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Applications of Graph Theory in Computer Science, Network Theory and Scheduling – An overview

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ABSTRACT

This article highlights on few applications of graph theory which occurs in our daily life and different branches of science such as computer science (algorithms), Network Theory (communication networks) and operation research (scheduling) etc. that can uses concepts of graphs to analyse and find the solution to the problem.

Key Words: Computer Science, Graph Theory, Network Theory, Scheduling

INTRODUCTION

The beginning of Graph theory was in the year 1736, when considering the Konigsberg Bridge problem, Is there a walk which crosses all seven Konigsberg's bridges exactly once? Euler demonstrated that walking through all of the Kongsberg bridges exactly once and returning to the initial point is impossible. The concept of Eulerian cycle was introduced from there on. Hamilton in 1857 created a game based on the dodecahedron graph. This game introduces the concept of Hamiltonian graphs, which now has numerous applications for obtaining the shortest paths between cities, i.e. a travelling salesman problem. Given the fact that the four-color problem was invented, it took a century to solve it, finally two American Mathematicians Kenneth Appel and Wolfgang Haken have solved it. The Applications of Graph Theory have been studied by many researchers in Computer Science and Engineering [3, 4, 7]. The applications of Graph Theory are numerous in computer science, Network Theory and Operation Research, few of them are represented below:

APPLICATIONS OF GRAPH THEORY IN COMPUTER SCIENCE

Designing of chips in a Computer: The chips are connected by wires in an electrical network as a part of the component in a computer. These integrated circuits(IC) which are connected by the billions of transistors are designed in a most efficient way by using graph theory algorithms and here we can consider the IC chip as vertices and the wires connecting them as edges.

Network Security in Computers: A detail study and practical approach on "Network security using graph theory" has been discussed by [1]. At the Virology and Cryptology Lab and the French Navy, ESCANSIC a team of Scientists in Computers which is led by the Eric Filiol have recently applied the vertex cover algorithm to simulate the spread of secrecy worms on enormous computer networks and designed the optimum plans for guarding the network against such virus attacks in real-time[6]".

Web Designing:
"Website designing may be structured as a graph, where the web pages are entitled by vertices and the hyperlinks between them are entitled by edges in the graph. This concept is called as a web graph[2,7]".

APPLICATIONS OF GRAPH THEORY IN NETWORK THEORY

Networks for Flights: In this world everything is linked, as an example the cities are linked by roads, rail and flight networks. The numerous cities of the world are joined by the airlines to move from one country to another by the most efficient way and to avoid air crashes and air traffic congestions with the use of different algorithms. To analyse, optimize these networks many researchers are using Graph theory as a tool to understand it better and find the solution to the existing problems by using the basic concepts of graph theory and the cities can be considered as

vertices and roads, rail tracks can be considered as edges or lines. To find the optimal solution different algorithms are used for network problems like Prim's Algorithm, Kruskal's Algoritm and Dijkstra's Algorithm.

Road Networks: The Intelligent transportation system can be developed by means of a graph and for reducing the traffic congestion different algorithms are used in order to travel faster by avoiding accidents on roads.

Information Networks: A web graph is used by search engines to identify all of the information on a web that could be related to a specific search so when a person type to search a particular item or choose to collect anything in particular which he wants to search a web graph is used to collect all the web pages that have information about that particular subject.

GRAPH THEORYIN OPERATION RESEARCH (OR):

Graph theory is playing adominantrole in operations research. Few essential OR problems that can be answered by means of graphs are mentioned at this point. A network called transport network where a graph is applied to model the transportation of a product from one place to another. The aim is to maximize the flow or minimize the cost within the recommended flow. The constraints are more, even though the approach of graph theory is found to be effective for these kinds of problems [5,8]. There are several applications for the shortest path algorithms of a weighted graphs.

The weight on an edge represents distance (or cost) and the shortest path is just the shortest (or cheapest) route between the two points. Another area of application to weighted digraphs, where the arcs represent tasks which must be performed in a particular demand and the weight of an arc represents the time need to carry out the task. The problem is to find the order in which the tasks should be undertaken in order that they all be completed in the shortest possible time[9]. Digraphs and networks have bloomed not only in mathematics branch but also in methodical tools in operations research [10].

A directed network **is a digraph with an integer weight attached to each arc.**
Three different types of such "scheduling problems" are given below.

Timetable Scheduling: Suppose we offer numerous classes to conduct but a few number of classrooms are available. Some classes cannot be offered at the same time because the same teacher teaches the subjects. What is the smallest number of classrooms required for the following?

We can construct the graph depending upon the constraints or conflicts between any two subjects which cannot be taught at the same time and the concept of vertex coloring algorithm can be used to find the least number of classes required for conducting classes without any clashes.

The Optimum Assignment Problem: Let us say there are three jobs for the three persons who can do these jobs, to carry out these jobs it cost something to allocate these people. There are an equal no. of jobs and people at the end these jobs has to be allocated in such a means that each person gets only one job i.e. there is one to one assignment how to perform this task at minimum cost is called the assignment problem. The aim is to lessen the total cost of assignment or total cost of allocation.

Airline Scheduling: A graph is another name for a network, network is made up of nodes(locations in the network) and arcs the connections between nodes and for airline, nodes are airports (locations) at a particular time and arcs or edges are flights and their connections between airports are arcs. In the airline industry, we are always dealing with the directed graphs in which the weights are associated with edges and these weights are the cost or the time to travel. Consider the problem of moving an individual from one origin to the destination, we must know the quickest or the cheapest journey possible, to achieve this, we use shortest path algorithms, these algorithms existed in 1960, and we use them every day in public transport planning website to calculate the best public transport journey between two locations.

CONCLUSION

The objective of this paper is to present the significance of graph theoretic concepts in everyday problems and an overview is articulated to highlight the graph theory notions and also it is beneficial for researchers to get an idea of graph theory and its practical applications in different areas such as Computer Science, Network Theory, Operation Research etc. to have an idea connected with their field of exploration. There are several problems in these areas which are unsolved and to be examined for getting the optimized solutions with a suitable algorithm as per the situations.

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