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Application of Graph Algorithm in Social Network

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***Abstract**: Graphs are mathematical structures used to study associations between objects and entities. Graph theory can be used to study and model social networks. The prime graph theoretic problems twig with shortest path problem, topological sort of the graph and spanning tree. The social network analysis is an interdisciplinary area to recognize the composition of the relationships between social units such as an individual, family and cluster. Ubiquitous social network applications unified with computation can be nimble fingered adroitly with graph structures. Graphs offer an intuitively visual way of thinking about the concepts of relationship found in social network analysis. Operations like insertion, deletion, traversal and merging can be substantiated with the representation of graph. This paper explores how social network can be palpable with the existing algorithms which squeezed graph theoretical concepts.*

***Keywords**: Adjacency Matrix, Breadth First Search, Depth First Search, Graph Algorithm, Node Link Diagram, Social Network*

I. INTRODUCTION

Graph Theory is the branch of discrete mathematics which has variety of applications in computer science, chemistry, linguistics, operations research, sociology and so on [1- 4]. The social network can be symbolized as graphs. Social network analysis using graph algorithm is a developing area of research on the analysis of interactive data. Graphs can help to analyze the relationships between different pairs that are entities in a social context [5- 7]. Graph depiction helps to disentangle complicated methodical glitches. In social network, graph notion is being used to mine frequent substructure pattern from big data [6, 7]. The prevalent algorithms which espoused in graph theory help to identify the shortest path and optimal path exploration. There are numerous algorithms existing which embraced graph theoretical concepts and these algorithms are used to extract the information about social network. The social network analysis is an interdisciplinary area to forecast the composition of the relationships between social units [6]. As an area of buoyant reputation, the methods of social network analysis are probable to see significant growth in the years to come. This paper, explores how graph theory in social network is cogitated.

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II. GRAPH ALGORITHM

Graph is a pair of sets denoted as G = (V, E), where V and E are the set of vertices and edges respectively. Figure 1 shows a directed graph representation, where V = {a, b, c, d} and E = {e1, e2, e3, e4}.

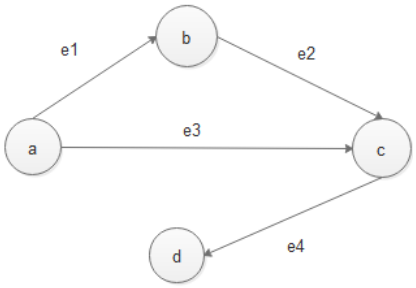

Figure 1: A directed graph representation

A graph can be symbolized in numerous ways. These include Set representation, Linked representation and Matrix representation [3, 4]. Set representation is one of the straightforward methods of representing a graph by maintaining two sets. Linked representation is another space saving way of graph representation. This can be done by assuming node structure for non- weighted graph and node structure for weighted graph. Matrix representation is the best worthwhile way of representing a graph. This procedure uses a square matrix of order (n x n), n being the number of vertices in the graph. Passes in the matrix can be computed as follows: a_{ij} = 1, if there is an edge from v_i to v_j; a_{ij} = 0, otherwise. Graphs can be indorsed in two diverse procedures. These are adjacency matrix and adjacency list. The adjacency matrix fashioned with rows and columns as the vertices of graph. The one row of adjacency matrix is with set of neighbors of a vertex. On the other hand, the adjacency list is a cluster of lists with its neighbors. The data depiction in realistic frameworks is the adjacency matrix, (n x n) matrix, where ijth cell is equal to 1 if vertex i sends an edge to vertex j, and 0 otherwise. In the case of undirected graph, the adjacency matrix must be symmetric. An undirected graph G with adjacency matrix A, A_{ij}= $A_{ji.}$ If G has no loop, then all rudiments of the diagonal of A will be 0. Otherwise, A_{ii} =1 if vertex i has a loop. The adjacency matrix representation has the detriment that it constantly requires an (n x n) matrix with n vertices, willy-nilly of the number of edges. If the graph is clear cut sparse, the majority of the entries are null. But from the operational point of view, this depiction is the best.

