Research Methodology on Application of Graph Theory to Computer Science in Big Networks for Big Data

K.Rama Krishna[#1], Dr.M.Upendra Kumar[*2]

[#]Research Scholar, Dept. of Mathematics, Noida International University, Noida, India

[#]Dr.M.Upendra Kumar, Associate Profesdsor, Dept. of CSE, MGIT, Hyderabad, India

Abstract — *This literature review paper discusses about research methodology on application of Graph Theory with focus of application case study of Big networks for Big Data in Computer Science.*

Keywords — *Graph Theory, Computer Science Application, Big Networks and Big data.*

I. Introduction

Big networks for Big data: Modern computer aided data acquisition and storage systems are creating more than quintillion bytes of new data every day. Only a small fraction of the voluminous data, for example metadata is currently being exploited. Graph theory provides a natural framework for analyzing such mammoth data stores by fusing together different data sources into one informational complex network. Over the next couple of decades, the future of algorithmic graph theory will be inspired by such big data problems. Several directions for future research remain open in many practical scenarios, nodes in a system are connected through multiple relationships and their interrelationships are best studied by combining information from these multiple interrelationships into a singly relation. This has been traditionally achieved by musing together information using algebraic methods to produce a single network with nodes and at most one edge between a pair of nodes. Such an ad hoc way of combining data is known to create problems to predictive data analytics, and we believe that a truly graph-theoretic framework of information fusion will become an active area of interest in the near future. For example how can one compute single collection communities on a set of nodes from multiple weighted graphs containing these modes? An example would be the identification of known acquaintances of an individual from multiple social networks, email metadata, phone records and video surveillance records-each of which will produce its own graph. [1].

Graph theory has a theory dating back more than 250 years. The era of graph theory started when a famous mathematician, Leonhard Euler had a problem of crossing the seven bridges of Konigsberg. Ever since he was a child he had a quest for a walk linking seven bridges in Konigsberg. This was today called as the first problem of graph theory Since then, graph theory, the study of graphs with nodes and inter-connections of nodes has evolved and proved with its tremendous use in various fields. It has crept itself into the hands of many famous mathematicians making them easy to solve every complicated real world problem. Its method of representing every problem using pictures or graphs had made itself a pioneer in finding solutions for many unsolved problems.

Graph theory is playing an increasingly important role in the field of computer science. Any software that has to be developed, any program that has to be tested is making themselves easy using graphs. Its importance is derived from the fact that flow of control and flow of data for any program can be expressed in terms of directed graphs. Graph theory is also used in microchip designating, circuitry, scheduling problems in operating system, file management in database management system, data flow control between networks to networks. The theory of graphs had made the field of computers to develop its own graph theoretical algorithms. These algorithms are used in formulating solutions to many of computer science applications.

Some algorithms are as follows:

Shortest path algorithm in a network.

Kruskal’s minimum spanning tree.

Euler’s-graph planarity.

Algorithms to find adjacency matrices.

Algorithms to find the connectedness.

Algorithms to find the cycles in a graph.

Algorithms for searching an element in a data structure (DFS, FBS) and so on.

Graph theory has its sprawling applications in various fields. It is now viewed as one of the subject of interest that is used for many of real time problem solving. As a theory of graphs it is showing its easiness to represent each real time problem using a visual graph to find the solution. Many of the fields like computer science, business, microbiology, medical etc. Are able to solve existing complicated problems using graphs. [2]

Graph Theory has found applications in varied domains ganging from transportation problems. VLSI design to social networks. Geometric representation of graphs, where nodes are physical location on the plane or higher dimensional spaces is getting special attention. These are the obvious representations of natural objects like road railway or airlines networks. An edge in a geometric representation has an obvious properly-the length in this article, we discuss about a special aspect of the geometric representation of graphs-Rigidity of Graphs.

II. Research Methodology on Application of Graph Theory to Computer Science in Big Networks for Big Data

Applications: Graph rigidity has several practical applications. New domains from different disciplines of sciences and technologies are regularly being added to them.

In a reconfigurable sensor network, the mobile devices may need to maintain a specific formation in order to gather data. For example, a useful formation for reconfigurable sensor networks is a regularly spaced polygon. Pattern formation is an important problem in the area of multirobot networks also in this problem, when a swarm of robots are deployed over certain area to achieve a task collectively, they may need to form a target pattern to achieve their goal. There is an intgerensitn relationship between the concept of graph rigidity and pattern formation problem

Different mathematical models and algorithms developed on the basis of cobinationrial rigidity theory have several applications in protein science and mechanical engineering in study of allostery in proteins, rigidity based allostery models and protein hinge prediction algorithms are considered as useful tools. A bridge consisting of metal rods should have a rigid structure for its safety.

