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BATCH : CSE DS D1
EXP : DAA - 6

AIM:
Greedy-Approach single source shortest path- Dijkstra's Algorithm

THEORY:
Dijkstra's Algorithm was conceived by computer scientist Edsger W. Dijkstra in 1956. It is a single source shortest paths algorithm. It means that it finds the shortest paths from a single source vertex to all other vertices in a graph. It is a greedy algorithm and works for both directed and undirected, positively weighted graphs (a graph is called positively weighted if all of its edges have only positive weights).
In this algorithm each vertex will have two properties defined for it-
• **Visited property**:-
• This property represents whether the vertex has been visited or not.
• We are using this property so that we don't revisit a vertex.
• A vertex is marked visited only after the shortest path to it has been found.
• **Path property**:-
• This property stores the value of the current minimum path to the vertex. Current minimum path means the shortest way in which we have reached this vertex till now.
• This property is updated whenever any neighbour of the vertex is visited.
• The path property is important as it will store the final answer for each vertex.

ALGORITHM :

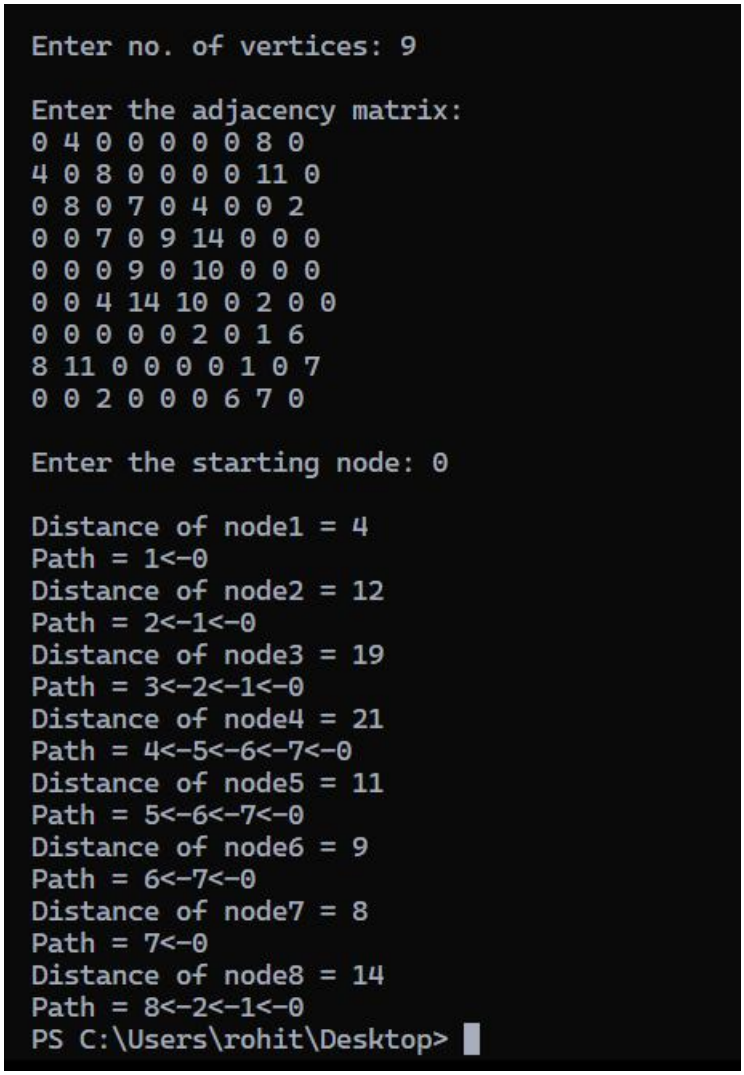
1. Create cost matrix C[ ][ ] from adjacency matrix adj[ ][ ]. C[i][j] is the cost of going from vertex i to vertex j. If there is no edge between vertices i and j then C[i][j] is infinity.
2. Array visited[ ] is initialized to zero. for(i=0;i<n;i++)
visited[i]=0;
3. If the vertex 0 is the source vertex then visited[0] is marked as 1.
4. Create the distance matrix, by storing the cost of vertices from vertex no. 0 to n-1 from the source vertex 0.
for(i=1;i<n;i++) distance[i]=cost[0][i];
Initially, distance of source vertex is taken as 0. i.e. distance[0]=0;
5. for(i=1;i<n;i++)
– Choose a vertex w, such that distance[w] is minimum and visited[w] is 0. Mark visited[w] as 1.
– Recalculate the shortest distance of remaining vertices from the source.
– Only, the vertices not marked as 1 in array visited[ ] should be considered for recalculation of distance. i.e. for each vertex v
if(visited[v]==0)
distance[v]=min(distance[v],
distance[w]+cost[w][v])

