



# APPLICATIONS OF SOFT COMPUTING TECHNIQUES FOR SOCIAL NETWORK ANALYSIS: A SURVEY

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## Abstract

Big measurement, ambiguous, inexactitude and boisterous data is generated from social networks in large quantities. It has been emerging from the characteristics of social media, diverse mobile sensing devices and dynamic users social behaviors. Evolving of soft computing techniques is extensively used for handling with the forbearing of roughness, ambiguity, fractional truth, and calculation. Social Network Analysis (SNA) is one of the most important and promising applications to examining social structures and its properties through the use of network and graph theories. By techniques of soft computing such as fuzzy logic, formal concept analysis and

rough sets theory, the purpose of this paper is to analysis different SNA methodologies.

**Keywords:** Social computing, soft computing, Fuzzy logic, Formal concept analysis, Rough Sets.

## 1 Introduction

Computer-mediated tools such as social media which permits public to make, part or swap information, notions, portraits, acoustic or videotapes in practical communities by means of Internet. The existence of interesting tasks regarding research works on improvement of a proficient social media computing as well as making an operational social network analysis to serve both academics and industrial field among online public networking services. Therefore being a wing in research, social computing is evolving for managing this type of figures produced from social media. Generally, numerous techniques contain methods of statistics and pictorial representation and so on. In order to solve such problems, state-of-art soft computing technologies such as probabilistic computing, neural network systems, fuzzy set, formal concept analysis as well as rough sets are making a way to superior and flexible answers for upcoming social media and big data, lastly creating a bright prospect social media network. This study will be conducted aiming at SNA from different features, such as presenting the network, status of those who are using it, description of social relationships, evaluation of topological structure and social data.

The present survey is organized in this manner: “Social Network Analysis as Social Computing” section overviews the main stream of Social Network Analysis as social computing; and a complete classification and its soft computing practices centered SNA methods are exhibited in “Soft Computing and its Applications” segment. To end with, “Social Networking Analysis vs Soft computing” segment determines the survey by awarding common annotations.

## 2 Social Network Analysis as Social Computing

This segment presents the description of social computing and the latent applications.

### 2.1 Social computing

Various definitions for social computing are there since social computing terminology was proposed in 1994. Schuler [1] stated that any type of computing application which focuses on social relation using software as a medium is social computing. His opinion therefore highlighted the social software importance. According to Dryer et al. [2] social computing is the interaction among public, responding with computing technologies and social behaviors. They also stated that its pattern concentrates on mutual interaction of the human behavior, system pattern and interaction results in the mobile computing system and social contribution.

The architecture of social computing is depicted in Figure 1. The bottom part of this architecture provides an illustration regarding the components of the real-life world namely mental world, physical world as well as artificial world. It is easy to get recognition from practical perception that certain products of the above three worlds are social physics, social computing and social psychology respectively, and of course here lies a noteworthy intersection. Prominently, the acknowledgement allows everyone to use the opportunity of the full-fledged artificial society model. The trials of theory of social computing in the artificial world under parallel system will be checked and demonstrated using computers.

### 2.2 Research directions in Social computing

As social computing is a social phenomenon rather than a technique, Social science-oriented social computing and application-oriented social computing are the two main research fields which can impact each other.

### 2.2.1 Social science orientation

SNA and Computational Social Science are part of Social Science-Oriented Social Computing. The topics that covered mainly in social network analysis are Social flows, care regarding Health hazards, Prime nodes mining for disease diffusion, groups finding etc. The SNA approaches are classified into graph theory, agent-based model and theoretical physics approach. [3] and [4] initiated the study on small-world and approaches grounded on them, [5] established the relation amid nodes which adhered the power-law distribution. The important research accomplishments in addition to the above said literature are like strong and weak ties [6], structural holes [7], and information cascades [8] and so on. Computational social science is a cross-discipline amongst systems science, control science, and complex science. It principally emphasizes on the investigation on social simulation and social system modeling with the help of modeling equation and modeling on computational aspects [9]. In principle, machine learning approaches can be used to find out the fascinating and beneficial models from enormous data by considering data mining as an important technology for computational social science.

