Information Processing and Management 48 (2012) 671–679

Contents lists available at SciVerse ScienceDirect

Information Processing and Management

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

Egocentric analysis of co-authorship network structure, position and performance

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ARTICLE INFO

Article history:
Received 27 May 2011
Received in revised form 6 September 2011
Accepted 16 September 2011
Available online 19 October 2011

Keywords:
Co-authorship network
Social network analysis
Ego-centric analysis
Scholars performance
g-Index

ABSTRACT

In this study, we propose and validate social networks based theoretical model for exploring scholars' collaboration (co-authorship) network properties associated with their citation-based research performance (i.e., g-index). Using structural holes theory, we focus on how a scholar's egocentric network properties of density, efficiency and constraint within the network associate with their scholarly performance. For our analysis, we use publication data of high impact factor journals in the field of "*Information Science & Library Science*" between 2000 and 2009, extracted from Scopus. The resulting database contained 4837 publications reflecting the contributions of 8069 authors. Results from our data analysis suggest that research performance of scholars' is significantly correlated with scholars' ego-network measures. In particular, scholars with more co-authors and those who exhibit higher levels of betweenness centrality (i.e., the extent to which a co-author is between another pair of co-authors) perform better in terms of research (i.e., higher g-index). Furthermore, scholars with efficient collaboration networks who maintain a strong co-authorship relationship with one primary co-author within a group of linked co-authors (i.e., co-authors that have joint publications) perform better than those researchers with many relationships to the same group of linked co-authors.

1. Introduction

As in most large organizations, performance of individuals and teams is measured through a set of metrics that pertain to task and contextual performance. Similarly in academia, scholars and scientists are evaluated based on their academic performance such as teaching evaluations, governance capabilities, research output, number of secured grants and so on. Such evaluation of researchers is not only needed for faculty recruitment, but also for governmental funding allocation and for achieving a high reputation within the research community. The reputation of research organizations indirectly affects the society's welfare, since a high reputation attracts foreign purchases, foreign investments, and highly qualified students from around the world. The implication of such ranking provides basis and justification for federal funding thus encouraging high research standards and goals. Therefore, on a global level, with respect to governmental funding (i.e., the allocation of funding for a specific project to a scientific research group) and university strategy, it is important to identify key scholars, collaboration areas and research strengths within universities with the aim of maximizing the research output, cost optimization, and resource utilization. However, in all these cases, the common problem exists, namely answering the question of how can research productive scientists be identified, clustered, and configured for optimal research synergies (Jiang, 2008).

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doi:10.1016/j.ipm.2011.09.001

In light of the above, in recent years there has been a sharp increase in the number of collaborations between scholars. An explanation for the rapid growth of international scientific collaboration has been provided by Luukkonen, Persson, and Sivertsen (1992) and Luukkonen, Tijssen, Persson, and Sivertsen (1993) as well as Wagner and Leydesdorff (2005). By jointly publishing a paper, researchers show their knowledge sharing activities, which are essential for knowledge creation. As most scientific output is a result of group collaboration, it often needs scientific cooperation between individuals across national borders (Leclerc & Gagné, 1994).

Due to the necessity to keep pace with scientific progress not only at the micro level (e.g., level of individual researchers) but also at the macro level (i.e., nationally), most governments are interested in enhancing the level of international collaborations through appropriate policies (Katz & Martin, 1997; van Raan, 2004). Scientific collaboration in addition to advance research, facilitates increasing the visibility and authorship of the highly productive researchers (Pao, 1992). An important result of scientific collaborations is the creation of new scientific knowledge, including new research questions, new research proposals, new theories, and new publications (Stokols, Harvey, Gress, Fuqua, & Phillips, 2005). Although Duque et al. (2005) have found that collaboration was not associated with an increase in scientific publications in the developing countries of Ghana, Kenya, and India (Kerala) (2005), Lee and Bozeman show that the total number of publications for US scientists is positively associated with the total number of collaborations (Lee & Bozeman, 2005). Also, other researchers show that research collaboration enhance the quality of research (considering publications' citation count) in different disciplines such as medicine (Figg et al., 2006); biotechnology and applied microbiology (Frenken, Holzl, & Vor, 2005); and chemistry (Glänzel & Schubert, 2001).

Since scientific collaborations are defined as "interactions taking place within a social context among two or more scientists that facilitates the sharing of meaning and completion of tasks with respect to a mutually shared, super-ordinated goal" (Sonnenwald, 2007), those collaborations frequently emerge from, and are perpetuated through social networks – formal and informal. Since social networks may span disciplinary, organizational, and national boundaries, social networks can influence collaboration in multiple ways (Barabasi et al., 2002; Cross, Borgatti, & Parker, 2002; Kraut, Egido, & Galegher, 1988; Newman, 2004; Sonnenwald, 2007). Co-authorship network represents a prototype of a social network by mapping the graph containing authors who have joint relevant publications (Yin, Kretschmer, Hanneman, & Liu, 2006).

To date, most studies on the effects of collaboration network properties and its evolution on citation patterns have either focused on (i) sociocentric properties of centralization, cohesion (e.g., clique structure) and density or (ii) egocentric properties of node centrality such as betweenness, point and closeness centrality. Very few though, have considered evaluating the position effect of egocentric network constraint and efficiency on performance in the scholarly collaboration network domain. The motivating questions for our study are: (i) what predictors of egocentric network position explain scholarly performance within a collaboration network? (ii) can structural holes theory, its assumptions and its implication for individual performance be applied and extended within the context of a non-competitive, non-corporate and educational settings? (iii) do network position properties matter more than properties of network structure in terms of scholarly performance? (iv) what social factors and implications should be accounted for scholars in order to enhance performance in an educational setting?

For our analysis, we use publication data of high impact factor journals in the field of "*Information Science & Library Science*", extracted from Scopus. In this study, we analyse the results for co-authorship networks of the authors who has at least one publication in the top 9 selected journals of the field. For the purpose of this study, single-authored papers were neglected as part of the analysis.

In the following section, we review current literature on theories of social network and performance. In particular, we focus on egocentric network literature such as point centrality and structural holes theory and present a model to understand individual scholarly performance. Section 3 describes the data resources, the data gathering and validation process followed by a definition of measures used in our analysis. Section 4 provides details of our findings. Correlation results of network properties and individual performance are also presented. Finally, we discuss the implication of the results, research limitations, and our future work.

2. Literature review

2.1. Overview of social network

A social network is a constituent of two or more actors (individuals) who are connected through one or more relationships such as providing advice, information and so on. In general, analysis of social networks is usually either conducted using the sociocentric approach or the egocentric approach (Chung, Hossain, & Davis, 2005). In the latter, the node of interest is the ego, and its immediate neighbors are the alters. At the individual level, the debate concentrates on how the structural position of an individual in the network impacts outcome, such as performance, of that person (Chung & Hossain, 2009).

Social networks operate on many levels, from families up to the level of nations. They play a critical role in determining the way problems are solved, organizations are run, markets evolve, and the degree to which individuals succeed in achieving their goals (Abbasi & Altmann, 2011). Social networks have been analyzed to identify areas of strengths and weaknesses within and among research organizations, businesses, and nations as well as to direct scientific development and funding policies (Owen-Smith, Riccaboni, Pammolli, & Powell, 2002; Sonnenwald, 2007).