Book Review – Generative Social Science: Studies in Agent–Based Computational Modeling

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Eric Jones
University of Texas Health Science Center at Houston
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interesting that the ethnographic voices presented by Haberman do not raise these issues, but seem to neatly fit into his overall narrative. Haberman's study thus produces silences as much as it seeks to illuminate Hindu environmentalism around the Yamuna.

This book will be useful across a wide range of scholarly endeavors, from South Asian to environmental studies. Written in a personable style, it is also likely to draw in readers whose primary interests are not academic, since it is a remarkable description of travel along the Yamuna river and provides an opportunity to follow an expert scholar into Hindu cultural texts and contexts. However, though a compelling read by itself, the book is likely to be even more useful when combined with critical understandings of religious environmentalism in India.

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Pratyusha Basu, Department of Geography, University of South Florida, pbasu@cas.usf.edu

Generative Social Science: Studies in Agent-Based Computational Modeling

REVIEWED BY ERIC C. JONES

This book calls for a generative social science. Generative social science rests on the idea that you cannot explain current phenomena without describing the rules or preceding conditions that produced these current phenomena. In other words, the author believes that we must not only explore causality in terms of 'A affects B,' but also in terms of how a specific suite of physical, biological, social or cultural tendencies play out across time for a given population, producing some observed state or phenomenon. Epstein argues that anything short of being able to model the flow between prior and present conditions is mere description. He says his naming of the Generative approach took inspiration from Chomsky's *generative* syntactic structures.

Generative social science is tightly wed to the methodology of Agent-Based Modeling made more feasible lately by faster computers. However, Epstein warns against its identification solely as a computer-driven technique. His point is that past behavior of individuals, households, firms or other agents must be accounted for when understanding a phenomenon. Following the lead of mathematicians and most modelers, the author seeks parsimonious or small sets of rules to explain the arrival at any current condition.

This 'new' kind of social science is probably too mathematical for most ethnographically oriented social scientists to adopt, although this historicist/evolutionary approach is one that must regularly be

injected into the social sciences in order to augment the complimentary yet more dominant functionalist and ideationist approaches. Ecosystem researchers would certainly be able to make use of the agent-based modeling approach, perhaps even being able to better account for the individual agents in their systems. Population researchers similarly could better develop models and parameters for animal/plant/agent behaviors.

Generative Social Science is generally an update to the 1996 book *Growing Artificial Societies* (Brookings Institution and MIT Press) by Epstein and Robert Axtell, although this new book is a compilation of works with all but three chapters (Introduction, Chapters 2 and 13) published separately elsewhere in books or journals. Preludes by Epstein for each chapter make the flow awkward, but provide contextual insights or connections between chapters. All chapters have Epstein as an author—typically the primary author—and half of the chapters are single-authored by Epstein; as such, the publisher considers the book a single-authored work. A CD with several of the models accompanies the book, so that you can change a few of the parameters and graphically view the results (hundreds of colored pixels on a square space).

The agent-based modeling technique is one way to bridge the micro-macro gulf, producing non-intuitive macro results along the way. Epstein is careful to define such emergence as the computable result of agent actions, and not as the old (and even contemporary, in some cases) idea of emergence as something that can never be reduced to its parts. Despite proposing this form of reductionism, the book allows that emergent properties maybe something that the individuals themselves might not possess, so emergence is not so much a sum of parts as a product of parts. Different agent-based models with different suites of variables might produce the same social phenomena, in which case field data and theoretical plausibility assist in determining which model to pursue. Models can also be used to find out which rules will *not* account for observed behavior.

The first three chapters constitute the introductory material, primarily advocacy for the approach as well as delimiting the domain. The domain of generative social science is based upon the following: heterogeneous agents, bounded rationality, explicit/geographic space, local interactions, non-equilibrium dynamics and initial autonomy of agents. There is much attention to philosophy of science in this section, such as seeking generality, comparing this approach to mathematical models in general, discussing deductive and inductive explanation, and dealing with incompleteness and incomputability in mathematical social science.

Chapters 4-6 take up the Artificial Anasazi Project in which an agent-based model relatively accurately predicts settlement location for several hundred years in Long House Valley in northeast Arizona. The model considers actual soil type, slope, corn production, precipitation drawn from ethnographic, ethnohistorical, climatological and mainly archeological data. Since the model shows that the valley could have continued to support population, albeit considerably reduced, the model does not accurately predict the evacuation of the valley around 1300 C.E. As a result, the authors invoke the possibility that unconsidered cultural factors may be responsible for the total depopulation—an interesting hypotheses for collapse researchers to work with. This really is the only chapter in the book that uses real diachronic field data.

Chapter 7 looks at a model explaining why it took three decades for retirees in the United States to adapt to the retirement age of 62, which was made law in 1961. The model suggests that imitation of people in one's social networks—a sort of slow contagion effect—explained the delay in adoption, as long as there was at least a small percentage of rational individuals who chose to retire at 62 (that were then imitated). Parameters for one model included a life span of 80 years, networks consisting of 10-25 individuals up to five years younger/older than each agent, five percent of individuals retiring at 62 via rational decision making, and 10 percent of individuals acting totally randomly.

