	Marathwada Mitra Mandal's	
	Institute of Technology, Lohgaon Pune - 47	
	Department of Artificial Intelligence and Data Science	

Semester -I A.Y.2025-26 Sub.: - Artificial Intelligence Lab Class: SE

Assignment 07: Implementing a Maze Solver using AI Search Algorithms (BFS & DFS).

Objective: Solve AI search problems using Graph Search Algorithms..

Explanation:

Maze Representation:

- **The maze is represented as a list of lists (a 2D grid).**
- **Each inner list represents a row.**
- **'#' indicates a wall.**
- **' ' indicates an open path.**
- **'S' is the starting point.**
- **'E' is the ending point.**

Common Elements for Both BFS and DFS:

1. **find_start_end(maze) (implicit in the code):**
   - **The first step is to iterate through the maze to locate the start ('S')**

and end ('E') coordinates.

2. directions:

    ○ A list of tuples [(0, 1), (0, -1), (1, 0), (-1, 0)] represents possible movements: right, left, down, up.

3. is_valid(r, c, rows, cols, maze, visited) (implicit in the code):

    ○ Checks if a given cell (r, c) is within the maze boundaries, is not a wall ('#'), and has not been visited yet.

Breadth-First Search (BFS):

- Goal: Find the shortest path from the start to the end.
- Data Structure: collections.deque (double-ended queue).
- How it works:
    ○ Starts at the start node.
    ○ Explores all its immediate neighbors.
    ○ Then explores all unvisited neighbors of those neighbors, and so on. ○ It expands layer by layer, ensuring that the first time it reaches the end node, it has found the shortest path.
- queue = collections.deque([(start, [start])]):
    ○ Each item in the queue is a tuple: (current_position, path_taken_to_reach_here). This is crucial for reconstructing the path. ● visited = set([start]):
    ○ Keeps track of all cells that have been added to the queue to prevent cycles and redundant processing.
- queue.popleft(): Removes the element from the front of the queue (FIFO - First-In, First-Out).

Depth-First Search (DFS):

- **Goal: Find *any* path from the start to the end. It doesn't guarantee the shortest path.**
- **Data Structure: A list used as a stack.**
- **How it works:**
  - **Start at the start node.**

○ Explores as far as possible along each branch before backtracking. ○ It goes deep into one path before trying another.

● stack = [(start, [start])]:

○ Similar to BFS, each item in the stack is (current_position, path_taken_to_reach_here).

● visited = set([start]):

○ Keeps track of visited cells.

● stack.pop(): Removes the element from the end of the list (LIFO - Last-In, First-Out), simulating a stack.

print_path(maze, path):

● This helper function takes the original maze and the found path, then prints the maze with the path marked by '*'.

Choosing Between BFS and DFS for Maze Solving:

● BFS is generally preferred for maze solving when you need the shortest path because it explores evenly in all directions from the start.

