Social Networking Analysis

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Abstract A social network indicates relationships between people or organisations and how they are connected through social familiarities. The concept of social network provides a powerful model for social structure, and that a number of important formal methods of social network analysis can be perceived. Social network analysis can be used in studies of kinship structure, social mobility, science citations, contacts among members of nonstandard groups, corporate power, international trade exploitation, class structure and many other areas. A social network structure is made up of nodes and ties. There may be few or many nodes in the networks or one or more different types of relations between the nodes. Building a useful understanding of a social network is to sketch a pattern of social relationships, kinships, community structure, interlocking dictatorships and so forth for analysis.

1 Introduction

Communication is and has always been vital to the growth and the development of human society. An individual's attitudes opinions and behaviours can only be characterised in a group or community [5]. Social networking is not an exact science, it can be described as a means of discovering the method in which problems are solved, how individuals achieve goals and how businesses and operations are run. In network theory, social networks are discussed in terms of node and ties (see Fig. 1). Nodes are individual actors and ties are relationships within networks. The social capital of individual nodes/actors can be measured through social network diagrams, as can measures of determination of the usefulness of the network to the actors individually [4]. The shape of a social network helps determine a network's

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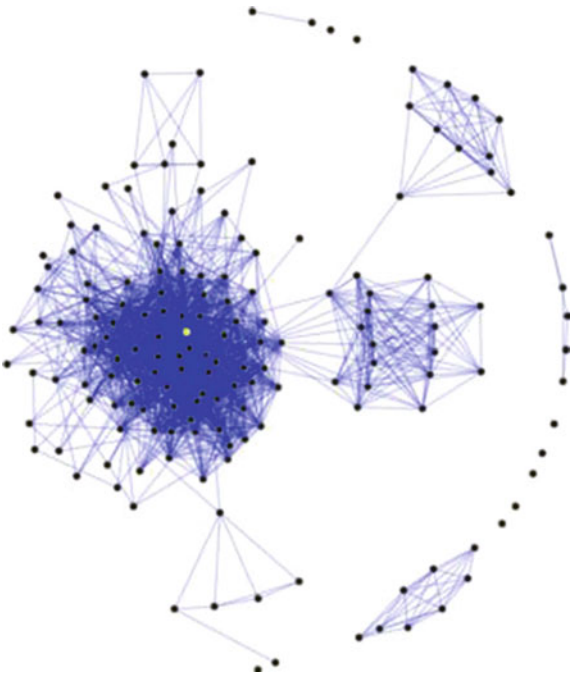

Fig. 1 Social networking diagram

usefulness to its individuals. Smaller, tighter networks can be less useful to their members than networks with lots of weak ties to individuals outside the main network. More open networks, with many weak ties and social connections, are more likely to introduce new ideas and opportunities to their members than closed networks with many redundant ties. In other words, a group of friends who only do things with each other already share the same knowledge and opportunities. A group of individuals with connections to other social worlds is likely to have access to a wider range of information. It is better for individual success to have connections to a variety of networks rather than many connections within a single network. Similarly, individuals can exercise influence or act as brokers within their social networks by bridging two networks that are not directly linked essentially filling structural holes [1].

Resulting graphs from node/tie diagrams can be complex. Social Networks operate on many different levels from families up to nations, and play a critical role in determining the way problems are solved, organisations are run and the degree in which people succeed in achieving their goals. Below is an example of a social network diagram, the node with the highest betweenness centrality (Betweenness—The extent to which a node lies between other nodes in the network. This measure takes into account the connectivity of the node's neighbours, giving a higher value for nodes which bridge clusters. The measure reflects the number of people who a person is connecting indirectly through their direct links, and Centrality—measure

giving a rough indication of the social power of a node based on how well they "connect" the network) is marked in yellow [11].

