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Using Social Network Analysis to Investigate the Potential of Innovation Networks: Lessons Learned from NASA's International Space Apps Challenge

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Abstract

This research analyzes the affiliated multipartite social networks of hackathon style mass collaboration events. Using social network analysis we model the innovation networks for NASA's International Space Apps Challenge and use social network analysis to understand the structure of and relationships within the modeled networks. Using metrics such as degree, degree distribution, degree correlations, and density, the resulting models and study answer questions like: can social network statistics act as indicators of innovation performance within a network and which statistics provide insight to the likelihood of innovation performance? We address these research questions by building the affiliation networks for the 2012 and 2013 NASA International Space Apps Challenges and applying Gnyawali and Srivastava's conceptual model on cluster and network effects against these real-world networks to empirically prove the likelihood of innovation.

Keywords: Innovation networks; social network anlysis, mass collaboration, bipartite graphs, affilation networks

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1. Introduction

The subject of network structure and innovation has been a keen area of interest in management, technology, and engineering literature[1,2,3,4]. The examination of user innovation via mass collaboration is an emerging topic of interest[5] and a focus of this paper. This research supports recent research that identifies network and cluster factors that influence innovation catalysts and barriers[2].

Graph theory models of social networks have been used to understand innovation[1,2,3,4], this paper presents such an analysis. We are using graph theory to model user innovation social networks, which we will investigate to identify metrics that can be used to indicate the likelihood of innovation. This paper uses empirical data from NASA's International Space Apps Challenge events to examine how the structure of the social networks of these two mass collaboration events can inform the likelihood of innovation performance. Specifically we seek to answer the questions: can social network metrics act as indicators of innovation performance within a network; if yes, which statistics provide insight to the likelihood of innovation performance?

We address these research questions by building affiliation networks for the 2012 and 2013 International Space Apps Challenges and applying Gnyawali and Srivastava's conceptual model on cluster and network effects against these real-world networks. Using the conceptual model and social network analysis we will identify metrics that substantiate or unsubstantiate our model generated propositions. This research contributes to the body of knowledge concerning the engineering of large scale collaboration networks.

2. Literature review

Networks are an effective tool for the visualization and analysis of real-world systems. A network is a collection of elements, typically called nodes, actors, or vertices, grouped together by lines, which are called edges or arcs[6,7,8]. In a network lines (edges) run between the elements (nodes) to illustrate the existence or non-existence of connectivity. In their comprehensive review of research on network systems Newman and Watts[7,9] illustrate that the analysis and modeling of network structure and behavior is an interdisciplinary study with research spanning disciplines such as biology, mathematics, physics, sociology, computer science, business, and economics. Research indicates that in addition to the discipline area studied the type of network being studied is another poignant element of consideration when examining the network of a real-world system[7,9,6]. Although real-world networks tend to exhibit a few common characteristics the context and categorization of the network data set as either a social, information, technological, or biological network has impactful consideration on the interpretation and selection of network statistics and metrics. With the plethora of research and network examples available and the importance that context and perspective holds in network examination it is imperative to scope the area of interest before attempting a literature review. This study is specifically focused on social affiliation networks designed for innovation.

2.1. Social network analysis

Social networks are ubiquitous; the ties that bind individuals, organizations, industries, and systems are growing in size and complexity. This reality is illustrated in the multitude of articles and text concerning social networks. A social network is a broad class of networks in which the edges represent relationships between the network nodes. The nodes in a social network can represent any number of things; a small sampling of literature demonstrates the diversity of real-world social networks being studied with nodes representing essential proteins,[10] teams,[11] and individuals[1,12].

The study of social networks began in the social sciences with the examination of friendships and small social groups[7]. Early research concentrated on individual node and edge statics such as degree and path lengths. With current computing and data storage capability we have seen an increase in the size of data sets in current network research[7,6]. With node and edge counts in the tens of thousands and millions, the trend of studying larger scale as opposed to small scale networks is resulting in changes to the analytical approaches adopted as well. In larger networks, like the one studied in this analysis, the question of what will happen with the removal of a node becomes