

Applications On Graph Theory.

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Abstract

The field of mathematics plays very important role in different fields. One of the important areas in mathematics is graph theory which is used in structural models. This structural preparations of various objects or technologies direct to new inventions and modifications in the existing environment for development in those fields. The field graph theory started its journey from the problem of Konigsberg bridge in 1735. This paper gives an overview of the applications of graph theory in various fields to some extent but mainly focuses on the computer discipline applications that uses graph theoretical concepts. A variety of papers based on graph theory have been studied related to scheduling concepts, computer science applications and an overview has been presented here.

Keywords: Bipartite graph, Geometric spanner, Median graph

Introduction

Graph theoretical ideas are extremely utilized by computer discipline applications. particularly in research areas of computer discipline such data mining, image segmentation, clustering, image capturing, networking etc., For example a data structure can be designed in the form of tree which in turn utilized vertices and edges. Similarly modeling of network topologies can be done using graph concepts. In the same way the most important concept of graph coloring is utilized in resource allotment, setting up. Also, paths, walks and circuits in graph theory are used in wonderful applications say traveling salesman problem, database design concepts, resource networking. This leads to the development of new algorithms and new theorems that can be used in tremendous applications. This paper has been divided into two sections. First part I gives the

historical background of graph theory and some applications in setuping. Second part emphasizes how graph theory is utilized in various computer applications.

Part – I

History

1.The origin of graph theory started with the problem of Koinsber bridge, in 1735. Euler studied the problem of Koinsberg bridge and constructed a structure to solve the problem called **Eulerian graph**.

2. In 1840, A.F Mobius gave the idea of complete graph and bipartite graph and Kuratowski proved that they are planar by means of recreational problems.

3.The concept of tree, which is a **connected graph without cycles** was implemented by Gustav Kirchhoff in 1845, and he employed graph theoretical ideas in the calculation of currents in electrical networks or circuits.

4.In 1852, Thomas Gutherie found the famous four color problem.

5.In 1856, Thomas. P. Kirkman and William R.Hamilton studied cycles on polyhydra and invented the concept called **Hamiltonian graph** by studying trips that visited certain sites exactly once.

5.In 1913, H.Dudeney mentioned a puzzle problem.

6.Eventhough the four color problem was invented it was solved only after a century by Kenneth Appel and Wolfgang Haken.

7. Caley studied particular analytical forms from differential calculus to study the trees. This had many implications in theoretical chemistry. This lead to the invention of enumerative graph theory.

8.The term “Graph” was introduced by Sylvester in 1878 where he drew an analogy

between “Quantic invariants” and co-variants of algebra and molecular diagrams.

9. In 1941, Ramsey worked on colorations which lead to the identification of another branch of graph theory called **extremal graph theory**.

10. In 1969, the four color problem was solved using computers by Heinrich. The study of asymptotic graph connectivity gave rise to random graph theory.

Applications :

Graph theoretical concepts are widely used to study and model various applications, in different areas.

They are

1. study of molecules,
2. construction of bonds in chemistry and the study of atoms.
3. graph theory is used in sociology
4. It is used in biology
5. Graph theoretical concepts are widely used in Operations Research.
6. It is also used in modeling transport networks, activity networks and games.
7. It is used in computational biochemistry.

In briefly, graph theory has its unique impact in various fields and is growing large now a days. The subsequent section analyses the applications of graph theory especially in computer science.

Algorithms and graph theory:

The most important role of graph theory in computer applications is the growth of graph algorithms. several algorithms are used to solve problems that are modeled in the form of graphs. These algorithms are used to solve the graph theoretical concepts which intern used to solve the corresponding computer science application problems.

Some algorithms are as follows:

1. Shortest path algorithm in a network
2. Finding a minimum spanning tree
3. Finding graph planarity
4. Algorithms to find adjacency matrices.
5. Algorithms to find the connectedness
6. Algorithms to find the cycles in a graph
7. Algorithms for searching an element in a data structure (DFS, BFS) and so on.

Use of graph enumeration techniques:

Graph enumeration technique is used to identify the computerized chemical identification. The list of all distinct chemical structures will be generated based on the given chemical formula and the valence rules for any new substance. To identify the chemical compounds automatically, a computer language called DENDRAL has been developed.

Graph Theory in OR:

Graph theory is a very natural and powerful tool in combinatorial operations research. Some important OR problems that can be solved using graphs are given here. A network called transport network where a graph is used to model the transportation of commodity from one place to another. The objective is to maximize the flow or minimize the cost within the prescribed flow. The graph theoretic approach is found more efficient for these types of problems though they have more constraints .

Graph Coloring:

Graph coloring is one of the most vital concepts in graph theory and is used in many real time applications in computer science. Various coloring methods are available and can be used on necessity basis. The proper coloring of a graph is the coloring of the vertices and edges with minimal number of colors such that no two vertices should have the same color. The minimum number of colors is called as the

chromatic number and the graph is called **properly colored graph**.

Precoloring extension:

In certain scheduling problems, the assignments of jobs are already decided. In such cases precoloring technique can be adopted. Here some vertices of the graph will have preassigned color and the precoloring problem has to be solved by extending the coloring of the vertices for the whole graph using minimum number of colors.

List coloring:

In list coloring problem, each vertex v has a list of available colors and we have to find a coloring where the color of each vertex is taken from the list of available colors. This list coloring can be used to model situations where a job can be processed only in certain time slots or can be processed only by certain machines.

Minimum sum coloring:

In minimum sum coloring, the sum of the colors assigned to the vertices is minimal in the graph. The minimum sum coloring technique can be applied to the scheduling theory of minimizing the sum of completion times of the jobs. The multicolor version of the problem can be used to model jobs with arbitrary lengths. Here, the finish time of a vertex is the largest color assigned to it and the sum of coloring is the sum of the finish time of the vertices. That is the sum of the finish times in a multicoloring is equal to the sum of completion times in the corresponding schedule.

Part II:

This section explores the applications of graph especially in computer science . Various applications that deal with computers are using graph theory concepts.
Some Applications:

1. **Map coloring and GSM mobile phone networks**
2. **Graph algorithm in computer network security**
3. **Graph theory relevant to ad-hoc networks**
4. **A graph model for fault tolerant computing systems**
5. **The optimal k-FT single loop system**
6. **Automatic channel allocation for small wireless local area networks using graph coloring algorithm approach**
7. **Clustering of web documents using graph model**
8. **Modeling sensor networks as graph.**

Conclusion:

The main aim of this paper is to present the importance of graph theoretical ideas in various areas of compute applications for researches that they can use graph theoretical concepts for the research. An overview is presented especially to project the idea of graph theory. So, the graph theory section of each paper is given importance than to the other sections. Researches may get some information related to graph theory and its applications in computer field and can get some ideas related to their field of research.

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