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APPLICATIONS OF GRAPH THEORY IN VARIOUS FIELDS

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Abstract: Mathematics is composed of a number of areas each having their very 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.

In recent years, graph theory has established itself as an important mathematical tool in variety of subjects ranging from Operations research and chemistry to sociology and architecture. At the same time it has also emerged as a worthwhile mathematical discipline in its own right. A variety of papers based on Graph theory and its applications have been studied and an overview has been presented here.

Keywords: Directed Graph, Bipartite graph, Binary Tree, Vertex Colouring.

INTRODUCTION:

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, Operations Research and also in real life. They are mostly used in studying and modeling various applications.

Graphs are used to model many problems of the real world in various fields. Graphs are considered extremely powerful and a flexible tool to model the problems. Given below are some of the fields where Graph theory is used.

GRAPH THEORY IN CHEMISTRY:

Graph theory is used in chemistry to study molecule, as graphs represent a substance's molecular and chemical structures. It can also be used to construct the molecular structure and lattice of any molecule.

It also helps in showing the bonding relationship between atoms and molecules and also in comparing the structure of one molecule to another. Here atoms can be considered as vertices of a graph and the bond that connects them is represented as edges between them.

These structures are created based on the properties of compounds and are taken for analysis and processing. This can be used to study the structure of the molecules and to check the similarity level between the molecules.

With the help of graphs, the 3D structure of complicated simulated atomic structures can be studied quantitatively by the gathering data on graph-theoretic properties related to atomic topology.

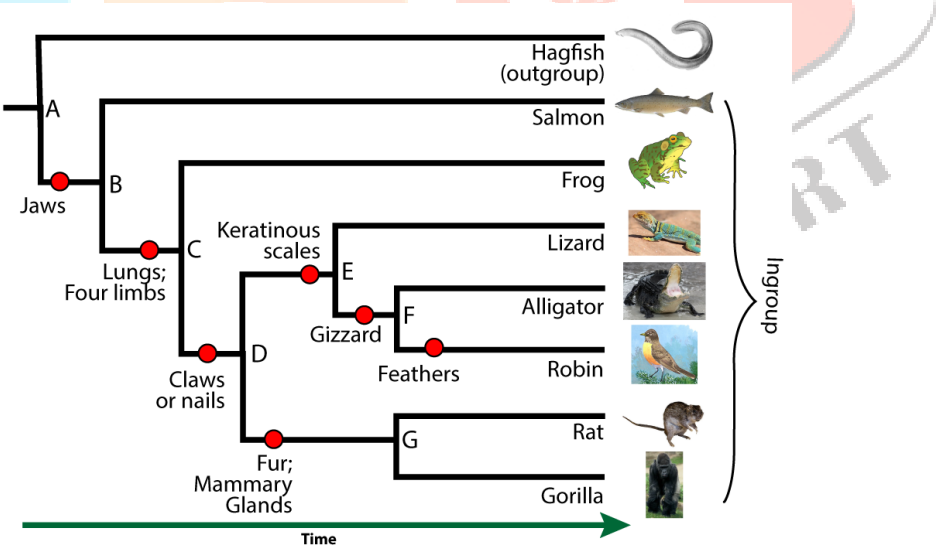
GRAPH THEORY IN PHYSICS:

Graph Theory plays a salient role in electrical modeling of electrical networks. Current, voltage and resistance in a circuit can be designed using the concept of Graph theory. To show the flow of current in circuits we can use directed graphs. Graphs can represent local connections between interacting parts of a system in statistical physics, as well as the dynamics of a physical process on such systems.

GRAPH THEORY IN BIOLOGY:

Graph Theory is used in many areas of Biology. It can be used in drug target identification, determining a protein's function, gene's function. It is also used in studying the structures of DNA and RNA.

Graphs are used to represent relationships among species on different physical and micro-biological criteria. For example, the evolutionary relationships among the existing species are expressed in a tree structure called phylogenetic tree.



(Fig. 1)

Graphs are also used in analyzing biological data. Ecological landscapes can be modeled using graphs. Habitat patches are represented as vertices and the movement between the patches is represented as edges when ecological landscapes are modeled as graphs.

Similarly, Graph theory is useful in conservation efforts where a vertex represents region where certain species exist and the edges represent migration paths or movement between the regions. This information is important when tracking the spread of diseases, parasites and how the changes in the movement can affect other species.

GRAPH THEORY IN OPERATIONS RESEARCH:

Graph Theory is a very useful tool in Operations research. Some problems in Operations Research make full use of graphs which makes it easier to solve the problem. Modeling, transportation, network activity, game theory, minimum cost path and the scheduling problem are some examples of applications of graph theory in operations research.

A large number of combinatorial problems are solved using network activity. The planning and scheduling of large complex projects are one of the most popular and successful applications of networks in operations research. Project Evaluation Review Technique (PERT) and Critical path method (CPM) are two of the most well know problems using Graph theory.

It is also used in different assignment problems such as assigning different people to different jobs, scheduling time tables and also in maximal flow problems.

Transportation problem is a directed graph application where each edge has a weight and each edge receives a flow, where the amount of flow cannot exceed the capacity of the edge. In transportation problem, when we need to minimize the transportation cost or maximize the profit, then the graph theoretical approach is very useful. Here directed graph is called a network, the vertices are called nodes and the edges are known as arcs.

