THE ROLE OF SOCIAL SIMULATIONS IN MENDING THE EPISTEMOLOGY OF THE SOCIAL SCIENCES

Robert Savit*

Since at least the mid-nineteenth century and continuing to the present day, social scientists have been engaged in a debate about the epistemological underpinnings of the social sciences. On the one hand are "social physicists" who view social phenomena as analogous to physical phenomena and claim that social phenomena can ultimately be understood, predicted and controlled by invoking a set of underlying general principles. On the other hand are the "narrativists" who claim that each social instance is intrinsically unique. This uniqueness follows from the high degree of complexity of social phenomena and their strong context dependence. In the narrativist view, it is possible to gain general insight from the study of instances of social phenomena which insight can be used to guide actions and policies, but it is not possible to reduce the intrinsically unique social phenomena of interest to a set of simple general principles with quantitative explanatory and predictive power. In recent years, computer based social simulations have been extensively used by social physicists to model human social systems. The results of these computer simulations have largely been discounted by narrativists as irrelevant to the much more complex social situations they are meant to model. But, properly understood, these simulations can contribute to the formulation of a more coherent epistemology of the social sciences by presenting themselves, not as models of human social interactions, but as objects of study themselves for social scientists of various epistemological stripes. Simulations are, themselves, complex systems with appropriately unique outcomes, but which are nevertheless simpler than real social systems. As such they can be used to test the limits of both the principled, mathematical description favored by social physicists and of the narrative description favored by narrativists.

Since at least the mid-nineteenth century, practitioners of the social sciences have been engaged, often implicitly and sometimes explicitly, in a debate over the meaning of knowledge in the social sciences. [See, for example, the brief review in Overman[1] and Hollis[2]] Very roughly, participants in these discussions have fallen into two camps.

The first are the proponents of "social physics" a term coined by Auguste Compte in a series of texts published in the 1830's and 1840's and soon after appropriated by Adolphe Quetelet. (Note that this term predates by over 150 years the more restricted and awkward "econophysics".) According to the social physics view, human behavior, including the phenomena studied by psychology, sociology, economics and allied fields, is governed by fundamental principles which are discoverable and can profitably be used to inform social and governmental policies. Further, a proper understanding of these underlying principles will allow one to predict and control human behavior, both with respect to individuals' responses to stimuli and to man's social, collective behavior. The term "social physics" is meant to convey the idea that the fundamental epistemology of the social sciences is just like that of the natural sciences: Although the phenomena are more complex, there are, nonetheless, underlying principles, and

* Physics Department and Research Center for Group Dynamics, Institute for Social Research, University of Michigan, Ann Arbor, MI 48109

there is an appropriate sense in which the outcome of human social situations can be considered instances of (potentially) repeatable experiments, just as a chemistry experiment can be repeated with similar, appropriately predictable outcomes.

Within this view, there are, of course, important subtleties around the issue of what, precisely, are meaningful questions that have answers. For social physicists the natural sciences provides a model for framing these questions. In classical Newtonian physics, the state of a system and its future are unambiguously determined by specifying values of a set of classical variables (for example, positions and momenta of particles). But we know that a neat classical specification and accurate predictability in terms of classical variables can fail for at least two distinct reasons: 1. if a system is quantum mechanical, or 2. if it is driven by certain kinds of nonlinear dynamics which, for example,[v] place it in a chaotic regime. In the quantum mechanical case, the position of a particle may not be precisely reproduced even though the experiment is prepared in exactly the same way. But the *probability distribution* of the particle's position may be predictable and consistent over the ensemble of experiments, and so there is predictability of the outcome of the ensemble of experiments, even though the outcome of any given experiment may not be predictable. A similar situation ensues in a (non-quantum mechanical) nonlinear chaotic system, but with a difference. In the nonlinear chaotic case there is practical unpredictability in the sense that any small difference in the specification of the system (for example, the initial value of a particle's position) between two runs of the experiment grows exponentially in time, resulting in practical unpredictability beyond a very short time interval. If the experiment and its initial conditions were specified with *infinite* precision, then, in principle, the behavior of the system could be predicted infinitely far into the future. But *infinite* precision is a *practical impossibility* in the real physical world, so that as a matter of practice chaotic systems are unpredictable after a very short time. There are many simple mechanical examples of this phenomenon including the famous double pendulum in which it is generally impossible to predict the precise position of one of the pendula after a very short time. The failure of classical predictability in the quantum mechanical case is a failure *in principle*, while the failure of classical predictability in a chaotic system is a failure *in practice*, but it is such a spectacular practical failure, that it begs the question of whether it should also be considered a failure in principle.

