Research Paper E-ISSN NO : 2455-295X | VOLUME : 4 | ISSUE : 12 | DECEMBER 2018

GRAPH THEORY & ITS APPLICATIONS IN SCIENCE: AN OVERVIEW

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ABSTRACT

Mathematics is composed of a number of areas each having their own distinct characteristics. Graph Theory is one among the area which is becoming popular. Graph Theory is the study of graphs which allow us to picturize the data and helps us to simplify the complex structure of the data. This structural arrangement of various objects or technologies leads to new inventions and modifications in the existing environment for enhancement of graph theory. In recent years, graph theory has established itself as an important mathematical tool in variety of subjects ranging from operation research and chemistry to sociology and architecture. This paper describes the description of graph theory and its application.

KEYWORDS: GRAPHS, DIRECTED GRAPH, BIPARTITE GRAPH, BINARY TREE, VERTEX COLORING.

1. INTRODUCTION

Graphs provide a convenient way to represent various kinds of mathematical objects. Essentially, any graph is made up of two sets:

1- A set of vertices

2- A set of edges

Depending on the particular situation, restrictions are imposed on the type of edges we allow. For some problems directed edges are applied and for other problem undirected edges are applied from one vertex to other. So, graphs give us many techniques and flexibility while defining and solving a real-lifeproblem. Graphs have many features, some of them are:

- Provides abstracted view
- Establishes relationship among objects
- Balancing
- Modeling
- Decision-making ability
- Structural arrangement of various objects
- Easy modifications or change in the existing system

Graphs are significant because graph is a way of expressing information in pictorial form. Graph theory is becoming remarkable as it is applied to other areas of mathematics and various branches of science and technology. The concepts of Graph theory are widely used in various fields like Bio-Chemistry, Chemistry, Engineering, Computer science, Operation research and also in real life. They are mostly used in studying and modeling various applications. Graphs are considered extremely powerful and a flexible tool to model the problems.

2. APPLICATION OF GRAPH THEORY IN COMPUTER SCIENCE

Graph theory is playing an increasingly important role in the field of computer science such as website designing, network security, communication network & so on.

1] WEBSITE DESIGNING:

Website designing can be modeled as a graph where the web pages are represented by vertices and the hyper links between them are represented by edges in the graph. This concept is known as web graph. Here complete bipartite graph plays a vital role that each vertex representing a type of object is connected to every vertex representing other kind of objects. There are many advantages of using graph representation in website development such as:

- Searching and community discovery.
- Graph representation in website utility evaluation and link structure.
- Finding all connected component and provide easy detection.

2] COMMUNICATION NETWORK:

Graph theory can be used to represent communication networks, which is a collection of terminals, links and nodes which enables communication between users of terminals. Every communication network has three basic components namely terminals, processors and transmission channels. This network transmits packets of data between computers, telephones or other devices. Graph theory helps to model the communication network by vertices as terminals, processors and edges represent transmission channels through which data flows. Thus, the data packets can be transmitted from input to output through a sequence of switches joined by directed edges.

3] IMAGE PROCESSING:

Image Analysis is the methodology by which information from image is extracted. Image analysis which is mainly performed on digital image processing techniques can be improved using a graph theoretic approach. The applications of graphs in image processing are; to find edge boundaries using graph search algorithms in segmentation.

- To calculate the alignment of the picture.
- Finding mathematical constraints such as entropy by using minimum spanning trees.
- Finding distance transforms of the pixels and calculates the distance between the interior pixels by using shortest path algorithm.

4] SOFTWARE ENGINEERING:

Graph has many applications in software engineering. For example, during requirements specifications data flow diagrams are used where vertices represent transformations and edges represent the data flows. During Design phase, graphical design is used for describing relations among modules. Even software process management has also applications of network diagrams which involves graph algorithms.

5] OPERATING SYSTEM:

A graph is a data structure of finite set of pairs, called edges or vertices. Many practical problems can be solved with the help of graph in the field of operating system such as job scheduling and resource allocation problems. For example, graph coloring concept can be applied in job scheduling problems of CPU, jobs are assumed as vertices of the graph and there will be an edge between two jobs that cannot be executed simultaneously and there will be one to one relationship between feasible scheduling of graphs.

3. GRAPH THEORY IN CHEMISTRY

In Chemistry, the importance of graph theory emerges out from isomerism phenomenon that is extenuated by chemical structure theory. This theory accounts for all the constitutional isomers by using different methods in the graph theory. In chemistry, graph theory is used for mathematical modeling of chemical phenomena. The natural models of a molecules can be made where atoms are represented by the vertices whereas the bonds are represented by the edges. The Chemical graph theory is the mathematical branch which deals with the non-trivial applications of graph theory used to solve molecular problems.

4. GRAPH THEORY IN PHYSICS

The graph theoretical concepts are exploited successfully in various electrical, electronic or digital circuits. The concept of graph theory is a good aid for the drawing and indicating the current, voltage and resistance on a circuit. The directed graphs are used for indicating the conventional current flow in circuits. It is easy to connect the different physical process using graph theory concepts.

5. GRAPH THEORY IN BIOLOGY

In the field of Biology, only one graph serves to explain many sentences. Graph are used in determining the function of protein or gene, a drug target identification, studying the structures of DNA and RNA etc. In the ecological system, the food chain of different living organisms is well understood by the graphs using a pyramidal figure or by drawing some arrow diagrams representing the dependence of one living organism upon another for their food, where the animals are vertices of graph and connected if any one of them depends on other for food. In the computational neuro-sciences, the graphs are used to describe the functional connections between the areas of the brains and spinal code that interact to give rise to various cognitive processes in which the vertices represent different areas of the brain while the edges represent the connection between these areas.

6. CONCLUSION

This paper is designed to gain a sufficient knowledge on applications of graph theory in relevance with various subjects like website designing, communication network, Image processing and many more. Still today graph theory awaits new innovative applications in the untouched fields.

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