Application Of Graph Theory To Find Optimal Path And Minimized Time For The Transportation Problem

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Abstract- Graph theory is used to model many types of relations and process in real world network systems such as internet, power grids, telephone, transportation, affiliation networks, food webs, electricity, water and so on. Many practical problems can be represented by graphs. In this paper we study about finding minimum spanning tree and the shortest distance between two place using algorithms. We have developed a network model to find the minimum distance and the minimum time of transporting a product from place A to place B through an airline.

Index Terms- Spanning tree, vertices, edges, algorithms, place, distance, time.

I. INTRODUCTION TO GRAPH THEORY

A graph G is defined as a set of vertices called nodes „V" which are connected by edges called links „e". Thus $G = (V, e)$. A vertex (node) v is an intersection point of a graph. It denotes a location such as city, an airport intersection or a transport terminal (stations, harbours and road).A edge „e" is a link between two vertices (nodes). Transport geography can be defined by a graph. Most networks, namely airport, transit and rail networks are defined more by their link (edge) than by nodes (vertex). In this paper graphs are finite, simple, connected and undirected graph.

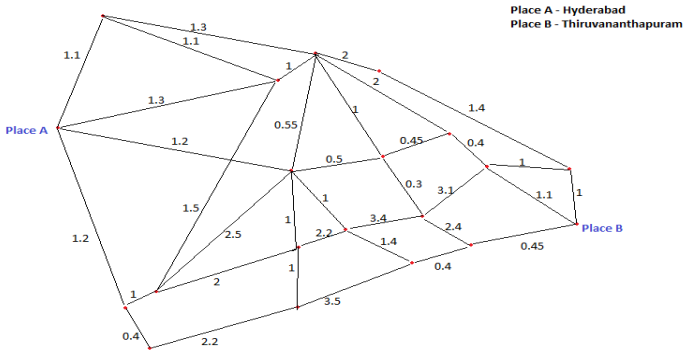

Figure 1: Connected Graph

There are different ways to reach from place A to place B. Here we find the shortest distance between A to B with minimum time.

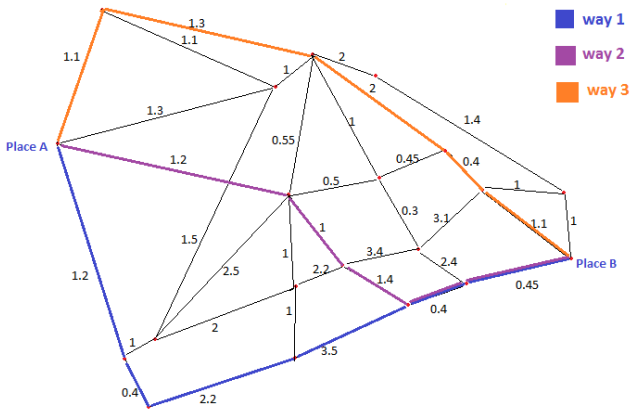

Figure 2: Different ways to reach place A to place B

Here we can find three different ways to reach the places from place A to place B.

II. MINIMUM SPANNING TREE [MST]

A minimum spanning tree for a weighted, connected and undirected graph is a spanning tree with weight less than or equal to the weight of every other spanning tree. The weight of a spanning tree is the sum of weights given to each edge of the spanning tree.

III. KRUSKAL'S ALGORITHM

Spanning tree to find the shortest distance between to two places from A to B.

Step 1: Remove all loops and parallel edges

Step 2:Arrange all the edges in ascending order of timing in hours. Step 3: Add edges with least weight.

IV. MINIMUM SPANNING TREE [MST] USING KRUSKAL'S ALGORITHM

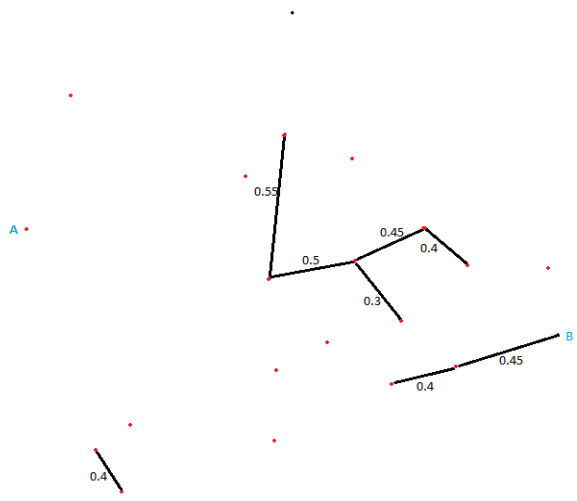

Figure 3: Minimum Spanning tree for 0<1

In this paper the minimum spanning tree for the given graph is described by several figures. First we will start to put the edges in their place A starting from the shortest timing to the highest timing to the place B. Here we taken the timing as hours and we find a condition that 0<1 that is we consider the timing from 0 to 0.9 for the given figure.

