Proceedings of the 3rd International Conference on Signal Processing and Machine Learning
DOI: 10.54254/2755-2721/5/20230677

The use of social network analysis in different fields

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Abstract. Social network analysis is a well-established research method in sociology. Some scholars also refer to this quantitative approach to graph theory as network science. As research intensified in the 1970s, it gained the attention of researchers in many other fields and has become an interdisciplinary research method. Social network analysis collects data from multiple sources and unearths new information by building network structures.The constructed network topology diagram and the calculated network properties are eventually analysed and generalised to produce further research results. The use of social network analysis (SNA) in a few different fields—tourism, society, transportation, citation, viral communication, medical education, and economic geography—is reviewed in this essay. Social network analysis is a quantitative analysis method that blends multiple disciplines. Various relationships are quantified through the construction of networks and property analysis. The paper is categorized according to the different fields of application. The different applications of social network analysis in various fields show its general and specific analytical approach.

Keywords: network science, social network analysis(SNA), complex networks.

1. Introduction

The primary purpose of social network analysis is to examine the nature and characteristics of relationships in networks. It has evolved considerably over the last few decades and has become a productive and unique analytical method. Studies of social mobility, scientific citations, kinship relationships, and many other topics have all benefited from the use of social network analysis[1]. Many scholars have developed an interest in the concept of social networks and the methods of social network analysis. Furthermore, research has found that the analysis of network structures and attributes in social network analysis allows for the precise definition of different social structural environments. In contrast to traditional methods of analysis, social network analysis offers new directions for answering standard social and behavioral science research questions. This paper focuses on the analytical methods and reviews results of social network analysis in a few selected areas. It also reveals the efficiency and validity of social network analysis methods through the diversity of analysis methods and results in different domains.

2. Tourism

Social network analysis (SNA) has many applications in the study of human and other animal behaviour. An analysis of social networks through Italian tourism intermediaries reveals the entangled relationships

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between human organisations. Data was collected through interviews with tour managers and an online questionnaire. The data collected was used to create a network diagram of the travel agency. The main network attributes calculated from the network diagram include density, average path length, clustering coefficients, etc., and the modularity is shown in Figure 1. This is followed by a dynamic and evolutionary study to further derive the main characteristics[2]. The comparison and analysis of network attributes and modularity allow for a social network analysis of the tourism industry. This can further corroborate or disprove traditional findings and improve the efficiency of tourism development.

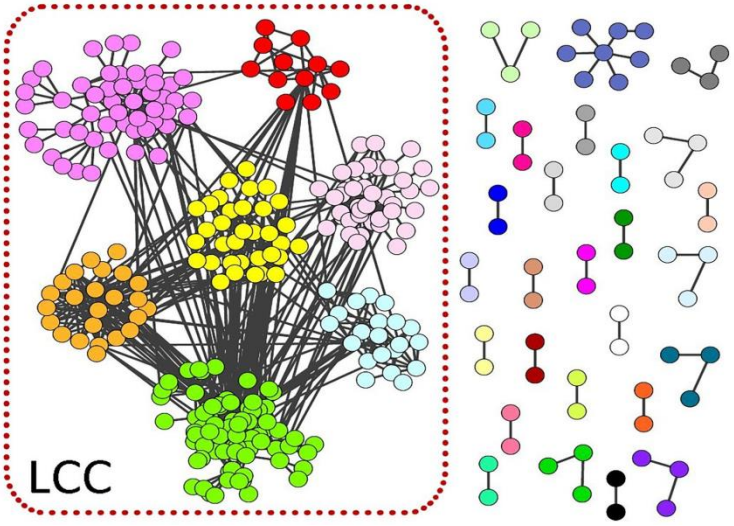

Figure 1. Seven communities in the network[2].

The use of social network analysis to analyse phenomena and relationships offers a new research approach to managing tourism systems. In addition, social network analysis in network science has become a reliable bridge to tourism research and has increased the rigour of the research. It offers a possibility to reduce the gaps caused by the lack of theoretical constructs[3].

