Chapter 1

Using agent-based modeling to traverse frameworks in theories of the social

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The historical formation and social positioning of disciplines in the social sciences—and science in general—scaffold the development of methodologies and tools in the social sciences, which further attune analysts to specific dimensions of social reality. With the proliferation of problem-based social science and interdisciplinary knowledge spaces it is becoming increasingly important for researchers to understand the interrelationships between the structures studied by other disciplines and their own view on reality. In this paper we present a social science laboratory called Virtual Simulation and Analysis of Group Evolution (ViSAGE), which was developed to bridge methods and theories in computer science and social science to study the evolution of social groups. We describe the development of ViSAGE into a tool for traversing various levels and dimensions of sociality.

1.1 Introduction

Social systems are possibly the most complex systems science has to study. One indicator is that the basic components of social systems, human agents, are often regarded as “complex and adaptive.” If the components of the system are themselves complex and adapting to the context in which they act, the system must be of a higher order of complexity. For this reason social science as a human organization can be looked at as a social and technological arrangement for sorting through and making knowledge about this complex system. It contains methods, frameworks, and the human values needed to reinforce social boundaries and labor divisions to explore dimensions of social complexity. Understanding the specifics of this arrangement of actors and tools, how it self-organizes and develops, is critical for building tools for analyzing complex systems in the future. How does computer modeling and simulation mediate social boundaries and in what way do those boundaries function to facilitate the creation of theories and frameworks for understanding the multidimensionality of social reality—called “traversing” theories or frameworks [10]?

In this paper the evolution of a social science computer modeling and simulation laboratory developed by an interdisciplinary group at Rensselaer Polytechnic Institute called Virtual Simulation and Analysis of Group Evolution (ViSAGE)[1] is reviewed. We first give a short discussion of our theoretical position which is derived from the field of Science and Technology Studies (STS). Second, we give a short description of ViSAGE. Next we describe traversing in the laboratory from two points of view. First, an important aspect of the laboratory is to formally create an epistemological relationship between students interested in computer science problems, namely reverse-engineering laws of network evolution from large-scale network data, and students interested in social issues. Although this relationship is quite pragmatic it is not guaranteed to produce traversing theories between computer science and social science. Second, we highlight the construct in the laboratory that models the relationship between ‘agency and structure’ which is a concept widely discussed and disputed in the social sciences [9]. Depending on how the parameters and functions are arranged in the laboratory the meaning of agency and structure, the levels and dimensions of analysis put into view by the formal specification, changes. As such the capacity to quickly change the settings of the laboratory in the terms of each researcher’s dimension of focus, run computational experiments, and discuss the differences in results builds robust conclusions about the phenomenological relationships built-into the laboratory [1].

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1.2 Social Boundaries

One of the main factors in constructing a scientific organization is the construction of boundaries and division of labor. Often matters of disciplinary agenda setting and problem definition are subject to matters of identity making and identity politics as opposed to matters of human survival, social well-being, and prosperity, which, idealistically, should be an end that scientists seek [18, 22]. The construction and maintenance of knowledge boundaries as well as the modes through which actors cross and blur boundaries are often correlated with social in-group and out-group divisions between, for example, disciplines, sub-disciplines, intellectual lineages, instrument and equipment user groups, departmental roles, public sector alliances, and institutions. Thus an analysis of how the social sciences deal with complexity, the organization of social science as a tool for making knowledge in the face of complexity, fall into the research program of Science and Technology Studies (STS). Following the research program in field of STS, it is important in the study of complex systems to understand how perspectives are formed and solidified in modern scientific settings and the role that modeling and computation takes in establishing modes of analysis in complexity science.

It is often the assumption that scientific disciplinary boundaries are drawn in some objective fashion with a muted role for politics and values. This, however, has been shown not to be the case [14, 19]. The mind-body dualism that is so prevalent in Western social science, for example, is often linked to Christian mysticism and the separation of the soul from the worldly body [16]. Ideas of information, the mind, the body, and social structures scaffold the mind-body dualism and are resources for demarcating disciplines such as cognitive science [6], cybernetics [11] and the psychology/sociology divide [15]. The idea that human values, culture, and political projects are foundational to the production of knowledge is one of the central tenets of STS.

