Assessing Trust in a Classroom Environment, applying Social Network Analysis

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Abstract. This paper builds the study of social networks and their bonds with trust, through the methods of detection and description of structural properties. Networks of relationships can be mapped and managed to enhance organizational learning. Social Network Analysis (SNA) is detecting and interpreting patterns of social ties among actors. Due to trust is a crucial factor among the interaction between actors, we use NodeXL© tool to perform a case study in a classroom environment. We relate the trust measures to the clustering coefficient, centrality, and strong and weak ties which are computable characteristics of a social network. We find that more connected classes, and classes with stronger friendship relationships, enjoy more trust.

Keywords: Social Network Analysis, trust, NodeXL©, Classroom Climate, Graphs, Students.

1 Introduction

The interest in Social Networks has been increasing and evolving across a wide variety of fields and researches, such as Physics, Psychology and Computer Science. Social Network Analysis (SNA) was developed in a relatively non-technical manner from the structural concerns. Anthropologists like Radcliff-Brown started to develop a concept of social structure and a web of social life. Social networks have also been studied by Milgram's small world research [1]. SNA is a methodological tool for the analysis and study of Social Networks. The main goal of SNA is detecting and interpreting patterns of social ties among actors [2].

The specific objectives of this research lead to introducing of certain elements that help establish the conceptual frame-work of the social network. Moreover, we introduce a methodological tool for the practical analysis of social network in the classroom environment. In order to make this proposal practical, we present a case study developed in a tool called NodeXL© [3] that allowed us to create visualizations of social networks and to assist us in our analysis. In particular, we present and explore trust structures in social networks, and the influence in the network of the

weak bounds. Trust is a component which acts under uncertainty in many social interactions. We will intend to define the qualitative way of relations between different actors and their consequences under trust and weak bounds. The advantage of the use of NodeXL© is that it permits a qualitative analysis by studying networks over patterns and visualizations, that makes it easy and intuitive.

The remainder of this paper is structured as follows. Firstly, in the related work section, we describe the state of art of SNA and trust among social relations. Then, the main structure and basic concepts within the social networks are described. This section is followed by the explanation of trust and its powerful relation with SNA. Then, we contextualize NodeXL©, a powerful SNA tool which allows us to perform the study case in the next section. Also, a study of the trust among ties in a classroom through different metrics is detailed. Then, we present the results. Finally, in the last section, we describe the main conclusions and the future work.

2 Related work

Several approaches have been published about Social Network Analysis, trust and weak bounds. Among others, the work of Robert A. Hanneman [4] considers Network Analysis as a method for describing and analyzing a web of links among entities, including people. Marc A. Smith [5] adds SNA features to the familiar Excel spreadsheet with NodeXL©. Formally, a social network is formed by actors and their relationships which their content, as may be trust. Indeed, Golbeck [6] considers trust is a concept in computing systems while Sibel Adali [7] treats trust as a social tie between a trustor and trustee. In general, the difference between these proposals and ours is that we are suggesting the association between SNA and trust for a specific environment, such as a classroom, in a practical way.

Weak ties, introduced in the paper written by Granovetter [8] refer to relationships with acquaintances outside their social circle. He studied the tie between the jobseeker and the person who supplied the information that led to the job. Granovetter also estimated that new information comes via weak ties, those that are local bridges. He showed that the weak ties play an important role in the dissemination of trust, because strong ties by themselves generate fragmentation, as subgroups in a community become isolated from each other, and weak ties allow for student community integration, connecting these subgroups.

3 SNA and Trust

Newman [9] defines a social network as "*a set of people or groups of people with some pattern of contacts or interactions between them*". Part of SNA [10] studies all the interactions between individuals and organizations, and flows of information. The analysis of the relations between actors allows delimiting the dynamics of flow circulation between actors located in different places in the network. Most of the bounds among actors have a purpose or may have it because there is some interest. A

trust network is a social network in which persons are connected via explicit trust relationships.

