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Modeling online social signed networks

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Abstract

People's online rating behavior can be modeled by user-object bipartite networks directly. However, few works have been devoted to reveal the hidden relations between users, especially from the perspective of signed networks. We analyze the signed monopartite networks projected by the signed user-object bipartite networks, finding that the networks are highly clustered with obvious community structure. Interestingly, the positive clustering coefficient is remarkably higher than the negative clustering coefficient. Then, a Signed Growing Network model (SGN) based on local preferential attachment is proposed to generate a user's signed network that has community structure and high positive clustering coefficient. Other structural properties of the modeled networks are also found to be similar to the empirical networks.

Keywords: signed networks; online rating systems; growing network model

1. Introduction

Social network is used to study the relationships between individuals, groups, and organizations in social sciences [1, 2]. With the development of the Internet, online social networks are regularly used by billions of people in their daily life. The accumulating data of online social networks facilitate the research about the network properties [3], network spreading [4] and the recommendation [5] on the network. Teutle modeled Twitter by complex networks, and explored its network properties [6]. With the open data of Facebook, some researchers studied the properties of the big dataset [7, 8]. In addition, the research about social networks has a lot of remarkable conclusions such as Six Degrees of Separation and The Strength of Weak Ties .

Our study focused on the online rating system that can be expressed by bipartite networks. Online rating data is a type of data that records users, items and ratings. The import information of online rating data is the users attitude towards the items i.e. like and dislike. In fact, when the network has opposite relationships, such as like and dislike, love and hate, support and oppose, cooperation and competition, trust and distrust, traditional network structure cannot express these relationships effectively. In order to take the negative relations into consideration, we use the signed bipartite networks to model the online rating system. The existing works about signed bipartite networks are focus on the classification of the nodes, the spectral analysis, and the edge prediction [9, 10, 11]. Mining the interactions of users is crucial to the social networks. The user-item bipartite networks don't have direct relations among users, so we project signed bipartite networks to signed monopartite networks. Using signed network to express online rating system can bring different properties, because negative edges present distinct properties from positive edges [12].

For monopartite signed networks, the research always focuses on the balance and the community structure of the networks. Balance theory is a basic theory of signed networks which is derived from sociology. In the 1940s, Heider provided structural balance theory firstly [13]. Afterwards Cartwright and Harary further developed the theory to the whole network and described it with graph theory which makes it quantitative [14]. Then the follow-up works proposed the status theory (directed network) [15, 16] and weak balance theory [17]. All the theories above are based on triangle motifs. Furthermore, there is another index measuring the balance of signed networks from a more global perspective by examining the loop's balance of all length in networks [18, 19].

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