

Trust Analysis Techniques in Online Social Networks: A Review

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Abstract- Online social network (OSN) has become an important aspect of everyone's life. Social networking involves connecting users with their friends, relatives, family and companions. This is internet and development of other social media technologies which allow people to communicate through social media. The very well-known social sites such as Skype, Facebook, Twitter, Instagram and LinkedIn etc. enable their users for performing various activities like sharing photos, videos and information, organize events, chat, and playing online games. In this paper, a comparison study is done on various existing trust analysis techniques which will help to identify the problems need to be focused.

Keywords— Online Social Networks, Trust analysis, Privacy

I. INTRODUCTION

Online social networks are defined as a platform that provides a virtual community for people interested in a particular field. In the past few years, social network sites have become integrated into the daily practices of millions of users. Social network is an easy and inexpensive ways to organize members, arrange meetings and spread information. Users usually belong to more than one social network. People use different social networks for different purpose of their lives. The very well-known social sites share a variety of features that provide their users a platform for performing various activities like sharing photos, videos, graphics, event organizing, chat, and playing online games [1]. Each of these networks offer varying abilities to their users to personalize their profile page in terms of look and feel and also asked for other information they would include. Online social network allows people to connect with others by sending messages (private or posting status on the wall). Another feature of online social network is privacy allowance. In Facebook, one can personalize what friends can see and those who are not his "friends." The purpose of a social network is facilitating a members' ability to find and connect to other people online. The main aim of this paper is to identify the areas of problem that are still exists in the current using trust analysis techniques. For this purpose, a comparison study is done using nine existing trust analysis models based on various parameters

Organization of the paper is as follows. Section II explains various operations perform in OSN and significance of Trust

in social media; section III introduces works of variety of authors in the field of trust analysis; section III shows the comparison among various trust analysis models; section IV concludes the paper.

II. ONLINE SOCIAL NETWORKS

Many social networking sites have their own concept of attracting users. Like Facebook provide their users a webpage where they can post all the events, incidents, their moods etc. Whatever, he/she will post on their wall, it becomes visible to all users connecting with them on Facebook. On the other hand, twitter has set trends for real time services. Especially for famous personalities, they can communicate with their fans by broadcasting their messages. Fans can tweet to their followings and celebrity's response to them by retweeting on their fans.

A. OPERATIONS PERFORM ON ONLINE SOCIAL NETWORK

Mood Tracking: OSN provide us a platform where we can share our thoughts and feelings. The term "mood" is used to describe the psychological state [3]. The study of changes of individual's moods can be inferred by tracking their online activities. A person's mood may remain stable for hours to days in length. An idea about a person's mood requires a affective communication. The psychological state of users can be understood by their participation in affective communication. Information available on OSN can contain some clue about mood changes of individuals.

Community Detection: A community is a cluster or a group of people. Community detection is a way to divide individuals into groups. People in one community correlate more with each other than the people in another community. This way of community detection can be used to make assessment about the products, services which all people in single community would like to have. There are various kind of community structures present on OSN [18].

Opinion Mining: In social network, opinion mining is the mining of statements from texts, detection of arguments having opinions. There are various online blog repositories, sites, online discussions where people can express opinions and give their review about products, share ideas, etc. As a result, social sites are the best source for gathering datasets for performing opinion mining [4,5].

Influence Propagation: Influence propagation is a strategy for influencing people in decision making. In OSN, many sites are present which can help to decide which product to purchase, which audio/ video to watch which community to join and so on. In the field of marketing, influence propagation can play an important role. Companies can convince to buy products with the help of active people in OSNs. Now a days, influence propagation in OSNs a hot topic related to mining functionalities [19].

Recommender System: Recommender systems or recommendation systems are information filtering systems that seek to predict the "rating" or "preference" that a user would give an item. Recommender systems have become extremely common in recent years, and are utilized in a variety of popular applications include movies, music, news, books, research articles, search queries, social tags, and products in general [7,8]. However, there are also recommender systems for experts, collaborators, jokes, restaurants, financial services, life insurance, and Twitter pages.