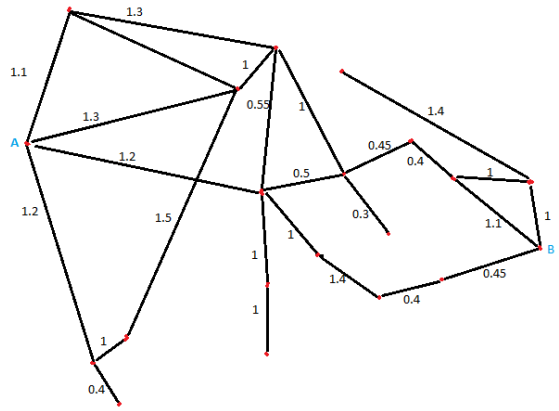

Figure 4: Minimum spanning tree for 1<2

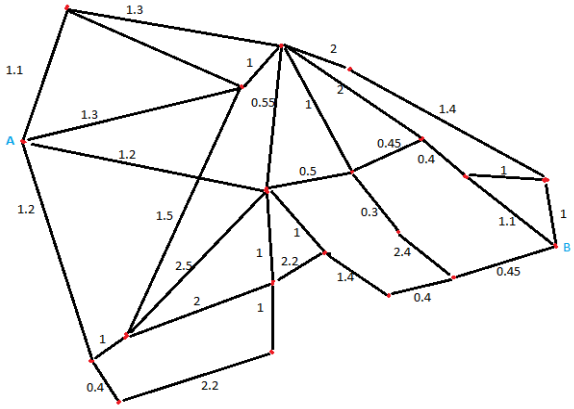

Figure 5: Minimum spanning tree for 2<3

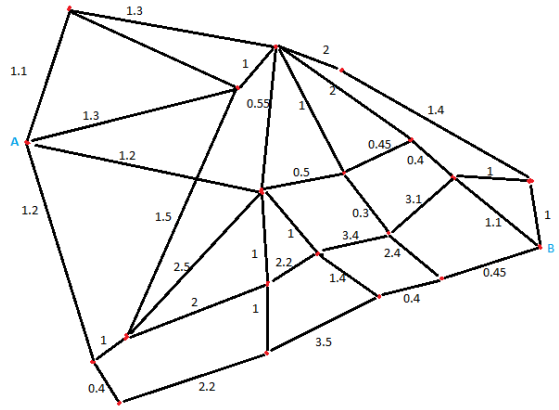

Figure 6: MST

In this above figure we have find the minimum spanning tree which it doesn't form a cycle. Since a tree is acyclic in nature. Applying this algorithm to all the edges, we obtain a minimum spanning tree as shown in the figure 6.

V. MINIMUM TIME PATH [MTP]

From the minimum spanning tree as shown in the figure, we find the minimum time from place A to place B.

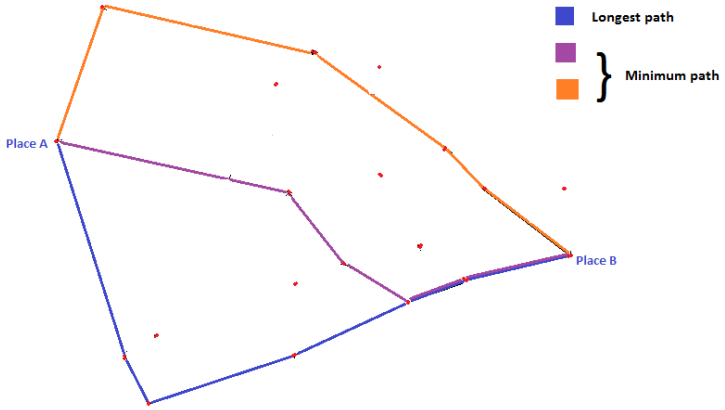

Figure 7

1) First option - To calculate the time from place A to place B (orange full line), the result is:

δ = 1.1+1.3+2+0.4+1.1=5.9 hrs (orange line)

2) Second Option (purple line)

δ =1.2+1+1.4+0.4+0.45=4.45 hrs (purple line)

3) Third Option (blue line)

δ = 1.2+0.4+2.2+3.5+0.4+0.45=8.15 hrs (blue line)

The second option represents the minimum time path from place A to place B (Hyderabad to Thiruvananthapuram).

