Telematics and Informatics 33 (2016) 165–175

Contents lists available at ScienceDirect

Telematics and Informatics

journal homepage: www.elsevier.com/locate/tele

A two-step model for self-organized social network pre-construction

Wei-Lun Chang

Department of Business Administration, Tamkang University, No. 151, Yingzhuan Rd., Tamsui Dist., New Taipei City 25137, Taiwan, ROC

ARTICLE INFO

Article history:
Received 4 March 2015
Accepted 17 June 2015
Available online 3 July 2015

Keywords:
Self-organization maps
Social network analysis
Social network theory

ABSTRACT

A social network is a relational connection between individuals, including any relationships related to the exchange of information such as those among friends or colleagues. The most significant problem associated with social networks is establishing the role of key individuals, who are charged with conveying important messages among everyone involved. However, the most appropriate representatives of classes are difficult to identify. The aim of this study was to develop a method with which to facilitate the automatic pre-construction of a social network prior to any interaction and pre-identify representatives within the network. The goals of this research were: (1) construct a social network based on a self-organization maps and social network analysis, (2) verify differences between pre-constructed and actual social networks, and (3) identify key representatives and validate the efficiency of the social network.

1. Introduction

Since the late 1920s, Hawthorne study has been the basis of research into the motives behind human relationships and the resulting behavior, and research into group behavior gained considerable attention in the 1950s. Groups play a vital role in determining the attitudes and behavior of members within an organization. Schein (1980) defined groups as a union of members who know each other and belong to the same cluster. Boone and Kurtz (1987) indicated that groups comprise more than one member, and demonstrate interaction and a common purpose. The formation stage of group development is critical, due to the exchange of information or resources among members and subgroups emerge during the brainstorming stage of group development (Zheng et al., 2014).

Investigating subgroups is important to help managers comprehend the behavior of the entire group (Lu et al., 2010). Existing approaches to the analysis of social networks also help firms to identify connections associated with subgroups. Social networks include specific individuals (e.g., group, organization or social entity) and a set of connections within the social structure (e.g., friendship) (Jamali and Abolhassani, 2006; Cavdur and Kumara, 2012). This research considers groups as an example of social networks, which have the potential to develop both in scope and coherence.

Weber (1947) indicated that social interaction and the division of work are important factors within successful organizations. The research of Cross and Prusak (2002) and Serrat (2009) specified that efficiency improves if the top manager can identify key members within a group. The traditional approach to analyzing social networks includes interviews to collect data and focus groups to generate visual representations of social networks (van Duijn and Vermunt, 2006). Recently, many researchers have incorporated a variety of data sources to generate social networks. AT&T examined communication

E-mail address: wlchang@mail.tku.edu.tw

http://dx.doi.org/10.1016/j.tele.2015.06.013
0736-5853/

records (Abello et al., 1998), IBM investigated web pages (Kumar et al., 1999), Sahar and Jabee (2009) analyzed Bluetooth communication records, and Thelwall (2008) evaluated social network website data. Nevertheless, these studies examined only the influence or relationships of groups or networks. Moreover, there has been a lack of research investigating the effect prior to the formation of the group.

Krackhardt and Hanson (2000) identified the significance of informal groups. This research considers subgroups to be informal groups and the relationships within the subgroups have an impact on the organization. The problems dealt with in the research are (1) determining how to automatically identify subgroups, (2) how to pre-construct a social network based on subgroups prior to the actual formation of the group, and (3) how to identify the key individuals in the pre-constructed network. To deal with these problems, we propose a two-step approach to identify clusters and build social networks. The first step it to use self-organization maps to generate homogeneous clusters (subgroups). The second step is to use social network analysis to construct social networks from each cluster and identify key individuals. This research aims to provide an automatic method to pre-construct potential social networks and identify major members in advance.

The remainder of this research is organized as follows. Section 2 presents the related literature, including data clustering methods, social network theory and social network analysis. Section 3 outlines our research framework. In Section 4, we analyze the collected data and discuss the implications. Finally, in Section 6 we provide our conclusions and the limitation of this research.

2. Related literature

2.1. Clustering method

The purpose of data clustering is to divide collected data into several clusters with a high degree of similarity. Vesanto and Alhoniemi (2000) defined clustering as a means with which to minimize distance within a cluster and maximize the distance among clusters. Berkhin (2006) specified the goal of clustering as a means to separate raw data into blocks (clusters), with different goals for each block. Conventionally, research has been categorized into two clustering methods (Jain et al., 1999): hierarchical clustering and partitional clustering. Hierarchical clustering uses top-down or bottom-up concepts to separate or combine clusters. Partitional clustering outputs a set number of clusters, using a criterion function to iteratively compute and generate clusters. Self-organization maps (SOM) use artificial intelligence to provide a different perspective from which to visualize clusters with learning concepts.

Self-organization maps are widely applied in the analysis of high dimensional data (Tasdemir and Merenyi, 2009; Troshani et al., 2011). The main advantage of SOM is the ability to convert non-linear high dimensional data to low dimensional data of neurons (Lampinen and Oja, 1992; Kohonen, 1990); an approach which is more efficient than traditional clustering methods. Self-organization maps represent an unsupervised and competitive learning approach based on the concept of neural networks. Competitive learning mechanisms are used to estimate the distance between each data point and neurons to discover a winner (best match unit) (Kohonen, 1995). Data that is closer to the winner will continue the learning process, thereby shortening the distance. Clusters are generated and distinguished automatically (Kohonen et al., 1996).

The other advantage of SOM is its ability to provide unsupervised learning, in which sample data is trained in a non-linear manner (Oja, 2002). In the real world, data is multidimensional and complex, which limits the outcome of conventional clustering methods. The problem results from the lack of data simplification (Hinton and Sejnowski, 1999), which can be overcome by the unsupervised learning approach. Basically, unsupervised learning algorithms can be separated into two categories (Haykin, 1998): linear data conversion and competitive learning. Moreover, this research considers the interaction of members and formation of groups (subgroups) in the social network is the unsupervised learning process (Goldberg et al., 2010). This study uses SOM as the means with which to separate clusters in the process of pre-constructing social networks.

2.2. Social network theory

Simmel (1950) was the first researcher to use social network theory to conduct research indicating that analyzing interactions in a social network is easier than analyzing individuals. Moreno (1934) used sociometry to investigate runaway students from a girl's school in New York, discovering that the reasons for this behavior stem from social networks rather than individual motives. Bavelas (1948) uses math models to present concepts of centrality based on social network theory. Most studies have assumed that each member (e.g., an individual, a group or an organization) is interdependent (Brass, 1995; Ehrlich and Carboni, 2005). Brass (1995) and Kilduff and Tsai (2003) claimed that a social network can be represented by a set of nodes and ties/linkages, which present the relationships among nodes. Haythornthwaite (1996) considered social networks as the generated potential social value via relationships resulting from ties/linkages among actors. Ehrlich and Carboni (2005) specified a social networks as a social structure among actors, maintained via relationships that are produced by ties/linkages.

This research concurs with previous researchers in that the significance of interaction and communication among actors and considers relationships to be the foundation for the preconstruction of social networks. This research uses three elements of social networks found in previous studies: actors, ties/linkages, and relationships. The actor is the basic element of a social network. In diagrams of social networks, each node represents an actor. Ties/linkages are the connections among