Link Analysis: With the advancement of information technology, people are moving to electronic media for communication. Link prediction in OSN is to predict future possibility of link creation between two unknown people. Bulk amount of data is available in OSN. Useful information about a person or product is analyzed and new interaction among nodes can be inferred by OSN. The application of link prediction are friends suggestion, terrorist network monitoring and building of recommender system [20].

Trust Analysis: People on OSN perform various activities like comments, like, share on each other posts. This information available on OSN can help in determining how much an individual is connected with every other user. Based on these interactions, trust factor can be calculated between

two users. If two users are directly connected, then trust calculation is quite easy. But in case if two users for whom trust is being analyzed are not directly connected, then a mediating term is required. This mediator can be another friend between them or a kind of similarity between their profiles. All this information can be collected from OSN and trust analysis can be performed.

Expert Finding: Expert finding is the important field in OSN. In expert finding, a person with some special, relevant expertise is identified. People join social networks with different goals and perform various activities. People share their knowledge on this sites. In return, they also expect some accurate and validate information on time. But finding the correct information is a difficult task. The solution to this problem is the mechanism for expert finding. By this, experts with their level of knowledge and the validity of posts can be determined [6].

Trust: Trust is a measure of confidence that a trustor will show to the trustee. Initially, the web-based social network was connecting individuals with their friends, families. With the expansion of social network services, the protection of personal information from being infected by unpredictable users has become a major concern. Users on web may be strangers to each other. In this situation, a person may face difficulty in deciding how much to trust another user. As there is no history available, people may ask their friend or friends of friends regarding the trustworthiness of a stranger. This may need a trust analysis mechanism to contact with socially distant users and also to find people through which trustworthiness of users is calculated.

Enterprises and government started exploiting the uses of social network services for improving and delivering their services to customers. Now the customer has to decide, what enterprise he has to believe in. Here, the trust play an important role. Figure 1. shows the full classifications of a social trust system. A building of social trust system is classified in to three main categories. They are (1) Trust Information Collection (2) Trust Evaluation (3) Trust Dissemination. In Trust information collection, the sources from where information regarding trust calculations are described [16]. Trust evaluation consists of the methods which use the information collected from first step and calculate trust values. Trust dissemination includes disseminating result obtained from previous step.

B ROLE OF TRUST ANALYSIS IN SOCIAL NETWORK

1) **Recommendation Models:** The main aim of trust analysis in recommendation system is to construct a trust network. Opinions of many users in a trust network are aggregated and personalized recommendations are generated.

Trust based recommendation system also enables propagation of trust over the network and make it possible to search for trustable users [10]. Further research on trust propagation explore the trust based recommendation for document references. Document, trust network, organization networks are integrated in multilayer network as document reference network. Document recommendations are made by reference-based visibility measures which refer a document if it is often referenced by important documents.

Visualization Models: Trust connections between people can be visualized as a graph. Graph show the strength of connection between two nodes. Higher number of connections between two nodes means a closer relationship exist between them. Many social network visualization tools such as ScoNetV6 (Social Network Visualization), NetVis7 (Network Visualization) and Graphviz8 (Graph Visualization) are available in the internet. The graph visualization shows the trust value and the trust strength calculated based on the frequency of transactions/comments between two users. In social network, trust visualization are very useful for analyzing and determining the level of trust in group of members. In addition, identification of most and least trustworthy, introducing of interesting and relevant product/material among the group are some important aspects of trust visualization. Trust visualization allows the provider to encourage positive behaviour and discourage disruptive behaviour.