### 2.2.2 Application orientation

It discusses a kind of specific application that incorporates the techniques of social computing, that include netizens and their mindset. It has three segments: group software, social software and social media [10]. Group software is used in many research institutes since it was proposed in 1970. Collaborative technology is a Soul of group software with an objective of assisting the communications cooperatively. For instance, computer supported collaborative learning and cooperative work are two definitive cluster applications. Web 2.0 [11], social media is emerged in 2005 and has a rapid development and emphasis the lively communication by netizens who can finish these communications by producing and using the matter in social media. Using ubiquitous gadgets like smart phones and other such electronic gadgets, the mobile social media [1214] drawing attention from the industrial field as well as academics.

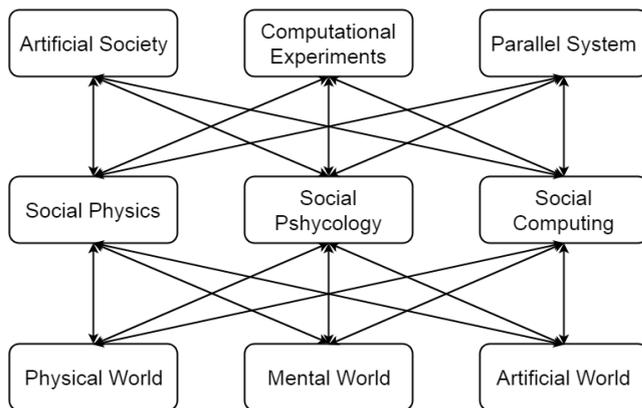


Fig. 1 Architecture of social computing

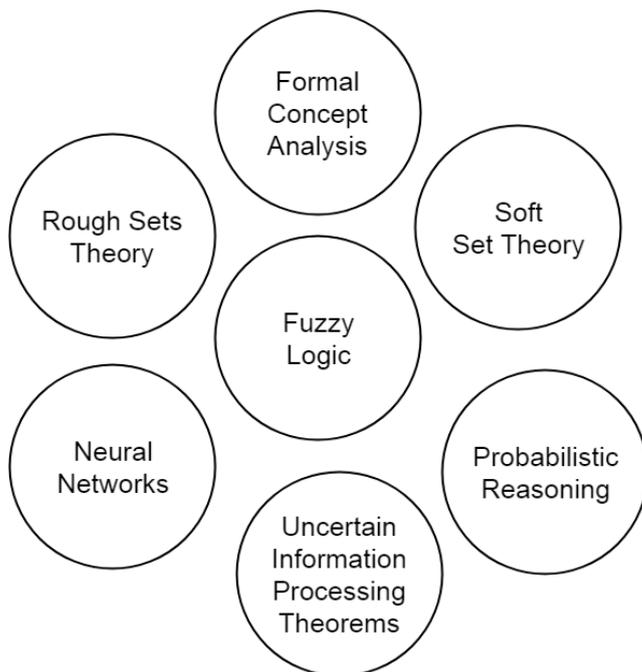
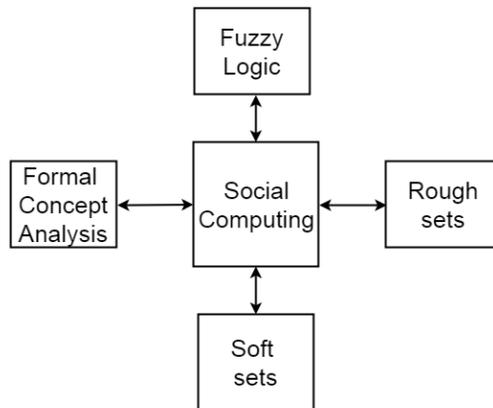


Fig. 2 Overview of main soft computing techniques



**Fig. 3** When social computing meets soft computing, what is happening ?

### 3 Soft computing and its Applications

It means a pool of systems across several sections which come under different classifications in computational intelligence [15]. It is a syndicate of techniques working with daily problems which thereby offers in some form or the other malleable information processing abilities for looking after day to day multifaceted circumstances [16]. Primarily, it is comprised of these divisions: fuzzy systems [17, 18], evolutionary computation [19, 20], and artificial neural computing [21]. Till this day, several fresh procedures are put forward for inaccuracy, ambiguity and fractional truth, that will be appropriate to its applications. Through this paper a study is done with these applications (depicted in Fig. 2) together with the techniques mentioned below. Other part of this segment is regarding the summary of those methods.

