

# Social Network Analysis: a practical measurement and evaluation of Trust in a classroom environment

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**Abstract.** A social network is formed by a set of actors and the relationships established by them. SNA leads to distinct goals and perspectives of social network analysis and computer science. This paper introduces the study of social networks and their relationship with trust. We study the methods of detection and description of structural properties. This covers the concepts, methods and data analysis techniques of social networks analysis. After that, we introduce the concept of trust and its relation with social networks, because trust is a crucial factor in the interaction between actors. We use the Node XL tool and a case study in a classroom environment, to test the usability of SNA techniques considering metrics to measure trust and, significantly, the power of a tightly integrated metrics/visualization tool to spark insight and facilitate sense making to SNA.

Keywords: Social Network Analysis, Trust, Node XL tool, classroom

## 1 Introduction

The interest in Social Networks has been increasing and evolving across a wide variety of fields and researches, such as Physics and Psychology. Social Network Analysis was developed, initially, in a relatively non-technical manner from the structural concerns of the great anthropologist Radcliffe-Brown<sup>1</sup>. He started to develop a concept of social structure and a web of social life. Social networks have also been studied by Milgram's<sup>2</sup> small world research [11]. Nowadays, the interest in Social Networks Analysis has been increasing. There is a variety of social environments, like health, education or academic organization that involve social networks. We focused on education, in the classroom environment. This setting can be a powerful tool for creating the social environment, because students develop and maintain learning

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<sup>1</sup> Radcliffe-Brown, Alfred Reginald (1881–1955). He was a British anthropologist and a founder of structural functionalism and father of modern British anthropological theory.

<sup>2</sup> Stanley Milgram (1933 – 1984) was an American social psychologist. He developed a study known as the Milgram Experiment, his research and writings continue to influence contemporary culture and thought.

systems that not only influence their immediate partners, but also are then transmitted to others.

In this research we show Social Network Analysis (SNA) as a methodological tool for the analysis and study of Social Networks. In particular, we present and explore trust structures in social networks. Trust is a component which acts under uncertainty in many social interactions. We will intend to define the qualitative way of relations between the different actors and their consequences under trust. In addition, in order to make this proposal practical, we present a case study developed in the Node XL tool. We take into account the classroom because this is the environment where teacher and students live together and it also involves a relational dataset, and that is a structure which is derived from the regularities in the patterning of relationships among students. We use Node XL tool to create visualizations of social networks and to assist us in our analysis. The advantage of this is that it allows a qualitative analysis by studying networks over patterns and visualizations, which makes it easy and intuitive.

Several approaches have been published about Social Network Analysis and Trust. Among others, the work of Robert A. Hanneman [1] considers Network analysis as a method for describing and analyzing a web of links among entities, including people. Marc A. Smith [2] adds social network analysis features to the familiar Excel spreadsheet with NodeXL [12]. Indeed, Golbeck [3] considers trust in computing systems while Sibel Adali [4] treats trust as a social tie between a trustor and trustee. In general, the difference between these proposals and ours is that we are proposing the relationship between SNA and Trust and also introducing this relationship for a specific environment -a classroom-, in a practical way.

This paper is organized as follows: In section 2 we introduce the main Social Network concepts while section 3 describes the properties of Trust over Social Networks. Section 4 presents a Case Study with Node XL. Finally, conclusions and future work are presented in Section 5.

## 2 Social Networks: Structure and Basic Concepts

Social network approaches provide ways of analysis to think about social relationships that are neither groups nor isolated duets. We observe how the methodologies of SNA develop the study of human groups by means of analysis of interpersonal relations supported by their members. This analysis conceives and describes social patterns, explains the impact of such social structures on other variables, and accounts for the change in social structures [5].

