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An Approach for Exploring Practical Phenomena in Social Network Analysis

Manoj Kumar Srivastav and Somsubhra Gupta

School of Computer Science, Swami Vivekananda University, Barrackpore, West Bengal, India.
*Email: mksrivastav2015@gmail.com / gsomsubhra@gmail.com

Abstract

Social networks like Facebook, LinkedIn, Twitter, WhatsApp, etc. have appeared more often these days, and their importance and influence in human life are growing rapidly. A social network is useful for connecting people to communicate and share information with one another in a virtual setting. A member of a social network can establish relationships with individual members or groups of members in that network. Utilizing networks and graph theory to construct social structures is the process known as social network analysis (SNA). The mapping and measurement of relationships and flows between individuals, groups, organizations, and so on is known as social network analysis (SNA). Social networks are represented using the concept of graph theory, where members of a social network are represented as nodes, and relationships between members are represented by edges, representing links, connections, and so on. The nodes represent the members of the social network, and the relationships between them are formed by the concept that there is either a direct or indirect path between them. Generally, members of social networks can establish relationships with each other using a one-to-one or one-to-many concept. The manner in which two or more members of a social network communicate or act toward one another constitutes relationships. The representation of social networks using graph theory helps to understand the trends in research on the relationships between different types of nodes and to predict the behaviour of nodes in social network analysis. The natural process of learning by doing is the subject of a subfield of computer science called machine learning (ML). ML assists in identifying patterns and the structure of node-to-node relationships in social networks. This paper attempts to study relationships among members of social networks using mathematical graph theory and machine learning.

Keywords: *Social networks, relationship, trends, machine learning.*

1.0 Introduction

Social network analysis, or SNA, is the process of identifying, analysing, and mapping the connections and flows among individuals, teams, communities, businesses, computers, URLs, and other entities that share information or knowledge[2]. In 1954, Barnes first used the phrase "social network"[3]. In the last decade, social networks have grown rapidly, piquing society's interest in communicating through online platforms. A network or graph G (V, E) consists of nodes, vertices, or entities (V), and edges, links, or relations (E). A simple graph is one that does not have parallel edges or self-loops[4]. A simple network does not have any self-loops (an edge whose ends are the same) or parallel edges (multiple edges whose end nodes are the same)[5]. Edges in an undirected graph are without direction. Due to the fact that each edge can be traversed in either direction, edges exhibit bidirectional relationships. A directed graph has directional edges. If each edge can only move in one direction, their relationship is unidirectional. Directed edges can be asymmetric and irreversible, while undirected edges are symmetric and reversible. Additionally, an edge might be given a weight to represent its strength. For example, on Twitter, the network of followers and followers is a directed

**Author for correspondence*

and unweighted network, while the Facebook friend network is an undirected and unweighted network. The user-to-user Twitter response network is a directed and weighted network with users as nodes; the link shows if a user has replied to a message from another user, and the weight of the edge shows how many times such replies have appeared before[5]. Social network analysis (SNA) is a field of data analysis that uses graph theory to understand social structures. Creating SNA diagrams requires two main components: users and relationships. Users who join social networks and form relationships with other members in the network. The process of instructing computers to perform particular tasks based on the natural learning processes they already possess is covered by machine learning (ML)[6]. Machine learning will be able to manage datasets based on Facebook, Twitter, YouTube, etc. and give some predictable results from the given dataset to understand relationship patterns and important phenomena in it[7]. This paper attempts to discuss the following social network patterns:

- Building relationships in social networks and implementing machine learning based on linear regression.
- Measures of centrality in social networks and the role of logistic regression in product advertising.
- Trust-Based Relationships and Fuzzy Logic Concepts in Social Networks.
- A decision-making approach in social networks.

2.0 Literature Survey

Shazia Tabassum et al. (2018), in their paper "Social Network Analysis: An Overview," have discussed a variety of topological networks, including perspective (ego-networks) and static, temporal, and evolving networks[8].

Michael J. Garee et al. (2018), in their paper "Regression-Based Social Influence Networks and the Linearity of Aggregated Belief," used experimental design to construct a collection of agent-based social influence networks that are comprised agents who exchange beliefs using a linear regression model[9].

Divya Sai Patnana et al. (2020) explained in their paper "Logistic Regression Analysis on Social Networking Advertisement" that logistic regression can be a powerful analytical technique for use with a dichotomous variable outcome as it is more informative than linear regression[10].