Chapter 8 considers the development of socioeconomic classes, using Nash games involving dyadic interaction and choices of high, medium and low rewards. The concern is that people don't choose to cooperate to the benefit of both. Class is a particularly important social problem. Epstein calls it a hard social problem. The theoretical computations for hard social problems suggest that many problems exist for which a solution would take too long to achieve. For example, in this case, equality is the most stable strategy and inequality the least stable, but often it surpasses human time scale to achieve equality, plus model parameters are likely to have changed over such a long time. The model introduces memory—agents remember certain number of behaviors of past opponent—and in many cases equality is achieved in a reasonable time frame, but initial conditions are paramount. The problem with this model is that it is quite a stretch to see how a Nash game approximates the interactions between individuals in everyday life—there appear to be many currencies in the process of discrimination or class formation.

Chapter 9 provides a variant on the Prisoner's Dilemma, which is a game between any number of people, in which the winner in any dyadic interaction gains a lot and the loser loses a lot, but through which cooperation produces modest gains for both participants. Defection (i.e., not cooperating) is the norm in Prisoner's Dilemma—people shoot for the higher payoff, and also become vengeful. The variant in this book is the Demographic Prisoner's Dilemma, which tries to add memory, modeled geographic space, and population growth. Memory involves participants have offspring that usually repeat the parent's strategy of cooperation or defection, although misbehavior or accidents or rebellion occurs at a specified rate. Having offspring results in population growth. The use of physical space limits probable interaction spheres. In the demographic version, clusters of cooperation develop based on local norms (brought largely about through parenting offspring) and based on the opportunity for payoffs to accumulate. This variant describes how various kinds of people/strategies always exist, that

there are oscillations between them (especially when payoffs are low), and how cooperators basically separate defectors who otherwise kill each other off. The take home message might be that it takes a sufficient percentage of compliant and good-willed people residing in a place for at least modest time periods to make society work. However, if people live long enough (have long memory), there is no deviation of parental strategies by offspring (total conformity), and payoffs are high enough, it looks like everyone will defect.

Chapter 10 follows up on how norms might develop among social groups, and Epstein invokes a normostat, or people's basic unthinking adherence to norms. Thus, in addition to the well-established fact that norms are self-reinforcing patterns of behavior, Epstein argues that norms are comprised of non-thinking behaviors and thus most behavior does not involve choices or decisions. This is proposed largely as an antithesis to rational choice theory that assumes people make decisions or consider alternatives. The agent-based model in this chapter produces local conformity, global diversity, and punctuated equilibrium.

Chapter 11 considers two cases of social violence: 1) rebellion resulting from perceived hardship, questionable legitimacy, and free assembly, and 2) ethnic conflict resulting from low levels of legitimacy and low levels of peacekeeping forces. Here, in the case of rebellion, the author allows bounded rationality in the forms of risk aversion and negative utility (doesn't pay to 'take it' anymore), although agents' utility calculations do not include the social implications of their rebellion.

Chapter 12 introduces a new kind of agent to the social setting—an infectious disease—and properly assumes that, although vaccination might increase deadliness due by producing resistant pathogens, deadly diseases are typically inefficient at spreading themselves (i.e., death before transmission). An exception the authors consider is smallpox, which is both deadly (30% death rate) and highly communicable. They take up vaccination models to deal with smallpox as a potential bioterrorism weapon. Their optimal model is both

preventative (preemptively vaccinating all hospital works and voluntary revaccination of those who were successfully vaccinated in the past) and reactive (hospital isolation of confirmed cases, and making family members of infected individuals be vaccinated and stay home). Although similarly based on hypothetical model runs, this simulation seemed to get more of a gut reaction from me than the others, but in doing so made me think even more seriously about the other social phenomena generated through the models in the other chapters—although the models are easy manipulated and don't involve real data, the phenomena studied are quite the opposite, they are gripping contemporary questions.

Chapter 13 covers the growth of adaptive organizations. True to the generative approach, the authors "want a single fixed set of operating rules and parameters at the individual agent level that will generate, or 'grow,' and entire optimal history of structural adaptation 'from the bottom up,'" including the creation of hierarchies when necessary and their dissolution when disadvantageous—based on labor scarcity vs. abundance.

The contributions from the book's generative approach and agent-based models appear to be fourfold. First, the rules in the models include some simple yet sophisticated additions to games or other utility models, and these additions are geographic space, cloning of offspring (providing both for population growth and 'recruitment' of participants in a strategy), influence from social networks, and allowing for death of participants. Second, the book shows how well-known and intriguing phenomena (e.g., classes, civil violence, cooperation, conformity) can be grown or produced based on realistic and small sets of variables and variable parameters. Third, the book pushes for a historical/evolutionary causal accounting for observed phenomena, which is valuable even if you don't go down the agent-based modeling road. Finally, the books assumes that conscious decision making among alternatives by individuals is the exception not the rule, and such decision making typically is witnessed only when we account for more fundamental biological, physical and interactional constraints.