Another field which formally studies Social Networks is Graph Theory [6] [10]. This theory is a branch of Mathematics. A graph  $G$  in graph theory is defined as an ordered pair  $G = (V;A)$  subject to the following conditions:

- $V$  is a set, whose elements are variously referred to as nodes, points, or vertices.
- $A$  is a set of ordered pairs of vertices, called arcs, arrows, or directed edges. An edge  $e = (x; y)$  is said to be directed from  $x$  to  $y$  where  $x$  is the tail of  $e$  and  $y$  is the head of  $e$ .

In social networks, nodes and vertices in a graph represent the actors and relations respectively. A social network is formed by actors, and it is also very important to try to identify the central individuals in the network. There are various types of data to take into account. Inside the data of Social Sciences, it is necessary to distinguish between attributes of the individuals. The attributes refer to different aspects, characteristics, and intrinsic properties of the individuals such as opinions, age, sex and so on. Actors do not act independently. For this reason, we characterize the actors and after that we develop a concept of relations. Relational data are the contacts, ties and connections, which relate one actor to another and so cannot be reduced to the properties of an individual actor. The relations connect pairs and express linkages of actors. The relations are specific to the context, and the context depends on the actors' interactions. Examples of relations are friendship, job relations, flow of information, and so on.

## **2.1 SNA Definition and its Application**

SNA refers to structural analysis. It has developed as a measurement and analysis of the social structures over the relationship between different types of actors like individuals, corporations and so on. In the organizations, SNA as simply stated is the study of how information flows in with whom are employees most connected, to whom they turn for information or advice, and identifies the roles individuals and departments play in the overall social network of the organization. In a certain way, SNA is focused on uncovering the patterning of people's interaction. Network analysis is based on the intuitive notion that these patterns are important features of the lives of the individuals who display them. For this reason, network analysts show how an individual life depends largely on how that individual is tied into the larger web of social connections. SNA, whose aim is the formal study and analysis to describe and characterize relational social systems as well as their regulatory framework, makes dynamics.

## **2.2 Properties of the Relationship between Actors in SNA**

Part of SNA 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 between actors have a purpose or may have it because there exists some interest. Therefore, the interpersonal bounds in a network are characteristic by the roles and the context of the roles they have. In this section we present some of the most important properties of the relations in a social network. Signs of the strength of the relations [5] are the frequency and the length. In many cases, people frequently interact and maintain close relationships in the course of time, but it is not so in most cases, a high frequency in the contacts does not imply high intensity in the relationship, as we can observe in weak ties' links that bound actors who frequently see each other as the porter, supermarket employee and so on. The strength of the relations can be indicated by its multiplicity. The multiplicity

appears because actors are bound by different types of ties. These links make actors stay close to each other, and reinforce their bounds. Also, it is important to take into account the length of the relations; this is related to the networks which have a dynamic character. This character of the network appears because sometimes the relations are more or less persistent, or also it might be for the existence or not of its actors. Finally, it is necessary to take into account the directionality of the relations. Sometimes the relationships between actors are reciprocal and their directions do not matter, and they are important in some type of relations like parenthood or friendships.

### **3 Properties of Trust over Social Networks**

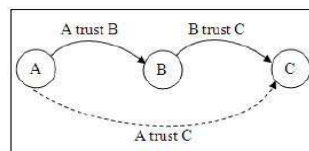
Trust is present in every situation in everyday life, besides it is an important requirement of every kind of relationship. This is because it allows to overcome doubt during different acts, and as an important value with high social capital, as the main asset of the social relations between people. Trust can be a social capital when there are situations where asymmetric information and knowledge are present. For example, when a person is ill and goes to the doctor the information is asymmetric because it supposes the patient's acceptance and belief on medical advices, in view of the seriousness of the situation, so the patient needs to trust.

Lately, the topic of trust has been generating increasing interest in different studies. We are considering prior approaches to the study of trust, including the concept of trust and how this concept is brought by different approaches such as Physiological, Social and Computer Sciences [7]. From that on, different approaches to trust have been developed, like the relational approach which intends to predict behaviour based on strategic calculus. Another one is an interpersonal approach, and it intends to centre in a cultural aspect. Furthermore, a clear understanding of trust and its causes will facilitate its introduction to social networks. As we have seen in previous sections, social networks are based on shared values, interests and relationships between members. In addition, they offer a powerful way to promote employees or business people and they help individuals to build credibility and influence, but the most important value is trust. So trust can be seen as part of the supporting network of any person attachment in closer relationships, reducing the complexity of social environment.

