

Graph Theory and its Applications in Diverse Domain: A Survey Paper

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Abstract - The field of mathematics plays essential role in various domains. Among various areas of computation graph theory is used in different applications of computer science. Graph appears in a many domains whenever it is useful to represent the relationship among two objects either physically or logically such as network structure, visualization of data. In this paper, we study about the graph theory knowledge which is more important for different application based on computer science strategies. In this paper, we review about the graph theory recent studied related to graph theory concepts, application areas and future road map of the work is also presented.

Keywords: Graph, Computer science and applications, Ad-hoc Network, random walk, Graph Theory

I. INTRODUCTION

When a human analyses or synthesizes a designing framework by utilizing the numerical portrayal administering its conduct, he or she makes a scientific model of the building framework, and after that controls the conditions utilizing learning about them and their connection with the physical reality. In regular designing practice, one uses a model that is known to be reasonable for the current framework and the point of the calculation. Diagrams are considered as a superb displaying apparatus which is utilized to show many kind of relations among any physical circumstance. Numerous issues of true can be spoken to by diagrams. Diagrams are one of the prime objects of concentrate in Discrete Mathematics. Diagram hypothesis is one of the branches of current arithmetic having encountered a most noteworthy improvement as of late. At the outset, Graph hypothesis was just an accumulation of recreational or testing issues like Euler visits or the four shading of a guide, with no unmistakable association among them [1] [2]. Graph theory is used find solutions for the real world problems, in addition of that new generation computing is depends on the graph theory. Graph theoretical ideas are highly utilized by computer science applications. Especially in research areas of

computer science such information mining, picture division, bunching, picture catching, organizing and so on, For instance an information structure can be planned as tree which thusly used vertices and edges. So also displaying of system topologies should be possible utilizing chart ideas. Similarly the most vital idea of diagram shading is used in asset portion, planning. Additionally, ways, strolls and circuits in diagram hypothesis are utilized as a part of colossal applications say voyaging sales representative issue, database outline ideas, asset organizing. This prompts the advancement of new calculations and new hypotheses that can be utilized as a part of colossal applications [3].

II. HISTORY OF GRAPH THEORY

Leonhard Paul Euler (1707-1783) was a renowned Swiss mathematician, who spent a large portion of his life in Russia and Germany. Euler (articulated as OILER) was taking care of the principal issue utilizing chart hypothesis and in this manner driving the establishment of an essential and huge field of diagram hypothesis. He additionally made the primary diagram to reproduce an ongoing spot and circumstance in order to take care of an issue which was around then thought to be one of the hardest issues [4].

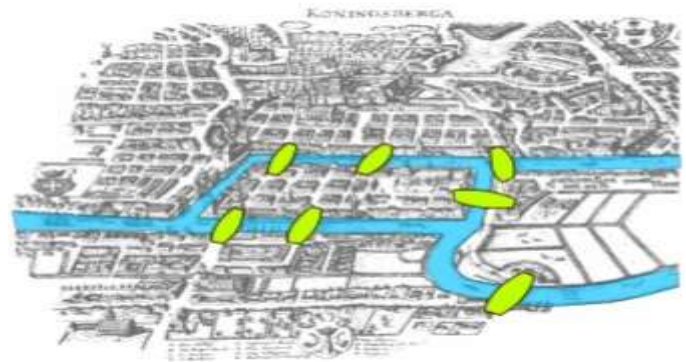


Figure 1: Seven Bridge Problems

The 'Konigsberg connect' issue began in the city of Konigsberg, which was in the past in Germany now it is known as Kaliningrad and is a piece of Russia. It is situated on the stream Pregel. This city had seven scaffolds; these extensions associated two islands with the principle arrive through seven extensions. Individuals utilizing the scaffolds needed an approach to stroll over every one of the extensions just once. The given picture beneath is the guide of Konigsberg as in amid Euler's chance it demonstrates the genuine format of the seven extensions and features the stream Pregel and the scaffolds [5].