#### 3.1 Fuzzy logic(FL)

FL is normally utilized as soft computing method for providing an easy method to obtain a certain decision grounded on unclear, uncertain, inaccurate and unstructured information of inputs. Data is processed by the operational principle of FL by permitting partial set membership rather than crisp set membership or

non-membership. FL joins fuzzy rule based conclusion approach for solving a problem rather than make an effort to model a system statistically. Fuzzy conclusion engine for example could be applied to procure trust bond amid mobile social network users [22].

### **3.2 Formal concept analysis(FCA)**

FCA [23] is a distinctive calculating aptitude method to analyze data. For representing the dealings between entities and attributes in a domain, FCA describes formal concepts. Clubbed entities and aspects into formal concepts and intangible grading of every formal concept can be built that is a comprehensive framework. All formal concepts can be derived by FCA from this context to build their proper perception framework.

### **3.3 Rough set theory**

The extensive usage of Rough sets theory (RST) [2527] is to dispense unfinished as well as ambiguous information. Present time has seen the abundant presentations of RST in the areas of machine learning, data mining etc. The rough set analysis [28] main motive is to estimate combination of notions from the attained data. Practical practices say that subset is hard to describe a notion in a specified information center and these sets can approximate the subset regarding the information center.

### **3.4 Soft set theory**

To deal with uncertainty, a common mathematical tool in soft set theory [29, 30] can be used. Proven is this theory is the simplification of fuzzy set [31]. Till now many procedures and presentations of soft sets have been delivered [32, 33]. To find enhanced result under the ambiguous environment, soft set is used as proficient ambiguous information processing mathematical methodology. Soft set theory can effortlessly distinguish the unfinished and unreliable information from parameterization perspective, particularly the unpredictability and incompleteness of the unclear information.

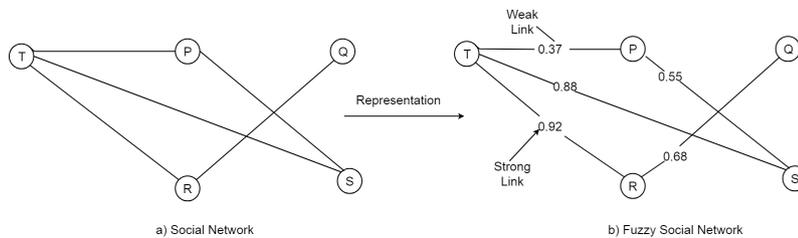


Fig. 4 Representation for social networks based on fuzzy logic

## 4 SNA vs Soft Computing

Both areas of soft computing and social computing provides the opportunities to research people. Fig 3, interprets the study on social networks analysis that can be visualized through soft computing context. This paper elaborates the survey on three main aspects structural analysis, social data analysis and social interaction analysis of soft computing techniques for social networks.

### 4.1 Social Networks

A graph (of course sometimes adjacency matrix) is used to model Social Network where the nodes and edges represent the individuals and relationships between them, respectively. Generally, the social relationships are considered as binary values; however, with the dynamic nature of the social relationships between individuals under various conditions, there is huge uncertainty or vagueness in social networks.

#### 4.1.1 Fuzzy Logic based SNA

[34 - 41] proposed various techniques based on fuzzy set theory to overcome these uncertainties in the representation of the social networks. Fuzzy graph is commonly used to depict a social network with vague relationships [42] and Figure 4 shows a sample representation of fuzzy graph for a social network. [43], [44] represented the FL based social networks, computing with words and fuzzy graph (fuzzy social network) that can be described different kinds of relationships.

#### 4.1.2 FCA based SNA

A sample topology of a social network with formal context is represented in Fig. 5. In the representation of the solution the individuals are presents as both objects and attributes, and according to the individual relations the construction of formal context is performed. A social network  $G$  is presented as an undirected graph in which subjects have relationships with others.