Another application of graph rigidity theory is in network localization problem in the domain of wireless ad-hoc and sensor network. In this application, lit is assumed that a sensor node is capable of measuring the distance between itself and the neighboring nodes. Localization problem determined the positions of sensor nodes so that they satisfy the given distance measurements.. However, the solution to this problem is non-unique as there may exists several non-congruent realization of the given distance measure. Considering the importance of accurate node positioning a query can be raised as given as instance of localization problem is it uniquely localizable? If so, how efficiently can it be found? It has been shown that for any d (>1), a generic network realization instance if uniquely localizable in Rd if the corresponding ground network graph is generically globally rigid inR^d. [3]

The challenge of research:

In the twentieth century, major challenges for mathematics came from physics. As the crucial role of symmetry was recognized, group theory emerged as the mathematics of symmetry. Quantum physics drove the development of noncommutative mathematics, and functional analysis arose at least partly from the desire to understand physicists ‘use of Dirac delta functions and other operators on a more rigorous basis.

The major new challenges to mathematics are coming from biology, with the need to understand truly complex systems, in which the parameters at the various levels do not relate directly by a mere however large the factor. The traditional reductionist, bottom up methods are out of their depth here. Information-theory based, top-down approaches offer a better way to tailor the level of detail in the model to the level of knowledge available to the user. Barycentric algebras (defined by the laws of idempotence, skew commutatively, and skew-associatively) offer a way to combine convex-set based optimization techniques at each level with the ordered structure of the set of levels. [4]

Context—aware computing refers to a general class of mobile systems that can sense their physical environment, and adapt their behavior accordingly. In this paper we seek to develop a systematic understanding of context-aware computing by constructing a formal model and notation for expressing context-aware computations. This discussion is followed by a description and comparison of current context modeling and reasoning techniques.

In the paper we presented a set of requirements that context modeling and reasoning techniques should meet. The discussion of the requirements was followed by a description of the most prominent, approaches to context modeling. These approaches are rooted in database modeling techniques and in ontology based frameworks for knowledge representation. Spatial models provide efficient procedure for the execution of typical spatial queries; however, theory does not always cope with the uncertainty of actual location readings. With regard to fact-based models, the CML language has advantages in its support for software engineering and in the good balance between expressive than ontological language like OWL-DL. Finally, ontological models have clear advantages regarding support for a) interoperability, b) heterogeneity, and c) representation of complex relationships and dependencies among context data. However, when considering the tradeoff between expressiveness and complexity, the choice of ontological models may not always be satisfactory. [5]

Random intersection graphs have received much interest and been used in diverse applications. They are natural induced in modeling secure sensor networks under random key predistribution schemes, as well as in modeling the topologies of social networks including common-interest networks, collaboration networks, and actor networks. Simply put, a random intersection graph is constructed by assigning each node a set of items in some random manner and then putting an edge between any two nodes that share a certain number of items.

Broadly speaking, our work is about analyzing random intersection graphs, and models generated by composing it with other random graph models including random geometric graphs and Erdos-Renyi graphs. These compositional models are introduced to capture the characteristics of various complex natural or man-made networks more accurately than the coexisting models in the literature.

For random intersection graphs and their compositions with other random graphs, we study properties such compositions with other random graphs, we study properties such as (k-) connectivity, (k-) robustness, and containment of perfect matchings and Hamilton cycles. Our results are typically given in the form of asymptotically exact probabilities or zero-one laws specifying critical scaling, and provide key insights into the design and analysis of various real-world networks. [6]

In this paper we review five years of research in the field of automated crawling and testing of web applications. We describe the open source CRAWLJAX tool, and the various extension that have been proposed in order to address such issues as cross-browser compatibility testing, web application regression testing, and style sheet usage analysis.

Based on the we identify the main challenges and future direction of crawl-based testing of web applications. In particular, we explore ways to reduce the exponential growth of the state space, as well as ways to involve the human tester in the loop, thus reconciling manual exploratory testing and automated test input generation. Finally, we sketch the future of crawl-based testing in the light of upcoming developments, such as the pervasive use of touch devices and mobile computing, and the increasing importance of cyber,-security.