Euler turned out with the arrangement as far as chart hypothesis in 1736. He demonstrated that it was difficult to stroll through the seven extensions just once. To achieve this conclusion, Euler detailed the issue as far as diagram hypothesis. He made a theoretical of the instance of Konigsberg by taking without end every single pointless component. He at that point drew a photo comprising of "dabs" speaking to the landmasses and the line-sections that spoke to the extensions that associated those land masses. The subsequent picture more likely than not looked to some degree like the figure demonstrated as follows.

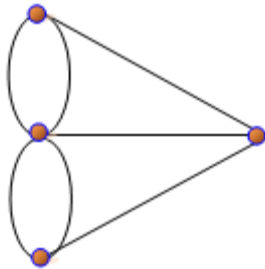


Figure 2: Euler Graph

This disentangles the issue to a huge degree. The issue would now be able to be just observed as the method for following the diagram with a pencil without truly lifting it. You can attempt it in all conceivable ways, yet you will soon make out that it is unrealistic. Euler demonstrated that it's inconceivable, as well as clarified why it is not and what ought to be the normal for the diagrams, so its edge could be navigated precisely once. He turned out with an idea which was then very new i.e. level of hubs. The level of Node can be characterized as the quantity of edges touching a given hub. Euler suggested that any given diagram can be navigated with each edge crossed precisely once if and just on the off chance that it had zero or precisely two hubs with odd degrees. The chart that takes after this condition is called, Eulerian circuit or way. We can without much of a stretch construe this hypothesis. Precisely two hubs are (and should be) starting and end of your trek. In the event that it has even hubs than

we can undoubtedly come and leave the hub without rehashing the edge twice or more [6].

In a real instance of seven scaffolds of Konigsberg, once the circumstance was displayed as far as diagram, the case was streamlined since the chart had only 4 hubs, with every hub having an odd degree. Euler consequently inferred that these extensions can't be crossed precisely once. Utilizing this hypothesis, we can make and take care of various issues. We might need to make the chart made from extensions of Konigsberg, an Euler's circuit. Presently, according to Euler's hypothesis we have to acquaint a way with make the level of two hubs even. What's more, other two hubs can be of odd degree out of which one must be starting and another endpoint. On the off chance that we need to begin our adventure from blue hub and end at the yellow hub. In this way, the two hubs can have odd edges. In any case, by one means or another we have to alter the genuine diagram by adding another edge to the chart with the end goal that the two different hubs have even degree. Along these lines, the subsequent figure is appeared beneath [7].

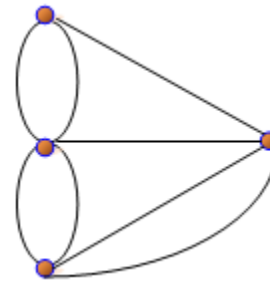


Figure 3: Euler's Circuit

III. ABOUT GRAPH THEORY

Graph theory is a branch of discrete arithmetic. Chart hypothesis is the investigation of diagrams which are scientific structures used to demonstrate match shrewd relations between objects. A diagram is comprised of vertices V (hubs) and edges E (lines) that interface them. A chart is a requested match $G = (V, E)$ comprising an arrangement of vertices V with an arrangement of edges E . There is wide utilization of diagrams in giving critical thinking procedures, since it gives an instinctive way preceding showing formal definition. To investigate the diagram hypothesis application two issue zones are considered. Charts offer an advantageous approach to speak to different sorts of numerical items. Basically, any diagram is comprised of two sets, an arrangement of vertices and an arrangement of edges. Contingent upon the specific circumstance we are attempting to speak to, in any case, we may wish to force limitations on the sort of edges we permit. For a few issues we will need the

edges to be guided starting with one vertex then onto the next; though, in others the edges are undirected [8] [9].