Despite the necessity of carefully defining "predictability" in the face of these important dynamical subtleties, the underlying view of knowledge in the natural sciences remains grounded in a commitment to the power of underlying principles and their discovery and application through careful and repeatable (and repeated) controlled experiments. The proponents of social physics, even while accepting the possibility (actually, the reality) that human social systems are nonlinear and therefore may require great care in their description and in the definition of which aspects are "predictable", still hold to this same pragmatic epistemology, namely, that there are general underlying principles that can be discovered by careful and repeated experiments.

Against this view of the social sciences as "social physics" is a second view which may be called the "historical" or "narrative" view of the social sciences. In this view, primary emphasis is given to the fact that social scientists are fundamentally interested in *unique* situations. For example, a political scientist may be interested in the causes leading up to World War II. Although there may be superficial similarities between the state of the world prior to World War I and the state of the world prior to World War II, these similarities are not determinative for understanding the outbreak of a world-wide conflict. Each situation is complex, intrinsically unique and highly context-dependent, so that no general, underlying principle can provide any important insight, certainly no predictive guidance, and categorically no quantitative understanding. In the historical or narrative view of the social sciences, knowledge is primarily embodied not in quantitative predictability of sets of similar situations, but in narrative. Narratives, or stories, attempt to encompass complex situations by layering connotation and implication upon denotative description. In the same way, according to this epistemology, the goal of a narrative discussion of a social situation is to suggest, as far as possible, the complexity inherent in a particular situation, and by that explication, to help develop some sense of wisdom which might inform a view of another related, albeit intrinsically unique, social situation. This view of the social sciences is ubiquitous, extending even into popular writing. Consider, for example, an op-ed piece about Alcoholics Anonymous (A.A.) by David Brooks in the June 29, 2010 issue of the New York Times.

> . . . [W]e should get over the notion that we will someday crack the behavior code, that we will someday find a scientific method that will allow us to predict behavior and design reliable social programs. As Koerner notes, A.A. has been the subject of thousands of studies. Yet "no one has yet satisfactorily explained why some succeed in A.A. while

> others don't, or even what percentage of alcoholics who try the steps will eventually become sober as a result."
>
> Each member of an A.A. group is distinct. Each group is distinct. Each moment is distinct. There is simply no way for social scientists to reduce this kind of complexity into equations and formula [sic] that can be replicated one place after another.
>
> Nonetheless, we don't have to be fatalistic about things. It is possible to design programs that will help some people some of the time. A.A. embodies some shrewd insights into human psychology.

Note that Brooks strongly emphasizes the uniqueness of each human situation, but at the same time claims that this (narrative) view of the social sciences does not eschew the possibility of generalization. That is, it is possible to learn lessons from one unique situation that can usefully inform one's view of another unique situation: "It is possible to design programs that will help some people some of the time." But the nature of generalization is different than that found in social physics. In the narrative view, one recognizes from the outset that, unlike the natural sciences, the phenomena of interest in the social sciences are inherently and fundamentally *unique,* (which uniqueness follows from their much higher order of complexity and context-dependence). This fundamental property of the objects of study demands a very different epistemology, one that eschews, not wisdom or understanding, but general, quantitative, transferrable principles with predictive power.