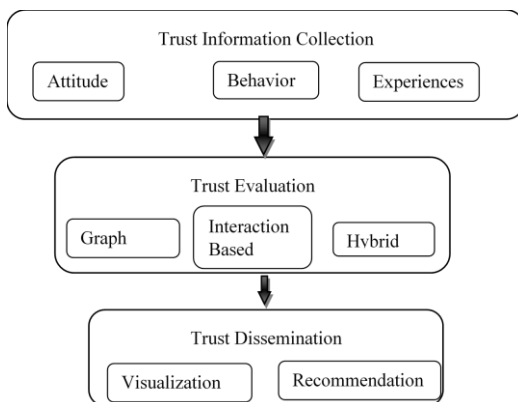


Fig 1 Social Trust System

2) **Trust Communities :** By seeing the current level of popularity of social network, users are very much concerned about privacy. For balancing the open nature of social network and privacy concerns of users, it is important to build the trust communities [2]. A community can create environment where members can share their thoughts, opinions, and experiences in an open and honest way. Members of that community need not to worry about being judged or feel any type of privacy loss. The communities are

based on authenticity, open sharing, like-mindedness and mutual respect. So, we can say that social trust provides an ideal foundations for building trust communities.

3) **Decision Making:** Calculative, emotional, cognitive, institutional, relational and dispositional are some facts of trust models. All these facts have some effects on computing trust values. These facts of trust comes into play when making decision. In computer science, the trust decisions is based on a node exceeding a certain trust threshold or having the highest trust value [2]. These facts needed to be considered in social network to reflect the human trust decision-making process. The following are some facts/aspects of trust:

- *Calculative:* This fact defines trust as the result of a calculation on behalf of the trustor to maximize the trustor's stakes in the interaction.
- *Relational (direct):* Trust is built up over time as a result of repeated interactions between the trustor and trustee. Relational trust uses the information available to the trustor from within the relationship itself. Reliability and dependability in previous interactions with the trustee give rise to positive expectations about the trustee's intentions.
- *Emotional:* The emotions define the security and comfort a trustor feel on a trustee.
- *Cognitive:* The strength of the link between members in social network structures within networks can impact the trustor's cognitive trust of the trustee. With positive referrals within the relations of social network, cognitive trust is increases in the trustee.
- *Institutional:* The institutional trust is related with the environment provided in a social network. Like an institution where cooperation between members is encouraged and misbehaviors are penalized.

Dispositional: Sometimes trustor develop generalized expectations about the trustworthiness of trustee regardless of whether the trustor has knowledge of the trustworthiness about the trustee or not. This state of mind contributes to depositional trust.

III. RELATED WORK

Trust analysis in online social networks is one of the most important issue. Several algorithms have been designed for trust calculation that deals with trust propagation and other problems related to trust. TidalTrust [9] uses a weighted average strategy to compute an inferred trust value for the destination. The TidalTrust algorithm searches for the shortest paths from the source to the destination. There could be several shortest paths between two users hence only the strongest paths among the shortest paths are considered in trust computation. The drawback of this algorithm is that it is

not efficient for longer chain as a path may also contain valuable information which should not be neglected. MoleTrust algorithm [10] takes care of this drawback. The MoleTrust algorithm is also based on shortest-path distance from the source user, but users with a propagative distance less or equal to the trust propagation horizon are considered. Trust propagation horizon is the maximum distance from the source user to which trust can be expected to propagate and is independent of any specific user and item. The disadvantage of this approach is its high time complexity.

Hasan and Brunie [11] shows the effectiveness of iterative multiplication approach for trust propagation and the results showed the significantly strong positive linear correlation that exists between trust values established from direct experience and propagated trust values derived through the iterative multiplication approach. Later, Chakraborty [12] introduced a decay factor with increase in path length for trust propagation based on simple multiplicative strategy. He integrates the path length and decay of direct trust values along the trust path into trust propagation algorithms.

Kim [13] proposed four strategies and estimated how the aggregation techniques affect the accuracy of the calculated trust. Two of those strategies use shortest paths and the other two makes use of all paths for inferring trust. The aggregation strategies are the weighted mean aggregation and the min-max aggregation. After implementing all those four, it was discovered that the weighted mean aggregation strategy gives the most accurate result.