Mayadunna et al. (2018), in their paper, "A Trust Evaluation Model for Online Social Networks," have taken some selected features of social networks for the training feature and the determination of whether there is an edge serving as label information between nodes. The node trust value will also be determined using the training model[11].

K. Mittal et al. in their paper , "An Insight into "Decision Tree Analysis," discuss the theory and history of decision tree analysis, as well as its application, benefits, and drawbacks, and how decision trees represent decision making in the face of uncertainty[12].

3.0 Study of Trends In Social Networks

A. Building Relationships in Social Networks and Implementing Machine Learning based on Linear Regression

When a member joins a social network like Facebook, he wants to create a friend circle, and for this, he sends a friend request to another member of the social network. A user can ask a lot of other members to be friends with them, and those members can either accept or reject the request. The process of sending such a friend request and accepting or rejecting it introduces the concept of probability theory[13].

Models are fitted to the data using regression. The dependent variable association is a technique for determining the statistical relationship between two or more variables in which a change in one or more independent variables is linked to or depends on a change in the dependent variable[14]. Also here, linear regression helps with the predicate relationships among two or more members of social networks. Regression analysis[15] is one such statistical tool that is frequently used to perform the following steps:

(i) understanding how two or more variables are related to one another.
(ii) expressing the relationship mathematically, i.e., proposing a suitable regression model.
(iii) make predictions using the model.

(1) Algorithm

Step 1: Members of a social network send friend requests to other members of the social network.

Step 2: Other members may accept or decline your friend request.

Step 3: When another member accepts friends, the relationship between two or more friends can be understood by using two or more conditions from it.

Step 4: It is required to establish an appropriate regression model.

Step 5: Use this model to predict the appropriate purpose.

B. Measures of Centrality in Social Networks and the Role of Logistic Regression in Product Advertising

Centrality is a measure that expresses the importance of nodes in a network[16]. A user (node) plays an important role in joining a group (community social network). The node can be either in the middle position, in between, or close. For instance, a true social network has two sections: a denser section and a sparser section. In denser sub-networks, individuals are tightly connected to one another. Communities are the name given to these denser sub-network groupings. Centrality measures indicate the importance of a node in a network. There are three important aspects of centrality: degree, closeness, and betweenness[17].

Table 1: Important aspects of centrality

Degree	What number of peoples will be able to reach this person directly?[3]
Betweenness	How likely is it that this individual will be the most direct link between two other people in the network?[3]
Closeness	How quickly can this individual connect with everyone in the network?[3]

An organization can use important members of a social network to advertise a product, which will have more influence on other members of the network.

C. Trust-Based Relationships and Fuzzy Logic Concepts in Social Networks

A member of a social network can trust another member completely or never trust them to communicate via private messages. If the members trust other members completely or not at all, it is represented as {0, 1} i.e., truth table {True, False}, but there will be another situation where trust is neither true nor false but are partially either. To deal with such situation, Lukasiewicz suggested in 1920, a 3-valued logic. Everything is the same as in the 2-valued logic, with the exception of the three truth values: True, may be and false. These linguistic values are usually represented by 1, $^1/_2$, 0 respectively[18].

In the 3-valued logic denoted by L_3, the truth value of the statement can be either 1, $^1/_2$, 0 i.e T(P) = 1, $^1/_2$, 0. We define three operation on the statement p, q, r, …, denoted by $p \wedge q$ and $p \vee q$ $\neg p$ analogous to three operation or, and, and not

$T(p \wedge q)$ - max $\{T(p), T(q)\}$

$T(p \wedge q) = \min \{T(p), T(q)\}$

$T(\neg p) = 1 - T(\neg p)$

Luckasiewicz also defined the implication operation by

$T(p \rightarrow q) = 1 - T(p) + T(q)$ if $T(p) > T(q)$

$=1$ if $T(p) \leq T(q)$

Or simply as $T(p \rightarrow q) = \min \{1, 1 - T(p) + T(q)\}$ if $T(p) > T(q)$[18].

Use this formula truth table for $\rightarrow$

So, it is possible to study trust relationship in social networks using the concept of 3-valued logistic relationship[18-19].