Diagram hypothesis is the investigation of focuses and lines. In particular, it incorporates the courses in which sets of centers, called vertices, can be related by lines or bends, called edges. Graphs in this setting shift from the more common arrange plots that portray logical relations and limits. Outlines are requested by their multifaceted nature, the amount of edges allowed between any two vertices, and paying little heed to whether headings (for example, up or down) are distributed to edges. Diverse courses of action of principles result specifically properties that can be communicated as theories [10].

IV. APPLICATIONS OF GRAPH THEORY

Charts are among the most universal models of both characteristic and human-made structures. They can be utilized to show many sorts of relations and process flow in physical, natural and social frameworks. Numerous issues of functional intrigue can be spoken to by diagrams. From the overview the domain study of the graph theory and in continuation of research study in this survey paper in further section we demonstrate about application of graph theory in different computer science area. Some of the important applications are explained here:

1. Text Mining

Automated text analysis and text mining methods have received a great deal of attention because of the remarkable increase of digital documents. Computer technology has brought a dramatic change to our daily life. Nowadays, by using digital methods, we can store, manage and retrieve information in text documents automatically without looking at printed documents. Automated text analysis and text mining are becoming more and more important in computer applications. Diagram models have the ability of catching auxiliary data in writings however they don't consider the semantic relations between words [11] [12].

Record is models as Graph where term spoke to by vertices and connection between terms is spoken to by edges.

$$G = \{Vertex, Edge Relation\}$$

There are generally five different types of vertices in the Graph representation

$$Vertex = \{F, S, P, D, C\}$$

Where,

F – Feature term, *S* – Sentence, *P* – Paragraph, *D* – Document, *C* – Concept

$$F = \{t_1, t_2, t_3\}$$

$$S = \sum_{i=0}^n t_i$$

$$P = \sum_{i=0}^n S_i$$

$$D = \sum_{i=0}^n P_i$$

$$DC = \sum_{i=0}^n d_i$$

EdgeRelation = {Syntax, Statistical, Semantic}

Edge connection between two component terms may distinctive on the setting of Graph.

- (1) Word event together in a sentence or passage or area or record
- (2) Common words in a sentence or passage or area or record
- (3) Co-event on the settled window of n words
- (4) Semantic connection - Words have comparable significance, words spelled same way yet have diverse significance, inverse words Bag-of-words approach is not reasonable system to catch term significance

2. Network Technology

The field of Graph Theory assumes indispensable part in different fields. One of the essential regions in chart hypothesis is remote system correspondence. Part of diagram hypothesis is identified with arrangement of the issues in Mobile Ad-hoc Networks (MANETS). In Ad-hoc systems, issues, for example, availability, versatility, directing, demonstrating the system and reproduction are to be considered. Since a system can be displayed as a chart, the model can be utilized to break down these issues. Charts can be arithmetically spoken to as lattices. Likewise, systems can be mechanized by methods for calculations. The issues, for example, hub thickness, versatility among the hubs, connect arrangement between the hubs and bundle steering must be recreated. To reproduce these ideas arbitrary chart hypothesis

is sued. The availability issues are investigated by utilizing chart spanners, (A geometric spanner or a k-spanner diagram or a k-spanner was at first presented as a weighted diagram over an arrangement of focuses as its vertices and each combine of vertices has a way between them of weight at most k times the spatial separation between these focuses, for a settled k.) vicinity graphs, (A nearness diagram is basically a diagram in which two vertices are associated by an edge if and just if the vertices fulfill specific geometric prerequisites), scarification and ghastry chart hypothesis. Different calculations are likewise accessible to investigate the blockage in MANET's the place these systems are displayed in view of chart hypothetical thoughts [13].

3. Information Retrieval System

A network is defined as a system of elements that interact or regulate each other. Networks can be mathematically represented as graphs. Typically, the term 'graph' refers to visual representations of the variation of one variable compared to other variables, or the mathematical concept of a set of vertices connected by edges, or data structures based on that mathematical concept; whereas the term 'network' typically refers to interconnected systems of things (inanimate objects or people), or specialized types of the mathematical concept of graphs. Graph theoretic approaches to Information Retrieval can be traced back to the early work in [14] on semantic Information Retrieval, which was followed by several variants of conceptual Information Retrieval and knowledge-based Information Retrieval. Numerous variants of graph formalisms have since been used in connectionist approaches to Information Retrieval. More recently, graph theoretic applications have been used for other applications within IR, for instance IR evaluation measurements [15], and re-ranking [16].