3.1 Trust

Castelfranchi & Falcone [11] suggest that it's crucial to distinguish at least between two kinds and meanings of trust: (a) Trust as psychological attitude of X towards Y relative to some possible desirable behavior or feature. (b) Trust as the decision and the act of relying on, counting on, depending on Y. Also, they say that there are five inter-related categories: the construct, the trustee, actions and behaviors, results and outputs of behavior and the risk.
Also, with the growth of Internet, Facebook is gaining ground over other social networks. People share and reflect their whole lives online and become more comfortable, sometimes even blending their personal and professional life. Through the Facebook's privacy, users can choose who are going to include in their list of friends and who does not. In this context, it is one of the great challenges be able to assess what information to trust and who to trust [12].

Trust is a dynamic phenomenon defined as a person's willingness to be vulnerable in order to obtain benefits from someone or something. For example, trust develops between two people through shared experiences and exchange of favors, their exchanges of lower risk before engaging in higher risk exchange. In a social network, when two actors are directly connected they may have a certain degree of confidence, but for actors that are not directly connected there does not exist trust information by default. However, it is possible to obtain information and knowledge from those links that connect the network and this can be used for inferring how much one may trust others. Trust relationships are special types of social relationship. Trust edges are weighted with numeric values.

3.2 Practical trust measures

Trust is rather than a purely cognitive or emotional phenomenon a facet of the relationship and the trust construction requires reciprocal self-disclosure and affirmative responses. In a social network each user has his/her friends. Close friends have closer ties and hence higher trust, so our approach takes into consideration the social ties and trust in the social network [13]. Thus, SNA brings the explanation of behaviour of relations that requires an analysis of how the actors are connected to one another considered in a particular environment with contextual factors [7]. We now present structure-based metrics that support the identification of trustworthy individuals. We note that these metrics provide critical cues about trust, but they are not the only indicators of trustworthiness.

Clustering Coefficient. Is the ratio of how many actual edges there are between neighbours to how many potential edges that are between neighbours. To determine the diameter of a network [14], we search the distance between every pair of vertices. The diameter is equal to the greatest distance. Also is defined as the actual number of

connections among his neighbours divided by the maximum potential number of such connections.

Centrality. It contributes to our understanding of communication flows within social structures [15]. In general, centrality refers to actors who are in a central position within a social network. The centrality measure on which this research focuses is closeness centrality due to its function as a global evaluator of centrality. As a measure of reachability, closeness is a centrality measure that explains an actor's ability to easily connect to others. That is, closeness centrality explains the ties within a network placing an actor in a central location such that the persons access to information and could potentially pass that information along to others people. The average of the direct and indirect links to all others in the network determines an actor's closeness centrality [16].

Strong and weak ties. In SNA's terms, the ties or interpersonal ties are defined as information-carrying connections between people or individuals. The weak ties are more present in social networks in society as well as those most responsible for the transmission of information through these networks. Mark Granovetter [8] pointed out that the emphasis on weak ties lends itself to discussion of relations between groups and analyse segments of the social structure that are not easily defined in terms of unit groups.

The most of intuitive notions of the strength of an interpersonal tie should be satisfied by the following definition: the strength of a tie is a (probably linear) combination of the amount of time, the emotional intensity, mutual confiding and the reciprocal services which characterize the tie. The strength of the interpersonal ties can be defined as the combination of the amount of time spent in interaction, the emotional intensity, the intimacy and the reciprocal services which characterize the tie. Individuals are sometimes influenced by others with whom they or tenuous or even random relationships.

The influences are labelled weak ties. Weak ties are assumed to be responsible for dissemination of information, effective role in social cohesion. So, individuals with many weak ties are best placed to diffuse ideas of those ties ill form local bridges between different networks. Weak ties appear very suited for the transfer of knowledge, but obtaining an effective transfer of knowledge requires extensive personal contact and trust. Transferring trust is less difficult through strong ties. The strength of the relations can be indicated by its multiplicity, that appears because actors are bound by different types of ties, and this make actors stay close to each other by reinforcing their bounds.

3.3 A tool called NodeXL

NodeXL© is an extensible toolkit for network overview, discovery and exploration implemented as an add-in to the Microsoft Excel 2007 spreadsheet software. Thus, is a tool for network interactive visualization that leverages the widely available Excel application, as the platform for representing generic graph data, performing advanced

network analysis and visual exploration of networks [17]. We used this software tool, which allows us to show how a classroom is from within, by using certain metrics from SNA. NodeXL© is designed to enable Excel users to easily import, to clean, analyse and visualize network data. Extends the existing graphing features of the spreadsheet with the added chart type of “network”, thus lowering the barrier for adoption of network analysis [5].