In tree pattern, there is a hierarchical rapport between parent and children. That is, in tree structure, one parent and many children. On the other hand, in graph, the connection is from numerous parents to many children. Operations on Graphs include insertion, deletion, merging and traversal [3]. Insertion operation helps to insert a vertex and hence establish connectivity with other vertices in the principal graph. Deletion operation helps to delete a vertex from the graph and to delete an edge from the graph. With the help of merge operation, we can combine two graphs G1 and G2 into a single constituent. This can be spick and span by instituting one or more edges between the vertices in G1 and G2. Let us define this operation such that it will merge two graphs G1 and G2 over a set of edges and reappearance a new graph G. This can be done by bootlegging all the adjacency lists from G1 and G2 to the adjacency list of G and then establishing edges among the given vertices. Operations like insertion, deletion, traversal and merging can be conceded in matrix representation of graph. It can be comprehended that, in this representation all these operations are computationally efficient.

Graph Traversal helps to visit all the vertices in the graph exactly once. A number of methods are known to traverse a graph scientifically, out of them two methods are recognized as standard. These methods are called Breadth First Search (BFS) and Depth First Search (DFS). With these traversals, starting from a given node we can visit all the nodes which are reachable from that starting node. In Breadth First Search, the notion is to start from a vertex, and then visit all its neighbors and then visit neighbors of its neighbors in orderly. A queue is a best data structure to record the neighbors of a vertex, once a vertex is visited. On the other hand, in Depth First Search, the idea is to start from a vertex and first visit one of its neighbors, and then one of its neighbors until the recent vertex has no unvisited neighbors. A stack is a upright data structure to record the neighbors of the visited vertices by this technique. DFS traversal is analogous to the in order traversal of a binary tree. Starting from a given node, this traversal visits all the nodes up to the innermost level. The enactment trace of the BFS traversal is almost same as the DFS traversal. Contrariwise in BFS, we will use a queue structure instead of a stack structure as in DFS.

III. SOCIAL NETWORK

The notion of Graph algorithms are comprehensively used in social network [12]. Social network helps to symbolize various forms of associations in the form of links [7]. Networks can be represented using graph theoretic notation [5, 6]. Network data are represented either in the form of matrix or vector. Networks are commonly represented through lines in which each vertex is represented by a circle, with lines connecting the shapes associated with end to end vertices. For the studies of social mobility, citations in Science, kinship structure, relationship among members of groups, corporate power, trade exploitation, class structure and many other areas, Social network analysis has been used [6]. Graph algorithm can unswervingly use in social network. For example, in Facebook, each person as nodes, and tag, share and likes as edges. On the other hand, in Twitter, persons are considered as nodes and if someone follows the other; that is revealed as the edges between persons. Social network analysis is probably the best known application of graph theory for Data Science.

IV. APPLICATIONS OF GRAPH ALGORITHM IN SOCIAL NETWORK

A graph is a pictorial representation of a network with the duo of vertices and edges. Graphs act as the key for social media mining, in which data is obtained from user generated content on social networks. This will help in extracting patterns, forming conclusion about the users and analyzing relationship among the data found. Thus, it can provide information for the purpose of advertising to users or conducting researches. Graph searching algorithms are used for the purpose of Social Network Analysis which helps to locate, and identify information about the entities in social context.

Currently, heterogeneous applications interconnected with computation can be accomplished adroitly with graph structures. Transportation problem is an acquainted problem in shipment [4]. Assume there are several warehouses which are strewn over geographically different places. The solution to transportation problem helps to ship merchandises from a particular warehouse to another. Map coloring is an interesting problem- that is to color a map so that no two adjacent sections have the matching color [1, 3, 4]. This can be symbolized with the help of graph; each section is epitomized as vertex. If two areas are adjacent, we can denote this by an edge in the middle of two vertices which represent two sections. The foremost graph theoretic problems encompass shortest path problem, topological sort of a graph and spanning tree [1]. In shortest path problem, a graph helps to find a trajectory between two vertices in such a way that this route will mollify specific benchmark of optimization. This problem can be address with diverse algorithms. Some of them are Warshall's algorithm, Floyd's algorithm and Dijkstra's algorithm [8, 9, 13]. Warshall's algorithm helps to identify a path from any vertex v_i to vertex v_j either directly or through one or more transitional vertices. That is, we can investigate the accessibility of all pairs of vertices in a graph. The path matrix gifted using Warshall's algorithm shows the incidence or nonappearance of certain path between a pair of vertices. It helps to discover the existence or skiving of a cycle in the vertex. If weights are to be taken for interpretation by considering the length of the shortest path between pair of vertices, then the best solution is Floyd's algorithm. The elementary structure of the Floyd's algorithm is same as Warshall's algorithm. Dijkstra's algorithm helps to address the single source shortest path problem. Dijkstra's algorithm gives the solution to find the shortest path from source vertex to all other vertices.

