



DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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Experiment-8

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Subject Name: DAA

1. Aim: Develop a program and analyze complexity to find shortest paths in a graph with positive edge weights using Dijkstra's algorithm.

2. Objective: To implement Dijkstra's algorithm in C++ for finding shortest paths from a source vertex to all other vertices in a weighted graph and understand its working and complexity.

3. Procedure:

1. Start

2. Input the number of vertices V and the graph (weighted adjacency matrix).

3. Initialize:

- dist[] array with INFINITE values except for dist[src] = 0
- sptSet[] array (boolean) to keep track of vertices whose shortest distance is finalized

4. Repeat V times:

- Pick a vertex u not in sptSet with the minimum distance value
- Include u in sptSet
- For every adjacent vertex v of u:
 - If v not in sptSet and dist[u] + weight(u,v) < dist[v]
 - Update dist[v] = dist[u] + weight(u,v)

5. After the loop ends, dist[] contains the shortest distance from source to all vertices.

6. Optionally, use a parent array to track the actual shortest paths.

4. Code:

```
#include <iostream>
#include <vector>
#include <climits>
using namespace std;
```



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```
int minDistance(vector<int>& dist, vector<bool>& sptSet, int V){  
    int min = INT_MAX, min_index;  
    for(int v = 0; v < V; v++){  
        if(!sptSet[v] && dist[v] <= min){  
            min = dist[v];  
            min_index = v;  
        }  
    }  
    return min_index;  
}  
int main(){  
    int V;  
    cout << "Enter number of vertices: ";  
    cin >> V;  
    vector<vector<int>> graph(V, vector<int>(V));  
    cout << "Enter adjacency matrix (0 if no edge):\n";  
    for(int i = 0; i < V; i++)  
        for(int j = 0; j < V; j++)  
            cin >> graph[i][j];  
    int src;  
    cout << "Enter source vertex (0 to " << V-1 << "): ";  
    cin >> src;  
    vector<int> dist(V, INT_MAX);  
    vector<bool> sptSet(V, false);  
    dist[src] = 0;  
    for(int count = 0; count < V-1; count++){  
        int u = minDistance(dist, sptSet, V);  
        sptSet[u] = true;  
        for(int v = 0; v < V; v++){  
            if(!sptSet[v] && graph[u][v] && dist[u] != INT_MAX  
                && dist[u] + graph[u][v] < dist[v]){  
                dist[v] = dist[u] + graph[u][v];  
            }  
        }  
    }  
    cout << "Vertex \t Distance from Source\n";  
    for(int i = 0; i < V; i++)  
        cout << i << " \t " << dist[i] << endl;
```



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```
    return 0;  
}
```

5. Observations:

```
Enter number of vertices: 5  
Enter adjacency matrix (0 if no edge):  
0 10 0 30 100  
0 0 50 0 0  
0 0 0 0 10  
0 0 20 0 60  
0 0 0 0 0  
Enter source vertex (0 to 4): 0  
Vertex      Distance from Source  
0            0  
1            10  
2            50  
3            30  
4            60
```

6. Time Complexity:

- Using simple adjacency matrix and linear search for min distance: $O(V^2)$
- Using a min-priority queue / min-heap: $O(E \log V)$

7. Learning Outcome:

- ❖ Learned how to implement Dijkstra's algorithm using C++.
- ❖ Understood the concept of shortest path tree (SPT) and how to select the next vertex.
- ❖ Gained practical experience in updating distances and maintaining a visited set.
- ❖ Strengthened understanding of graph representations (adjacency matrix, adjacency list) and traversal.
- ❖ Learned to analyze the time and space complexity of Dijkstra's algorithm.