Current work on modeling and computer simulation in STS highlights the computer model and informatics tools in making visible social divisions and facilitating the reworking of these boundaries in terms of newer social and political projects. The most notable division is the separation of theory from experiment [8, 17, 21]. Thus the computer model holds a particularly important role in providing an affordance for traversing disciplinary boundaries and socially constructed experimental systems that couple analysts with certain scales and dimensions of social reality.

1.3 Background to ViSAGE

ViSAGE was originally developed to reverse engineer the parameters that guide the evolution of online group membership and the evolution of online communication networks [20]. Groups were considered as either formal spaces where people could post messages and chat, such as message boards and chat rooms, or network clusters. In fact, much of the research centered on developing novel algorithms for defining and locating groups from network clusters found in communications data [4]. These algorithms were set apart from others in network theory and social network analysis in that they located overlapping groups rather than mutually exclusive groups, the former of which are said to be a closer representation to real world groups.

Once groups are conceptualized, either through an existing structure (chat room) or an emergent one (network cluster), actors are classified in relation to their behavior among the group structures. Actors are classified through their interaction with these groups: joining new groups, leaving groups they are members of, and, even, remaining in a current set of groups. In the current implementation of ViSAGE, actors are categorized into three classes: actors that choose to enter groups with many members, actors that choose groups with few members, and actors that choose medium sized groups. These classifications become resources for theorizing evolution of the community through multi-agent-based processes.

As with any agent-based model the behavior of individual actors creates patterns at a larger unit-of-analysis. Collective behavior creates properties of individual groups such as class proportions internal to the group, group property distributions such as group size, and community properties such as number of active groups or average group size. In addition the properties of of these larger units feedback and constrain or open up the action possibilities of individual actors. In a basic sense this feedback loop is known as "agency and structure" in the social sciences, which is the aspect of the research presented in this paper.

1.4 Traversing computer and social science

The laboratory was designed to play off of the fact that models mediate between social worlds and between theory and data. On one end, computer scientists and mathematicians, experimenting and gathering data through the method of reverse-engineering, and on the other end, social scientists, positing theories. The theorists interpret and frame data while the experimenters use data to disprove a theoretical assertion. This relationship is formalized in ViSAGE.

The challenge of theorizing ViSAGE was in the fact that network categorization and network behavior as categorization can happen at an innumerable number of scales. How long does an actor have to persist in a given location for it to become classified? How, in observing what kind of groups an actor is entering, is consistency and persistence determined? How and why are the boundaries drawn in determining different categories?

Categorization was often derived from patterns found in the data or even selected because of the ease through which patterns could possibly be found in the data given the nature of the communication forum. It is apparent any change in assumptions about how data was gathered and categorized was to to have dramatic ramifications on the theoretical assumption in the model. Exacerbating this problem was the fact that the method and rules of categorization could change easily and significantly, as is the nature and power of informatics.

One can easily decide to change categorizing actors as choosers of group size to choosers of group makeup or even group location in a community even if such changes are dissonant with the theoretical representation, the computer model, in which the categorized data feeds into.

Over the last year the work on ViSAGE has emphasized social theoretical development [2, 7]. During this time ViSAGE has displayed many signs of partitioning off from the main research group and losing its reverse-engineering component.[2] The possible reasons for this separation are many. Looking at the project from a micro-sociological point of view there are three explanations. First, it was easy for the social scientists in the group to become "seduced by the simulation" [13], putting much time and effort into interpreting the parameters, functions, and general construct of the model. This work was not directly engaging the dimensions of sociality valued by the computer scientists. Although the possibility of a connection between these dimensions exists in the laboratory the actual time spent on this boundary, of making traversals, is quite small. The data that the computer scientists were analyzing nor the social contexts in from which the data was gathered, such as the Enron email corpus or Russian political blog networks [3], were being directly assessed by the social scientists in the group. Second, the computer scientists were not directing their work on the simulation as resolving differences in social dimensions because (1) the complexity and dimensionality of the social structures are not in their theoretical lexicon and (2) the particular social structures that the social scientists were interested in were not clear to them. Third, much effort was placed into the original design of the model, predefining a particular social theory in code, which was never made explicit, and then handed off to continue development. If the problem of traversing was problematized at the outset perhaps the solution to traversing computer science and social science would have had more of a social fix than a technical one. For example, requiring students working on a model to share an office. Such fixes are constrained, unfortunately, by many different institutional policies and practices and norms of computer work, such as working at home.