Topological sorting is another application of the graph structure. This helps to diktat the vertices of a graph, such a way that, if there is a route from u to v in the graph then u acts before v in the ordering. Spanning Tree is a notable graph structure; here, the graph G can be defined as a tree which comprises all the vertices of G. It is possible to observe that the DFS and BFS traversals on graph results into two trees as DFS spanning tree and BFS spanning tree and these are realized by DFS and BFS traversals [1, 10, 13]. Spanning tree whose weight is the tiniest is called a minimal spanning tree of the graph.

Two popular algorithms for constructing minimum spanning trees are Kruskal's algorithm and Prim's algorithm [1]. In Kruskal's algorithm, let us adopt an undirected weighted graph with n vertices, initially the spanning tree is unfilled. Prims algorithm does not require entry of all the edges in the increasing order of weights or ascertaining each step to find whether a recently selected edge run through a circuit or not [14]. According to Prim's algorithm, a minimum spanning tree matures in consecutive phases. At each phases in the algorithm, it is possible to observe that the set of vertices that have previously been included in the tree and the residual vertices are not roofed. The Prim's algorithm can straightforwardly be instigated using the adjacency matrix portrayal of graph. Sugiyama-Tagawa-Toda algorithm has the potential to locate the positions of the nodes and edges on the levels of a hierarchical layout [11]. PageRank algorithm does link analysis and arrange for the ordering of web explorations [15]. The social network can represent graphically as node link diagram, where nodes and edges are small graphical object and line segments respectively. Figure 2 represents relationship within entities in a social media (say, Facebook). Here, "western music" and "fantasy tales" are two of the official groups that exist in Facebook.

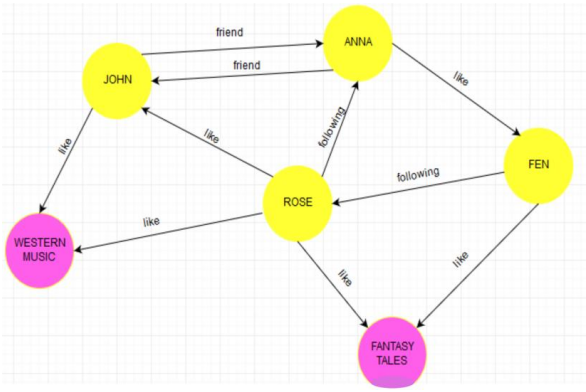

Figure 2: Relationship within entities in a social network

V. CONCLUSION

The article explores graph theoretic fundamentals that are used in social networks. The application of graph algorithm over social data helps to figure out an enhanced underpinning for social network. We have presented certain elementary blueprint of graph algorithm and its basic application in the within social network. The graph theoretic methods of social network are magnanimous to visualize the network.

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Megha Narayanan stood first in both BCA and MCA degree examinations of Kannur University in 2016 and 2018 respectively. Her areas of interest are AI techniques, algorithms for Big Data, and decision making under uncertainty. Presently, Megha is doing research in Data Visualization methods.

Sanil Shanker KP did his PhD in Computer Science from the University of Kerala in 2011. He was the recipient of European Research and Educational Collaboration with Asia Research Fellowship in 2009. Sanil successfully completed Kerala State Council for Science, Technology and Environment (KSCSTE), and UGC funded research projects in the year 2015 and 2016 respectively. He has more than a dozen published papers to his credit. His areas of interest include computational structures in Data Science, computational complexity, graph algorithm for complex network and Information Visualization. At present, he is working as the Assistant Professor in Computer Science under the Directorate of Collegiate Education, Government of Kerala.