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LAB-4

1) 8 PUZZLE USING ITERATIVE DEEPENING DEPTH FIRST SEARCH ALGORITHM

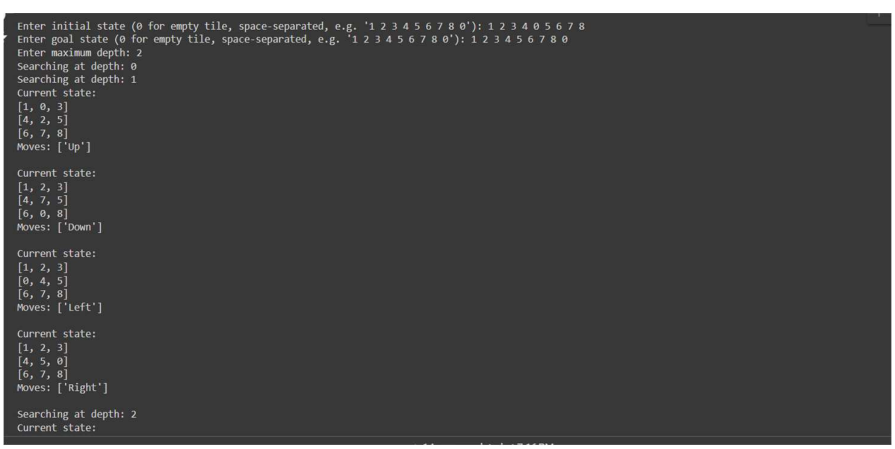
Code:

```
class PuzzleState:
    def __init__(self, board, empty_tile_pos, depth=0, path=[]):
        self.board = board
        self.empty_tile_pos = empty_tile_pos  # (row, col)
        self.depth = depth
        self.path = path  # Keep track of the path taken to reach this state

    def is_goal(self, goal):
        return self.board == goal

    def generate_moves(self):
        row, col = self.empty_tile_pos
        moves = []
        directions = [(-1, 0, 'Up'), (1, 0, 'Down'), (0, -1, 'Left'), (0, 1, 'Right')]  # up, down, left,
right
        for dr, dc, move_name in directions:
            new_row, new_col = row + dr, col + dc
            if 0 <= new_row < 3 and 0 <= new_col < 3:
                new_board = self.board[:]
                new_board[row * 3 + col], new_board[new_row * 3 + new_col] =
new_board[new_row * 3 + new_col], new_board[row * 3 + col]
                new_path = self.path + [move_name]  # Update the path with the new move
                moves.append(PuzzleState(new_board, (new_row, new_col), self.depth + 1,
new_path))
        return moves
```

```
    def display(self):
        # Display the board in a matrix form
        for i in range(0, 9, 3):
            print(self.board[i:i + 3])
        print(f"Moves: {self.path}")  # Display the moves taken to reach this state
        print()  # Newline for better readability


def iddfs(initial_state, goal, max_depth):
    for depth in range(max_depth + 1):
        print(f"Searching at depth: {depth}")
        found = dls(initial_state, goal, depth)
        if found:
            print(f"Goal found at depth: {found.depth}")
            found.display()
            return found
    print("Goal not found within max depth.")
    return None


def dls(state, goal, depth):
    if state.is_goal(goal):
        return state

    if depth <= 0:
        return None

    for move in state.generate_moves():
        print("Current state:")
        move.display()  # Display the current state
        result = dls(move, goal, depth - 1)
```

```
        if result is not None:
            return result
    return None


def main():
    # User input for initial state, goal state, and maximum depth
    initial_state_input = input("Enter initial state (0 for empty tile, space-separated, e.g. '1 2 3 4 5 6 7 8 0'): ")
    goal_state_input = input("Enter goal state (0 for empty tile, space-separated, e.g. '1 2 3 4 5 6 7 8 0'): ")
    max_depth = int(input("Enter maximum depth: "))
    initial_board = list(map(int, initial_state_input.split()))
    goal_board = list(map(int, goal_state_input.split()))
    empty_tile_pos = initial_board.index(0) // 3, initial_board.index(0) % 3  # Calculate the position of the empty tile

    initial_state = PuzzleState(initial_board, empty_tile_pos)
    solution = iddfs(initial_state, goal_board, max_depth)


if __name__ == "__main__":
    main()
```