Table 2: Truth table for

$\rightarrow$	1	$^1/_2$	0
1	1	$^1/_2$	0
$^1/_2$	1	1	$^1/_2$
0	1	1	1

D. Decision Making Approach in Social Networks

Trees are connected graphs that do not have any circuits.[4,20]. In a social network, a member has to make decisions at different stages, like which social networks to join. When a member joins a social network, it will make decisions about making friends and following other topics on the social network.

Taking decisions at different stages will form a structure like a tree. Tree models are the most popular models in machine learning, and classification and regression trees, or CART models, are decision trees. A decision tree is a supervised learning algorithm that works for both categorical and continuous input and output variables[21]. It has a predefined target variable and is mostly used for classification problems. These methods divide the population or sample into two or more homogeneous sets (or sub-populations) based on the most significant participants or differences in the input variables[22].

Example: The purpose of decision tree analysis is to show how different alternatives can create different problems that can be solved. Let us suppose that someone wants to make advertisements for products through the social network platform. Then he will look for various social networks where

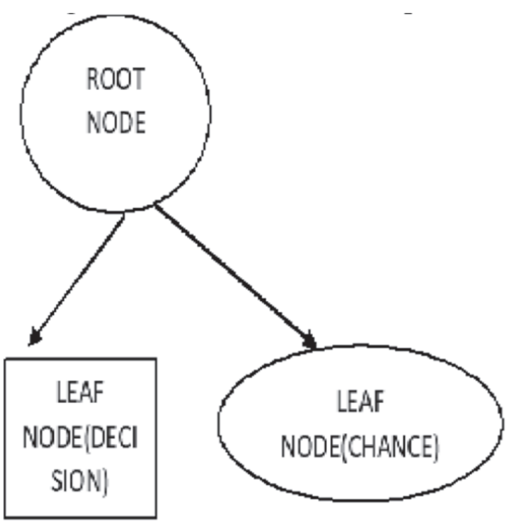

Figure 1: Decision tree concept

Table 3: Alternative representation for a product advertisement

	Types of social networks	Advertising cost	Success rate	Failure rate
Alternative 1	Facebook	\$X	P_1%	$(1-P_1)$%
Alternative 2	Instagram	\$Y	P_2%	$(1-P_2)$%
Alternative 3	LinkedIn	\$Z	P_3%	$(1-P_3)$%

Note: X, Y, Z and P_1, P_2, P_3 are real numbers and value of P_1%, P_2%, and P_3% lies between 0 and 1 (with respect to probability).

he can make advertisements and research the various criteria that will help them improve their product.

When more alternatives are available, it is possible to make a decision about which alternative is best to achieve the required goal. The following decision tress illustrates different way of displaying alternative information with respect to advertising of product through social network platform.

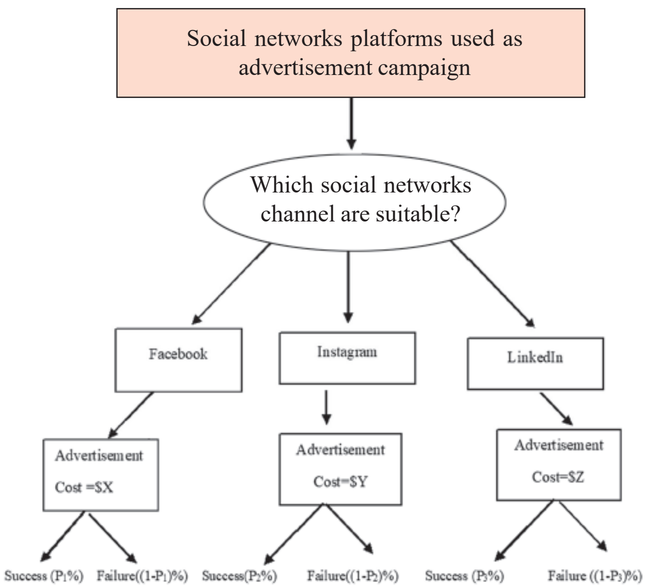

Figure 2: Decision tree approach in social networks

4.0 Conclusion and Future Scope

Social network analysis (SNA) is primarily focused on finding relationships between individuals and groups and how those relationships can be used to derive additional information about individuals and groups. The proposed research will make it possible to study the behaviour of members of social networks and will contribute to the development of a linear regression model for friendship, a logistic regression model for making advertisements through social network platforms, and a fuzzy logic concept to understand the trust relationship. A decision-making approach will be helpful to take appropriate decisions in social networks to identify the pattern of social relationships and factors that influence positive relationships.

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