As seen above, major questions in many fields of social science might be approached with generative social science using agent-based modeling. The book's scope is broad. The author does not use cases with real field data, except in the Anasazi study which is constrained more by biophysical parameters than by interactional ones—the only interactions for the Anasazi case are the unavailability of specific pieces of land due to occupation by neighbors, and a matrilocal residence rule. However, the author numerous times restates that the goal of the book's chapters is to investigate how simple models based on aggregate individual behavior can produce the primary characteristics of compelling social phenomena, and not to test hypotheses against real data. Epstein calls for further improvements in agent-based model research by creating a more explicit or standard formalism for practitioners (e.g., stochastic vs. uniform or synchronous vs. asynchronous updating of agents), using agent models to explore social network dynamics, making agents more psychologically real with all the competing motivations a person experiences, and examining the performances of models across various realistic spatial and time scales. It is surprising that the book does not call for greater use of real data.

There is an unfortunate physics envy that motivates the author to defend the generative social science research strategy. For example, the book says that the generative approach is deductive and not inductive. By strict definition, that is true—Agent-Based Models are not data mining, but are theoretically driven equations/models. However, in practice, all of the model parameters are tinkered with dozens or hundreds of times until they produce interesting results. That is the inductive process. And it is certainly appropriate for a young field like this to be spending more time in inductive inquiry than in deductive inquiry.

Despite the book's religious invocation of parsimony, and its frequently dismissive attitude toward non-generative social science, the utility of agent-based modeling is compelling. Most ethnographically oriented social scientists will be concerned about the determinism and the mindless agents depicted in this approach. As already noted,

the author similarly wants to see agents with more complicated motivation sets than currently have been modeled. However, the current Agent-Based Modeling approach does already provide the potential for clear examination of when individual agents, in concert or in parallel, can produce fundamental change in social systems. In other words, tipping points, oscillations, punctuated equilibrium, lock-ins/run-aways, and persistent cohesion all can be studied via the probabilistic behaviors of individuals over time. What is lacking, then, is validation, or being able to detail the story of exactly how those specific people participated in that specific social change, given just a few simple maxims of human behavior. And that, of course, will have to wait until social scientists regularly team up with ethnographers, historians and mathematical modelers.

Eric C. Jones, Department of Anthropology, University of North Carolina at Greensboro, ecojones@uncg.edu

Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination

Julie Cruikshank

University of British Columbia Press, Vancouver, BC, 2005

328 pp. $32.95 Paperback

Reviewed by Rebecca K. Zarger

This fascinating book weaves together a study of memory, oral history and transformations through a series of encounters between people and glaciers in the region where the Saint Elias Mountains and the Alsek River converge in the southwest Yukon Territory and Alaska. I recently selected Cruikshank's award winning book (winner of the 2006 Julian Steward Award, given by the American

Anthropological Association's Anthropology and Environment section, a 2007 Clio Award from the Canadian Historical Association and the 2006 Victor Turner Prize in Ethnographic Writing, awarded by the Society for Humanistic Anthropology) for required reading in a graduate seminar in environmental anthropology. This review is framed within the discussion and critique that emerged from the seminar, with the aim of providing not just a synopsis of the intellectual and practical contributions of the book, but its pedagogical value as well.

One compelling illustration of the impact of this book is the attention that has been paid to it across a variety of disciplines, including anthropology, sociology, history, and science and area studies. Clearly Cruikshank is speaking across chasms of inquiry as she writes about stories of glaciers' connections to human communities and oral traditions as local people, explorers and scientists negotiate meanings in a particular, out-of-the way cultural landscape. Another reason this book was chosen for the graduate seminar was the way the author engages with the topics of local (or traditional) environmental knowledge, environmental change, and social memory. Historical documents, carefully presented Tlingit and Athapaskan oral histories, 19th century explorer's accounts, and the current politics of conservation, identities and territories are analyzed with equal intensity. As the author links these lines of evidence together (in some chapters more seamlessly than others), bridges are created between types of inquiry, voices of local elders, the human-nature divide, and local and global histories.

Do Glaciers Listen? is divided into three sections. Part one, "Matters of Locality" situates the reader in time and space (during the Little Ice Age) as well as within current theories of the nature of knowledge and its representations. The three chapters in the first section convey, through tales of the actions of both glaciers and humans in response to one another, the distinctions between narratives of Athapaskan/Tlingit elders and geophysical scientists. Extensive passages from "glacier stories" of three women, including excerpts from thirteen different stories shared by Kitty Smith, Annie Ned and Angela Sidney, tell us of the dangers of falling through glaciers, traveling under