A few analytic tendencies distinguish social network analysis. There is no assumption that groups are the building blocks of society: the approach is open to studying less-bounded social systems, from nonlocal communities to links among websites. Rather than treating individuals (persons, organizations, states) as discrete units of analysis, it focuses on how the structure of ties affects individuals and their relationships. In contrast to analyses that assume that socialization into norms determines behaviour, network analysis looks to see the extent to which the structure and composition of ties affect norms.

In fact, long before it became the commercialised and significant entertainment juggernaut that it is today, social networking was nothing more than a theory. However, this theory of social networking stems back as far as the late 1800s as numerous sociologists were able to outline its basic principles [6]. German sociologist, Ferdinand Tönnies was a major contributor to sociological theory and it was him who initially highlighted that social groups exist by containing individuals which are linked together through shared beliefs and values. By the turn of the twentieth century, another major German sociologist, Georg Simmel became the first scholar to think appropriately in social network terms. Simmel produced a series of essays that pinpointed the nature of network size. He further displayed an understanding of social networking with his writings as he highlighted that social interaction existed within loosely-knit networks as opposed to groups [9]. The next real significant growth of social networking didn't really commence until the 1930s when three main social networking traditions emerged. The first tradition to emerge was pioneered by Jacob Levy Moreno, who was recognised as one of the leading social scientists. Moreno began the systematic recording and analysis of social interaction in smaller groups such as work groups and classrooms. The second tradition was founded by a Harvard group which began to focus specifically on interpersonal relations at work. The third tradition originated from Alfred Radcliffe-Brown, an English social anthropologist. Radcliffe-Brown strongly urged the systematic studies of networks; 'Social Network Analysis' was born. However, SNA did not advance further until the 1950s. This was when social network analysis was developed through the kinship studies of Elizabeth Bott who studied at the University of Manchester in England. It was here that the University's group of anthropologists began a series of investigations of community networks in regions such as Africa and India [11]. This research set the trend as more universities began similar investigations and studies as time progressed. During the 1960s a group of students at Harvard University began work to unite the different tracks and traditions already associated with social networking. Additional research was carried out in universities such as the University of California, Irvine and the University of Toronto. The latter contained a sociology group that emerged in the 1970s. The research undertook by this group argued that viewing the world in terms of social networks provided a greater analytical advantage. This view is also supported by Wasserman, S. and K. Faust, 1994, in their Social Network Analysis writings in the Cambridge University Press as they explain the extent of which SNA provides analytical advantage; "*The unit of analysis in network analysis is not the individual,*

but an entity consisting of a collection of individuals and the linkages among them". In recent times, social networking theories have been put aside as social networking has transferred to social media such as social networking sites like Facebook and MySpace. Although nowadays social networking is seen as more of an entertainment package, its roots stem back to the theoretical studies of sociologists such as Tönnies and Simmel as well as the progression of Social Network Analysis [7].

2 Social Networking

Social groups can exist as personal and direct social ties that either link individuals who share values and beliefs or impersonal, formal, and instrumental social links. Durkheim gave a non-individualistic explanation of social facts arguing that social phenomena arise when interacting individuals constitute a reality that can no longer be accounted for in terms of the properties of individual actors. He distinguished between a traditional society—"mechanical solidarity"—which succeeds if individual differences are lessened, and the modern society that develops out of support between differentiated individuals with independent roles. Social network analysis has emerged as a key technique in modern sociology, and has also gained a following in anthropology; biology, communication studies, economics, geography, information science, organizational studies, social psychology, and sociolinguistics, and has become a popular topic of speculation and study.

- Anthropology—is the study of humanity. It has origins in the natural sciences, the humanities, and the social sciences.
- Biology—is a natural science concerned with the study of life and living organisms, including their structure, function, growth, origin, evolution, distribution, and taxonomy.
- Communication Studies—is an academic field that deals with processes of communication, commonly defined as the sharing of symbols over distances in space and time. Hence, communication studies encompasses a wide range of topics and contexts ranging from face-to-face conversation to speeches to mass media outlets such as television broadcasting.
- Economics—is the social science that analyzes the production, distribution, and consumption of goods and services.
- Geography—is the science that deals with the study of the Earth and its lands, features, inhabitants, and phenomena.
- Information Science—is an interdisciplinary science primarily concerned with the analysis, collection, classification, manipulation, storage, retrieval and dissemination of information.
- Organizational Studies—encompass the systematic study and careful application of knowledge about how people act within organizations.