OUTPUT 1:



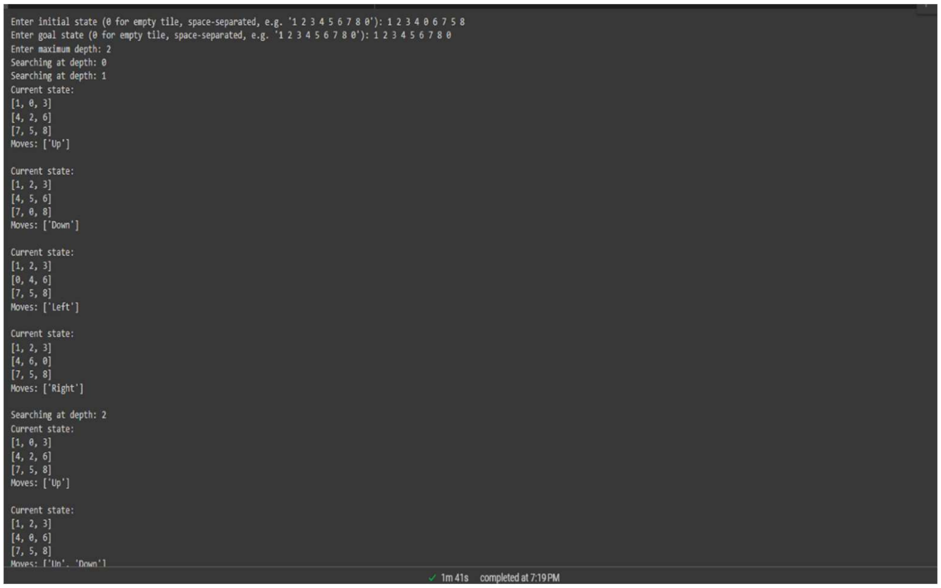
```
Enter initial state (0 for empty tile, space-separated, e.g. '1 2 3 4 5 6 7 8 0'): 1 2 3 4 0 5 6 7 8
Enter goal state (0 for empty tile, space-separated, e.g. '1 2 3 4 5 6 7 8 0'): 1 2 3 4 5 6 7 8 0
Enter maximum depth: 2
Searching at depth: 0
Searching at depth: 1
Current state:
[1, 0, 3]
[4, 2, 5]
[6, 7, 8]
Moves: ['Up']

Current state:
[1, 2, 3]
[4, 7, 5]
[6, 0, 8]
Moves: ['Down']

Current state:
[1, 2, 3]
[0, 4, 5]
[6, 7, 8]
Moves: ['Left']

Current state:
[1, 2, 3]
[4, 5, 0]
[6, 7, 8]
Moves: ['Right']

Searching at depth: 2
Current state:
```

```
Searching at depth: 2
Current state:
[1, 0, 3]
[4, 2, 5]
[6, 7, 8]
Moves: ['Up']

Current state:
[1, 2, 3]
[4, 0, 5]
[6, 7, 8]
Moves: ['Up', 'Down']

Current state:
[0, 1, 3]
[4, 2, 5]
[6, 7, 8]
Moves: ['Up', 'Left']

Current state:
[1, 3, 0]
[4, 2, 5]
[6, 7, 8]
Moves: ['Up', 'Right']

Current state:
[1, 2, 3]
[4, 7, 5]
[6, 0, 8]
Moves: ['Down']
```

```
Current state:
[1, 2, 3]
[4, 0, 5]
[6, 7, 8]
Moves: ['Down', 'Up']

Current state:
[1, 2, 3]
[4, 7, 5]
[0, 6, 8]
Moves: ['Down', 'Left']

Current state:
[1, 2, 3]
[4, 7, 5]
[6, 8, 0]
Moves: ['Down', 'Right']

Current state:
[1, 2, 3]
[0, 4, 5]
[6, 7, 8]
Moves: ['Left']

Current state:
[0, 2, 3]
[1, 4, 5]
[6, 7, 8]
Moves: ['Left', 'Up']

Current state:
```

```
Current state:
[1, 2, 3]
[4, 0, 5]
[6, 7, 8]
Moves: ['Left', 'Right']

Current state:
[1, 2, 3]
[4, 5, 0]
[6, 7, 8]
Moves: ['Right']

Current state:
[1, 2, 0]
[4, 5, 3]
[6, 7, 8]
Moves: ['Right', 'Up']

Current state:
[1, 2, 3]
[4, 5, 8]
[6, 7, 0]
Moves: ['Right', 'Down']

Current state:
[1, 2, 3]
[4, 0, 5]
[6, 7, 8]
Moves: ['Right', 'Left']

Goal not found within max depth.
```