In contemporary Computer Science research there also exists another concept which is interrelated with trust, and it is reputation. Reputation is defined as the opinion or perspective of someone of or something [8]. Trust is the belief one agent has that the counterpart will do what he has promised and that it will be reciprocal even if there exists an opportunity of abandoning it to obtain a higher profit. The relationships between them are established, for example, when we observe the e-commerce buyers and sellers have reputation, if a seller has a low reputation. Given this information, potential buyers form opinions and infer the reputation about him, and this leads to potential buyers not to trust him, so reputation is established during the actions across time.

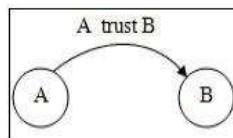
New and diverse methodologies have begun in a variety of academic research. From that, it is possible to take into account some interesting points. With the growth of Internet, Facebook<sup>3</sup>, with its 250 million members, is gaining ground over other social networks. People share and reflect their whole lives online and become more comfortable, sometimes even blending their personal and professional life. Some users take advantage of Facebook's privacy, because social networks make the importance of social information explicit in aiding members of a social network to choose whom they want to partner with or who they want to avoid. Solving whom to trust and what information to trust is becoming a powerful tool. 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 walks that connect the network and this can be used for inferring how much one may trust others. Formally, as we have seen in previous sections, a social network is formed by actors and their relationships. When we mention the relation it is necessary to consider its content. The content of the relations in a network may be trust. A trust relationship in a social network is made when a pair of actors like A and B trust each other, and the collection of trust relationship of all entities in a social network leads to a graph. But to calculate trust relationships in the network it is necessary to know properties of trust that are mentioned in the next section. Also, in this section we present the qualities or features, like transitivity and asymmetry that belong to and make them recognizable to trust [7].

1. *Transitivity*: Trust transitivity means, that if A trusts B, and B trusts C, then A will also trust C, as we see in Fig.1.



**Fig. 1.** Trust between actor A and C

2. *Asymmetry*: Trust asymmetry means that trust is not necessarily identical in both directions, and it depends on interpersonal experiences, as we see in Fig. 2.



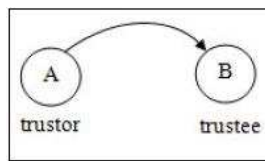
**Fig. 2.** Trust asymmetry

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<sup>3</sup> es-es.facebook.com/

Previously we have provided a definition of trust and extensions to a possible formalism for describing trust. In this section we present the qualities or features like transitivity, personalization and asymmetry that belong to and make them recognizable to trust. Previously, we have introduced the concept of trust, but it is necessary to focus on involving two specific parties, a trusting party trustor and a party to be trusted (trustee). Trustor and trustee, can represent entities like organizations, banks, people, and students and so on, as we see in Fig.3.

- Trustor: The higher the trustor propensity to trust, the higher the trust for a trustee prior to availability of information about the trustee.
- Trustee: The trustee has some characteristics that will lead to be more or less trusted, but we are considering one, which is the most important: the ability. The ability is a relationship with a specific domain; a company's manager might have management abilities like leadership, strategic, direction, oversight, coordination, organizational skills, some characteristics of the position and does not have the ability of manufacturing the product an employee has.



**Fig. 3.** Trustor and Trustee

#### **4 A case Study with Node XL**

NodeXL [12] is a tool for interactive network visualization and analysis that leverages the widely available MS Excel application as the platform for representing generic graph data, performing advanced network analysis and visual exploration of networks. Node XL is a practical tool, because it uses a highly structured workbook template that includes multiple worksheets to store all the information needed to represent a network graph. In the next section we try to link the theoretical focus to a practical case study [9].