3. Society

The interactions between individuals who belong to various teams in human societies can be studied using social network analysis. The most common example is the game of football, where players from both teams form interactions through passing and confrontation. The data for the study was sourced from Opta (a sports data provider). Information on all passes made by each team in 380 matches. Network science uses the interactions between players to build football networks. By analysing and comparing network attributes, the playing styles and differences between teams can then be identified. Network science can reveal the evolution and key elements of an entire football team[4]. Using social network analysis to understand interactions in work teams and evaluate them from multiple perspectives. This improves interactions while making interactions between team members more efficient. In addition, it pinpoints the root of the problem and improves the team's common understanding[5].

Societies also exist for some animals other than humans. The social network analysis of Tursiops truncatus reveals the diversity of interacting behaviours in animal populations. Between February 2003 and September 2011, data was gathered in the northern Adriatic Sea's Gulf of Trieste and surrounding waters. The entire study area was surveyed and observations were recorded on dolphin populations. The network of Tursiops truncatus was visualised and modularised for social network analysis, as shown inFigure 2. Some network attributes and other indices for testing associations were also calculated. Studies have shown that different dolphin clusters exhibit different temporal divisions and interactions with fisheries. Different parts of the same cluster will perform differently[6]. The dolphin social network was divided into two main clusters and one smaller cluster. The analysis revealed that the different groups do not overlap in activity time and have different interaction behaviours with fishing vessels. This can help to study the diversity of animal interaction behaviour.

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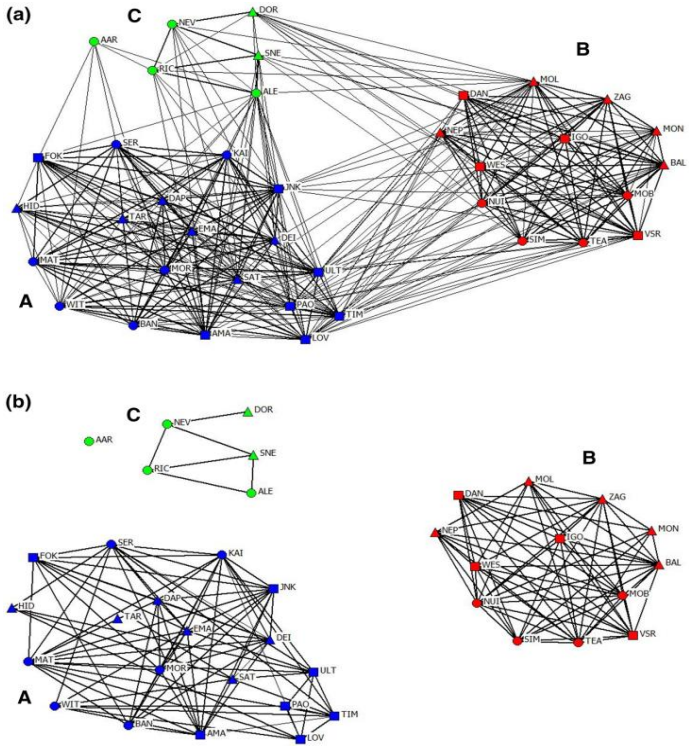

Figure 2. Population network of the bottlenose dolphin[6].

4. Transport

There are various uses for social network analysis in the transportation. The contrasts in the cities' transportation infrastructure are demonstrated via a comparative social analysis of transportation governance in London and New York[7]. Structured interviews were conducted with key people involved in urban governance. Snowball sampling methods were used to collect data. By comparing the basic network attributes and other centrality data of the two cities in Table 1, differences in urban transport and some of the determinants can be effectively identified. This study demonstrates the usability of data from social network analysis using snowball sampling. The social network analysis(SNA) approach to data sampling can allow the centrality of a network member to be predetermined. This can be used to verify certain predictions or conjectures.

Table 1. Basic network properties in New York and London[7].

Urban transport network	Diameter undirected, binary data	Average path length undirected, binary data	Centralisation undirected, binary data	Network density of undirected networks	Network density of directional networks
NYC	6	2.5	32.05%	4.14% (0.0771)	2.27% (0.0414)
London	4	2.2	52.94%	3.70% (0.0907)	2.03% (0.0508)

Social network analysis of traffic helps to relieve traffic pressure. El-adaway et al. [8] employed social network analysis in the case study to examine transportation networks. This study shows that nodes with high centrality indicators have a greater traffic impact on urban traffic. Rational improvement of the areas where these nodes are located can effectively improve the efficiency of urban traffic. Separate analysis of the centrality indicators for the three transport network cases reveals different results, as shown in one of the cases in Table 2. Different indices of the centrality of their transportation networks can be found in the three cities. This has prompted a variety of solutions to ease traffic

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congestion. Social network analysis(SNA) saves time and effort, and the advantage of SNA is that it balances network complexity with node interconnectivity. As a result, SNA enhances traditional analysis methods. In addition, the study shows that social network analysis can increase efficiency and reduce costs. Combining traditional analytical techniques with social network analysis can facilitate transport management and improve transport networks.