In [45], [20], [24] the authors worked to find the  $k$ -balanced trusted clique in signed social networks and they explored the disclosure of  $k$ -clique communities in social networks. A given social networks is converted in to a formal context and which is followed by the construction of the concept lattice and finally, proved that equivalence between cliques and the equi-concepts. In addition to this, Dorfein [46] proved that the basic theorem on coherence networks of concept lattices.

### 4.2 Positional Analysis

The prime utilization of positional analysis is to disclose the similarities among the individuals of a social network [47], [48] presented a regular equivalence which is widely discussed the notions in the positional analysis. A regular equivalence is generalized for fuzzy social networks as it is needed rational attention [37]. An organizations online reputation is well studied, based on fuzzy logic, and introduced a framework named FORA [48]. Identification of influential people is a prime chore in positional analysis of social networks so, a hybrid method is presented by [48], [49]. In this method to detect authors profiles based on keywords by using FCA.

### 4.3 Topological Structure Analysis

Topological structure analysis by using soft computing techniques is presented in Fig. 6. Topological structure mining primarily concentrates on finding cliques and communities from social networks.

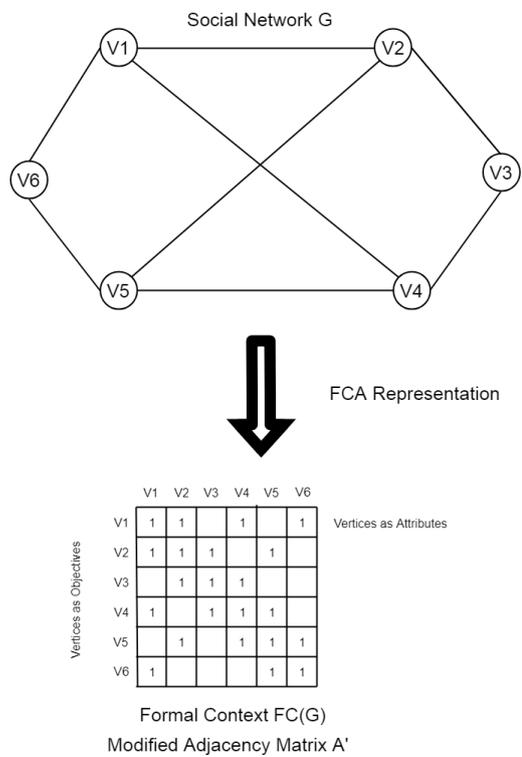


Fig. 5 Solution of FCA-based representation for social network

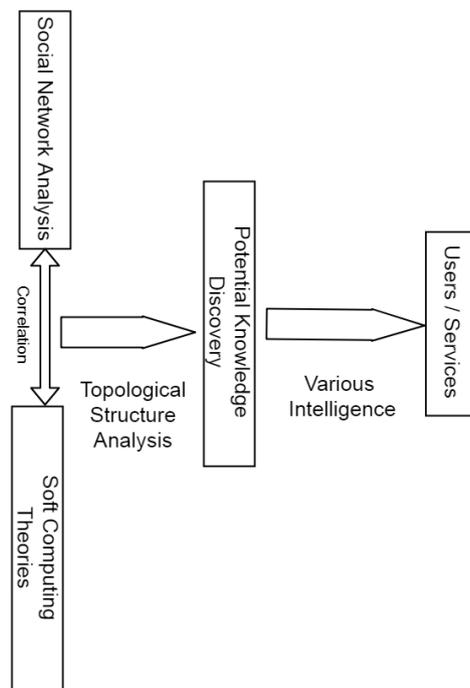


Fig. 6 The framework of topological structure analysis with soft computing techniques

#### 4.3.1 FL based Topological Structure Mining

In [50], [51], authors studied issues related to finding the fuzzy communities in social networks, in which each vertex of the graph may be a part of multiple communities at the same instance. It determines, even in the vagueness conditions in the data, by exact numerical membership degrees. Golsefid et al. [52] proposed a method to disclose the overlapping communities by adopting fuzzy clustering in complex networks. CPM clustering model [53] is used to analyse their proposed method and it assigns each node to each cluster by membership function. Stochastic model is being used to find overlapping groups in social networks with fuzzy logic and they modeled an optimization problem to detect fuzzy overlapping group[41].

