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Practical No. 4

Aim: Create a program that finds the shortest paths from a given source vertex in a weighted connected graph to all other vertices using Dijkstra's algorithm.

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Semester/Year: V/III

Academic Session:2024-2025

Date of Performance:

Date of Submission:

AIM: Create a program that finds the shortest paths from a given source vertex in a weighted connected graph to all other vertices using Dijkstra's algorithm.

OBJECTIVE/EXPECTED LEARNING OUTCOME:

The objectives and expected learning outcome of this practical are:

- To understand the concepts of single source shortest path.
- To implement the Dijkstra algorithm to find single source shortest path.

THEORY:

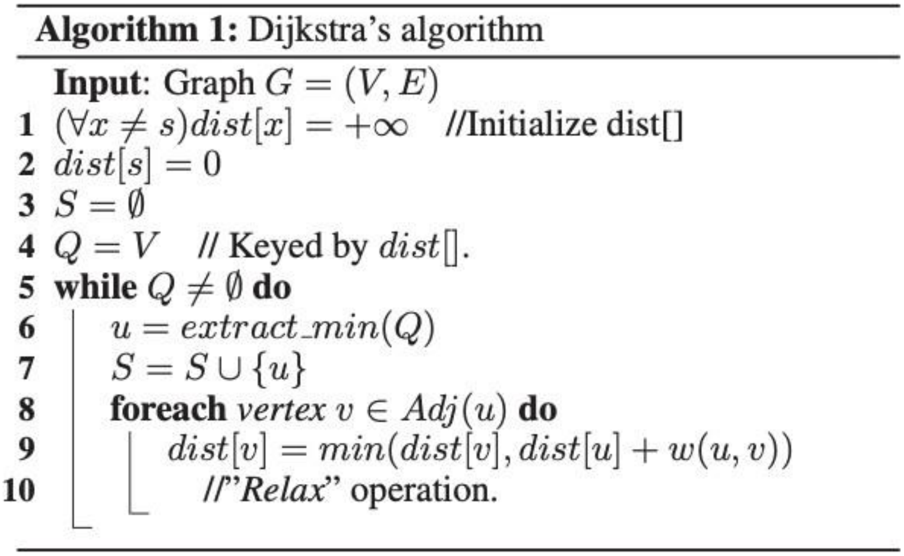
Dijkstra's algorithm is a popular algorithm for solving many single-source shortest path problems having non-negative edge weight in the graphs i.e., it is to find the shortest distance between two vertices on a graph. It was conceived by Dutch computer scientist Edsger W. Dijkstra in 1956.

The algorithm maintains a set of visited vertices and a set of unvisited vertices. It starts at the source vertex and iteratively selects the unvisited vertex with the smallest tentative distance from the source. It then visits the neighbors of this vertex and updates their tentative distances if a shorter path is found. This process continues until the destination vertex is reached, or all reachable vertices have been visited.

The need for Dijkstra's algorithm arises in many applications where finding the shortest path between two points is crucial.

For example, It can be used in the routing protocols for computer networks and also used by map systems to find the shortest path between starting point and the destination.

ALGORITHM:



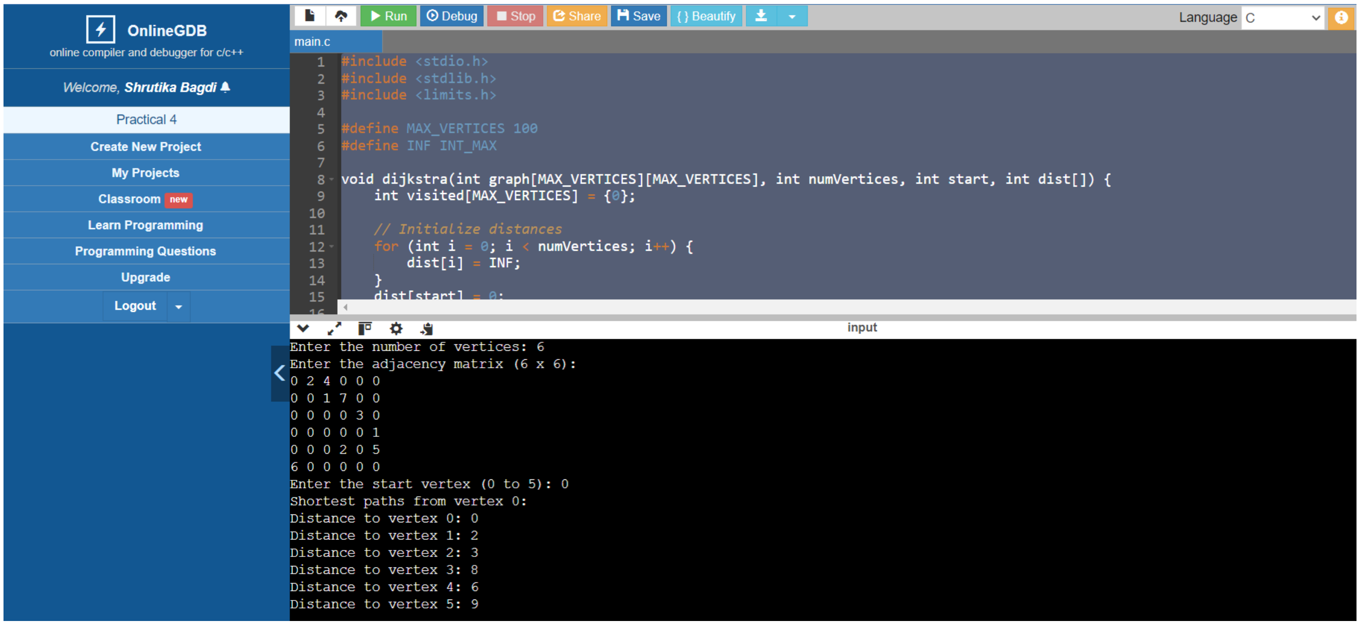
Algorithm 1: Dijkstra's algorithm

```
Input: Graph $G = (V, E)$
$(\forall x \neq s) dist[x] = +\infty$    //Initialize dist[]
$dist[s] = 0$
$S = \emptyset$
$Q = V$    // Keyed by $dist[]$.
while $Q \neq \emptyset$ do
    $u = extract\_min(Q)$
    $S = S \cup \{u\}$
    foreach vertex $v \in Adj(u)$ do
        $dist[v] = min(dist[v], dist[u] + w(u, v))$
            //"Relax" operation.
```

