Significance & Application of Graph Theory in Evaluation & Analyses of Complex Scientific & Non-Scientific Research Work

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Abstract

This paper examines the relation between graph theory and also the current analysis together with its application and its scientific use. Since graph theory plays an important and significant role in research project. with increasing complexness in the analysis work, designing, advanced arithmetic, applied science, associated alternative scientific and non scientific areas it's gained an impulsion in past few years in rapacious dimensions and has been developed into an intensive and standard branch of arithmetic, it's emerged mutually of the foremost powerful tools for illustration and resolution of the issues that are chronological in nature in the past decades. During this paper numerous aspects of graph theory and its role in scientific and non-scientific research work with its applications have been studied.

Keywords: Graph Theory, Euler Theory, nodes and edges, network topology.

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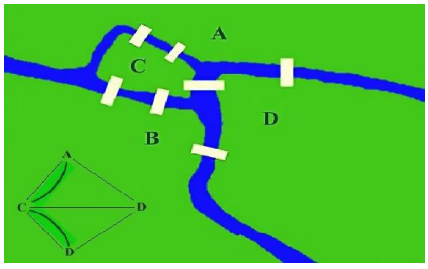
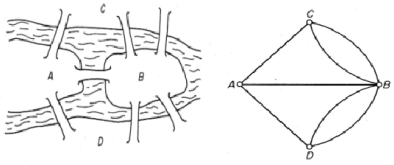
1. INTRODUCTION

Graph theory could also be aforesaid to possess its starting in 1736 [1], is branch of arithmetic that was possibly started by Euler once he take into account one amongst his mathematical problem called Konigsberg bridge downside and he showed that it's not possible to parade through city crossing every of its seven bridges just the once while not repetition a crossing [2]. when a few years second contribution was created by G. R. Kirchhoff, he had enforced graph theory for analysis of electrical networks, it took nearly two hundred years before the primary book "Theorie der endlichen and unendlichen Graphen" (Teubner, Leipzif, 1936) was printed by Konig in 1936.





(a) **(b)**

Figure 1. The Bridges of Konigsberg and their graph.

In 1990's contribution was created by cluster of physicists in graph theory that is thought as "new science of networks" and emphasized topological structure instead of graph algorithms as graph theory relates to percolation theory and activity [3]. There aren't any customary notions for graph

theoretical objects, this is often as a result of since names one uses for the objects reflects the applications, and thus as an example, if we have a tendency to take into account a communication network as a graph, then the pc participating during this network, area unit known as nodes instead of vertices or point.

2. BACKGROUND

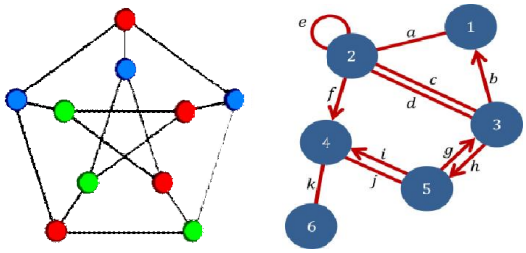
Graph theory has found several applications in the majority fields of science and engineering as well as civil, electrical, mechanical, design, control and management, communication, distributed matrix technology, applied science and so on. In literature there are many analysis articles, journals and books are printed in previous couple of years as a result of extension of conception and application of graph theory like Bondy and Murty, Wilsion and Beineke, Gondran and Minoux, Cooke et al, Kaveh, and journals like Journal of Graph theory, Journal of Combinatorial Theory, separate and applied math, are being printed to show the advancement in Graph theory. With rapid growth of technology and high precision methodology, quality and complexity of the work has enhanced which might be scale back by using completely different approach of graphs theory and by numerous application of it.

3. BASIC DEFINITION OF GRAPH THEORY

There are several physical systems whose performance depends not solely on the characteristics of their parts, however conjointly on their relative location and therefore topology of the merchandise influences the potency of the whole structure. And it's necessary to represent a system so its topology may be understood clearly and rule may be created in line with issues, graph theory provides a strong mean for this purpose.The study of graph and therefore the development of techniques for analyzing graphs represent the graph theory.

