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Fuzzy queries processing based on intuitionistic fuzzy social relational networks

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ABSTRACT

In this paper, we propose fuzzy queries processing techniques based on the proposed intuitionistic fuzzy social relational network (IFSRN) model which contain positive relationships, neutral relationships, and negative relationships between actors, where the degrees of relationship between actors are represented by intuitionistic fuzzy values (IFVs). The proposed fuzzy queries processing techniques based on the proposed IFSRN model are more flexible than the ones of Yager's fuzzy social relational network (FSRN) model due to the fact that the system can get the degrees of truth and the degrees of false of fuzzy queries, respectively, whereas the fuzzy queries processing techniques based on Yager's fuzzy social relational network (FSRN) model only can get the degrees of truth of fuzzy queries.

1. Introduction

In recent years some social network models [1,5–7,9–11,13,15–19,24–36,38,40,43–48,50,51] have been presented, such as social networks analysis [1,5,6,15,17,25,27,30,32,34,36,38,44,50,51], online social network analysis [6,28,45], social networks growing [7], social networks clustering [9], social networks classification [10], crime investigations [13], fuzzy social networks [18,26,29,33], fuzzy communities detection [19], social recommender systems [24,31,47,48], social networked multiagent systems [40,46], fuzzy social relational networks (FSRNs) [43], … , etc. Anand et al. [1] presented a quantitative model to maximize the relevance of information in social networks with multiple information providers. Benevenuto et al. [5] presented an in-depth analysis of user workloads in online social networks. Buccafurri et al. [6] presented a common-neighbor approach to detecting missing me edges across social networks. Buscarino et al. [7] presented a model for growing social networks, where the main characteristic of the model is an ability to form groups among users in the social networks. Cai et al. [9] presented a greedy discrete particle swarm optimization framework for large-scale social network clustering. Chen et al. [10] presented a suspicious URL identification system for use in social network environments based on Bayesian classification. Chu et al. [13] presented data mining techniques to collect and analyze digital evidences from the online social network "Facebook" to investigate a crime. Costa et al. [15] investigated the task of identifying different types of tip spam in a popular Brazilian location-based social network. Dreżewski et al. [17] presented social network analysis algorithms for Money Laundering Detection System (MLDS). Fan et al. [18] presented the notion of regular equivalence in fuzzy social networks, which is aimed to find similarities between actors

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in fuzzy social networks. Havens et al. [19] presented a soft modularity function for detecting fuzzy communities in social networks. Kazienko et al. [24] presented a multidimensional social network model for social recommender systems. It is built from different kinds of relationships between users, which can be grouped into layers based on the two types of relations between users, i.e., direct relations and object-based relations, which correspond to either social or semantic relations between users, respectively. Kim and Phalak [25] presented a trust prediction framework in rating-based experience sharing social networks without a web of trust. Kundu and Pal [26] presented the fuzzy granular social network (FGSN) model based on the fuzzy granular theory to describe a network in terms of granules. Kundu and Pal [27] presented a deprecation based greedy strategy and the corresponding algorithm for target set selection in large scale social networks. Li et al. [28] revealed the efficiency of information diffusion in online social networks of microblog. Liao et al. [29] presented the notion of structural equivalence in fuzzy social networks and applied it to analyze fuzzy technology innovation networks. Lin et al. [30] applied an integer programming approach to detect hierarchical community structures in social networks. Meo et al. [31] presented an approach for the recommendation of similar users, resources and social networks in a social internetworking scenario. Monclar et al. [32] designed and constructed the Mobile Exchange of Knowledge (MEK) using spatial-temporal information to improve social networks and knowledge dissemination. Nair and Sarasamma [33] presented data mining techniques for fuzzy social network analysis. Ni et al. [34] studied the problem of minimizing the expected complete influence time of a social network and presented a framework of greedy algorithms to make a balanced trade-off between the optimality and the complexity. Shafiq et al. [36] presented a solution to re-order Web search results in a systematic way based on the contextual information collected from a user's social network. Tian et al. [38] presented a generalized Markov graph model for social networks and applied it for social networks analysis. Wang and Jiang [40] presented a community-aware task allocation model for social networked multiagent systems, where the agent' cooperation domain is constrained in a community and each agent can negotiate only with its intracommunity member agents. Yager [43] presented the concept representation and database structures in fuzzy social relational networks (FSRNs) based on fuzzy sets [49], where the value of a fuzzy relationship between actors in a fuzzy social relational network is between zero and one. Yang et al. [44] presented a multi-dimensional image quality prediction model for user-generated images in social networks. Yoon et al. [45] presented a community-based sampling method using densification power law (DPL) for online social networks. Yu et al. [46] presented a collective learning framework for the emergence of social norms in networked multiagent systems. Yu [47] presented a dynamic competitive recommendation algorithm in social network services based on the competition of multiple component algorithms. Yu [48] presented a friend recommendation method ACR-FoF (algebraic connectivity regularized friends-of-friends) that considers both success rate and content spread in social networks. Zhou et al. [50] presented a secure and privacy-preserving key management scheme for cloud-assisted wireless body area network in m-healthcare social networks. Zhou et al. [51] presented a linear threshold-hurdle model for product adoption prediction incorporating social network effects. In summary, Table 1 shows a comparison of the characteristics of the existing social network models.