Above in this section and subsections, we present and we refer specifically to a practical case study in a classroom environment. Furthermore we use this case study to show how the combination of social network and qualitative analysis can offer interesting evaluation of trust. The classroom is the environment where teacher and students live together. When teaching and learning take place, a process begins and it is affected by relationships. Interactions and relationships between teachers and students, and among students, as they work side by side, constitute the group processes of the classroom. Social network analysis is the study of social structures. It involves relational datasets. We obtain that from the regularities in the patterning of relationships among students.

#### 4.1 How to map the network with the tool

The classroom environment allows to measure social trust. For representing a classroom we use graphs. In this case each node or vertex represents a student, and also the teacher. We take into account a class formed by 13 male plus 8 female, a total of 21 students. We specify above the student's name followed by a space and either an "m" or "f" to indicate gender. The list of the student's class is: Mrs. Bittner (the teacher), Andrew, Anna, Brittany, Casey, Connie, Don, Greg, Jamie, Joseph, Kay, Lawrence, Matthew, Miranda, Patty, Rebecca, Richard, Ricky, Rodney, Toni, Troy and Victor.

Each actor can be provided with a list of all actors in the network and asked to indicate those with whom he or she has a particular relation (and any other relevant relational information such as strength of the tie). We simulate this asking to each actor the names of people to whom he or she is connected in a particular way. This can be done for each student who chooses to sit near whom and who he would like to play with (Fig. 4 shows that). In this case, connections might involve identifying people with whom a student expresses with he or she frequently socializes.

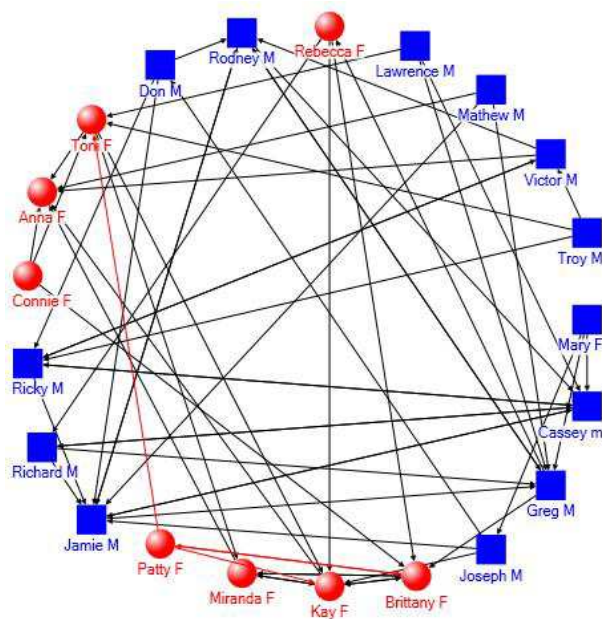


Fig. 4. Sociogram that represents Classroom with Node XL

After we simulate, we ask them about specific instances of past trusting behaviors. For example when considering the next question to the students, did the level of trust you had with the other students affected the way you communicate with the other student and the outcome of the dispute?. Students answer this questions and maps this in a sociogram as we see in Fig. 5.