Taherian [14] proposed a new trust inference algorithm (called RN-trust) which take trust network as a resistive network, called Res. They modelled each trust relationship between two nodes by a resistor in Res, such that the more the trust value, the less the value of the corresponding resistor. The mapping function used for calculating the resistance of a register is $R = -\log(t)$. RN-trust considered all paths not the shortest paths to compute the final inferred trust values.

Jiang [15] proposed a framework, called Distributed Breadth-first Search (DBFS), to generate trusted graphs for trust evaluation in an OSN and to compute the inferred trust. It search for trust paths between the source and the destination with length less than or equal to the L, where L is the limit of the depth value of the path. For each path, the direct trust values are multiplied and the average of the paths' values is calculated which in turn used to multiplied by the average of direct trust values between the sink and its neighbors to retrieve the inferred trust value.

Jiang and Wang [18] analyzed the similarity between trust propagation and network flow, and convert a trust evaluation

task with path dependence and trust decay into a generalized network flow problem. They proposed a flow-based trust evaluation scheme *GFTrust*, in which they address path dependence using network flow, and model trust decay with the leakage associated with each node. As a flow-based model, GFTrust has the advantage of generality, while saving the normalization process. But this method did not provide a unique path through which trust information can flow from source to destination.

Hamdi [16] introduced a new model, TISON, to infer trust relationships among people. In this model, a new TPS algorithm is proposed and a new TIM is presented. They discussed how trust inference with TISON tackles all the major problems of previously existing algorithms. A trust network is modelled to validate the effectiveness of TISON. We conducted several experiments and the results show that our algorithm can generate high-quality, trusted networks. The disadvantage of TISON is that there is no decay handling in trust network.

Liu [17] solves the problem of decay in trust network in trust analysis. To address this problem, they first proposed a new complex social network structure that takes trust, social relationships, recommendation roles and preference similarity between participants into account. These factors have significant influence on trust transitivity. Then proposed a general concept, called Quality of Trust Transitivity (QoTT), that takes any factor with impact on trust transitivity as an attribute to illustrate the ability of a trust path to guarantee a certain level of quality in trust transitivity. Finally, a novel Multiple QoTT Constrained Trust Transitivity (MQCTT) model was proposed. The results of experiments demonstrate that proposed MQCTT model follows the properties of trust and the principles illustrated in social psychology, and thus can compute more reasonable trust values than existing methods that consider neither the impact of social aspects nor the properties of trust. But this method ignores the concept of propagation in trust calculation. Also, no shortest path is taken between source and destination.

IV. COMPARISON STUDY

In this section nine models for trust analysis have taken for comparison analysis based on various parameters i.e. Handling large number of Users Counts, Shortest Path (Based on Maximum Nodes and Minimum Trust Threshold), Trust Decay, Propagative nature of trust, Composability of trust link. The resulted table is shown below.

Models for Trust Analysis	PARAMETERS FOR COMPARISON				
	Handling large number of Users Counts	Shortest Path (Based on Maximum Nodes and Minimum Trust Threshold)	Trust Decay	Propagative nature of trust	Composability of trust link
Golback's Tidal Trust Model	NO	YES	NO	NO	YES
Avesani's Mole Trust Model	NO	YES	NO	YES	YES
Hasan & Burnie's iterative multiplication approach	NO	NO	NO	YES	YES
Kim's Aggregation method	NO	NO	NO	NO	YES
Taherian's RN-Trust Model	NO	NO	NO	NO	YES
Jiang's DBFS Framework	YES	YES	NO	YES	YES
Jiang's Generalized Flow Trust	YES	NO	YES	NO	NO
Hamdi's Trust Inference mechanism	YES	YES	NO	NO	NO
Liu's Trust Transitivity Model	NO	NO	YES	NO	NO

V. CONCLUSION

In this paper, an idea about online social network is presented which has high impact on human's life. On one side, OSNs have various applications but at the other side, it also have some issues associated with it. Opinion mining, mood tracking, trust analysis, recommendation system, expert finding, community detection, influence propagation, link analysis are the actions that can use the information from OSNs. Through this paper, comparison study on various trust calculation models is presented.

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