Today's web applications are more and more moving towards the single-page paradigm, in which a JAVASCRIPT engine is responsible for maintaining the DOM-represented user interface and interaction. This poses important analysis sand understanding challenges. In particular, we have provided a survey of five years of research in analyzing and understanding web applications through automated crawling. Furthermore, we identified a number of important and promising areas of future research in the field of dynamic analysis of modern web applications. [7]

Cloud computing is a powerful technology to perform massive-scale and complex computing. It eliminates the need to maintain expensive computing hardware, dedicated space, and software. Massive growth in the scale of data or big data generated through cloud computing has been observed. Addressing big data is a challenging and time demanding task that requires a large computational infrastructure to ensure successful data processing and analysis. The rise of big data in cloud computing is reviewed in this study. The definition, characteristics, and classification of big data along with some discussions on cloud computing are introduced. The relationship between big data and cloud computing, big data storage systems, and Hadoop technology are also discussed. Furthermore, research challenges are investigated, with focus on scalability, availability data integrity, data transformation, data quality, data heterogeneity, privacy, legal and regulatory issues, and governance. Lastly, open research issues that require substantial research efforts are summarized.

The size of data at present is huge and continues to increase every day. The variety of data being generated is also expanding. The velocity of data generation and growth is increasing because of the proliferation of mobile devices and other device sensors connected to the internet. These data provide opportunities that allow businesses across all industries to gain real-time business insights. The use of cloud services to store, process, and analyze data has been available for some time; it has changed the context of information technology and has turned the promises of the on-demand service model into reality. In this study, we presented reviews on the rise of big data in cloud computing. We proposed a classification for big data, a conceptual view of big data, and a cloud services model. This model was compared with several representative big data cloud platforms. We discussed the background of Hadoop technology and its core comp9nents, namely, Map Reduce and HDFS. We presented current Map Reduce projects and related software. We also reviewed some of the3 challenges in big data processing. The review covered volume, scalability, availabilikty77, data integrity, data protection, data transformation, data quality/heterogeneity, privacy and legal/regulatory issues, data access, and governance. Furthermore, the key issues in big data in clouds were highlighted. In the future, significant challenges and issues must be addressed by the academia and industry. Researchers, practitioners and social science scholar should collaborate to ensure the long-term success of data management in a cloud computing environment and to collectively explore new territories. [8]

In this data-driven society, we are collecting a massive amount of data from people, actions, sensors algorithms and the web, handling "Big Data" has become a major challenge. A question still exists regarding when data may be called big data. How large is big data? What is the correlation between big data and business intelligence? What is the optimal solution for storing, editing, retrieving, analyzing maintaining, and recovering big data? How can cloud computing help in handling big data in business intelligence? This chapter attempts to answer these questions. First, we review a definition of big data second; we describe the important challenges of storing, analyzing maintaining, recovering and retrieving a big data. Third, we address the role of Cloud Computing Architecture as a solution for these important issues that deal with big data. We also discuss the definition and major features of cloud computing systems. Then we explain how cloud computing can provide a solution for big data with cloud services an open-source cloud software tools for handling big data issues Finally. We explain the rule of cloud architecture in big data. The role of major cloud service layers in big data and the role of cloud computing systems in handling big data in business intelligence models.

In this chapter, we discussed a definition of big data, the importance of big data and major big data challenges and issues. We understand that, if we analyze big data with business intelligence tools, we may provide a catalyst to change an organization to a smart organization. We discussed the importance of cloud computing technology as a solution to handle big data for both computing and storage. We reviewed the capabilities of cloud computing systems that are important for big data., Such as resource scalability, resource shrink-ability, resource pool sharing, on-demanded servicing, elastic servicing, and collaboration with other cloud computing systems., We explained xouud architecture service layers and role of each service layer to handle big data. We discussed how business intelligence could change big data to smaller valuable data by using cloud computing services and tools., Finally, we discussed major cloud computing system issues that need to be addressed for could computing to become a viable solution for handling big data. [9]

Social clouds provide the capability to share resources among participants within a social network-leveraging on the trust relationships already existing between such participants. In such a system, users are able to trade resources between each other, rather than make use of capability offered at a (centralized) data centre. Incentives for sharing remain an important hurdle to make more effective use of such an environment, which has a significant potential for improving resource utilization and making available additional capacity that remains dormant. We utilize the socio-economic model proposed by Silvio Gesell to demonstrate how a "virtual currency" could be used to incentivize sharing of resources within a "community". We subsequently demonstrate the benefit provided to participants which such a community using a variety of economic (such as overall credits gained) and technical (number of successfully completed transactions) metrics, through simulation.

