

**TASK 3**  
**A \* Algorithm**

Implementation of A \* Algorithm to find the optimal path using Python by following constraints.

- The goal of the A\* algorithm is to find the shortest path from the starting point to the goal point as fast as possible.
- The full path cost (f) for each node is calculated as the distance to the starting node (g) plus the distance to the goal node (h).
- Distances is calculated as the manhattan distance (taxicab geometry) between nodes.

**Tools- Python, Online Simulator - <https://graphonline.ru/en/>**

**PROBLEM STATEMENT:**

**CO2      S3**

An AI navigation system for an autonomous drone flying over a network of waypoints (nodes). Each node represents a location, and edges represent possible paths between locations with different travel costs. The drone must find the shortest and most efficient route from a starting waypoint to a target waypoint, avoiding longer or costly paths. Each node has a heuristic value representing the estimated cost to reach the goal (e.g., based on straight-line distance).

**TASK:3**  
**Implementation of A \* Algorithm to find the optimal path**

**AIM**

To implement the A\* (A-Star) Search Algorithm using Python to find the optimal shortest path between a start node and a goal node in a weighted graph, using both the actual path cost and a heuristic estimate (Manhattan or straight-line distance).

**ALGORITHM**

1. Start at the starting point on the map.
2. Write down the cost to reach this point from the start ( $g = 0$ ), and estimate how far it is from the goal using straight lines or grid steps ( $h = \text{heuristic}$ ).

Then calculate the total cost:

$$f = g + h.$$

3. Look at all the neighbouring points you can go to from your current position.
4. For each neighbour:
  - Add the cost to get there from where you are now ( $g$ ).
  - Estimate how far it is from the goal ( $h$ ).
  - Add them to get the total cost:  $f = g + h$ .
  - Write down this total cost for each possible path.
5. Pick the point with the lowest total cost ( $f$ ) and go there next.
6. Repeat the process:
  - Check all neighbouring points from your current position.
  - Update their  $g$ ,  $h$ , and  $f$  values.
  - Always move to the next point with the lowest  $f$  value.
7. Stop when you reach the goal.
8. Trace back the path you took to get the full route from start to goal.

## PROGRAM

### A\* Algorithm on a Graph

```
import heapq

# Graph: adjacency list with edge costs
graph = {
    'A': [('B', 2), ('C', 4)],
    'B': [('D', 1), ('E', 12)],
    'C': [('F', 8)],
    'D': [('G', 6)],
    'E': [('G', 1)],
    'F': [('G', 4)],
    'G': []
}

# Heuristic values (estimated cost from node to goal)
heuristic = {
    'A': 9,
    'B': 6,
    'C': 7,
    'D': 2,
    'E': 1,
    'F': 4,
    'G': 0
}

# A* Algorithm
def a_star(graph, start, goal):
    open_list = []
    heapq.heappush(open_list, (0 + heuristic[start], 0, start, [start])) # (f, g, current_node, path)
    visited = set()

    while open_list:
        f, g, current, path = heapq.heappop(open_list)

        if current in visited:
            continue
        visited.add(current)

        # Goal reached
        if current == goal:
            print("Optimal Path Found:", " → ".join(path))
            print("Total Cost:", g)
            return

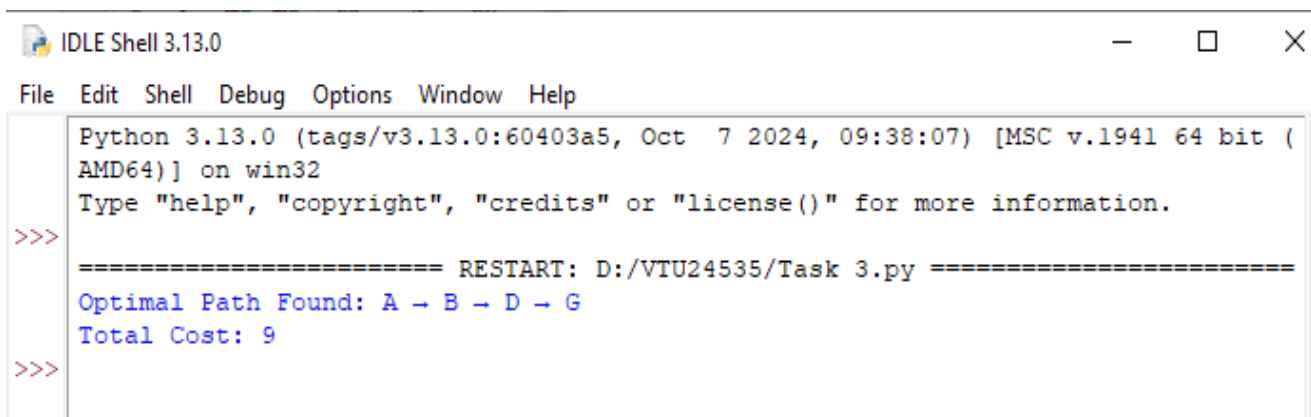
        # Explore neighbors
        for neighbor, cost in graph[current]:
            if neighbor not in visited:
```

```
        new_g = g + cost
        new_f = new_g + heuristic[neighbor]
        heapq.heappush(open_list, (new_f, new_g, neighbor, path + [neighbor]))

    print("No path found.")

# Run the algorithm
start_node = 'A'
goal_node = 'G'
a_star(graph, start_node, goal_node)
```

## OUTPUT



```
IDLE Shell 3.13.0
File Edit Shell Debug Options Window Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct 7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: D:/VTU24535/Task 3.py =====
Optimal Path Found: A -> B -> D -> G
Total Cost: 9
>>>
```

## RESULT

Thus, the Implementation of A \* Algorithm to find the optimal path using Python Was successfully executed and output was verified.