OUTPUT 2:



```
Enter initial state (0 for empty tile, space-separated, e.g. '1 2 3 4 5 6 7 8 0'): 1 2 3 4 0 6 7 5 8
Enter goal state (0 for empty tile, space-separated, e.g. '1 2 3 4 5 6 7 8 0'): 1 2 3 4 5 6 7 8 0
Enter maximum depth: 2
Searching at depth: 0
Searching at depth: 1
Current state:
[1, 0, 3]
[4, 2, 6]
[7, 5, 8]
Moves: ['Up']

Current state:
[1, 2, 3]
[4, 5, 6]
[7, 0, 8]
Moves: ['Down']

Current state:
[1, 2, 3]
[0, 4, 6]
[7, 5, 8]
Moves: ['Left']

Current state:
[1, 2, 3]
[4, 6, 0]
[7, 5, 8]
Moves: ['Right']

Searching at depth: 2
Current state:
[1, 0, 3]
[4, 2, 6]
[7, 5, 8]
Moves: ['Up']

Current state:
[1, 2, 3]
[4, 0, 6]
[7, 5, 8]
Moves: ['Up', 'Down']
```


```
Current state:
[0, 1, 3]
[4, 2, 6]
[7, 5, 8]
Moves: ['Up', 'Left']

Current state:
[1, 3, 0]
[4, 2, 6]
[7, 5, 8]
Moves: ['Up', 'Right']

Current state:
[1, 2, 3]
[4, 5, 6]
[7, 0, 8]
Moves: ['Down']

Current state:
[1, 2, 3]
[4, 0, 6]
[7, 5, 8]
Moves: ['Down', 'Up']

Current state:
[1, 2, 3]
[4, 5, 6]
[0, 7, 8]
Moves: ['Down', 'Left']

Current state:
[1, 2, 3]
[4, 5, 6]
[7, 8, 0]
Moves: ['Down', 'Right']

Goal found at depth: 2
[1, 2, 3]
[4, 5, 6]
[7, 8, 0]
Moves: ['Down', 'Right']
```