CODE:

```
#include <stdio.h>
#include <stdlib.h>
#include <limits.h>

#define MAX_VERTICES 100
#define INF INT_MAX

void dijkstra(int graph[MAX_VERTICES][MAX_VERTICES], int numVertices, int start, int dist[]) {
    int visited[MAX_VERTICES] = {0};

    for (int i = 0; i < numVertices; i++) {
        dist[i] = INF;
    }
    dist[start] = 0;

   for (int count = 0; count < numVertices - 1; count++) {
        int min = INF;
        int u = -1;
        for (int v = 0; v < numVertices; v++) {
            if (!visited[v] && dist[v] <= min) {
                min = dist[v];
                u = v;
            }
        }
        if (u == -1) {
            break;
        }
      visited[u] = 1;
        for (int v = 0; v < numVertices; v++) {
            if (!visited[v] && graph[u][v] && dist[u] != INF && dist[u] + graph[u][v] < dist[v]) {
                dist[v] = dist[u] + graph[u][v];
            }
        }
    }
}

int main() {
    int numVertices;
    printf("Enter the number of vertices: ");
    scanf("%d", &numVertices);

    int graph[MAX_VERTICES][MAX_VERTICES];
    printf("Enter the adjacency matrix (%d x %d):\n", numVertices, numVertices);
    for (int i = 0; i < numVertices; i++) {
        for (int j = 0; j < numVertices; j++) {
            scanf("%d", &graph[i][j]);
        }
    }

    int startVertex;
    printf("Enter the start vertex (0 to %d): ", numVertices - 1);
    scanf("%d", &startVertex);

    if (startVertex < 0 || startVertex >= numVertices) {
        printf("Invalid start vertex.\n");
        return 1;
    }

    int dist[MAX_VERTICES];
    dijkstra(graph, numVertices, startVertex, dist);
    printf("Shortest paths from vertex %d:\n", startVertex);
    for (int i = 0; i < numVertices; i++) {
        if (dist[i] == INF) {
            printf("Distance to vertex %d: INF\n", i);
        } else {
            printf("Distance to vertex %d: %d\n", i, dist[i]);
        }
    }

    return 0;
}
```

INPUT & OUTPUT WITH DIFFERENT TEST CASES:



```c
#include <stdio.h>
#include <stdlib.h>
#include <limits.h>

#define MAX_VERTICES 100
#define INF INT_MAX

void dijkstra(int graph[MAX_VERTICES][MAX_VERTICES], int numVertices, int start, int dist[]) {
    int visited[MAX_VERTICES] = {0};

    // Initialize distances
    for (int i = 0; i < numVertices; i++) {
        dist[i] = INF;
    }
    dist[start] = 0;
```

```
Enter the number of vertices: 6
Enter the adjacency matrix (6 x 6):
0 2 4 0 0 0
0 0 1 7 0 0
0 0 0 0 3 0
0 0 0 0 0 1
0 0 0 2 0 5
6 0 0 0 0 0
Enter the start vertex (0 to 5): 0
Shortest paths from vertex 0:
Distance to vertex 0: 0
Distance to vertex 1: 2
Distance to vertex 2: 3
Distance to vertex 3: 8
Distance to vertex 4: 6
Distance to vertex 5: 9
```

CONCLUSION:

DISCUSSION AND VIVA VOCE:

- Explain single source shortest path problem.
- Discuss the greedy method.
- Explain Dijkstra algorithm and its advantages and disadvantage.
- Discuss the complexity of Dijkstra algorithm.

REFERENCES:

- *https://www.geeksforgeeks.org/introduction-to-dijkstras-shortest-path-algorithm/*
- *https://www.javatpoint.com/dijkstras-algorithm*
- *https://www.programiz.com/dsa/dijkstra-algorithm*
- *https://www.w3schools.com/dsa/dsa_algo_graphs_dijkstra.php*