4. Knowledge Representation

Nowadays, companies are established in an environment characterized by increasing amounts of data, which make knowledge aggregation, representation and reasoning highly important for handling this data. Creativity techniques are useful for acquiring knowledge [17]. As human reasoning and its environment are uncertain and imprecise, especially in contexts where creativity is applied, fuzzy logic can enhance the process of knowledge aggregation and representation. Graph theory is a useful formalism to represent knowledge in a computer-understandable way. Some types of graphs can account for imprecision and uncertainty by introducing fuzziness. Knowledge-graph-based applications need to work productively finished semantically rich, yet very much organized and obliged chart information. While social demonstrating methods and chart databases are helpful devices to address a portion of the particular issues, they can't

offer an extensive specialized and calculated framework for the whole undertaking. Many swing to the Semantic Web benchmarks rather, with the unmistakable Web Ontology Language (OWL), as a claimed "silver slug" for the semantic chart administration challenge. Notwithstanding, as effective as the Semantic Web stack ends up being with regards to connected information distributing on the web, its incentive as a learning diagram portrayal answer for remain solitary, space particular applications is more subtle [18].

5. Artificial Intelligent and Searching

Software engineers more often than not utilize counterfeit consciousness procedures created for keen frameworks. Chart hypothesis is a helpful portrayal on the grounds that from one perspective the components of the diagram can be characterized in order to have a balanced correspondence with the components of numerous sorts of building frameworks. In software engineering, seeking methods are systems that search for answers for an issue in a hunt space. The arrangements or 'objective states' could now and again be a question, an objective, a sub-objective or a way to the looked thing. The pursuit space can be spoken to by a "chart" which depends on diagram hypothesis. The "chart" structure is not to be mistaken for the diagrams that the per-users may have gained from their consistent arithmetic courses. A PC "tree" information structure is an uncommon sort of diagram. A tree has a root hub on the highest point of the structure and it has at most one way to every hub. Every hub might be associated with a lower level of neighbors which are called youngster hubs (successors). Hubs that have no kids are called leaf hubs. Utilizing the auto key case, the proprietor's house is characterized as the hunt space. It has the "home" hub as the base of a tree. The home hub has three tyke hubs (the room hubs) and other kid hubs, for example, work areas and drawer in the rooms. Accordingly chart hypothesis is extremely helpful for seeking in fake keen framework [19] [20].

V. RECENT RESEARCHES ON GRAPH THEORY

The specialist has made an endeavor to survey the writing identified with various space of software engineering in different applications. However there are number of literary works, the specialist figured out how to audit few articles/papers distributed in the diary and books. Rundown of other investigation title in diaries and articles identified with look into issue:

Comprehensively, our work is tied in with examining irregular crossing point diagrams, and models created by making it with other arbitrary chart models including irregular geometric diagrams. These compositional models are acquainted with catch the attributes of different complex regular or man-made systems more precisely than the current

models in the writing. For arbitrary convergence diagrams and their sytheses with other irregular charts, **Jun Zhao et al. [21]** think about properties, for example, (k-) availability, (k-) power, and control of impeccable coordinating and Hamilton cycles. These outcomes are ordinarily given as asymptotically correct probabilities or zero-one laws indicating basic scaling, and give enter bits of knowledge into the plan and investigation of different certifiable systems

In this paper **Arie van Deursena et al. [22]** audit five years of research in the field of computerized slithering and testing of web applications. They depict the open source Crawljax apparatus, and the different augmentations that have been proposed so as to address such issues as cross-program similarity testing, web application relapse testing, and template utilization examination. In view of this we recognize the primary difficulties and future bearings of creep based testing of web applications. Specifically, creators investigate approaches to decrease the exponential development of the state space, and in addition approaches to include the human analyzer on the up and up, subsequently accommodating manual exploratory testing and computerized test input era. At last, creators portray the eventual fate of creep based testing in the light of up and coming advancements, for example, the unavoidable utilization of touch gadgets and versatile processing, and the expanding significance of digital security.