2) N QUEENS PROBLEM USING HILL CLIMBING METHOD

CODE:

```
import random
```

```
def calculate_cost(board):
    n = len(board)
    attacks = 0
    for i in range(n):
        for j in range(i + 1, n):
            if board[i] == board[j]:  # Same column
                attacks += 1
            if abs(board[i] - board[j]) == abs(i - j):  # Same diagonal
                attacks += 1
    return attacks

def get_neighbors(board):
    neighbors = []
    n = len(board)
    for col in range(n):
        for row in range(n):
            if row != board[col]:  # Only change the row of the queen
                new_board = board[:]
                new_board[col] = row
                neighbors.append(new_board)
    return neighbors

def hill_climb(board, max_restarts=100):
    current_cost = calculate_cost(board)
    print("Initial board configuration:")
    print_board(board, current_cost)
    iteration = 0
    restarts = 0
    while restarts < max_restarts:  # Add limit to the number of restarts
        while current_cost != 0:  # Continue until cost is zero
```

```
            neighbors = get_neighbors(board)
            best_neighbor = None
            best_cost = current_cost

            for neighbor in neighbors:
                cost = calculate_cost(neighbor)
                if cost < best_cost:  # Looking for a lower cost
                    best_cost = cost
                    best_neighbor = neighbor
            if best_neighbor is None:  # No better neighbor found
                break  # Break the loop if we are stuck at a local minimum
            board = best_neighbor
            current_cost = best_cost
            iteration += 1
            print(f"Iteration {iteration}:")
            print_board(board, current_cost)
        if current_cost == 0:
            break  # We found the solution, no need for further restarts
        else:
            # Restart with a new random configuration
            board = [random.randint(0, len(board)-1) for _ in range(len(board))]
            current_cost = calculate_cost(board)
            restarts += 1
            print(f"Restart {restarts}:")
            print_board(board, current_cost)
    return board, current_cost
def print_board(board, cost):
    n = len(board)
    display_board = [['.'] * n for _ in range(n)]  # Create an empty board
```

```
    for col in range(n):
        display_board[board[col]][col] = 'Q'  # Place queens on the board
    for row in range(n):
        print(' '.join(display_board[row]))  # Print the board
    print(f"Cost: {cost}\n")


if __name__ == "__main__":
    n = int(input("Enter the number of queens (N): "))  # User input for N
    initial_state = list(map(int, input(f"Enter the initial state (row numbers for each column, space-separated): ").split()))
    if len(initial_state) != n or any(r < 0 or r >= n for r in initial_state):
        print("Invalid initial state. Please ensure it has N elements with values from 0 to N-1.")
    else:
        solution, cost = hill_climb(initial_state)
        if cost == 0:
            print(f"Solution found with no conflicts:")
        else:
            print(f"No solution found within the restart limit:")
        print_board(solution, cost)
```

OUTUT:

```
Enter the number of queens (N): 4
Enter the initial state (row numbers for each column, space-separated): 0 1 2 3
Initial board configuration:
Q . . .
. Q . .
. . Q .
. . . Q
Cost: 6

Iteration 1:
. . . .
Q Q . .
. . Q .
. . . Q
Cost: 4

Iteration 2:
. Q . .
Q . . .
. . Q .
. . . Q
Cost: 2

Restart 1:
. . . .
Q . . .
. Q Q .
. . . Q
Cost: 3

Iteration 3:
. . Q .
Q . . .
. Q . .
. . . Q
Cost: 1
```

```
Cost: 1

Restart 2:
Q . Q Q
. Q . .
. . . .
. . . .
Cost: 5

Iteration 4:
Q . . Q
. Q . .
. . . .
. . Q .
Cost: 2

Iteration 5:
. . . Q
. Q . .
Q . . .
. . Q .
Cost: 1

Restart 3:
. Q . .
. . . .
Q . Q .
. . . Q
Cost: 2

Iteration 6:
. Q . .
. . Q .
Q . . .
. . . Q
Cost: 1
```

```
Cost: 2

Iteration 7:
. . . Q
. Q . .
Q . . .
. . Q .
Cost: 1

Restart 5:
. . . .
. . . .
Q Q . Q
. . Q .
Cost: 5

Iteration 8:
. . . .
. . . Q
Q Q . .
. . Q .
Cost: 2

Iteration 9:
. Q . .
. . . Q
Q . . .
. . Q .
Cost: 0

Solution found with no conflicts:
. Q . .
. . . Q
Q . . .
. . Q .
Cost: 0
```