- Social Psychology—is the study of the relations between people and groups; or how situational factors affect the thoughts, feelings, and/or behavior of an individual.
- Sociolinguistics—is the study of the effect of any and all aspects of society, including cultural norms, expectations, and context, on the way language is used, and the effects of language use on society.

It has now moved from being a suggestive metaphor to an analytic approach to a pattern with its own theoretical statements, methods social network analysis software and researchers. The potential for computer networking to facilitate new forms of computer-mediated social interaction was suggested early on. Efforts to support social networks via computer-mediated communication were made in many early online services, including Usenet, Arpanet, listserv, and bulletin board services (BBS). Many prototypical features of social networking sites were also present in online services such as America Online, Prodigy, and CompuServe. Early social networking on the World Wide Web began in the form of generalized online communities such as TheGlobe.com (1995), Geocities (1994) and Tripod.com (1995). Many of these early communities focused on bringing people together to interact with each other through chat rooms, and encouraged users to share personal information and ideas via personal web pages by providing easy-to-use publishing tools and free or inexpensive web space. Some communities—such as Classmates.com took a different approach by simply having people link to each other via email addresses. In the late 1990s, user profiles became a central feature of social networking sites, allowing users to compile lists of "friends" and search for other users with similar interests.

New social networking methods were developed by the end of the 1990s, and many sites began to develop more advanced features for users to find and manage friends. This newer generation of social networking sites began to flourish with the emergence of Makeoutclub in 2000, followed by Friendster in 2002, and soon became part of the Internet mainstream. Friendster was followed by MySpace and LinkedIn a year later, and finally Bebo and Facebook in 2004. Attesting to the rapid increase in social networking sites' popularity, by 2005, MySpace was reportedly getting more page views than Google. Facebook launched in 2004, has since become the largest social networking site in the world. Today, it is estimated that there are now over 200 active sites using a wide variety of social networking models. Web based social networking services make it possible to connect people who share interests and activities across political, economic, and geographic borders. Through e-mail and instant messaging, online communities are created where a gift economy and mutual unselfishness are encouraged through collaboration. Information is particularly suited to gift economy, as information is a non-rival good and can be gifted at practically no cost. Facebook and other social networking tools is increasingly the object of scholarly research. Scholars in many fields have begun to investigate the impact of social networking sites, investigating how such sites may play into issues of identity, privacy, social capital, youth culture, and education Several websites are beginning to tap into the power of the social networking model for humanity. Such models provide a means for connecting otherwise fragmented industries and

Fig. 2 Matrix of group relationships

	Paul	**Laura**	**Aidan**	**Sarah**
Paul	---	1	0	1
Laura	1	---	1	0
Aidan	0	1	---	0
Sarah	1	0	0	---

small organizations without the resources to reach a broader audience with interested users. Social networks are providing a different way for individuals to communicate digitally. These communities of hypertexts allow for the sharing of information and ideas, an old concept placed in a digital environment. The amount of information needed to describe even the smallest of social networks can be quite big. As the information can be in large quantities, this can make managing and manipulating the date to show patterns of social structure quite complicated. Tools from mathematics are used to help all of the tasks of social network methods. Matrices are useful for recording information such as the calculation of indexes describing networks. An example of a simple matrix is shown in Fig. 2.