However, Yager's FSRN model [43] has the drawbacks that (1) it lacks the capability for representing and reasoning with negative, positive and neutral relationships between actors for fuzzy queries processing and (2) the fuzzy queries processing techniques based on Yager's FSRN model only can get the degrees of truth of fuzzy queries. Therefore, we need to propose a new social relational network model, called the intuitionistic fuzzy social relational network (IFSRN) model, based on intuitionistic fuzzy sets (IFSs) [2] and to propose fuzzy queries processing techniques based on IFSRNs to let the system has the capability for representing and reasoning with negative, positive and neutral relationships between actors in IFSRNs and can get the degrees of truth and the degrees of false of fuzzy queries, respectively, for increasing the flexibility of the system to overcome the drawbacks of Yager's FSRN model [43] for fuzzy queries processing.

In this paper, we propose the intuitionistic fuzzy social relational network (IFSRN) model based on intuitionistic fuzzy sets (IFSs) [2] and propose fuzzy queries processing techniques based on intuitionistic fuzzy social relational networks (IFSRNs) which contain positive relationships, neutral relationships, and negative relationships between actors, where the degrees of relationship between actors are represented by intuitionistic fuzzy values (IFVs). First, we propose the concept of intuitionistic fuzzy social graphs (IFSGs) to model IFSRNs. Then, we propose some concepts of intuitionistic fuzzy relations (IFRs) which represent relationships between actors in an IFSRN. Then, we propose the concepts of the strength of connectedness between vertices having at most k edges between them, the intuitionistic fuzzy level-cut of the strength of connectedness between vertices, and the degree of centrality of a vertex in an IFSG. Finally, we propose fuzzy queries processing techniques based on IFSRNs. The originality of this paper is that we propose fuzzy queries processing techniques based on the proposed IFSRN model. The main contribution of this paper is that the proposed fuzzy queries processing techniques based on the proposed IFSRN model can overcome the drawbacks of Yager's FSRN model [43] for fuzzy queries processing due to the fact that

(1) The proposed IFSRN model has the capability for representing and reasoning with negative, positive and neutral relationships between actors for fuzzy queries processing, whereas Yager's FSRN model [43] lacks the capability for representing and reasoning with negative, positive and neutral relationships between actors for fuzzy queries processing.
(2) The proposed fuzzy queries processing techniques based on the proposed IFSRN model can get the degrees of truth and the degrees of false of fuzzy queries, respectively, for fuzzy queries processing, whereas the fuzzy queries processing techniques based on Yager's FSRN model [43] only can get the degrees of truth of fuzzy queries.

The rest of this paper is organized as follows. In Section 2, we briefly review some basic definitions of IFSs [2,3,41], IFRs [3,4,8], IFGs [22,23,37], and intuitionistic fuzzy weighted ordered averaging operator [41]. In Section 3, we propose the concept of IFSGs to model IFSRNs and propose the concept of centralities of actors in IFSRNs. In Section 4, we propose the concepts for computing