Chart hypothesis gives an essential apparatus to dissecting and outlining PC correspondence systems. In the previous couple of decades, Graph hypothesis has been utilized to ponder different sorts of systems, including the Internet, wide Area Networks, Local Area Networks, and systems administration conventions, for example, outskirt Gateway Protocol, Open briefest Path Protocol, and Networking Networks. In this paper, **Kamal A. Ahmat et al. [23]** introduce some key diagram hypothesis ideas used to speak to various sorts of systems. At that point they depict how systems are displayed to examine issues identified with arrange conventions. At last, creators display a portion of the apparatuses used to produce diagram for speaking to useful systems.

Soumyajit Ganguly et al. [24] exhibit Paper2vec, a novel neural system installing based approach for making logical paper portrayals which make utilization of both printed and chart based data. A scholastic reference system can be seen as a chart where singular hubs contain rich printed data. With the present pattern of open-access to most logical writing, we assume that this full content of a logical article contain essential wellspring of data which helps in different proposal and forecast assignments concerning this space. To this end, we propose an approach, Paper2vec, which contains data from both the modalities and results in a rich portrayal for

logical papers. Over the current past portrayal learning methods have been examined widely utilizing neural systems. Be that as it may, they are displayed freely for content and chart information. Paper2vec use late research in the more extensive field of unsupervised component gaining from the two diagrams and content reports. We exhibit the viability of our portrayals on three certifiable scholarly datasets in two undertakings - hub grouping and connection expectation where Paper2vec can beat cutting edge by an extensive edge.

In this paper, **Luca Deri et al. [25]** propose novel systems for displaying DNS activity that permit Internet spaces, DNS resolvers and their communications to be spoken to viably by methods for diagrams. DNS movement gathered at ".it" ccTLD DNS area servers has been utilized to approve this work on an extensive scale. We discovered exceedingly skewed, fat-followed area and resolver degree frequencies, obeying power laws in any event in their tails. These discoveries shed light on the without scale nature of the DNS biological community, where a couple of areas and a couple of resolvers are in charge of a large portion of the DNS movement.

A chart is a key and general information structure basic all information applications. Numerous applications today require the administration and question capacities specifically on charts. Continuous diagram streams, as found in street systems, social and correspondence systems, and web demands, are such applications. Occasion design coordinating requires the familiarity with diagram structures, which is not the same as customary complex occasion handling. It additionally requires an emphasis on the dynamicity of the diagram, time arrange imperatives in designs, and online question preparing, which strays fundamentally from past work on subgraph coordinating also. **Chunyao Song et al. [27]** ponder the semantics and proficient online calculations for this vital and interesting issue, and assess our methodologies with broad tests over genuine datasets in four unique spaces.

VI. CONCLUSION AND FUTURE RESEARCH DIRECTION

Graph theory is a branch of mathematics that has a wealth of applications from science to engineering, natural science to social sciences. There is hardly any field in which graph theory is inapplicable. Graph theory is used in network, information retrieval system, and text mining, artificial intelligence pattern recognition and fault diagnosis in computer memory. Graph theory has developed into a subject itself with a variety of applications. The main purpose of this paper is to demonstrate the significance of diagram hypothetical thoughts in different zones of process applications for examines that they can utilize chart

hypothetical ideas for the exploration. An outline is displayed particularly to advancement diagram hypothesis.

Future Direction

Graph theory is a big concept that can be utilizing by various techniques for ease of complexity of computational structure in this domain. In near future we are going to present some of important task which is to be considering for web information mining. In order to optimize web based information system by considering semantic knowledge and their structural information using graph theory.

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