Table 2. Indicators of the centrality of the transport network in Case 1[8].

	Betweenness		Bonacich power		Eigenvector		2-Step Reach	
Rank	Node	Value	Node	Value	Node	Value	Node	Value
1	11	180.77	19	1120.03	19	0.36	11	13
2	18	159.02	20	1073.38	20	0.34	17	13
3	19	154.83	18	1052.06	18	0.34	18	12
4	24	139.07	17	987.69	17	0.32	20	11
5	12	128.45	24	940.97	24	0.3	10	10
6	6	101.87	8	733.68	8	0.23	12	10
7	8	91.13	14	730.55	14	0.23	19	10
8	7	91	11	727.24	11	0.23	22	10
9	10	88.5	22	613.09	22	0.2	24	10
10	17	87.4	21	592.55	21	0.19	2	9

5. Citation

A social network analysis(SNA) uses network topology analysis to interpret topology and obtains a holistic view of knowledge flows in literature citations. The nodes in the citation network represent different documents. The edges represent the citation relationships between the documents. In addition, the centrality analysis in SNA provides the importance and value of each node. The data for the study is derived from the current composition of the number of patents registered in the United States provided by Global IP Services. Park, Y.-N. et al.[9] performed centrality analysis for each node in a study of citation network analysis. Three types of centrality were analysed including degree centrality, proximity centrality, and eigenvector centrality. The study uses social network analysis to visualise citation networks. The attributes of the network are calculated and analysed to obtain a knowledge structure system for the entire citation network. The centrality analysis method also enables a thorough investigation of the significance of each node in the citation network.

Social network analysis focuses on the interactions between entities, and these connections can be visualised through the construction of various models. Social network analysis has demonstrated that it can be effective in understanding the growth and dissemination of information through the study of network structure. Social network analysis shares the same position as citation analysis and can further expand its methodology[10].

6. Virus transmission

Social network analysis contributes to the study of the COVID-19 epidemic. Saraswati et al. claim that social network analysis allows for real-time visualisation and changes in virus propagation networks, as shown in Figure 3. The data is derived from statistics including relevant demographic and exposure data for all cases in the last two months. The data is then aggregated through an Excel tool. Finally the data is imported into Gephi to apply the layout algorithm for visualisation. Analysing the basic properties of a virus network can help to identify the main transmission nodes. In addition, community detection can reveal high-risk clusters and virus propagation patterns[11]. Social network analysis helps to better develop measures as well as control the spread of viruses.

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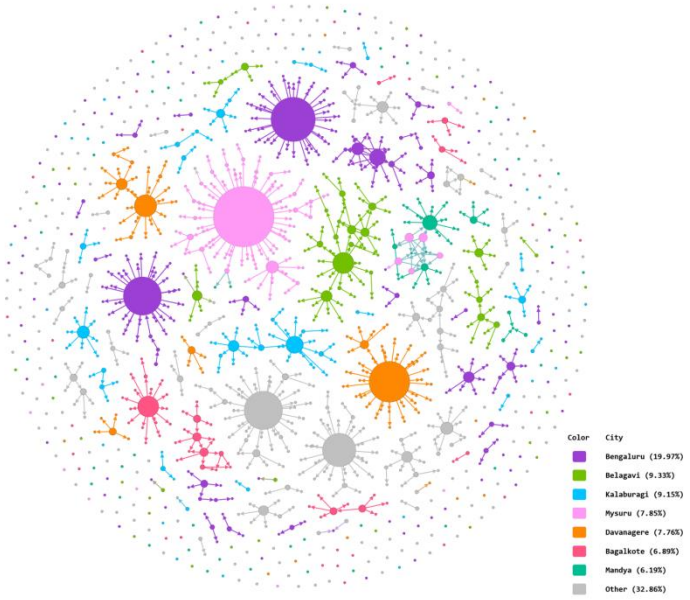

Figure 3. Aggregate network graphics created by Saraswati et al.[11].