4 Case Study: Network mapping and data extraction strategy

Because trust is a social construct, it is valid to apply this concept to various fields. One of them is the classroom environment. The classroom is a learning space in which students take the first steps into what is known as socialization. In this area are conducted countless relationships, in which ties between students are created. Furthermore, the classroom environment allows to measure social trust. Indeed, trust give rise to cooperation and directly affects the effectiveness and success of teamwork.

We use this case study to show how the combination of social network and qualitative analysis can offer interesting evaluation of trust and also, design data extraction forms to accurately record the information that researchers obtain from the primary studies. In order to apply these concepts in the classroom, it is worth emphasizing certain topics that make entanglement between SNA and ties in the classroom. To represent the classroom, we use graphs in which each node (vertex) represents a student. We consider a class consists of 30 students and a teacher named Mr. Hugh. Therefore, the dataset implemented for the present study case is as follows: Abraham, Adam, Adele, Benjamin, Bonnie, Brooke, Carol, Cedric, Connor, Danielle, Daphne, Diana, Edmond, Ellen, Elsa, Frankie, Frederic, Gavin, Georgia, Harry, Helen, Jeremy, Katy, Madison, Maggie, Maxwell, Olivia, Ralph, Randy and Rose.

It is feasible to mention that to protect the privacy of the students involved, we change the real names with fancy labels names. Furthermore, it was presented to the students a set of questions such as "*Who would you choose to study for the test?"* or “*With whom would you sit in the classroom?”,* among others, in order to indicate how they feel in relation to their peers, and any other relevant relational information such as strength of the tie. These types of test allow us to determine the degree to which individuals are accepted or rejected in a group, discover relationships between individuals and reveal the structure of the group itself. The questions may be of selection or perception type, which in turn, each may be positive or negative.

We have selected the negative questions because we can use them to differentiate between the rejected and abandoned children, to identify the social polarization of a large number of rejections, to determine the leaders and subgroups. In other words, all of these concepts fulfilled a method of social information retrieval. The content of these questions will allow us to know classroom climate and then determine the levels of trust that exist there. A good education individually and/or collectively is directly related to the human future and/or communities. In this context, it has been aimed to relate trust concept with teaching. Mitchell and Forsyth [18] claim that trust has significant implications for everyone connected with schools, and trust can be a vital

resource in establishing a healthy school climate. A classroom environment is the combination of variables within a classroom, working together to promote learning in a comfortable environment. There are many variables that influence climate (or environment) in a cl assroom, for that reason each class is unique. NodeXL© is a handy tool to map the network that is generated from the interactions among the classroom. A graph generated with NodeXL© is shown in Figure 1. In this case, the connections may involve identifying individuals with whom a student often socialized.

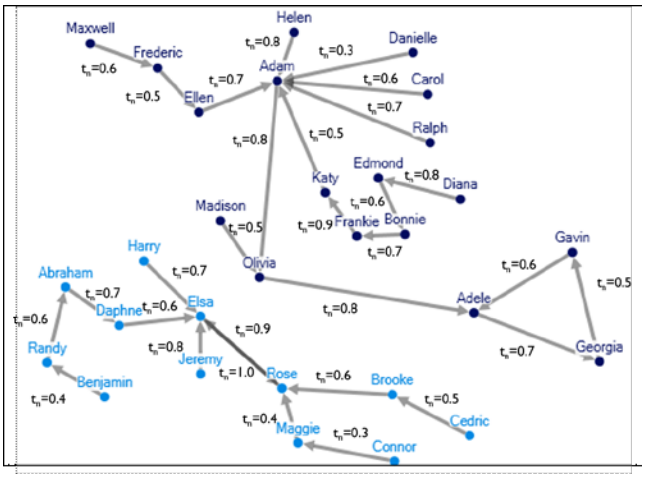

Fig. 1. Trust measures within the classroom

In Figure 1, it is possible to delimitate the trust values for each and every single one of the relations that exist in the classroom. These values vary according to the level of trust that the students put in their choices. Subsequently, the fact that they chose a partner and not another fluctuated levels of general and individual trust. This also explains the existence of two completely distinct leaders, who oversee all those who have chosen them.