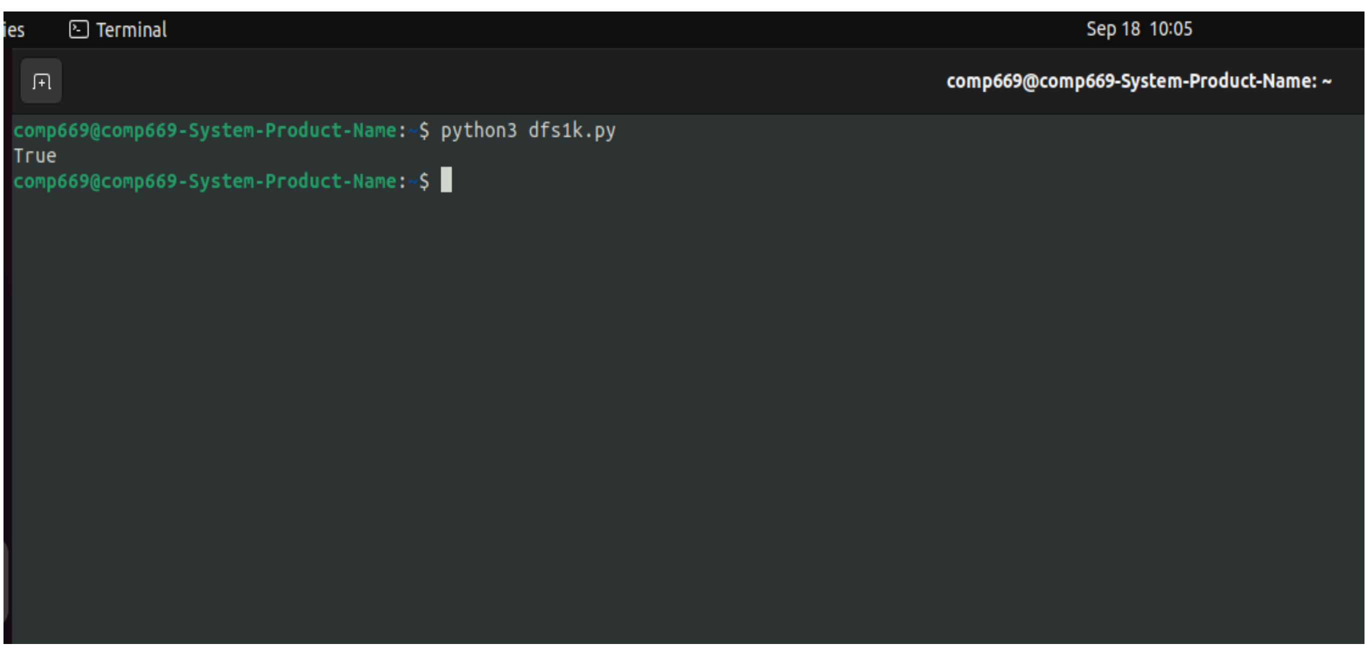
● DFS is simpler to implement recursively (though the iterative stack version is shown here). It can find *a* path quickly, but not necessarily the shortest. If the maze has a very long, winding path to the solution while a shorter one exists, DFS might explore the longer one first.

DFS:

```
def dfs(maze, start, end):
    stack = [start] # Initialize stack with start position
    visited = set() # Track visited positions

    while stack:
        position = stack.pop() # Get current position
        x, y = position

        # Check if we've reached the end
        if position == end:
            return True

        # Mark the current cell as visited
        visited.add((x, y))

        # Explore neighbors (up, down, left, right)
        for dx, dy in [(-1, 0), (1, 0), (0, -1), (0, 1)]:
            new_x, new_y = x + dx, y + dy

            # Check bounds and if the cell is already visited or is a wall
            if (0 <= new_x < len(maze) and 0 <= new_y < len(maze[0]) and
                    maze[new_x][new_y] == 0 and (new_x, new_y) not in visited):
                stack.append((new_x, new_y))

    return False # Return False if no path is found

# Example maze: 0 -> open path, 1 -> wall
```

```
maze = [
    [0, 1, 0, 0, 0],
    [0, 1, 0, 1, 0],
    [0, 0, 0, 1, 0],
    [1, 1, 1, 1, 0],
    [0, 0, 0, 0, 0]
]

# Start and end positions
start = (0, 0)
end = (4, 4)

# Solve the maze
print(dfs(maze, start, end))
```

Output: True



BFS:

```
from collections import deque

def bfs(maze, start, end):
    # Directions: up, right, down, left
    directions = [(-1, 0), (0, 1), (1, 0), (0, -1)]
    queue = deque([start])  # Queue for BFS
    visited = set(start)    # Keep track of visited cells

    while queue:
        current = queue.popleft()
        if current == end:
            return True  # Path found to exit

        for direction in directions:
            # Calculate the next cell's position
            next_cell = (current[0] + direction[0], current[1] + direction[1])

            # Check if the next cell is within the maze and not a wall
            if (0 <= next_cell[0] < len(maze) and
                    0 <= next_cell[1] < len(maze[0]) and
                maze[next_cell[0]][next_cell[1]] != '#' and
                next_cell not in visited):
              queue.append(next_cell)
              visited.add(next_cell)

    return False  # No path found
```

```
# Example maze where '#' is a wall, 'S' is start, and 'E' is end
maze = [
    ['S', '.', '.', '#', '.', '.', '.'],
    ['.', '#', '.', '#', '.', '#', '.'],
    ['.', '#', '.', '.', '.', '.', '.'],
    ['.', '.', '#', '#', '#', '.', '.'],
    ['.', '#', '.', '.', '.', '#', '.'],
    ['.', '#', '#', '#', '.', '#', '.'],
    ['.', '.', '.', '.', '.', '.', 'E'],
]

start = (0, 0)  # Starting position
end = (6, 6)    # Ending position (exit)

# Run BFS to find the path
path_exists = bfs(maze, start, end)
print("Path found!" if path_exists else "No path exists.")
```

#output: path found!