The social physics and narrative epistemologies of the social sciences are archetypical. Social scientists often adopt practical epistemologies that fall between these archetypes. So, for example, to return to our political scientist who studies the world on the eve of World War II, he may write a book weaving a narrative of events in Eastern Europe just before the outbreak of that war, but he may rely on census data and statistics to support parts of his story, or he may refer to simple models to contribute to an explanation of his phenomena. As another example, one can accept the power of the underlying lesson in Schelling's model of segregation[3] without adopting the view that that dynamics actually *explains* (much less is able to predict) segregation in any real case. Or a social scientist leaning toward the social physics epistemology (for example, a game-theoretically inclined economist) may be committed to the general explanatory power of equilibrium economic models, but might also be willing to admit that there may be unique properties of real systems that limit the applicability of such models.

Despite the fact that social scientists array themselves someplace between the poles of social physics and narration, the underlying fractured epistemology takes a large toll on the social sciences. Two social scientists, if they do not live near each other epistemologically, run the risk of talking past each other or discounting each other's insights. The formulation of a more coherent epistemology would greatly benefit the social sciences. Social simulations (by which we mean agent-based simulations or "artificial societies" [see, for example, Epstein[4]]) have an important role to play in helping to develop that coherence.

It may seem odd to suggest that simulations could help bridge the social physics/narrative gap in the social sciences. The provenance of social simulation is clearly in the social physics camp. [See Squazzoni[5] for some recent discussions of the epistemology of social simulations.] Indeed, real card-carrying physicists and their fellow travelers have been at the forefront of the development of agent-based simulations in the social sciences. (See, for example, the Wikipedia entries on "econophysics" and "social simulation" for a reasonable, if not entirely complete or scholarly overview.) And there is no question that most practitioners of social simulation understand their work as an attempt to uncover and isolate the underlying dynamics that govern human economic and social behavior. They believe that their efforts will result in the elucidation of fundamental, underlying principles with predictive power, properly defined. Given this *a priori* epistemological bias, what role could simulations possibly play in the broader epistemological discussion?

The key to answering this question lies in recasting the purpose of simulations. In their use by social physicists, most simulations are thought of as simplified models of real, or at least typical, human social situations of interest. The data from simulations are only of interest insofar as the simulations bear some correspondence to the typical human situations they model. The simulations are not the primary objects of study, but are tools used to illuminate some aspect of the dynamics of the real objects of interest, namely, human social interactions. However, it is possible to consider the simulations, not as models of human social interactions, but as objects of study in themselves. Social scientists from various points on the epistemological spectrum (including hard-core narrativists) could then study the systems and their data with the tools they generally use for the analysis of natural social data.

To see why this is useful, consider again the underlying difference between the social physicists and the narrativists. The former have faith in the discovery and development of general principles of human interaction, while the latter focus on the uniqueness and context dependence of every individual instance. It is clear that this difference can be understood as a difference in the way the *complexity* inherent in social situations affects one's ability to understand. The unbridled faith of social physicists in their approach stems, undoubtedly, from an extrapolation of their experience in constructing principled explanations for natural systems of increasing complexity (albeit much less complex than human social systems), while the narrativists, as a class, have no such experience. For narrativists, more directly steeped in a historical or humanistic tradition, the road to understanding is paved with stories and qualitative generalization.

Stated this way, one can see why social science suffers from a split epistemology. The objects of study in the social sciences, human social interactions, constitute extreme examples of complexity. The systems in this set are so complex that the justification for the approach of the social physicists is not likely to be apparent, particularly to those who are more humanistically inclined and have no *a prior* reason to accept it. If it were possible to back away from that extreme level of complexity, while still retaining the salient features of human social interaction, it might be possible to better appreciate the limits of different approaches to such systems and their interplay. This is the role that artificial societies constructed by social simulation can play. Social simulations can easily be tuned to varying degrees of complexity and the systems studied as a function of their complexity. (Complexity here should not be thought of a scalar. It is clearly a very high dimension variable that encompasses a wide range of effects.) At the simple end of the spectrum most social scientists from either camp will readily see the utility of principled mathematical understanding. (For example, systems as simple as Schelling's segregation model are clearly understandable in principled mathematical terms.) As the systems are made more complex the utility of a principled, mathematical approach will become less apparent, but in a controlled and understandable way. At the same time, the appeal of narrative to describe the outcomes of increasingly complex artificial societies will increase, again in a controlled and understandable way.