4.1 Clustering coefficient: Results.

Individuals learn through group experimenting how to relate and how to strengthen these ties. Based on these links various groups may differ from the members or can strengthen and build lasting friendships. The clustering coefficient is a measure of an "*all-my-friends-know-each-other*" property. This is sometimes described as the friends of my friends are my friends. If your friends all know each other, you have a high clustering coefficient. If your friends don´t know each other, then you have a low clustering coefficient [3]. The evaluation of the clustering requires a set of community graphs as input.

We are using a principle known as "*triadic closure*" in which, if nodes B and C have a friend A in common, then the formation of an edge between B and C produces a situation in which all three nodes A, B, and C have edges connecting each other — a structure with reference to a triangle in the network. The term "*triadic closure*" comes from the fact that the B - C edge has the effect of "closing" the third side of this triangle [19]. Considering that the clustering coefficient is the fraction of pairs of neighbors who are themselves neighbors, it is feasible to mention the following example. The clustering coefficient of node A (Adele) in Figure 1 is 1/17 (because there is only the single B-C (Georgia-Gavin) edge among the pairs of friends). In general, the clustering coefficient of a node ranges from 0 (when none of the node's friends are friends with each other) to 1 (when all of the node's friends are friends with each other), and the more strongly triadic closure is operating in the neighborhood of the node, the higher the clustering coefficient will tend to be.

Through the analysis of trust by the triadic closure concept, it is achievable to delimitate the values related to each tie of the triangle. Thus, Gavin trusts Adele with 0.6; Adele trusts Georgia with 0.7; and from the tie needed to make the triangle closure we can say that Georgia trusts Gavin with 0.5. And this is the tie, the link that allows the flow of communication among them. Therefore, the structure of a classroom environment depends on the existence of trust relations between the members and the level of trust they represent.

As such we pointed out that one reason why Georgia and Gavin are more likely to become friends, when they have a co mmon friend Adele, is simply based on the opportunity for Georgia and Gavin to meet: if Adele spends time with both Georgia and Gavin, then there is an increased chance that they will end up knowing each other and potentially becoming friends. A second, related reason is that in the process of forming a friendship, the fact that each of Georgia and Gavin is friends with Adele (provided they are mutually aware of this) gives them a basis for trusting each other that an arbitrary pair of unconnected people might lack.

4.2 Centrality: Results.

One property of closeness centrality is that it te nds to give high scores to individuals who are near the center of local clusters (aka network communities), in an overall larger network. Students who are highly connected to others within their own cluster will have a high closeness centrality. This condition is shown in Figure 1, in which the students that obtain a high value are Elsa and Adam. Actors who are trusted will be more often used as information transfer conduits. Students possessing high levels of closeness centrality will maintain those positions as long as trust levels do not decline. On this occasion, there is no incentive from a vulnerability standpoint to find alternate routes of communication. Subsequently, actors are likely to utilize the most efficient communication routes through these trusted actors.

Schein's original definition of centrality is that centrality is *"denotes the person's objective position as measured by the degree to which company secrets are entrusted to him, by ratings of others of his position, and by his actual power"* [20]. The Schein's definition provides two aspects of interest to the present discussion. First, centrality involves trust (see Fig. 1). Without trust, one will likely have a decrease in

his or her ability to successfully occupy a central position in a network. In addition, centrality is, in part, a function of "*ratings of others of his position*". Thus, an actor's centrality is partially a function of his or her ability to be trusted, which in turn, leads to others rating the actor as a central player, such as Adam and Elsa (see Fig. 1).

