An Empirical Study of Virtual Social Networks

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ABSTRACT

Virtual social network is a kind of social network established through indirect interactions between individuals, especially through online interactions. Virtual social network has significant implications on business operations, governing, scientific research, and social relations. This paper describes several virtual social networks and studies their properties and effects using empirical approach and computer simulations. Furthermore, the authors find that these virtual social networks have similar distributions with respect to the frequency of nodes and different edges. These distributions are similar between directed networks and undirected networks. In addition, through simulations they demonstrate that the roles played by different nodes in a virtual social network are unequal. Limitations of this study and future research directions are also presented.

KEYWORDS

Amazon, BitCoin Rating, DBLP, Empirical Study, Google Scholar, Simulation, Social Network, Statistical Analysis, Twitter, Virtual Network, Virtual Social Network

INTRODUCTION

Human beings are a social species that relies on interactions and cooperation to survive and thrive (Editorial, 2018). The social institutions and organizations formed by individual human beings also need to coordinate and collaborate to maintain orders of the society and support operations of the business (Fowler & Christakis, 2010). Interactions between individuals or between organizations could also have negative effects, such as competitions, confliction, and opposition. The interactions (positive and negative) between these social actors (individuals or organizations) form a social network (Carrington et al., 2005). A social network basically contains social actors and social relations between actors, and they can be graphically described as nodes (actors) and edges (relations) (Knoke & Yang, 2019).

The study of social networks can help us identify hidden social relations, uncover local and global relation patterns, locate influential actors, and examine social dynamics (Wasserman, 1994). These findings could potentially help business enhance its operations, government improve its management, and organizations and institutions better allocate resources and achieve their objectives (Afuah, 2013; Freeman, 2004).

Virtual social network is also formed by social actors (Parks, 2010). However, in this network the social relations between actors are virtual, which means the actors are connected indirectly, often through online interactions (Blattner & Fiori, 2011). Examples of virtual social networks include social media network, buyer-seller rating network, and P2P (Peer-to-Peer) business network (Freedman & Jin, 2008). Relatively speaking, virtual social network is more complex than the traditional social

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network (Potts et al., 2008). This is mainly due to the scale of virtual social networks. For example, a regular node (actor) might have at most hundreds of edges in a traditional face-to-face coworker network. However, a node (actor) in a Twitter Follower network might have millions of incoming edges (Watanabe & Suzumura, 2013). Therefore, virtual social network analysis is more challenging than the traditional social network analysis due to its large scale (Nazir et al., 2008).

In this paper, we first describe several virtual social networks, including DBLP coauthor network, Google Scholar citation network, Amazon product co-purchase network, and several Twitter networks. Next, we perform an empirical study on these networks. Some properties about these networks are analyzed and presented. Finally, we discuss the implications of these virtual social networks on business management, government operation, and social relations.

The remainder of this paper is organized as follows. We first review the theoretical framework and related literature. We then describe research objectives, the data source, and the data mining and data analysis process. Next, we present the research methodology, followed by the empirical analysis and findings. Finally, conclusions, limitations, and future research are presented.

THEORETICAL FRAMEWORK

A social network is a network structure made up of nodes and edges. In social network, nodes are called social actors (such as individuals or organizations) and edges represent the relations or interactions between actors. The edges could be directed or undirected, which are determined by the type of relations or interactions between actors. The study of social network could help us reveal hidden network patterns, discover influential actors, and understand institutional and organizational dynamics.

Social network study has been conducted in many areas, such as communication, business, criminal activity, language, art, community, and so on and so forth. In the next section of this article, related work will be reviewed.

The theoretical (mathematical) framework of social network analysis is graph theory. In mathematics and computer science, graph theory is the study of graphs, which are abstract structures used to model pairwise relations between objects. A graph is defined to be made up of vertices (nodes) which are connected by edges (links). There are two kinds of graphs: undirected graph and directed graphs. Many problems regarding graphs have been studies, such graph coloring. Accordingly, many research methods have been proposed and practiced. Therefore, there are plenty of research tools available for graph analysis.

Graph theory has many applications in different domains, including linguistics, physics, chemistry, biology, and social science. Therefore, graph theory can also be applied to social network analysis. The study performed in this article is based on graph theory, model fitting, and statistical analysis.

LITERATURE REVIEW

Virtual social network has been studied extensively. In this paper, we will review related work on communication network, social media network, coauthor network, e-business and e-commerce network.

Two decades ago, Microsoft Messenger was a popular instant-messaging program. Once, its number of users has reached 300 million. Therefore, communication virtual networks were formed through Microsoft Messenger. Leskovec & Horvitz (2007) presented a study of Microsoft Instant Messenger network, which is defined by user interactions and demographics. They found out that the network graph has an effective diameter of 7.8, and is highly clustered, with a decaying coefficient. They also found out that people with similar characteristics tend to communicate more with one another, with the exception of gender, where they found out that cross-gender conversations are both more frequent and of longer duration than conversations with the same gender. In their other study, Leskovec & Horvitz (2008) examined communication activities of the Microsoft Messenger network.

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