Mathematically a graph may be describes by two information structure: one that describes its nodes and one that describes its edges. Graph edges may be merely outlined as distance between nodes.

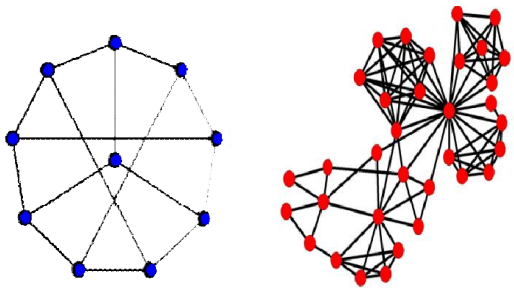
A simple Graph could be a finite uni-facial graph without loops and multiple edges. In mathematics graph may be categories into totally different classes:



(a) A non-straightforward Graph

(b) An easy Graph

Figure 2. Non-Simple and Straightforward Graph



(a) **(b)**

Figure 3. (a) A connected Graph (b) a complex graph

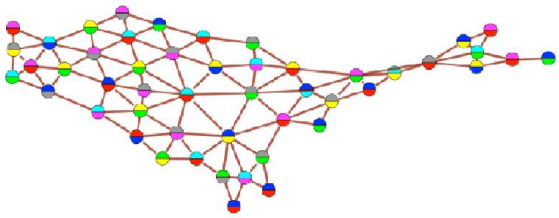


Figure 4. The Cut edges of a Graph

A. *Simple classes / Straightforward Categories.*

B. *Comparability Graphs:* A binary relation on a set A is a subset of $A^2 = A \times A$.

C. *Permutation Graphs:* The complement of a permutation graph could be a permutation graph additionally; each permutation graph could be equivalence graph.

D. *Bipartite Graphs:* A graph G is bipartite if and only if G has no cycles of odd length.

E. *Trees:* A tree is connected graph without cycles.

F. *Counting Trees:* The number of labeled trees on n vertices isn^{n-2}.

G. *Planer Graphs:* A graph is alleged to be plane graph if it may be drawn within the plane in such some way that no 2 edges intersect one another. Also, each plane graph includes a vertex of degree at the most 5.

4. APPLICATION OF GRAPH THEORY IN RESEARCH

Complexity is an intricate and versatile concept that is associated with the design and configuration of any system. For example, complexity can be measured and characterized by quantitative measures often called indices. When studyingthe concept of complexity, Graph theory has been playing apioneering and leading role.

A. Geomorphic coupling and Sediment Property using Graph Theory

One of the novel applications of graph theory is, it may be accustomed outline the network structure in fact sediment pathways, completely different numerical simulation models may be accustomed establish a spatially express graph model of sediment sources, and sinks [4]. Network analysis is applied in several analysis areas such social networks, transportation systems, communication networks, applied math mechanism and population and landscape ecology. Association between objects of components is referred as networks. Study of graph is terms as graph theory in arithmetic, and mathematical model of network is graph. Mathematical rationalization provided by graph theory has been accustomed tackles several advanced issues of generic system. The worth of network analysis has by no means that been neglected in geophysics. Within the starting of 1960's graph theory was used to study the topology of stream networks and to generalize landscape components in mapmaking [5]. One among the exceptions was by dessert apple Phillips (2012) once he printed concerning geomorphologists within which graph theory used to analyses geomorphic system. Graph provides a superb arrangement for illustration of landscape units connected by geomorphic processes through transport of sediments and might represent all types of spatial units, and might be connected by mapping and modeling. There are numerous fields in morphological analysis within which graph theory is promising to guide to new insights into system structure behavior, since it offer a robust technique for network analysis that has proved its capabilities in several alternative areas managing network-like system and it's going to greatly profit sediment flux and landscape sensitivity [6].