VI. COMPLEXITY

We consider all the three options and we observe that third option has the longest path so we are not considering the third option. Here we compare the two paths with the MST and minimum time path. We choose the second option because it covers minimum time of 4.45 hrs than 5.9 hrs. The minimum time path is denoted by purple line in figure 7.

VII. PRIM'S ALGORITHM

By using Prim's Algorithm we are able to find the shortest distance from a vertex (place A) to all other vertices to place B.

In this paper the MST for the given case is described by following figures. First we start from place A, which is chosen as permanent and assign its value 0. Assign the time (hours) of the neighbourhood vertices of the place A, to find the shortest path to vertex 2 which is equal to 1.4. Now vertex 2 is chosen as permanent and check the distance from vertex 2 to the neighbour vertices, to each neighbour vertex is add the time of the permanent vertex.

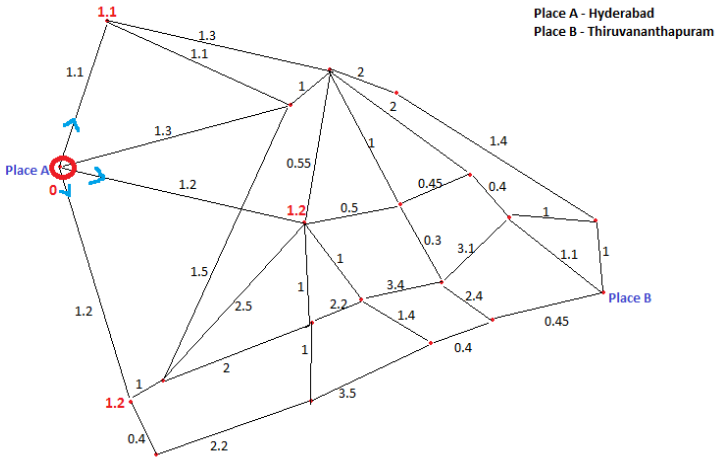

Figure 8: Minimum Path

From vertex A we start to find the values of each vertex ⇒ 0 + 1.1 = 1.1;

0 + 1.2 = 1.2;

0 + 1.2 = 1.2.

This process is repeated for each vertex respectively.

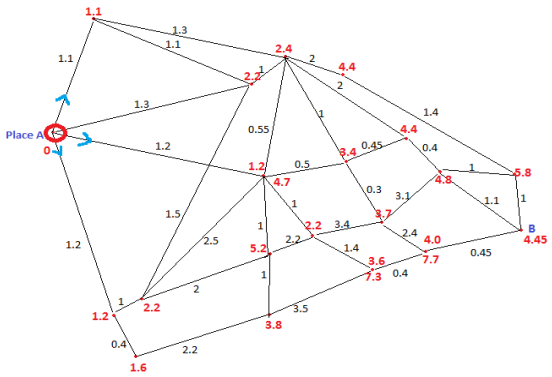

Figure 9: Minimum Path

Finally we find all the values of the vertices in minimum spanning tree with shortest time of 4.45 hours.

VIII. MINIMUM PATH BETWEEN VERTICES OF PLACE A TO PLACE B

Now we are going to find the shortest path from vertex A to vertex B, for every adjacent vertex v, if weight of edge u-v is less than the previous value of v and then update the value as weight of u-v.

