COP290 - Design Practices

Assignment-2
Subtask 2 Report

Student 1 = Ritika Hooda
Entry number - 2018CS10375

Student 2 = Pragya Dechalwal
Entry Number -2018CS10366

Simulation Problem

This is the story of "**Dora-The explorer**" .She loves to solve riddle and explore.In our game Dora is in search of a treasure and that treasure is hidden in the 6 wonder rooms in the maze .She has a backpack with her,in which there is map which stores the location of all 6 wonder rooms .She also has her previous treasures hidden in her house and there are looters surrounding her house and for every step she takes ,money in her treasure is being looted .Dora wants to visit all the 6 wonder rooms and collect the treasure in the least steps possible.

Mapping to theory problem

We can map the above problem statement to the Steiner Minimal Tree (SMT) problem.

Consider the six cells(6 wonder rooms) of the maze as terminal nodes and an edge in a tree T has cost equal to 1 and the cost between two nodes is the number of edges between them.We want to find an algorithm that covers all the six cells with a minimum cost.

Approach

1.Our Dora is entering the maze from the top left corner.We will use Dijkstra's shortest path algorithm to find the shortest path from the left corner cell to the 6 wonder rooms and whichever is closest,Dora will first reach that wonder room and collect her treasure.

2.When Dora is at the first wonder room , again using Dijkstra's shortest path algorithm we find the wonder room with minimum cost(distance) and our dora will reach that second wonder room and will collect her treasure.

3.We will repeat the above steps and Dora will finally reach the last wonder room and will collect her final treasure and then we hear Dora saying "**Count with me: uno, dos, tres. We did it!**"

Algorithm

We will implement the above approach as follows-

In the above problem

1.We will start with a subtree T consisting of one given terminal vertex

2). While T doesn't have all the terminals

A. By Dijkstra's shortest path algorithm ,Choose a terminal t which is closest to the vertex in T but currently not in T.
B. Now after finding t,add the shortest path that connects x with T to T.

Data Structures used.

1.An array to store the terminal node .

2.2d Array for storing included edges.

3.An array to store the minimum distance for all t which is not in T.

4.Adjacency List and Priority queue for Dijkstra’s shortest path algorithm.

Implementation plan

Here we need to form an MST "T" that contains all the given terminals (vertices).MST T can also include other needed nodes.Array T[ ] will store the vertices in T.Initially T does not contain any vertices.Take the input of terminal nodes T_i[ ] and the whole graph.Make an array output[ ] which stores the vertices and an 2d array edges[ ][ ] to store the edges of the minimum steiner tree.Start with the closest terminal node add it to T[ ] and output[ ] .While T[ ] does not have all the nodes of T_i[ ] run the loop.Inside the loop Run Dijkstra’s shortest path algorithm and find the terminal node which is not in T[ ] but present in T_i[ ] and is at minimum distance from the nodes of T[ ].Add the intermediate nodes and the new terminal node found to the output[ ] and add the corresponding edges to edges[ ][ ] .When every terminal node is present in T[ ] while loop stops and return the T[ ] and edges [ ][ ].

Runtime analysis of above algorithm

We know that the runtime of Dijkstra’s shortest path algorithm is O(**(N+E) log N**) where E is the number of edges and N is the number of vertex .In the above algorithm we are running Dijkstra’s Time complexity 6 times ,if the number of terminal nodes is not fixed .Than let it be k then the runtime of above algorithm will be **O(k(N+E) log N).**

Correctness of above algorithm

For proving the correctness of the above algorithm we need to prove the below statement.

Statement : Above algorithm will help dora to cover all the wonder rooms with minimum steps possible.

Proof: Dora will start from the left upper corner of the maze and using Dijkstra’s shortest path algorithm , we will know the wonder room(terminal node) which is closest to the entry node.After reaching the first wonder room (terminal node) we are again using Dijkstra’s shortest path algorithm to find the next terminal which is closest to first terminal so that the number of steps taken by Dora can be minimum and we repeat this process until we reach the last wonder room.Since at every terminal point Dora took the minimum steps possible for moving to next terminal point,so the total number of steps taken should also be minimum.Also the algorithm won't stop until dora visits every wonder house.So we can say that the above algorithm will help dora to cover all the wonder rooms with minimum steps possible

Simulation:

a).Our game starts with Dora on the upper left corner of the maze and looters at her house . Then a sound of a map comes “ *If there’s a place you wanna go I’m the one you need to know. I’m the Map! I’m the Map! I’m the Map!*”.

b).On clicking enter ,the map will show the positions of all the six rooms.

c)Every time the maze and position of wonder rooms will differ due to the maze creation algorithm.

d).After that backpack introduces itself and a sound comes " *I'm a backpack loaded up with things and knickknacks too. Anything that you might need I've got inside for you*".

e).After all this Dora starts walking towards the wonder rooms one by one and on reaching the wonder room she dances with happiness and a happy sound will come and a window will pop - up with "*Great! You found it!*".

f)When Dora reaches the last wonder room and collects every treasure ,a very cheerful sound comes and a celebration window opens with sparkle and lights and "**Count with me: uno, dos, tres. We did it!**" written on it.

g)If this happens the player wins otherwise the player loses.

Resources used:-

https://www.geeksforgeeks.org/steiner-tree/#:~:text=Spanning%20Tree%20vs%20Steiner%20Tree,becomes%20Minimum%20Spanning%20Tree%20problem.

https://github.com/rkarthik3cse/Steiner-Tree-in-Graph/blob/master/Steiner%20Tree.c

https://futureofworking.com/7-dora-the-explorer-sayings/