B. Graph Theory in Power Grid

Graph theory may be used to live the position that is applicable to power grids having most crucial and complete infrastructure, that (Centrally) is employed in network science to rank the relative importance of nodes and edges of graph and is helpful for locating vertices of high position that don't lie on the shortest ways and shown to own a powerful correlation with degree and between spatial relation, this was projected by Newman in 2005. Relative importance analysis supported position in graph theory may be performed on power system network with considering its electrical parameters [7]. Nodes or branches within the grid system have essential importance in term of vulnerability may be measured by analyzing the position distribution, interconnectivity of power system allows long distance transmission for top economical system operating [8], graph theory may be enforced in reducing the complexness of the ability of grid infrastructure and will be accustomed determine the foremost vital part of the power grid.

C. Graph Theory in Protein Science

Sets of point may be used to represent amino acids of protein that is entirely outlined by its contact matrix i.e. contiguity matrix and graph theory. Relation between neighboring amino, derivations from Laguere decomposition could also be characterized by the contact matrix [9]. The network paradigm relies on derivation of rising properties of studied systems by their illustration as oriented graph: system is derived back to line of nodes connected by edges reminiscent of relation existing between nodes [10]. Close packaging of amino acids in macromolecule may be compared with the random shut packing of spheres forming graph with close loop. Since protein could be a terribly complicated object whose properties don't seem to be solely associated with its structural stability, however additionally to its excitation states, therefore to scale back its basic complexness graph theory is extremely useful [11].

D. Graph Theory in Computer Science

The study of graphs, and graph theory, each in arithmetic and in engineering models combine relations between vertices from an exact assortment with a group of edges. In computer science depending upon the language or machine problems, a graph is stored in digital form using of the matrix form like Adjacency matrix, Incidence Matrix, Edge Listing etc. In engineering principally it's used for creating an appropriate association between several devices through wireless communication link (Wi-Fi) or by making wired communication (LAN) network. Recently in engineering application for network security purpose vertex cover algorithmic rule has been designed, Graphs are using in data transmission, cryptography theory, web design, in finite automata, in programming, in electronic network security, coming up with as a result of its ability to resolve and build a fancy downside as simple as it can be and provides satisfactory results [12].

E. Graph Theory in Atmospheric Information assortment

Initially the classification of weather chart for determination deferential issues associated with science, geophysical science or at alternative level was performed manually that was time overwhelming and subjective. However currently with increasing use of computers in analysis areas and in information assortment center manual ways aren't economical, and their replacement from automated based laptop primarily results to additional objective and more practical classifications. Automated-driven processing may be divided into 2 broad classes, correlation – primarily based and eigenvector-based [13]. Compact illustration of weather information provided in graph domain will scale back the general procedure time. Therefore, representing a problem as a graph reveals the underlying data structure supported the pair wise relations between data objects, concluding an economical classification scheme. Graph illustration is as various and economical structural illustration of datasets wherever data function as nodes on a graph, whereas their relations are indicated as weighted-edges between the connected vertices. One among the most fashionable problems that graph theory deals with is data clustering [14].

F. Graph Theory in Neurology (Medical Science)

In recent decades human brain has become a preferred research topic in neurobiology, and plenty of algorithms are developed to research brain networks and topology has been used as a tool from graph theory to investigate brain neural network.

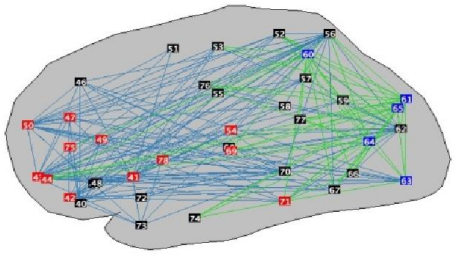


Figure 5. Graphical representation of Brain

It describes brain as a collection of nodes (brain region) and edges (connection).