#### 4.3.2 FCA based Topological Structure Mining

This process is performed according to the equivalence relation between topological structures and equi-concepts. Hence, this type of process gives new points for mining the topological structure from social networks. The web sub-graph and communities are modeled as a formal context as well as formal concepts [54]. The k-balanced trusted cliques from signed social networks are disclosed based on FCA [24]. Further, based on FCA, Hao et al. [45] proposed a novel algorithm for k-clique communities. Blog community detecting algorithm is proposed in Fu et al. [55], based on FCA. It used to reduce the high repetition rate between community cores and isolated community. The authors presented the community detection to determine the partial communities based on FCA [56]. [57] proposed an approach for finding the bases of maximal cliques and detection theorem based on FCA. Hao et al. [58], pioneered FCA based novel approach for evaluation of graphs similarity.

#### 4.3.3 RSTbased Topological Structure Mining

In community discovery, to improve the detection performance, most times traditional clustering algorithms are integrated with RST [59, 60]. Wang et al. [59] formulate a new approach by including the RST with k-means clustering to overcome the

difficulty of finding the value of  $k$ , and relations between the cluster object and community. Their algorithm is used to detect overlapping communities and it reflects the social network information better. In addition, the authors [61] presented rough  $k$ -clique theory that relaxes the conventional  $k$ -clique by adopting the definition of approximation of upper/lower vertices.

#### 4.4 Web Mining of Social Network Analysis

A mining procedure that works on social media includes various opinion graphs, hyperlinks, communities and etc., is called social web mining. It is an efficient way to extract social intelligence derived from the social knowledge by working on web log data. By taking the utility of the users directional behavior, Social media web sites provide a procedure, called personalization, to correcting the content and structure of the web site to the users precise requirements. In preprocessing phase, unwanted and noisy information has been removed from the collected data from web directories. In [16], authors applied Neuro-Fuzzy clustering for groups based on user and his sessions. They adopt Ant colony Optimization (ACO) for social web mining. Query routing and Expert identification in social networks are modelled by ACO [62]. Kwon et al. [63] proposed a novel method by adopting ACO algorithm and SentiWordNet for sentiment trend analysis.

#### 4.5 Data Analysis of Social Network Analysis

Soft computing techniques provided solutions for social network analysis and some them are Folksonomy mining [64], tag recommendation, social marketing [65], social recommendation and sentiment analysis [66]. In [67], author presented iceberg tri-lattices algorithm for mining the frequent tri-concepts. Based on FCA and users interest lattice matching (UILM), [22] proposed a novel approach for tag recommendation. In, [68] authors studied friends recommendations in social networks. FL based sentiment analysis has been modeled for social data analysis [69]. Trung et al. [49] presented a fuzzy propagation modeling for opinion mining. They worked on sentiment analysis of online social networks. Degree of positive and negative is presented based on

Fuzzy lexicon and fuzzy sets for sentiment analysis. Hao et al. [33] proposed a soft set-based recommendation model and devised the corresponding algorithm. In [70], authors presented novel approach by using fuzzy c-means algorithm to extract personal mobility patterns.

#### 4.6 Medicine and Healthcare Services

In past decade, wireless internet, the IoT and ubiquitous technologies are emerged into the development of modern medical technologies [71]. Firstly, Hao et al. [71], 3-order tensor is used to represent the medical treatment data. [58], [61] calculated the similarity between the targeted graph and the graphs in the database. They used rough-k cliques theory which is a novel soft computing methodology. Based on formal concept analysis, [72] presented a big medical data cognitive system and it includes various like efficient big data representation, natural semantics interpretation among dimensions and high-quality data associations.

### 5 Conclusion

Social Network Analysis (SNA) has become important research area in social computing, as social media is scaling up and rapid growth in the number of users. There is an urgent need of approaches for collecting network data and methodologies for analysis of data as the data is distributed on social site servers. Soft computing methodologies have recently been widely utilized to solve data mining problems. They strive to provide approximate solutions at low cost and hence speeding up the process. This paper, dedicated to provide the pathway for conjecture of social computing and soft computing. Then, it explored the state-of-art of literature on social network analysis using various soft computing techniques.

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