

The Emergence of Multidimensional Networks

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Recent advances in digital technologies invite consideration of organizing as a process that is accomplished by global, flexible, adaptive, and ad hoc networks that can be created, maintained, dissolved, and reconstituted with remarkable alacrity. We are all familiar with the conundrum facing information technology professionals and knowledge network practitioners in communities. Despite our best efforts to design technologies to support the creation and sharing of knowledge via point-to-point channels or databases, these technologies often remain largely underutilized. The “If we build it, they will come” adage has little currency in the design, deployment, and adoption of the vast majority of technologies. Yet there are some success stories that suggest the need to understand the social factors that shape the use of technologies to create and sustain organizational, inter-organizational, and community knowledge networks. Indeed, as developments in information and communication technologies continue to reduce or eliminate the potential *logistic* barriers to our communication and knowledge networks, it becomes increasingly important to identify the various *social* factors that enable or constrain the development of these network linkages.

Theorizing social motivations for emergence of multidimensional networks

Over the past two decades, social scientists have developed and tested theories about the social motivations for creating, maintaining, dissolving and re-creating social and knowledge network ties among individuals. However, recent developments in Web 2.0 and Cyberinfrastructure technologies underscore the need to theorize about the emergence of linkages in “multidimensional networks” – where the nodes might be people as well as “non-human agents” such as documents, datasets, analytic tools, and concepts (or keywords). The links among these nodes would include, for instance, people accessing/creating/citing documents, documents that report results based on a dataset, analytic tools used to investigate a dataset, keywords associated with certain documents, and so on.

In pragmatic terms, we need to build a theoretical foundation to address questions such as “Why is it that in some cases we seek information from other individuals while in other instances we go to a non-human agent such as a database? When do we go to a person to get suggestions about which non-human agent to access? When do we go to a non-human agent to identify the person we should contact? To what extent does the creation of common knowledge repositories substitute or augment direct communication between individuals or organizations?”

In intellectual terms, we ask the question: What are the social motivations that help us understand why we as individuals seek to forge, sustain, or dissolve our knowledge network ties with other human and non-human agents? Theorizing the emergence of these multidimensional networks should leverage several intellectual and methodological streams of ongoing research including social network theory and actor-network theory.

Design-assisted theory construction

The current activities surrounding the development of Web 2.0 and Cyberinfrastructure also create an unprecedented potential for the development of “design-assisted theory construction” to advance our understanding of communication technologies and social behavior. Recent scholarship (Larry Lessig, Francois Bar, Christian Sandvig, and Dmitri Williams among others) have documented how software code embedded in technologies have substantial influence on the structuring of society and social interactions. Their efforts underscore the extent to which “code” once in place might enable and constrain future activities. But a priori “code” is not necessarily a bug – it could be a feature (pun intended). We have the ability to design new technological features not as an end in itself but a means towards an end – theory construction. Not unlike the design of laboratory experiments, we have the

opportunity to embed in the “design code” of technologies various theoretical mechanisms and systematically observe the manner in which these mechanisms interplay with social behaviors. Indeed, firms such as Amazon.com (which a former Chief Scientific Officer described as the world’s largest social science laboratory) have been deploying similar techniques to better understand human purchasing behavior. Virtual worlds such as Second Life are especially well-suited to such “design-assisted theory construction.”

Development of cyberinfrastructure/Web 2.0 provide the technological capability to capture relational metadata needed to more effectively understand (and enable) communities.

The capturing of massive amounts of digitalized information about human behavior (especially relational behavior) and the capacity to manipulate those data provides an unprecedented opportunity for new insights into collective human behavior. The Web 2.0/cyberinfrastructure technologies that have enabled the multidimensional networks described above also provide the opportunity to capture, tag, and manifest high-resolution high-fidelity relational “metadata” (which node is connected to which other node) from these multidimensional networks. These include (i) technologies that “**capture**” communities’ relational meta-data (Pingback and trackback in interblog networks, blogrolls, data provenance), (ii) technologies to “**tag**” communities’ relational metadata (ranging from Dublin Core taxonomies to folksonomies (‘wisdom of crowds’) like tagging pictures (Flickr), social bookmarking (del.icio.us, LookupThis, BlinkList), social citations (CiteULike.org), social libraries (discogs.com, LibraryThing.com), social shopping (SwagRoll, Kaboodle, thethingsiwant.com), and social networks (FOAF, XFN, MySpace, Facebook), and (iii) technologies to “**manifest**” communities’ relational metadata (Tagclouds, Recommender systems, Rating/Reputation systems, ISI’s HistCite, Network Visualization systems)

Confirmatory Network Analysis using Exponential random Graph Models (ERGM)

Recent advances in the development of Exponential Random Graph Modeling techniques (by Stanley Wasserman, Pip Pattison, Garry Robins, Tom Snijders, Mark Hancock and others) in social network analysis have created the opportunity for a new generation of “confirmatory network analysis” - to empirically test cross-sectional and longitudinal hypotheses about the extent to which multiple theoretical motivations, operating at multiple levels of analysis, contribute to the emergence an observed multidimensional network. These techniques, have the potential to serve as the equivalent of a “statistical network MRI” to unravel the theoretically grounded structural signatures that contribute to the observed network.

Conclusion

In summary, spurred by recent advances in Web 2.0/Cyberinfrastructure, there is a pressing societal need to understand the social motivations for emergence of multidimensional social and knowledge networks. The research on the dynamics of these networks is well poised to make a quantum intellectual leap by facilitating transdisciplinary collaboration among:

- Social scientists that leverages recent advances in our understanding in disparate areas such as social network theories and actor network theory
- Social scientists and design scholars that enable the development of design-assisted theory construction.
- Social scientists and computer scientists that enable harvesting of the vast amount of relational metadata generated by Web 2.0/Cyberinfrastructure
- Social theorists and methodologists that enable the use of recent advances in confirmatory network analytic techniques to test hypotheses that will advance our understanding of how we are constrained and enabled by the multidimensional networks in which we are embedded.

Author Biography

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He is investigating factors that lead to the formation, maintenance, and dissolution of dynamically linked social and knowledge networks in communities. Specifically, his research team is developing and testing theories and methods of network science to map, understand and enable more effective (i) disaster response networks, (ii) public health networks, (iii) transnational immigrant networks, (iv) massively multiplayer online games (MMOs) networks and (v) environmental engineering networks. His research program has been funded continuously for the past decade by major grants from the U.S. National Science Foundation.

Professor Contractor has published or presented over 250 research papers dealing with communication. His book titled *Theories of Communication Networks* (co-authored with Professor Peter Monge and published by Oxford University Press) received the 2003 Book of the Year award from the Organizational Communication Division of the National Communication Association. He is the lead developer of *IKNOW* (Inquiring Knowledge Networks On the Web), and its Cyberinfrastructure extension *CI-KNOW*, a network recommender system to enable communities using cyberinfrastructure, as well as *Blanche*, a software environment to simulate the dynamics of social networks.