G. Graph theory in Ecological Science

Spatially express population models (SEPMs) are usually considered the simplest way to predict and manage species distributions in spatially heterogeneous landscapes. However, they are computationally intensive and require extensive knowledge of species' biology and behavior and are complicated that cause's immense error in model output, limiting their application in several cases. Compared to SEPM's, graph theory need lesser information and shows best algorithms with high dependableness, recently graph theory has been introduced to landscape ecology however it's additionally extremely reliable and economical for ecological application [15]. Graph theory is employed to maximize flow potency in networks, but it's found that they're additionally well matched for ecological applications concerning to property or fluxes and has been used a framework, for food web theory in ecology (Dunne et al 2002) since it need vey less information for a graph analysis of any explicit species and landscape as well as data of habitant necessities.

H. Graph Theory in modeling of Nano-networks systems

Nanonetwork is outlined as a mathematical model of Nano-size objects with biological, physical and chemical attributes, which are interconnected among certain dynamic method. Graph theory

plays a major role in study of structure principles, quantifies the relation between the operate of nanostructure material and their design and property of fluctuations at nanoscale. Advanced systems are composed of the many nanosize objects, controlled design of nano systems that may perform a definite function makes the proper basis for their quality in Nano-technology [16], graph theory has been employed in modeling of advanced systems by appropriate mapping and mathematical graphs and qualitative analysis of underlying advanced systems was enabled by graph theory strategies [17].

I. Quantitative Graph Theory: Information Inequalities for Network

When studying the concept of complexity, information theory has been playing a pioneering and leading role. Prominent examples are the theory of communication and applied physics where the famous Shannon entropy [18] has extensively been used. To study issues of complexity in natural sciences and, in particular, the influence and use of information theory,[19]

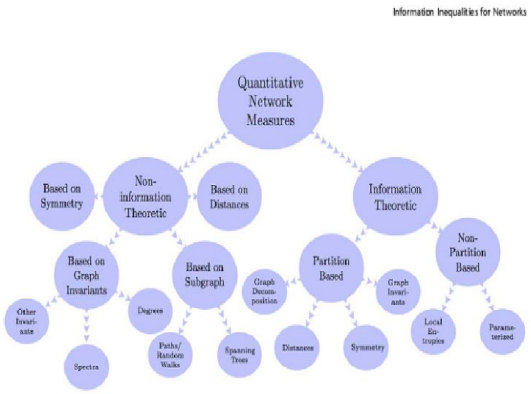


Figure 6. A classification of quantitative networks measures.

entropic measures have been used to quantify the information content of the underlying networks, Generally, this relates to exploring the complexity of a graph by taking its structural features into account. Note that numerous measures have been developed to study the structural complexity of graph Further, the use and ability of the measures has been demonstrated by solving interdisciplinary problems. As a result, such studies have led to a vast number of contributions dealing with the analysis of complex systems by means of information-theoretic measures.

It is important to emphasize that relatively little work has been done to investigate relations between network measures. A classical contribution in this area is due to Bonchev et al. [20]. Here, the relatedness between information-theoretic network measures has been investigated to detect branching in chemical networks. Further, implicit information inequalities have been studied for hierarchical graphs which turned out to be useful in network biology [21].

V. CONCLUSION

Graph are so named because they can be represented graphically, and it is the graphical representation which helps us understand many of their properties. Many real world situation can conveniently be described by means of a diagram consisting of a set of points together with lines joining certain pairs of these points. Recent literature survey counsel that graph theory has many application besides arithmetic and computers, application of graph theory may be found in most scientific and non scientific research project and is currently it's a significant research area itself.

Out of many application mentions above in this paper, graph theory has more application like in prediction of vegetation dynamic to state and transitions models, in business process models, water network sectorization, energy performance indices, and in drug repurposing, etc.

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Renu Thapliyal received her M.Sc degree in Mathematics from HNB Garhwal University, Uttarakhand in 2013. She was awarded by her B.Sc degree by PG College Kotdwara, HNB Garhwal University Pauri Garhwal in 2011. Her major area interest includes Probability, Graph Theory and Set theory. She is working and providing assistance on many ongoing projects related to reducing complexity of system and in analyzing complex data of atmospheric attenuation.

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