1.5 Traversing social theories

The social theory work in ViSAGE was driven by the popular debate over the definition and measurements of social capital [12]. Using ViSAGE to model the social capital discourse, the different perspective on social capital, was strategic because the discourse highlighted different units of analysis and a valuing of different social structures. Ronald Burt, for example, defines social capital as wealth that belongs to individuals while Robert Putnam defines it as wealth that belongs to groups and communities. Borgatti et al. show that these two views of social capital can be understood as three different levels of social network measures: individual, intra-group, and extra-group [5]. This resolution, however,

[2] This finding is based on informal ethnographic observations of the research group conducted as a pilot study for a dissertation.

does not account for the fact that social capital is often construed a qualitative and subjective valuing of social relationships. Each one of these dimensions are modeled in ViSAGE [4]. While network definitions of social capital embodies the interest and view of computer science the subjective and cultural valuing of social capital became the function in ViSAGE in which social scientists spent most of their time.

In ViSAGE the variables individual-level bridging social capital (C_i^{br}), individual-level bonding social capital (C_i^{bo}), local-level bridging social capital (C_j^{br}), and local-level bonding social capital (C_j^{bo}) represent the network specification of social capital.[3] On the other hand *returned social capital* (C_i^S) represents the wealth generated in relations to social structures outside of the network structures, or patterns of relationships. To specify C_i^S a 'real-world' variable (in this case it is energy (E_i), which is the physical, mental, and emotional capacity that each actor has for social interaction) is evaluated from the point of view of a structure and from an individual actor, an agent. The idea here is that two social things, two dimensions of sociality, one defined as structure and the other agency, are brought into tension with one another. One is the belief of the individual (we call this actor choice, Act_c) and the second is the common practices of the society (we call this normative action, Act_n) concerning how that reality, E_i, *ought* to translate into action and how action generates a socially perceived value.

These two actions, calculated from the action probabilities, are then processed in the agency and structure table (see table 1.1). This table is a tool for formally specifying the practices and habits of a given society. In our current implementation of ViSAGE the table increases or decreases an actor's returned social capital based on an actor's own subjective criteria and the best choice based on the accepted norm of the community. The idea of the structure and agency table is to model a socially constructed value, which in our current work is social capital. While the structure and agency table need not be turned on to run instances of ViSAGE—a convenient switch to simplify the model and mute the perspectives valued by social science—understanding how values and the the practices of valuing in a society are critical for understanding and modeling human behavior.

		"structure" Act_n		
		`join`	`stay`	`leave`
"agency" Act_c	`join`	$C_i^S + 1$	$C_i^S + 1$	$C_i^S + 2$
	`stay`	$C_i^S + 0$	$C_i^S + 0$	$C_i^S + 0$
	`leave`	$C_i^S - 2$	$C_i^S - 1$	$C_i^S - 1$

Table 1.1: The Agency and Structure Table

[3] The documentation for ViSAGE is in review for publication, for a copy please contact the authors.

1.6 Conclusion

The purpose of analyzing computer models and new forms of simulation from a Science and Technology Studies perspective is to understand how technologies, organizations, values, practices, and so on come together to facilitate traversal between disciplinary perspectives—and not to mention perspectives from different cultures and social standpoints, which is the critical need for analyzing traversal—of complex systems. Does computational capacity hinder or facilitate traversal? The finding in this paper and in the work of building ViSAGE show that, indeed, the possibility is real but we have much further to go. Also, something not touched on in this paper, is the strategic role traversal plays in understanding complexity and living in a complex world. Such a program of research, however, does deserve much more attention.

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