We propose an incentive model for resource sharing in social clouds. Our model extends work in credit networks, does not require a central reputation management system and supports asynchronous demands. In addition, we utilize trust inherent within social networks to achieve more flexibility by introducing a virtual currency representation motivated by work of Gesell. We study the long term liquidity that is the capacity to route payments, when nodes repeatedly transact with each other. Using simulations we show how network size, clustering strategy, reputation distributions, density of size, clustering strategy, reputation distributions, density of the social graph and credit limits impact the success of transactions and the overall credit gain. Our future work will focus on studying other realistic scenarios such as network and cluster dynamics and non-cooperative behavior, along with deploying the model using the Comet Cloud framework. [10]

Layered Graph Models and Exact Algorithms for the Generalized Hop-Constrained Minimum Spanning Tree Problem:

This article studies the generalized hop-constrained minimum spanning tree problem (GHMSTP) which has applications in backbone network design subject to quality-of-service constraints that restrict the maximum number of intermediate routers along each communicating path. Different possibilities to model the GHMSTP as an integer linear program and strengthening valid inequalities are studied. The obtained formulations are compared theoretically, i.e., by means of their linear programming relaxation. In addition, branch-and-cut approaches based on these formulations are developed and compared ion a computational study. [11]

Fundamental Products and Autonomous Set: An Algorithmic Approach

The main goal of this paper is to analyze an economy through its symmetric input-output table by using Graph Theory. After providing a definition of the characteristic digraph for the economy, the authors give some properties and algorithms to characterize and compute the fundamental products and, later, the autonomous sets of the studied economy. Six of these algorithms are explained in detail and formulated; the best choices are also implemented with the computational package Mathematica, compared in terms of efficiency, and applied to real input-output matrices from Greece. [12]

Proving logic formulas is a problem of immense importance both theoretically and practically. On the one hand, lit is believed to be intractable in general, and deciding whether this is so is one of the famous million dollar Clay Millennium Problem , namely the P vs. NP problem originating from the ground-breaking work of Cook. On the other hand, today so-called SAT solvers based on conflict-driven clause learning (CDCL) are routinely and successfully used to solve large-scale real-world instances in a wide range of application areas.

During the last two decades, there have been dramatic-and surprising-developments in SAT solving techno logy that have improved performance by many orders of magnitude. But perhaps even more surprisingly, the best SAT solvers today are still at the core based on relatively simple methods from the early 1960s (albeit with many clever optimizations), searching for proof s in the so-called resolution proof system. While such solvers can often handle formulas with millions of variables, there are also known tiny formulas with just a few hundred variables that cause even the very best solvers to stumble theoretical work in and experimental results. The fundamental question of when SAT solvers perform well or badly, land what underlying mathematical properties of the formulas influence SAT solver performance, remains very poorly understood. Other crucial SAT solving issues, such as how to optimize memory management and how to exploit parallelization on modern multicore architectures, are even less well studied and understood from a theoretical point of view.

Another intriguing fact is that although other mathematical methods of reasoning are known that are much stronger than resolution in theory, in particular methods based on algebra and geometry, attempts to harness the power of such methods have conspicuously failed to deliver any significant improvements in practical performance. And while resolution is a fairly well-understood proof system, even very basic questions about these stronger algebraic and geometric methods remain wide open.

The purpose of this workshop was to gather leading researchers in applied and theoretical areas of SAT and proof complexity research and to stimulate an increased exchange of ideas between these two communities. To the best of our knowledge, this was the first large-scale workshop aimed specifically at bringing together practititioners and theoreticians from the two fields. We believe that proof complexity can shed lightly on the power and limitations on current and possible future SAT solving techniques, and that problems encountered in SAT solving can spawn interesting new area in theoretical research. We see great opportunities for fruitful interplay between theoretical and applied research in this area, land believe that a more vigorous interaction between the two has potential for major long-term impact in computer science and mathematics as well for applications in industry. Judging from the feed-back from the participants, the workshop provided a powerful stimulus in this direction. [13]