PROGRAM :

```
#include<stdio.h>
#include<stdlib.h>
#define INFINITY 9999
#define MAX 10

void dijkstra(int G[MAX][MAX],int n,int startnode)
{
int cost[MAX][MAX],distance[MAX],pred[MAX];

int visited[MAX],count,mindistance,nextnode,i,j;
//pred[] stores the predecessor of each node
//count gives the number of nodes seen so far
//create the cost matrix
for(i=0;i<n;i++)
for(j=0;j<n;j++)
if(G[i][j]==0)
cost[i][j]=INFINITY;
else
cost[i][j]=G[i][j];
//initialize pred[],distance[] and visited[]
for(i=0;i<n;i++)
{
distance[i]=cost[startnode][i];
pred[i]=startnode;
visited[i]=0;
}
distance[startnode]=0;
visited[startnode]=1;
count=1;
while(count<n-1)
{
mindistance=INFINITY;
//nextnode gives the node at minimum distance
for(i=0;i<n;i++)
if(distance[i]<mindistance&&!visited[i])
{
mindistance=distance[i];
nextnode=i;
}
//check if a better path exists through nextnode
visited[nextnode]=1;
for(i=0;i<n;i++)
if(!visited[i])
if(mindistance+cost[nextnode][i]<distance[i])
```

```
{
distance[i]=mindistance+cost[nextnode][i];
pred[i]=nextnode;
}
count++;
}

//print the path and distance of each node
for(i=0;i<n;i++)
if(i!=startnode)
{
printf("\nDistance of node%d = %d",i,distance[i]);
printf("\nPath = %d",i);
j=i;
do
{
j=pred[j];
printf("<-%d",j);
}while(j!=startnode);
}
}

int main()
{
int G[MAX][MAX],i,j,n,u;
printf("\n\t--DIJKSTRA'S ALGORITHM--");
printf("\n\nEnter no. of vertices: ");
scanf("%d",&n);
printf("\nEnter the adjacency matrix: \n");
for(i=0;i<n;i++)
for(j=0;j<n;j++)
scanf("%d",&G[i][j]);
printf("\nEnter the starting node: ");
scanf("%d",&u);
dijkstra(G,n,u);
return 0;
}
```

OUTPUT :



RESULT ANALYSIS:

Time for visiting all vertices =O(V)
Time required for processing one vertex=O(V)
Time required for visiting and processing all the vertices = O(V)*O(V) =O(V^2)
So the time complexity of dijkstra's algorithm using adjacency matrix representation comes out to be **O(V2)**
With this implementation, the time to visit each vertex becomes O(V+E) and the time required to process all the neighbours of a vertex becomes O(logV).
Time for visiting all vertices =O(V+E)
Time required for processing one vertex=O(logV)
Time required for visiting and processing all the vertices = O(V+E)*O(logV) = O((V+E)logV)
The space complexity in this case will also improve to **O(V)** as both the adjacency list and min-heap require **O(V)** space. So the total space complexity becomes O(V)+O(V)=O(2V) = O(V)
.

CONCLUSION :

In this experiment I uderstood about the greedy approach- dijkistra's algorithm to find the shortest path from a single source vertex