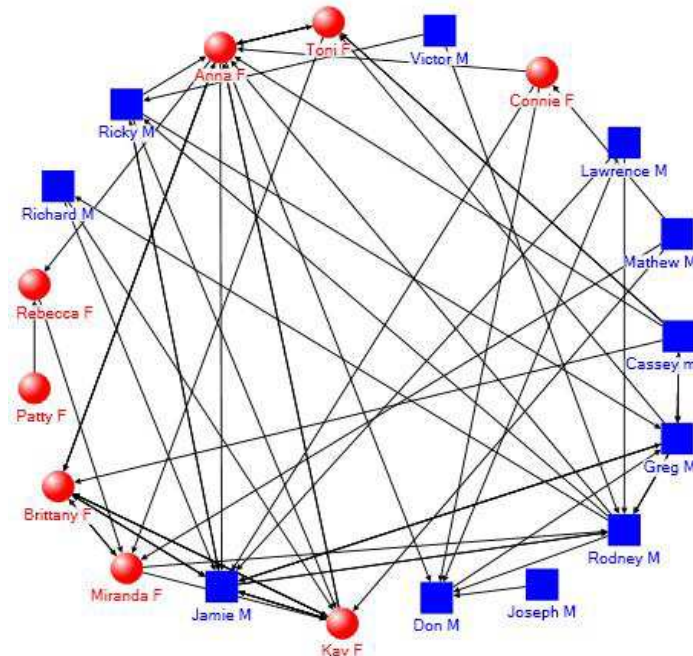


Fig. 5. Sociogram that represent trust with Node XL

#### 4.2 Some results

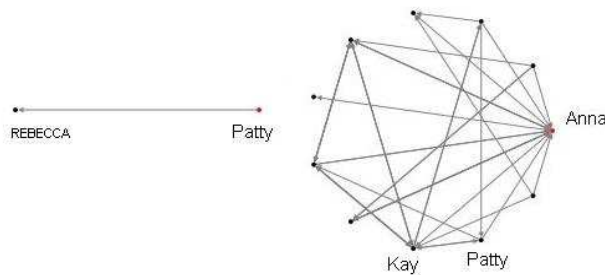
In this section, we present some different measures that have different meaning and give important information for the network analysis. Also these sociograms above may provide very valuable information to you about the interpersonal dynamics of your classroom. The tool allows calculates a set of metrics, like path length data for networks, Vertices (the number of nodes in the graph), Unique Edges, Edges With Duplicates, Total Edges, Self-Loops, Connected Components, Single-Vertex Connected Components, Maximum Vertices in a Connected Component, Maximum Edges in a Connected Component, Maximum Geodesic Distance (Diameter), Average Geodesic Distance, Graph Density.

- Degree: in this case is a positive measure in relation to the classroom, it reveals the more one student has relationships with, the greater the chance that one of them has the resources that he need. In this case study, the biggest, we have Anna with 11.
- Betweenness centrality: Students with high betweenness link together students who are otherwise unconnected, creating opportunities for exploitation of information. In this case study, the biggest, we have Ana with 81,72.
- Closeness: It is the greater distance to other students, the less the chance of receiving information in a timely way. In this case study Patty with 0,0018 has a low closeness, much lower than the largest, in this case Anna.



- Eigenvector Centrality: In our case it is a trust measure, because when a student has high eigenvector scores, he is well connected to others. In this case, the quality of the relationships established between students of any given social group, permits the growth of each student in particular as well as that of the group as a whole. In this case study, the biggest is Ana.

Also, we examine transitivity; like A trusts B, also B trusts C. In this case study, Patty only trust Rebecca versus Kay trust Jaime, Jaime trust Anna, as we see in Fig 6.



**Fig. 6.** Representing some concepts of Trust developed in section 3

## 5 Conclusion

Nowadays, people are changing the ways of communication due to the extraordinary proliferation of online social networks where they interact. The methodological approach of the study of human social interactions is designated as social network analysis (SNA) and allows studying the knowledge of social phenomenon in depth.

Early in this work we have presented some concepts related to SNA. In the first place, we intended to clarify the notion of SNA with a definition. Social Networks are a series of connections between people and they have rules for distributing information to people, based on their connections. Besides, people share ideas, mutually agreed friends and also connect and share rules of the social network. Their choices determine what others see and how they are connected to others. The connection and exchange between people are the most important sources of information and knowledge, and this is it because people trust more those who they know than those who they don't. As regards trust as a crucial factor in social network, it is used to build strategic connections and relationships that bring information and access which people do not currently have in a small circle of friends or colleagues.

Previously we intended to introduce the concept of SNA, and also some concepts of trust. In this way we showed a practical case study, that displays some metrics and properties of SNA and Trust, in a classroom set. On the whole, trust has given rise to exploit new studies cases, to extend this research applied to other domains, such as productive organizations.

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