For this program to work, the simulations must retain the most salient features of human social interaction so that the developed epistemology has relevance to the social sciences. Social simulations partake of two very important characteristics that are central to the nature of human social interactions. First, the results of social simulations are not uncorrelated. That is, even eschewing the development of quantitative metrics, related social simulations will have outcomes that share certain properties. This commonality forms the basis for at least qualitative generalization, a necessary condition for any project that aims to understand. On the other hand, (and of utmost importance for narrativists) the results of social simulations are unique, in the sense that if the initial conditions and specifications of the simulation (including the specification of seeds of random number generators) are not identical, then the outcomes will differ. It is true that simulations are, in their deepest sense, deterministic, but that is irrelevant for the current discussion. In practice the outcomes of related simulations will differ. In fact, the results of different runs of a single system sharing the same specification will differ, sometimes dramatically, if everything is identical except the seeds of random number generators used in the runs. For social physicists, those differences are used to study various mathematical properties of the model, for example, the basin of attraction of various solutions, or the probability distribution of various metrics associated with the outcomes. But in the context of the narrative epistemology, it is this “uniqueness” or variation in outcome that places the set of social simulations within the universe of discourse of the narrative approach. So, for example, varying only the seeds of random number generators can be taken as a simple analogue, in the narrativist approach, to studying some aspects of the uncontrollable (external) context dependence of human social interactions.

Admittedly, even the most complex social simulations will not approach the complexity of unique, human social situations, and this, in itself, may be grounds for rejecting any simulational insights by extreme narrativists. But for those who are not so philosophically dogmatic, simulation studies exploring, in a controlled way, the effects of increasing complexity either by the addition of noise, or by increasing the complexity of the dynamics or the complexity of the agents may be illuminating.

It is also important to emphasize that this use of simulations requires a much less extreme suspension of disbelief on the part of narrativists than does the traditional use of simulations by social physicists. Traditionally, social physics claims that there are underlying principles that can be used to understand and predict social systems, while narrativists reject that claim. However, a narrativist can still reject the epistemology of social physics and accept the legitimacy of social simulations as objects to be studied in their own right. To do so, he must only accept simulations as complex systems (although simpler than real systems) which, in the aggregate, generate their own narrative. If the task of the social scientist is to be sensitive to real social systems in all their complexity, and to construct illuminating narratives thereof, then as a matter of principle, one should be able to engage in the art of narrative and appropriate generalization with respect to the outcome of social simulations. Again, one could reject even this[v] position, claiming that as long as the agents in social simulations are not real humans, the results of those simulations are completely irrelevant to social science. But for narrativists who are not so dogmatic, the results of social simulations can provide a fertile testing ground for the study of narrative development and its relation to the principled, mathematical approach of the social physicists, without necessarily adopting the epistemology of social physics wholecloth.

The development of a more cohesive epistemology, would materially improve the efficacy of the social sciences and would encourage social scientists who now talk past each other to interact meaningfully. While it is difficult to be precise about what such an epistemology would look like, it would probably embody a general appreciation for modeling and for the long-term project of trying to understand social systems from a principled point of view. It would also have an element of humility, engendered by an awareness of the limitations of the modeling project, whose completion may be infinitely far in the future. And this epistemology would have an appreciation for the power of narrative in conveying ideas that are not yet precisely formed, but are nevertheless of significance, and it would recognize the role of narrative in taking over where mathematical principle ends. Social simulations can present social scientists with data from systems whose complexity can be graded and controlled. The study of such systems, as objects in themselves, rather than as models of human social systems can help social scientists in the development of that more coherent epistemology. ❐

References

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