Application of Graph Theory in Transportation Problem

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ABSTRACT

Graph Theory Is A Branch Of Mathematics Which Has Wide Application In Other Area Of Mathematics As Well As In Other Branches Of Science. It Also Plays Significant Role In Our Everyday Life. This Article Is Discussed On The Application Of Graph Theory In Our Day To Day Life And Various Fields Of Science. This Article Mainly Deals With How Graph Theory Is Used In Transportation Problem.

Keywords : Eulerian Graph, Hamiltonian Graph, Network, Transportation Problem

I. INTRODUCTION

Graph theory is a branch of Discrete Mathematics. Graph theory is the study of graphs which are mathematical structures used to model pair wise relations between objects. A graph is made up of vertices V (nodes) and edges E (lines) that connect them. A graph is an ordered pair G= (V, E) consisting a set of vertices V with a set of edges E. Graph theory is originated with the problem of Koinsberg bridge, in 1735. This problem escort to the concept of Eulerian Graph. Euler studied the problem of Koinsberg Bridge and established a structure to resolve the problem called Eulerian graph. In 1840, A.F Mobius presented the idea of complete graph and bipartite graph and Kuratowski proved that they are planar by means of recreational problems. The concept of tree, a connected graph without cycles was enacted by Gustav Kirchhoff in 1845, and he enrolled graph theoretical ideas in the calculation of currents in electrical networks or circuits. In 1852, Thomas Gutherie established the famous four color problem. Then in 1856, Thomas. P. Kirkmanand William R.Hamilton measured cycles on polyhydra and contrived the concept called Hamiltonian graph by studying trips that visited certain sites exactly once [5]. In 1913, H.Dudeney mentioned a puzzle problem. Eventhough the four color problem was invented it was solved only after a century by Kenneth Appel and Wolfgang Haken [6]. This is considered as origin of Graph Theory.

Euler Path

A Euler path is a simple path in a graph which visits every edge of the graph exactly once.

Euler circuit
Euler Circuit is a circuit in graph G which traverses every edge of graph exactly once. Euler Circuit is simply a closed path and called as Euler line.

Eulerian Graph
A graph which contains either Euler Path or Euler Circuit is called Eulerian Graph.

Hamiltonian Path
A Hamiltonian Path in aconnected graph is a path which contains eachvertex of graph exactly once.

Hamiltonian Circuit
A Hamiltonian circuit is a circuit that contains each vertex of graph exactly once except for the first vertex, which is also the last.

Hamiltonian Graph
A graph which possesses either Hamiltonian circuit or Hamiltonian path iscalled a Hamiltonian graph.

Application of Graph Theory in Everyday Life
There are many application of Graph theory in everyday life. In which few applications are mentioned below:

Application in GPS or Google Maps
GPS or Google Maps are to find a shortest route from one destination to another. The destinations are Vertices and their connections are Edges consisting distance. The optimal route is determined by the software. Schools/ Colleges are also using this technique to pick up students from their stop to school. Each stop is a vertex

and the route is an edge. A Hamiltonian path represents the efficiency of including every vertex in the route.

Application in Traffic lights
The functioning of traffic lights i.e. turning Green/Red and timing between them. Here vertex coloring technique is utilized to solve conflicts of time and space by identifying the chromatic number for the number of cycles needed.

Application in Social Networks
We connect with friends via social media or a video gets viral, here user is a Vertex and other connected users create an edge therefore videos get viral when reached to certain connec*t*ions.

Application to clear road blockage
When roads of a city are blocked due to ice.Planning is needed to put salt on the roads. Then
Euler paths or circuits are used to traverse the streets in the most efficient way.

Application of Graph Theory in Science
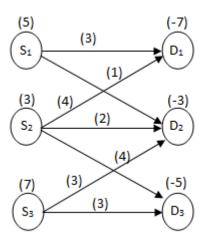
Application in Biology
Graph Theory is used in many areas of Biology. The concept of graph theory can also be used in studying the structure of DNA and RNA. If we want to study the food chain of different animals in an ecological system, then we draw some arrow diagrams which represent the dependence of one animal upon another for their food. This diagram can be considered as graph where the animals are vertices of graph and they must be connected if any one of them depends on other for food.

Application in Operation Research
Graph theory provides many useful applications in OR. A graph is defined as a finite number of points (known as nodes or vertices) connected by lines (known as edges or arcs).

A network called transport network where a graph is used to model the transportation of commodity from one place to another's the objective is to maximize the flow or minimize the cost within the prescribed flow.

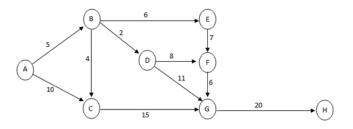The network model of the transportation problem is shown in the below figure

The sources are identified as the nodes (vertices) on the left and destinations on the right.

In the figure a positive external flow indicates supply flow entering the network and a negative external flow indicates supply flow leave the network.

For example

To calculate the distance from node A to node H.

First option
  Path=A+B+E+F+G+H =5+6+7+6+20 =44 units

Second option
  Path= A+B+D+F+G+H = 5+2+8+6+20=41 units

Third option:
  Path= A+B+D+G+H = 5+2+11+20 = 38 units

Fourth option
  Path= A+B+C+G+H =5+4+15+20 = 44 units

Fifth option
  Path= A+C+G+H = 10+15+20 = 45 units

Therefore third option represents the minimum cost path from node A to node H.

II. CONCLUSION

The objective of this paper is to investigate application of graph theory in science and everyday life. This paper is valuable for students and researches to get the overview of graph theory and its application in various fields like everyday life, Operation Research, Biology. There are many problems in this area which are yet to be examined.

III. REFERENCES

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