The above matrix shows the structure of a close friendship in a group of four people: Paul, Laura, Aidan and Sarah. It describes a pattern of linking ties with a point-to-point matrix where the rows represent choices by each actor. We put a "1" if a person likes another, and a "0" if they don't. One reason for using mathematical and graphical techniques in social network analysis is to represent the descriptions of networks efficiently and more economically. This also enables us to use computers to store and manipulate the information quickly and more accurately than we can by hand. The use of computers in social networks to show mathematical representations is also very important because if you had a huge amount of data that need manipulated, it could take years to do by hand, whereas it can be done by a computer in a few minutes. Formal Methods are used to represent data because matrices and graphs summarise and present a lot of information quickly and easily and allow us to apply computers in analysing data. This helps because most of the work is repetitive but requires accuracy and that is exactly the sort of thing computers do well. Matrices and graphs have rules and conventions. These help us communicate better but sometimes the rules and conventions of the language of the graphs and mathematics themselves lead us to see things in our data that might not occurred for us to look for if we described it ourselves.

The most popular social networking site is facebook.com. It currently has over 500 million active users world-wide and is a free use service. Through facebook.com you can search for friends, browse a news feed consisting of recent status updates, photo uploads, future events, videos, links posted by other users that are 'friends', learn more about people you see every day, comment and post on other people's walls, join 'Clubs', keep in contact with friends at other schools/colleges, share photos privately or publicly, etc. These social networks start out by an initial set of founders sending out a message inviting members of their own personal networks to join the site. The new members then repeat this process, growing the total number of members and

links in the network. These sites then offer different features like viewable profiles, chat, etc. Social connections can also be used for business connections. Blended networking is an approach to social networking that combines both offline elements (face-to-face events) and online elements. Social computing is the use of social software, which is based on creating or recreating social conversations and social contexts online through the use of software and technology. An example of social computing is the use of email for maintaining social relationships. The current metrics for social network analysis are as follows:

- Bridge—An edge is said to be a bridge if deleting it would cause its endpoints to lie in different components of a graph.
- Centrality—This measure gives a rough indication of the social power of a node based on how well they "connect" the network. "Betweenness", "Closeness", and "Degree" are all measures of centrality.
- Betweenness—The extent to which a node lies between other nodes in the network. This measure takes into account the connectivity of the node's neighbors, giving a higher value for nodes which bridge clusters. The measure reflects the number of people who a person is connecting indirectly through their direct links.
- Closeness—The degree an individual is near all other individuals in a network (directly or indirectly). It reflects the ability to access information through the "grapevine" of network members. Thus, closeness is the inverse of the sum of the shortest distances between each individual and every other person in the network. The shortest path may also be known as the "geodesic distance".
- Centralization—The difference between the number of links for each node divided by maximum possible sum of differences. A centralized network will have many of its links dispersed around one or a few nodes, while a decentralized network is one in which there is little variation between the number of links each node possesses.
- Clustering Coefficient—A measure of the likelihood that two associates of a node are associates. A higher clustering coefficient indicates a greater 'cliquishness'.
- Density—The degree a respondent's ties know one another/proportion of ties among an individual's nominees. Network or global-level density is the proportion of ties in a network relative to the total number possible (sparse vs. dense networks).
- Degree—The count of the number of ties to other actors in the network.
- Cohesion—The degree to which actors are connected directly to each other by cohesive bonds. Groups are identified as 'cliques' if every individual is directly tied to every other individual, 'social circles' if there is less stringency of direct contact, which is imprecise, or as structurally cohesive blocks if precision is wanted.
- Eigenvector centrality—A measure of the importance of a node in a network. It assigns relative scores to all nodes in the network based on the principle that connections to nodes having a high score contribute more to the score of the node in question.

- Prestige—In a directed graph prestige is the term used to describe a node's centrality. "Degree Prestige", "Proximity Prestige", and "Status Prestige" are all measures of Prestige.
- Reach—The degree any member of a network can reach other members of the network.
- Structural hole—Static holes that can be strategically filled by connecting one or more links to link together other points. Linked to ideas of social capital: if you link to two people who are not linked you can control their communication.