Wang, Y. et al. used social network analysis to demonstrate the transmission factors of the COVID-19 among health care workers in Wuhan, China[12]. The data were obtained from two investigator-designed questionnaires. Standardized practices and less exposure at work reduced the risk of infection. The study analysed and compared the characteristics of participants, infection factors in different groups, and network indicators in different groups separately. The study reveals that social network analysis can be used to find relevant viral transmission factors through different comparisons. Reviewing these transmission factors can reduce the occurrence of errors and the spread of viruses.

7. Medical education

Social network analysis can also be applied to medical education. It provides an analysis of medical trends and offers reflections. Research data are derived from information presented by keywords relevant to the field of medical education including publication date, article title, and abstract. The data was imported into Gephi for web visualisation and analysis. The study divides the data collection process into five stages and analyses them separately using social network analysis. The emergence of new keywords and the frequency of use of each keyword reveal trends in the field of medical education[13]. The integration of sociological research methods with medical education will create a unique trend in medical education in the future.

Another study in medical education reveals something else about the role of social network analysis. The social structure of online courses was analysed to predict changes in performance due to social interactions[14]. The data for this study is information derived from a database through a structured query language. The same Gephi tool was used to visualise the operations and analyse them. Some of the corresponding network properties including number of nodes, average degree, network density and average clustering coefficient were calculated from the constructed networks. Various centrality analyses were also carried out on online education networks. The study demonstrates the role and potential of social network analysis in medical education.

8. Economic geography

In a study on the geographic mobility of Italian students, Silvia Columbu et al. built network models using social network analysis (SNA) and illustrated the intricacy of students' geographic movement[15]. The study combines social network analysis methods with other clustering techniques methods. These methods present the determinants and geographical links that drive the variability of university students'

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choice of master's degree. The data for this study was obtained from microdata provided by the database. The use of social network analysis allows for the identification of core regions, provinces, and universities in the network where students flow in and out based on measures of network centrality. In addition, modeling analysis is used to show the network structure of regional student mobility[15].

The migration of organisations across areas can be investigated using social network analysis. Social network analysis also has great potential to diversify clusters and expand regional innovation systems. In recent years, social network analysis has been applied to the study of static networks in economic geography[16]. Like the social sciences, economic geography makes use of network concepts and attributes for its research, including regional industry clusters as well as various network models. Economic geography combined with social network analysis can expand the research even further[17]. Collaboration and exchange between disciplines can provide additional ideas and unique value to research.

9. Conclusion

Network Science is a new interdisciplinary discipline that studies the properties and laws of complex networks, involving the various topologies of complex networks and their network properties. The terms network science and network analysis are receiving increasing attention. As attention increases, the frequency of social network analysis rises with it. With the increased attention, the frequency of social network analysis has also risen. Many different disciplines are now beginning to adopt or have adopted social network analysis as a new research method. This method can extend or refute traditional research methods. This offers a new perspective and way of thinking about research. There is value in combining different disciplinary approaches. But considering the shortcomings of the original approach may also present new challenges and problems.

This paper reviews the use of social network analysis in several different fields including Society, Transport, Citation, Virus Transmission, Medical Education, and Economic Geography. A review of the studies in each literature is presented separately. The corresponding data sources and processing are presented. Social network analysis is used in studies from different disciplines to construct network models and visualize their manipulation. The patterns and characteristics are inducted through the calculated network properties. Even other analytical methods are combined to form unique research approaches and results. Social network analysis bridges the gap between qualitative and quantitative. It draws conclusions by building a data network model and analysing the network properties. In this paper, only six areas have been selected to provide an overview of the use of social network analysis. The applications of social network analysis are very diverse. The aspects selected in this paper demonstrate only some of its diversity. The application areas selected for this paper are few and partly specific. It is not capable of presenting a comprehensive picture of all the network properties in the network model constructed by social network analysis. Due to the wide range of applications of social network analysis, it is difficult to classify and summarise them all. This paper is also divided only by application area, lacking other divisions for comparison. It will be considered more comprehensively in the next stage of the study.

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