To find the best way to perform a specific task in competitive situations, game theory is applied to problems in engineering, economics, war science, etc. In this case, vertices represent the positions and the edges represent the movements.

GRAPH THEORY IN COMPUTER SCIENCE:

Graph theoretical concepts have wide scope in computer science areas such as website designing, network security, communication network and so on. A data structure can be designed in the form of a tree which in turn utilized vertices and edges. Similarly modeling of network topologies can be done using graph concepts.

Graphs are used to describe the computation flow. Graph transformation systems use in-memory graph manipulation based on rules. Graph databases allow for safe transaction, persistent storage and querying of graph-structured data.

- **Website Designing:**

Graphs can be used to design websites. Google's successful web search algorithms are based on the WWW graph, in which the web pages are represented by vertices and hyperlinks between them are represented by the edges in the 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.

Structure of a websites containing many pages can be represented using a directed graph. Each page can be considered as a vertex. A link exists between two pages if there exists an edge between them. By this way, we can identify which page is accessible from which page.

- **Graph Theory in Network Security:**

Graphs are used to simulate the propagation of stealth worms on large computer networks and to develop strategies to protect the networks from virus attacks. For this the French Navy ESCANSIC used the vertex cover algorithm. The idea is to find an optimal solution for designing the network design strategy. The main aim is to find a minimum vertex cover in the graph whose vertices are the route servers and whose edges are the connection between the routing servers.

- **Graphical Representation of 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.

- **Communication Network as Binary Tree:**

Communication network can be represented as a complete binary tree in which squares are represented as terminals, sources or destinations for packets of data, circles as switches that directs the packets through network. There is a unique path between every pair of vertices in an undirected tree, so that the switch can receive packets and forward in the computer binary tree in an analogue directed path.

- **Map Colouring and GSM Mobile phone networks:**

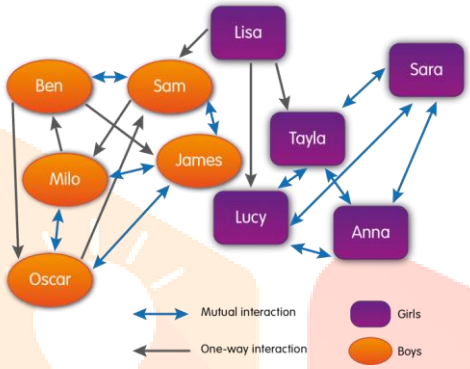
Group Special Mobile (GSM) is a mobile phone network where the geographical area of this network is divided into hexagonal regions or cells. Each cell has a communication tower which connects with mobile phones within the region. All mobile phones connect to the GSM network by searching for cells in the neighbours. Since GSM operate only in four different frequency ranges, it is clear by the concept of graph theory that only four colours can be used to colour the cellular regions. These four different colours are used for proper colouring of the regions. Therefore, the vertex colouring algorithm may be used to assign at most four frequencies for any GSM mobile phone network. The concept of assigning the colours is as follows:

In a map drawn on the plane or on the surface of a sphere, the four colour theorem assets that it is always possible to colour the regions of a map properly using at most four distinct colours such that no two adjacent regions are assigned the same colour. Now, a dual graph is constructed by putting a vertex inside each region of the map and connect two distinct vertices by an edge if and only if their respective regions share a whole segment of their boundaries in common. Then proper colouring of the dual graph gives proper colouring of the original map. Since, colouring the regions of planar graph G is equivalent to colouring the vertices of its dual graph and vice versa. By colouring the map regions using four colour theorem, the four frequencies can be assigned to the regions accordingly.

APPLICATIONS OF GRAPH THEORY IN SOCIAL SCIENCE:

Sociology makes extensive use of graph theory. For example,

- Friendship and knowledge graphs describe whether individuals know each other or not.
- Social network analysis software to investigate rumour spreading or to assess actors' reputations.
- Using the influence graphs model to influence the behavior of others by certain individuals.
- Collaboration graphs are used to examine whether two people collaborate in a special way, such as working in team together.
- Sociograms are used to represent relationships between people in a society or group, where a sociogram is a digraph that represents a person's social connections. In a sociogram, vertices denote people and directed edges denote relationships.



(Fig. 2)

- Anthropologists have studied a number of tribes and classified them based on their kinship structures.

REFERENCE:

[1] N.Vedavathi , Dharmaiah Gurram, 2013, Applications on Graph Theory., INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 02, Issue 01 (January 2013).

[2] Pranav Patel, Chirag Patel, 2013, Various Graphs and Their Applications in Real World, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 02, Issue 12 (December 2013)

[3] Bhagya Jyoti Nath, 2017, Applications of Graph Theory in Different Branches of Science, INTERNATIONAL JOURNAL OF MATHEMATICS AND ITS APPLICATIONS, Volume 5, Issue 3-A, 57 – 60.

[4] Robinson Chelladurai and S.J. Maghy, 2018, Graph Theory in Different Networks, INTERNATIONAL JOURNAL OF MATHEMATICS AND ITS APPLICATIONS, Volume 6(1-D), 711 – 717.

[5] Mahonen, P. & Riihijarvi, J. & Petrova, M.. (2004). Automatic channel allocation for small Wireless Local Area networks using graph colouring algorithm approach. 536 - 539 Vol.1. 10.1109/PIMRC.2004.1370928.

[6] https://prinsli.com/graph-theory-applications