PATHFINDING WITH A * ALGORITHM

1. Introduction

Pathfinding is a fundamental problem in computer science, particularly in fields like robotics, video games, AI planning, and network routing. The goal of pathfinding is to determine the most efficient route between two points, avoiding obstacles and unnecessary detours. There are several algorithms for pathfinding, and one of the most widely used is the A* (A-star) algorithm, known for its efficiency and ability to find the optimal path.

Code;

```
import heapq

import matplotlib.pyplot as plt

import matplotlib.colors as mcolors
```

Define the Node class

```
class Node:

  def __init__(self, position, g=0, h=0, parent=None):

    self.position = position

    Self.g=g  # cost from start to current  node

    self.h = h  # heuristic (estimated cost from current node to goal)

    self.f = g + h  # total cost

    self.parent = parent


  def __lt__(self, other):

    return self.f < other.f
```

```
def a_star(grid, start, goal):
  open_list = []
  closed_list = set()
  open_list_map = {}  # To track nodes added to open_list

  start_node = Node(start, 0, heuristic(start, goal))
  goal_node = Node(goal)

  heapq.heappush(open_list, start_node)
  open_list_map[start] = start_node

  while open_list:
    current_node = heapq.heappop(open_list)
    closed_list.add(current_node.position)

    if current_node.position == goal:
      path = []
      while current_node:
        path.append(current_node.position)
        current_node = current_node.parent
      return path[::-1], open_list_map, closed_list
       # Return reversed path, open list, and closed list

    for neighbor in get_neighbors(current_node.position, grid):
      if neighbor in closed_list:
```

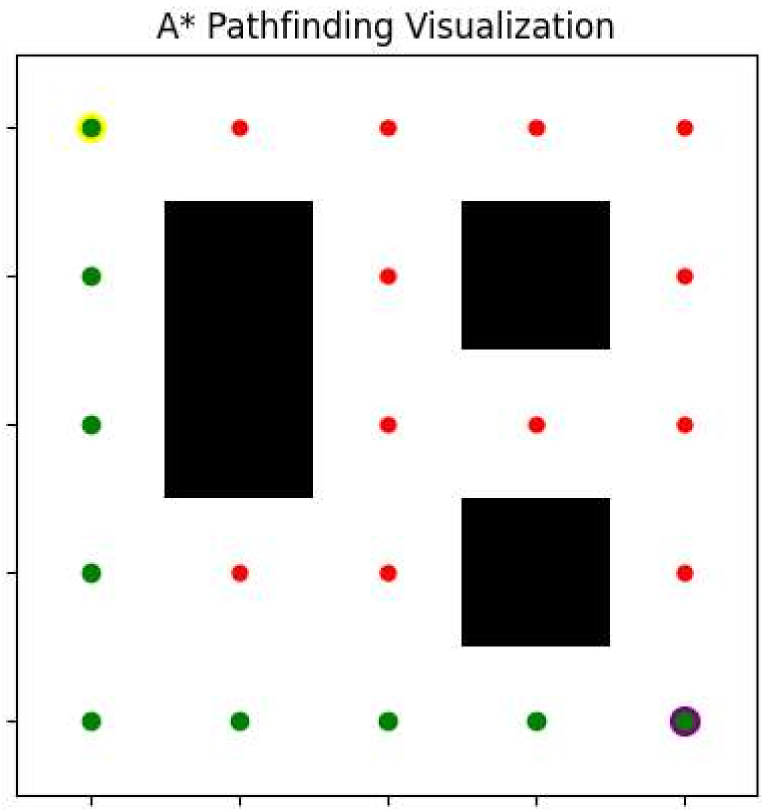
```
            continue

        g_cost = current_node.g + 1
        h_cost = heuristic(neighbor, goal)
        neighbor_node = Node(neighbor, g_cost, h_cost, current_node)

        if neighbor not in open_list_map or open_list_map[neighbor].f > neighbor_node.f:
            heapq.heappush(open_list, neighbor_node)
            open_list_map[neighbor] = neighbor_node

    return None, open_list_map, closed_list


def heuristic(a, b):
    return abs(a[0] - b[0]) + abs(a[1] - b[1])


def get_neighbors(position, grid):
    x, y = position
    neighbors = []
    directions = [(-1, 0), (1, 0), (0, -1), (0, 1)]

    for dx, dy in directions:
        nx, ny = x + dx, y + dy
        if 0 <= nx < len(grid) and 0 <= ny < len(grid[0]) and grid[nx][ny] == 0:
            neighbors.append((nx, ny))
```

```
    return neighbors


def visualize(grid, path, open_list_map, closed_list):
    # Create a colormap for visualization
    cmap = mcolors.ListedColormap(['white', 'black', 'blue', 'red', 'green'])
    bounds = [0, 0.5, 1.5, 2.5, 3.5, 4.5]  # Mapping to grid colors
    norm = mcolors.BoundaryNorm(bounds, cmap.N)

    fig, ax = plt.subplots()

    # Create the grid
    grid_image = [[1 if cell == 1 else 0 for cell in row] for row in grid]
    ax.imshow(grid_image, cmap=cmap, norm=norm)

    # Mark start and goal positions
    ax.plot(path[0][1], path[0][0], marker='o', color='yellow', markersize=10)  # Start
    ax.plot(path[-1][1], path[-1][0], marker='o', color='purple', markersize=10)  # Goal

    # Mark the path
    for node in path:
        ax.plot(node[1], node[0], marker='o', color='green', markersize=6)

    # Mark open list (explored nodes)
    for node in open_list_map:
```

```
        if node not in closed_list:
            ax.plot(node[1], node[0], marker='o', color='blue', markersize=5)

    # Mark closed list (visited nodes)
    for node in closed_list:
        if node not in path:
            ax.plot(node[1], node[0], marker='o', color='red', markersize=5)

    ax.set_xticks(range(len(grid[0])))
    ax.set_yticks(range(len(grid)))
    ax.set_xticklabels([])
    ax.set_yticklabels([])
    ax.set_title("A* Pathfinding Visualization")

    plt.show()


# Example grid (0 is walkable, 1 is blocked)
grid = [
    [0, 0, 0, 0, 0],
    [0, 1, 0, 1, 0],
    [0, 1, 0, 0, 0],
    [0, 0, 0, 1, 0],
    [0, 0, 0, 0, 0]
]
```

```
# Start and goal positions
start = (0, 0)
goal = (4, 4)

# Run A* algorithm
path, open_list_map, closed_list = a_star(grid, start, goal)

if path:
    print("Path:", path)
    visualize(grid, path, open_list_map, closed_list)
else:
    print("No path found!")
```

Output;



Special thanks;

Bikki sir ,

Mayank sir