Another type of social network is a sexual network, which is defined by the sexual relationships within a set of individuals. They can be formally studied using the mathematics of graph theory [2]. Epidemiological studies (scientific study of factors affecting the health and illness of individuals and populations) have researched into sexual networks, and have discovered that the statistical properties of sexual networks are crucial to the spread of sexually-transmitted diseases (STDs). Social network analysis has been used to help understand how patterns of human contact aid or inhibit the spread of diseases such as HIV in a population. The evolution of social networks can sometimes be modelled by the use of agent based models, providing insight into the interplay between communication rules, rumour spreading and social structure. Social Contract is a political theory that explains the basis and purpose of the state and of human rights. Within a society, all its members are assumed to agree to the terms and conditions of the social contract by their choice to stay within the society without violating the contract.

The Social Safety Net is a term used to describe a collection of services provided by the state, e.g. (welfare, homeless shelters, etc.). They help prevent anyone from falling into poverty beyond a certain level. An example of how the safety-net works would be in the case of a single mother unable to work. In many western world countries, she will automatically receive benefits to the support the child so the child will have a better chance at becoming a successful member of society. On large social networking services, there have been growing concerns about users giving out too much personal information and the threat of sexual predators. Users of these services also need to be aware of data theft or viruses. However, large services, such as MySpace and Netlog, often work with law enforcement to try to prevent such incidents. There is a perceived privacy threat in relation to placing too much personal information in the hands of large corporations or governmental bodies, allowing a profile to be produced on an individual's behavior on which decisions, harmful to an individual, may be taken. Privacy on social networking sites can be undermined by many factors. For example, users may disclose personal information, sites may not take adequate steps to protect user privacy, and third parties frequently use information posted on social networks for a variety of purposes. For the internet generation, social networking sites have become the preferred forum for social interactions. However, because such forums are relatively easy to access, posted content can be reviewed by anyone with an interest in the users' personal information. There is also an issue over the control of data or information that was edited or removed by the user may in fact be retained and/or passed to third parties. This danger was highlighted when

the controversial social networking site Quechup harvested e-mail addresses from users' e-mail accounts for use in a spamming operation. Interpersonal communication has been a growing issue as more and more people have turned to social networking as a means of communication. Beniger [3] describes how mass media has gradually replaced interpersonal communication as a socializing force. Further, social networking sites have become popular sites for youth culture to explore themselves, relationships, and share cultural artifacts. Many social networks also provide an online environment for people to communicate and exchange personal information for dating purposes. Objectives can vary from looking for a one time date, to a short-term relationship to a long-term relationship. Most of these social networks, just like online dating services, require users to give out certain pieces of information. This usually includes a user's age, gender, location, interests, and perhaps a picture. Releasing very personal information is usually discouraged. This allows other users to search or be searched by some sort of criteria, but at the same time people can maintain a degree of anonymity similar to most online dating services. Online dating sites are similar to social networks in the sense that users create profiles to meet and communicate with others, but their activities on such sites are for the sole purpose of finding a person of interest to date. However, an important difference between social networks and online dating services is the fact that online dating sites usually require a fee, where social networks are free. This difference is one of the reasons the online dating industry is seeing a massive decrease in revenue due to many users opting to use social networking services instead. Many popular online dating services such as Match.com, Yahoo Personals, and eHarmony.com are seeing a decrease in users, where social networks like MySpace and Facebook are experiencing an increase in users.

3 Network Analysis

There are two basic kinds of network analysis, reflecting two different kinds of data: ego network analysis, and complete network analysis. Ego network analysis can be done in the context of traditional surveys. Each respondent is asked about the people they interact with, and about the relationships among those people. Since respondents might be sampled randomly from a large population, in ego network analysis it is unlikely that the respondents will know anyone in common, and no attempt is made to link up the networks. Typically, the analysis of ego networks involves assessing the quality of a person's networks (size, diversity, average income, etc.) or relating attributes of ego with attributes of their alters (homophily). Ego network analysis is convenient because it can be used in conjunction with random sampling, which enables classical statistical techniques to be used to test hypotheses.