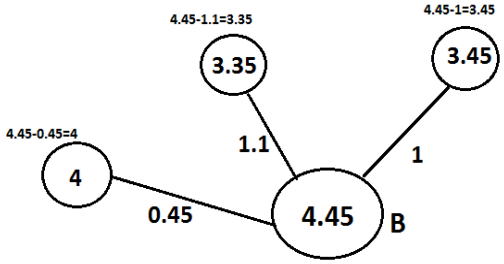

Figure 10

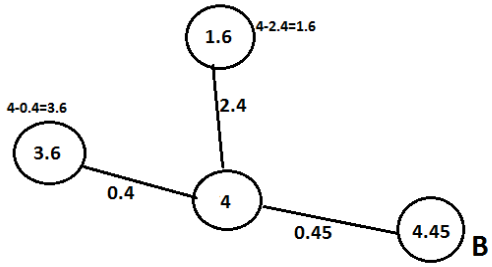

Figure 11

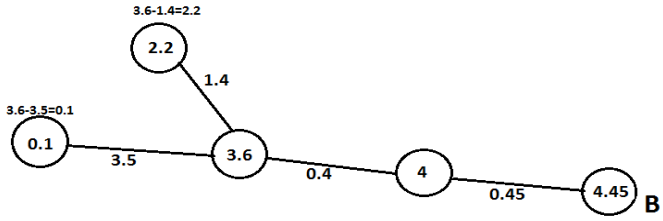

Figure 12

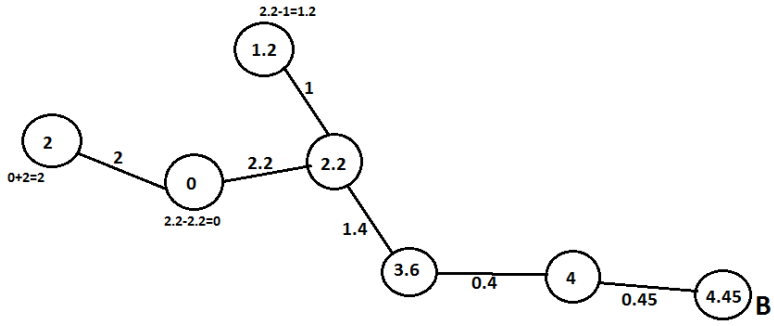

Figure 13

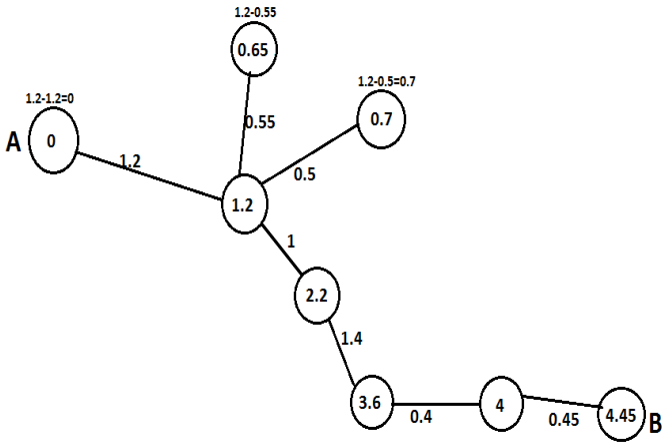

Figure 14

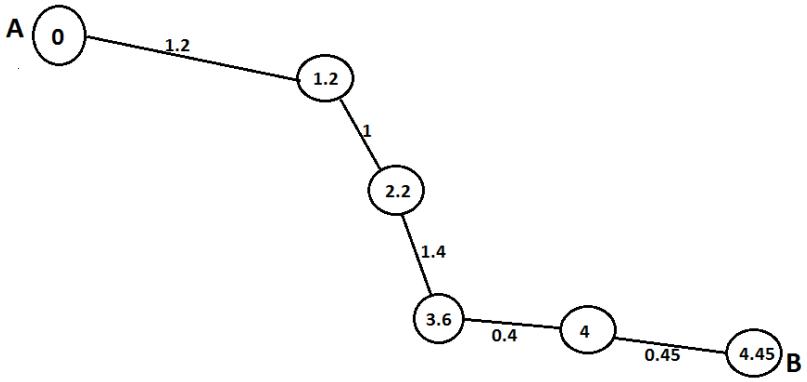

Figure 15

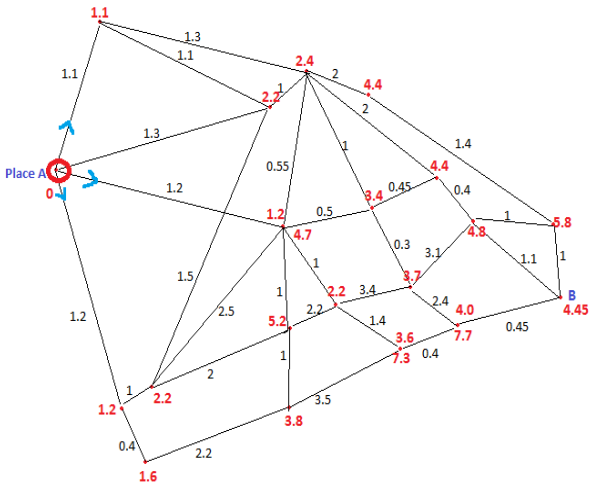

Figure 16

The above figure16 shows the minimum time path from place A to B.

IX. APPLICATIONS

Applications of Kreskas's algorithm are **landing cables, TV Network and Tour operations.**

Example: Most of the cable network companies use the Disjoint Set Union data structure in Kruskal's to find the shortest path to lay cables across a city or group of cities.

X. CONCLUSION

The results obtained from both the algorithms shows that Prim's Algorithm is very effective to find the shortest time from vertex A to vertex B. Similarly we obtain a minimum spanning tree by using Kruskal's Algorithm, in this case we find a MST to reach vertex B to vertex A with minimum time.

As a result of shortest time we have obtained a minimum time of 4.45 hours in Hyderabad to Thiruvananthapuram.

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