The six directed ties to Adam present the following trust values (see Fig. 1). Ellen trust Adam with 0.7, Helen with 0,8; Danielle with 0.3; Carol with 0.6, Ralph with 0.7 and Katy with 0.5. Distinguish the fact that the first trust bond Adam may lose if something may happen is Danielle because she had the lowest value among the group that chooses him directly. By comparing to the subgroup leads by Elsa, we find that is a truly united and cohesive group of students. The trust values of all the direct ties to Elsa show us that they really trust in their leader. Consequently, whether a person trusts a given leader depends heavily on whether there exist intermediary personal contacts who, from their own knowledge, assure him that the leader is trustworthy, and who can, if necessary, intercede with the leader or his lieu-tenants on his behalf. Trust in leader is integrally related to the capacity to predict and affect their behavior [8]. Parenthetically, it is significant to mention that the made selections by both Adam and Rose possess high levels of trust. Thereby, Adam trust Olivia with 0.8 and Elsa trust Rose with 1.0. Second, the phrase "*secrets are entrusted to him*" denotes the transfer of confidential information to those who possess centrality. These conditions are precisely those necessary to create the context for successful opportunism. Therefore, in low trust situations, opportunism is perceived to be a significant threat, otherwise central actors will not occupy a position of centrality. When this is the case, closeness centrality marks the most efficient routes of communication. Closeness centrality measures actual routes, but not necessarily the most efficient routes.

4.3 Strong and weak ties: Results.

Considering two arbitrarily selected individuals – call them A and B, and the set S composed of all students with ties to either or both of them – call them C, D, E, etcetera. As Granovetter [8] pointed out in his research, the hypothesis which enable us to relate dyadic ties to larger structures is: the stronger the tie between A and B, the larger the proportion of individuals in S to whom they will both be tied, that is, connected by a weak or strong tie. This overlap is predicted to be least when their tie is absent, most when it is strong, and intermediate when it is weak. From the proposed relationship, it is feasible to specify that stronger ties involve large time commitments.

In consideration of Figure 1, we are considering Adam and Olivia as 'A' and 'B' respectively, and Maxwell as the 'C' student. Therefore, if Adam-Olivia and Adam-Maxwell ties exist, then the amount of time Maxwell spends with Olivia depends (in part) on the amount that Adam spends with Olivia and Maxwell, respectively. If Maxwell and Olivia have no relationship, common strong ties to Adam will probably bring them into interaction and generate one. Implicit here is idea that the more frequently persons interact with another, the stronger their sentiments of friendship for one another are apt to be. As such, the stronger the tie connecting two individuals, the more similar they are.

Weak ties are crucial in binding groups of strong ties together. They bring circles of networks into contact with each other, strengthening relationships and forming new bonds between existing relationship circles. As such, in Figure 1, even though there is no direct tie between Georgia and Olivia, it exists a mediator that allows the flow of information between them: Adele. The relationship of the students with their weak ties should be maintained and cultivated, knitting them networks together to encourage information free flow between the different parts of the networks. One of the most remarkable feature in Figure 1 is the presence of a bidirectional tie between Elsa, one of the leaders, and Rose. We emphasize the structure within this tie because is the only case among both subgroups in which two students choose one to another. This type of relationship is feasible be seen when the contributing nodes are friends. In contrast, the weak ties are just the acquaintances.

Conclusions

According to constructivist approach, it is important to use the techniques which allow student-teacher and student-student interaction such as discovery learning, cooperative learning, and team works. It is clear that to build teams in a class first, a trusting environment should be created. In this research we present some measures that have different meaning and give important information for the network analysis. These metrics are likely to help analysts identify trustworthy information more quickly than manual inspection, and more generally contribute to the science of representing the behavior of students interacting through social networks. It is feasible, through NodeXL©, performing the trust analysis within the network and to elaborate the results from three metrics, such as clustering coefficient, centrality, and weak and strong ties. We find that trust levels are higher in more connected communities as may be a classroom.

When trust is absent, people are reluctant to work closely together, and collaboration is more difficult. Consequently, trust promotes communication, motivation, cooperative behavior within classes and it o btains a healthier school climate. For efficient team members reciprocal and approximately equal trust levels should be preferred. Also, counselors may use these networks as signals and take necessary precautions for risky personal relationships. Trusting relationships among classmates promote knowledge exchange. In addition to formal learning activities during school time, learning process continues via these informal knowledge exchanges. For extending this research, we will consider other metrics and we will compare the trust levels of different classes, which allow us to determine the various climate of the classroom. Future work may also consider comparing the contributions of the metrics to trustworthiness or information value metrics generated by human experts, and refining the metrics by including various aspects of expert judgments.

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