LAB 2 – ASSIGNMENT

SOLVE THE RAT IN A MAZE PROBLEM WITH VISUALIZATION

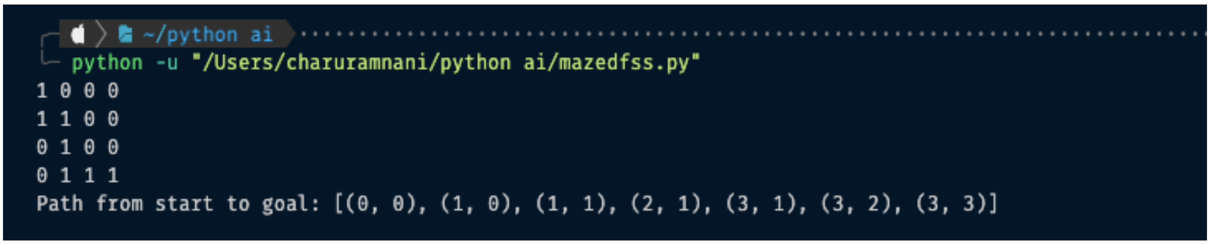
QUESTION-2. MAZE = [
[1, 0, 0, 0],
[1, 1, 0, 1],
[0, 1, 0, 0],
[1, 1, 1, 1]
]

CODE FOR DFS:

```
#USING DFS QUESTION 2
class MazeSolver:
   def __init__(self, maze):
      self.maze = maze
      self.rows = len(maze)
      self.cols = len(maze[0])
      self.visited = [[False] * self.cols for _ in range(self.rows)]
      self.solution = [[0] * self.cols for _ in range(self.rows)]

   def is_valid_move(self, row, col):
      return 0 <= row < self.rows and 0 <= col < self.cols and not self.visited[row][col] and self.maze[row][col] == 1

   def depth_first_search(self, row, col):
      if row == self.rows - 1 and col == self.cols - 1:
         self.solution[row][col] = 1  # Mark the destination cell
         return True

      if self.is_valid_move(row, col):
         self.visited[row][col] = True
         self.solution[row][col] = 1

         # Explore in all four directions: up, down, left, right
         directions = [(-1, 0), (0, -1), (1, 0), (0, 1)]
         for dr, dc in directions:
            if self.depth_first_search(row + dr, col + dc):
                    return True

            # If no valid move found, backtrack
            self.solution[row][col] = 0

        return False

    def solve_maze(self):
        if not self.depth_first_search(0, 0):
            print("No solution exists.")
        else:
            self.print_solution()

    def print_solution(self):
        for row in self.solution:
            print(" ".join(map(str, row)))

# question 2(written from the board)
maze = [
    [1, 0, 0, 0],
    [1, 1, 0, 1],
    [0, 1, 0, 0],
    [1, 1, 1, 1]

]

# We use this method to solve the given question 2
solver = MazeSolver(maze)
solver.solve_maze()

# we make a dfs function to solve this with dfs
def dfs(maze, start, goal):
    rows, cols = len(maze), len(maze[0])
    directions = [(-1, 0), (1, 0), (0, -1), (0, 1)]  # Up, Down, Left, Right
    stack = [start]
    visited = set()
    visited.add(start)
    parent = {start: None}

    while stack:
        current = stack.pop()
        if current == goal:
            break

        for dr, dc in directions:
            nr, nc = current[0] + dr, current[1] + dc
```

```
      if 0 <= nr < rows and 0 <= nc < cols and maze[nr][nc] == 1 and (nr, nc) not in visited:  # '1' indicates a valid path
        stack.append((nr, nc))
        visited.add((nr, nc))
        parent[(nr, nc)] = current

  # Reconstruct the path
  path = []
  step = goal
  while step:
    path.append(step)
    step = parent.get(step)
  path.reverse()

  return path

start = (0, 0)  # Starting point
goal = (3, 3)   # Goal point

path = dfs(maze, start, goal)
print("Path from start to goal:", path)
```

OUTPUT:



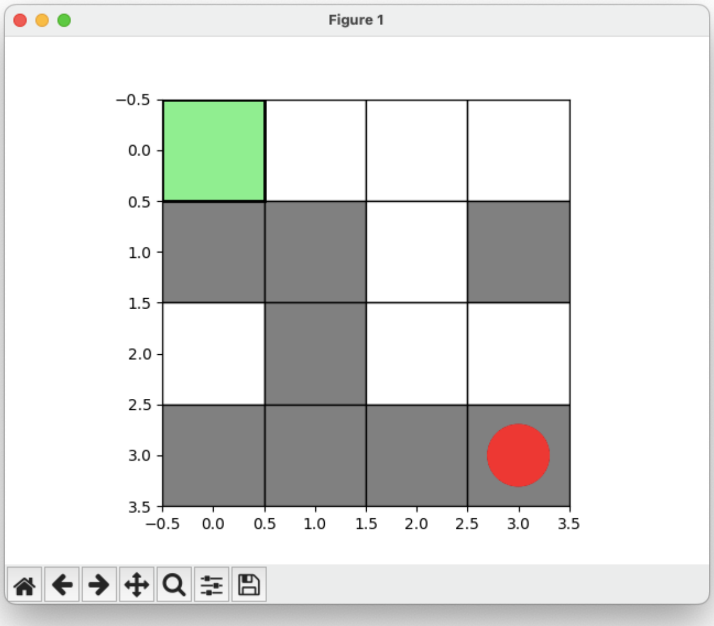
```
 ~/python ai
python -u "/Users/charuramnani/python ai/mazedfss.py"
1 0 0 0
1 1 0 0
0 1 0 0
0 1 1 1
Path from start to goal: [(0, 0), (1, 0), (1, 1), (2, 1), (3, 1), (3, 2), (3, 3)]
```

CODE FOR DFS VISUALIZATION:

```
import matplotlib.pyplot as plt
import matplotlib.animation as animation

class MazeSolver:
  def __init__(self, maze):
    self.maze = maze
    self.rows = len(maze)
    self.cols = len(maze[0])
    self.visited = [[False] * self.cols for _ in range(self.rows)]
    self.solution = [[0] * self.cols for _ in range(self.rows)]
```

```
        self.path = []  # To store the path of the rat

    def is_valid_move(self, row, col):
        return 0 <= row < self.rows and 0 <= col < self.cols and not self.visited[row][col] and
self.maze[row][col] == 1

    def depth_first_search(self, row, col):
        # If the goal is reached, stop searching
        if row == self.rows - 1 and col == self.cols - 1:
            self.solution[row][col] = 1
            self.path.append((row, col))
            return True

        if self.is_valid_move(row, col):
            self.visited[row][col] = True
            self.solution[row][col] = 1
            self.path.append((row, col))

            # Explore in all four directions: up, down, left, right
            directions = [(-1, 0), (0, -1), (1, 0), (0, 1)]
            for dr, dc in directions:
                if self.depth_first_search(row + dr, col + dc):
                    return True

            # If no valid move found, backtrack
            self.solution[row][col] = 0
            self.path.pop()
        return False

    def solve_maze(self):
        if not self.depth_first_search(0, 0):
            print("No solution exists.")
        else:
            self.print_solution()

    def print_solution(self):
        for row in self.solution:
            print(" ".join(map(str, row)))

def animate_solution(solver):
    fig, ax = plt.subplots()
    ax.imshow(solver.maze, cmap="Greys", vmin=0, vmax=1)

    # Add outlines for each cell in the maze and gray out the blocked paths
    for row in range(solver.rows):
        for col in range(solver.cols):
            if solver.maze[row][col] == 0:
                ax.add_patch(plt.Rectangle((col - 0.5, row - 0.5), 1, 1, edgecolor='black',
facecolor='white', lw=1))
            else:
                ax.add_patch(plt.Rectangle((col - 0.5, row - 0.5), 1, 1, edgecolor='black',
facecolor='grey', lw=1))

    # Create a circle to represent the rat
    rat_circle = plt.Circle((0, 0), 0.3, color='red', fill=True)
    ax.add_artist(rat_circle)

    def update(frame):
        # Update the rat's position based on the path
        row, col = solver.path[frame]
        rat_circle.center = (col, row)
        ax.add_patch(plt.Rectangle((col - 0.5, row - 0.5), 1, 1, edgecolor='black',
facecolor='lightgreen', lw=2))

        # If this is the last frame, indicate target achieved
        if frame == len(solver.path) - 1:
            ax.text(0.5, -0.1, 'Target Achieved!', fontsize=14, color='green', ha='center',
transform=ax.transAxes)
            ax.add_patch(plt.Rectangle((col - 0.5, row - 0.5), 1, 1, edgecolor='black',
facecolor='green', lw=2))

        return rat_circle,

    ani = animation.FuncAnimation(fig, update, frames=len(solver.path), interval=500,
blit=True, repeat=False)
    plt.show()

# Example usage:
maze = [
    [1, 0, 0, 0],
    [1, 1, 0, 1],
    [0, 1, 0, 0],
    [1, 1, 1, 1]

]
solver = MazeSolver(maze)
solver.solve_maze()
animate_solution(solver)
```

OUTPUT:



CODE FOR BFS AND VISUALIZATION:

```
from collections import deque
import matplotlib.pyplot as plt
import matplotlib.animation as animation

def bfs(maze, start, goal):
    rows, cols = len(maze), len(maze[0])
    directions = [(-1, 0), (1, 0), (0, -1), (0, 1)]  # Up, Down, Left, Right
    queue = deque([start])
    visited = set()
    visited.add(start)
    parent = {start: None}

    while queue:
        current = queue.popleft()
        if current == goal:
            break

        for dr, dc in directions:
            nr, nc = current[0] + dr, current[1] + dc
            if 0 <= nr < rows and 0 <= nc < cols and maze[nr][nc] == 0 and (nr, nc) not in visited:
                queue.append((nr, nc))
                visited.add((nr, nc))
                parent[(nr, nc)] = current
    # Reconstruct the path
    path = []
    step = goal
    while step:
        path.append(step)
        step = parent.get(step)
    path.reverse()

    return path

def animate_solution(maze, path):
    fig, ax = plt.subplots()
    rows, cols = len(maze), len(maze[0])

    # Plot the maze
    ax.imshow(maze, cmap="Greys", vmin=0, vmax=1)

    # Add outlines for each cell in the maze
    for row in range(rows):
        for col in range(cols):
            ax.add_patch(plt.Rectangle((col - 0.5, row - 0.5), 1, 1, edgecolor='black',
facecolor='none', lw=1))

    # Create a circle to represent the rat
    rat_circle = plt.Circle((0, 0), 0.3, color='red', fill=True)
    ax.add_artist(rat_circle)

    def update(frame):
        if frame < len(path):
            row, col = path[frame]
            rat_circle.center = (col, row)

            # Highlight the path cells from start to current cell
            for r, c in path[:frame+1]:
                ax.add_patch(plt.Rectangle((c - 0.5, r - 0.5), 1, 1, edgecolor='black',
facecolor='lightblue', lw=2))

            # Highlight the current cell being visited
            if frame > 0:
                prev_row, prev_col = path[frame - 1]
                ax.add_patch(plt.Rectangle((prev_col - 0.5, prev_row - 0.5), 1, 1, edgecolor='black',
facecolor='lightgreen', lw=2))

            # Indicate the target cell
            if frame == len(path) - 1:
                ax.add_patch(plt.Rectangle((col - 0.5, row - 0.5), 1, 1, edgecolor='black',
facecolor='green', lw=2))
                ax.text(0.5, -0.1, 'Target Achieved!', fontsize=14, color='green', ha='center',
transform=ax.transAxes)

            # Print the current cell being visited to the terminal
            print(f"Step {frame}: Current Position: ({row}, {col})")

        return rat_circle,

    ani = animation.FuncAnimation(fig, update, frames=len(path), interval=500, blit=True,
repeat=False)
    plt.show()

# Example Maze
maze = [
    [1, 0, 0, 0],
    [1, 1, 0, 1],
    [0, 1, 0, 0],
    [1, 1, 1, 1]
]

start = (0, 0)  # Starting point
goal = (3, 3)   # Goal point

path = bfs(maze, start, goal)
print("Path from start to goal:", path)

animate_solution(maze, path)
```

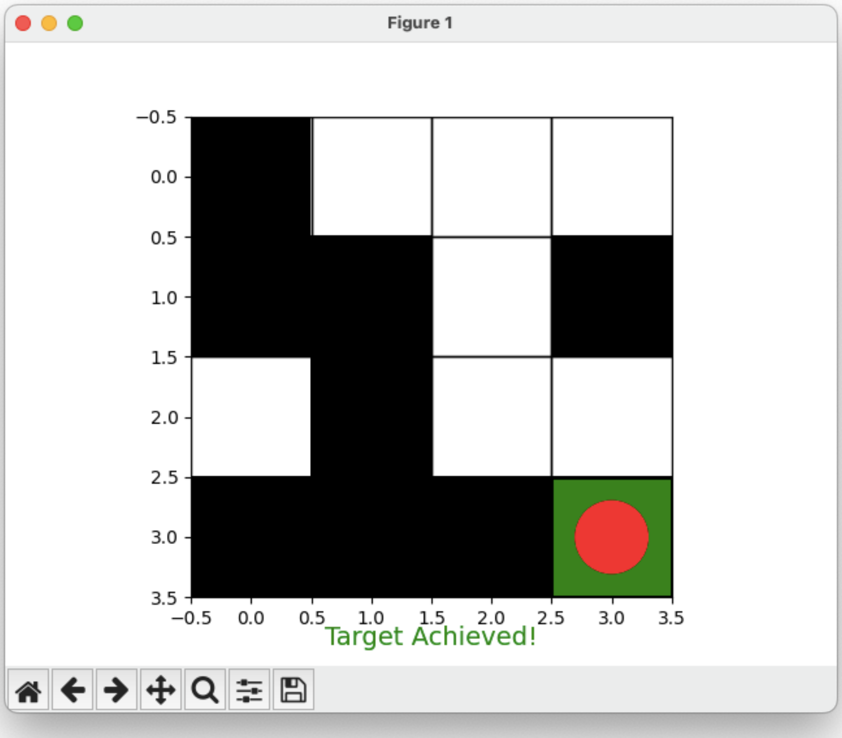


Figure 1
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Target Achieved!