Complete network analysis is where you try to obtain all the relationships among a set of respondents, such as all the friendships among employees of a given company. Most of the rhetoric surrounding network analysis is based on complete networks.

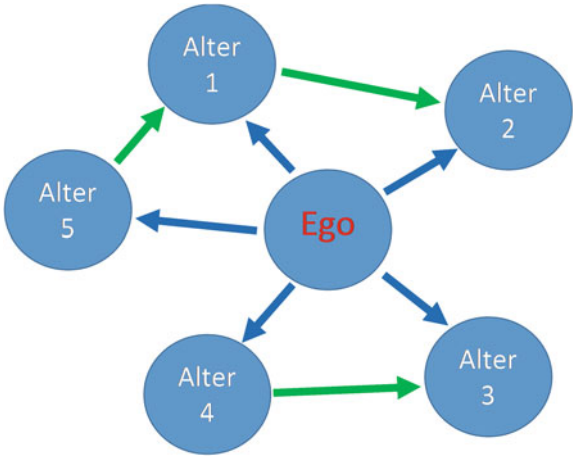

Fig. 3 Ego network

Techniques such as subgroup analysis, equivalence analysis and measures like centrality all require complete networks (Fig. 3).

There are numerous terms used to describe connections within social networks. Homophily is the extent to which actors make ties with similar versus dissimilar others. The similarity is defined by factors such as gender, race, age or other salient characteristic [8]. Multiplexity is the number of content-forms contained in a tie. For example, two people who are friends and work together would have a multiplexity of two. It can also be seen as simply the strength of a relationship. Network closure is the measure of the completeness of relational triads while propinquity is the tendency for actors to have more ties with others who are close geographically.

Of course, visual representation of social networks can be helpful in order to understand the network data and relay the result of the analysis. Most software presents data through visual nodes and ties attributing colours, size and other advanced properties to nodes. For complex information such as large social graphs with varying attributes, these visual representations can be a powerful means to convey complex information. Likewise, collaboration graphs can be used to show human relationships—both negative and positive. For instance, a positive edge between two nodes denotes a positive relationship (i.e. friendship) and a negative edge between two nodes denotes a negative relationship (i.e. hatred).

In the real world, social network analysis can be used in counter-intelligence and law enforcement activities. There are a number of hacking tools also known as information gathering tools online which allow one to build up detailed analysis of an individual's social graph. One such free tool is FOCA (Fingerprinting Organizations with Collected Archives). FOCA can do much more than build social graphs. In fact, it has recently come to the attention of the world that the National Security Agency (NSA) has been using its huge collections of data to create sophisticated social network graphs of some Americans' social connections that can identify their associates, their locations at certain times, their travelling companions and other

personal information, according to newly disclosed documents and interviews with officials [10]. This started around 2010. After initial maps of the social network are complete, we believe that analysis is then performed to determine the structure of the network and determine, for example, the leaders within the network. This allows military or law enforcement assets to launch capture-or-kill decapitation attacks on the high-value targets in leadership positions to disrupt the functioning of the network.

4 Conclusion

Social Networks are social structures made up of nodes and ties; they indicate the relationships between individuals or organisations and how they are connected through social familiarities. They are very useful for visualising patterns. They operate on many levels and play an important role in solving problems, on how organisations are run and they helps individuals succeed in achieving their targets and goals. In today's society social networks allow two people in different locations to interact with each other socially (e.g. chat, viewable photos, etc.) over a network. They are also important for the Social Safety Net because this is helping the society with the likes of the homeless, unemployment. Group politics relate to 'In-Groups' and 'Out-Groups' as each competes with each other. The use of mathematical and graphical techniques in social network analysis is important to represent the descriptions of networks compactly and more efficiently. Social Networking is all around us and so there is always going to be friends and casual acquaintances both within the sub-groups and outside it. These status types link all sub-groups together as well as the internal structure of a group. Hence there are direct and in-direct connections to link everyone together within social circle websites like facebook.com.

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