(initial_state)
    print(f"Number of states visited: {visited_count}")
    if solution:
        print("\nSolution found with the following steps:")
        for step in solution:
            print_matrix(step)
            print()
    else:
        print("No solution found.")
```

Output :

```
Enter the starting state as 9 numbers (0 for the empty space):
Format: 1 2 3 4 5 6 7 8 0
1 2 3 0 4 6 7 5 8
Initial state:
(1, 2, 3)
(0, 4, 6)
(7, 5, 8)
Number of states visited: 30

Solution found with the following steps:
(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)
```