Given a graph G, A cycle of G is a sequence of vertices of G. The graph G is k-ordered (resp. K-ordered Hamiltonian) if for any sequence of K distinct vertices of G, there exists a cycle (resp. Hamiltonian cycle) in G containing these K vertices in the specified order. Obviously, any cycle in a graph is 1-orderd, 2-ordered and 3-ordered. Thus the study of any graph being K-ordered (resp. k-ordered Hamiltonian) always starts with k=4. Most studies about this topic work on graphs with no real applications. To our knowledge, the chordal ring families where the first one utilized as the underlying topology in interconnection networks and shown to be 4-ordered. Furthermore, based on our computer experimental results, it was conjectured that some of them are 4-ordered Hamiltonian. In this conjectured that some of them are 4-ordered Hamiltonian. In this paper, we intend to give some possible directions in proving the conjecture. [14]

Graph Theory has been realized as one of the most flourishing branches of modern Mathematics finding widest applications in all most all branches of Sciences, Social Sciences, Engineering, Computer Science, etc. Number Theory in one of the oldest branches of Mathematics, which inherited rich contributions from almost all greatest mathematicians, ancient and modern. Nathanson paved the way for the emergence of a new class of graphs, namely Arithmetic Graphs by introducing the concepts of Number Theory. Using the number theoretic function, the Euler totient function, we have defined an Euler totient Cayley graph and in this paper we study the Edge dominating in Euler totient Cayley graph. This paper is devoted for the study of minimum edge cover, edge covering number, minimal edge dominating set and edged dominating numb e of Euler totient Cayley graph in two cases when n is even and when n is odd. [15]

Construction of algorithmic significant aspect in solving a problem before being transferred to the programming language. Algorithm helped a use to do their job systematic and can he reduce working time. The real problem must be modeled into mathematical equation(s) before construct the algorithm. Then, the algorithm be transferred into programming code using computer software. In this paper, a numerical method as a platform problem solving tool and researcher used Scilab programming to solve the mathematical model such as Ordinary Differential Equations (ODE). There are various methods that can be used in problem solving ODE. This research used to modify Euler's method because the method was simple and low computational. The main purposes of this research are to show the new algorithm for implementing the modify Euler's method and made comparisons between another modify Euler's and an exact value by integrating solution. The comparison will be solved the ODE's using built-in functions available in Scilab programming.[16]

In this thesis we study three combinatorial problems motivated by questions in design theory and graph theory. We now give the motivation for each of these problems and a brief description of the results

A k-class association scheme consists of a set X and k+1 nonempty symmetric binary relations

R_0={(x,x│x∈X) };

Given any (x,y)∈R_i and (z,y)∈R_j there are exactly P_ij^t elements z∈X such that (x,z)∈R_i and (z,y)∈R_j.

One of the main examples of the above notion is the Johnson Scheme: The point set X is the set of all k-element subsets of a set S. Two k-sets A and B are declared to be i^th associates, i.e., (A,B)∈R_i, when|A ∩B|=k-i. It is easy to see that the 0^th associates are

{(A,A):|A|=and A⊂S}

and the number P_ij^l exist by symmetry.

For each R_i of an association scheme the corresponding association matrix (adjacent matrix) is defined by

A_i (x,y)={■(1&if (x,y)∈R_i@0&otherwise.)┤

Let A denote the linear span of A_0,A_1,…..,A_k over R. Note that the matrices A_i are independent and closed the Bose-Mesner Algebra of the scheme. [17]

Nanotechnology Engineering applied ideas from chemistry, quantum physics, biology, and electronics to build objects through manipulations at the atomic or molecular level. We can use mathematics science, and engineering to model, design, and make structures for sensors, electronics bio-systems, or advanced materials.

Since mathematics is the language in which theory is expressed and advanced, developments in applied mathematics are central to the success of theory, modeling, and simulation for nano science. Novel applied mathematics is required to formulate new theory and to develop new computational algorithms applicable to complex systems at the nano scale. The collaborative efforts between scientists in nano science and applied mathematicians can yield significant advances central to a successful national nano science initiative. [18].

In this paper I discuss what, according to my long experience, every computer scientist should now from logic. We concentrate on issues of modeling, interpretability and levels of abstraction. We discuss what the minimal toolbox of logic tools should look like for a computer scientist who is involved in designing and analyzing reliable systems. We shall conclude that many classical topics dear to logicians are less important than usually presented, and that less-known ideas from logic may be more useful for the working computer scientist. [19]. S.Sekar, M.Nalini proposed model on Analysis of the Non linear Singular systems using Adomain Decomposition Method may be used in our research methodology.

III. CONCLUSIONS

This literature review paper discussed about various strategies of an research methodology on application of Graph Theory with focus of application case study of Big networks for Big Data in Computer Science. Future work includes deriving mathematical models with implementation on software case studies based on the proposed model of the research here.

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