Why complexity and epistemology?

September 30, 2004 · Academic
Professor Jeffrey Goldstein
1 Adelphi University

Introduction

The three papers in this section touch in one way or another on epistemological concerns involved in the study of complex systems. Why the apparently special relevance of epistemology for complexity research? The answer, I think, lies deep within epistemology itself (Gr: epistémé or knowledge) and in its traditional concern about the reliability of knowledge claims about our external and internal worlds (objectivity and subjectivity). This is acutely manifested in contemporary times in the examination of knowledge claims in both scientific theorizing and our diverse narrative construals of the different worlds we live in, whether personal, organizational, societal, or whatever. Accordingly, epistemological issues have been central to the different approaches taken to the nature of scientific advances, e.g., Thomas Kuhn’s notorious contention that new scientific theories offer such a radical revision of knowledge they in effect bring about a ‘new world’. The article by Fonseca and Zeidan in this section explores this Kuhnian claim in regard to the role of agent based modeling in economic theory.

At least three reasons explain why the complexity sciences have led to an intensification of interest in epistemological themes. First is the striking discovery of critical knowledge limitations regarding our ability to predict, deduce, reduce, and control complex systems behavior precisely because of their complexity. One salient example is the property of sensitivity to initial conditions in chaotic systems which render them largely unpredictable due to the impossibility of making infinitely accurate measurements of initial conditions. Another example is the phenomenon of emergence in complex systems and its customary association of an explanatory gap between ‘higher’ level emergent phenomena and the ‘lower’ level components from which they emerge. Whereas elsewhere in science the presence of such knowledge gaps has customarily prompted attempts to close them, in the case of emergence these very knowledge gaps are exactly how emergence is defined and recognized in the first place. That is why emergence has challenged traditional reductionist scientific strategies.

Emergence also points to a second reason why epistemological concerns have become of paramount interest in complexity theory, namely, the debate about whether emergent phenomena possess genuine ontological status or are ultimately nothing more than mere subjective impressions. It was in this sort of epistemological context, that no less a complexity luminary than the computer scientist and progenitor of genetic algorithms John Holland (1998) insisted that genuine emergents must be distinguished from what he termed “serendipitous novelty,” an example of the latter being an ephemeral play of light on tree leaves in a breeze. Yet, Holland, it seems to me, did not supply cogent enough grounds, either scientifically or metaphysically, on the basis of which his distinction can be universally applied.

Perhaps no one has more clearly articulated the epistemological issue of the role of subjectivity in the recognition of complex phenomena than the physicist James Crutchfield (1993: 3-4):
“Indeed, the detected patterns are often assumed implicitly by analysts via the statistics they select to confirm the patterns’ existence in experimental data. The obvious consequence is that ‘structure’ goes unseen due to an observer’s biases... It is rarely, if ever, the case that the appropriate notion of pattern is extracted from the phenomena itself using minimally-biased discovery procedures. Briefly stated, in the realm of pattern formation ‘patterns’ are guessed and then verified... At some basic level, though, pattern formation must play a role. The problem is that the ‘newness’ in the emergence of pattern is always referred outside the system to some observer that anticipates the structures via a fixed palette of possible regularities... When a new state of matter emerges from a phase transition, for example, initially no one knows the governing ‘order parameter’... After an indeterminate amount of creative thought and mathematical invention, one is sometimes found and then verified as appropriately capturing measurable statistics.”

Crutchfield’s own resolution of this dilemma rests on his notion of an intrinsic computational capacity in emergent phenomena that is computationally identifiable. However, defining emergence in terms of an intrinsic computational capacity raises all sorts of conceptual problems, e.g., the philosopher John Searle’s (1994) contention that computational capacity always contains an external connection so that it is not really totally an intrinsic property.

I think we can generalize Searle’s point by considering just how context dependent these debates about ontological versus mere epistemological emergence really are. In certain contexts, for example, aesthetic ones demonstrated in artistic productions, it may indeed be plausible to consider the play of light on leaves as an authentically ontological emergent phenomena. That is, the play of light on leaves may be insignificant for certain purposes or intentions of observers, whereas in a different context, say, that of impressionist art, it can assume the status of an ontological fact. Indeed, context in this sense arises out of a community of practice. That is, context amounts to that intersubjective framework within which theories and the theories’ interpretations of the phenomena under investigation take place, the subject of the papers by Moldoveanu and by Schlindwein and Ison in this section.

The indispensable role of context is related to the third reason why complexity theory has inspired a great deal of epistemological interest: the role of the observer in first interpreting a system as complex and then ascertaining the nature of this complexity, again a concern of the paper of Moldoveanu and the one by Schlindwein and Ison. Of course, such epistemic implications of the role of the observer are not unique to complexity. Thus, epistemology has been deeply implicated in the search for an adequate understanding of quantum mechanics. Two examples readily come to mind – the Heisenberg Uncertainty Principle and the so-called measurement problem – both of which have sparked vigorous debates concerning the ultimate status of quantum level ‘weirdness’.

A cognate ‘observer effect’ can be seen in complexity research in the role of an observer in typing an attractor in phase space:

“An attractor functions as a symbol when it is viewed through an output projection map [map of a system by concentration of some variable into a finite dimension state space] by a slow observer. If the dynamic along the attractor is too fast to be recorded by the slow-reading observer, he may then recognize the attractor only by its averaged attributes, fractal dimension, power spectrum, and so on, but fail to recognize the trajectory along the attractor as a deterministic system.”
This implies that, depending on the precise relation of the observer to the system, the system can be construed as either deterministic or not, certainly an assessment with significant scientific as well as metaphysical import. In psychological research, moreover, epistemology is always at issue as seen, for instance, in the persistent investigation into the reliability and validity of experimental and correlational methods.

In conclusion, I would propose that in the case of research into complex systems it needs to be kept in mind that just as scientific advances have typically led to revisions of our very understanding of causality (see for example, Nagel in Lerner, 1965; and Schlegel in Rolnick, 1974), complexity theory is leading to a radical revision of how we are to understand the relation of epistemology to ontology. This seems to me another confirmation of Charles Sanders Peirce’s prescient observation that when it comes to science and mathematics, “Metaphysics leaks in at every joint.” Complexity theory is just making these leaks more apparent and thereby making it more difficult to conceptually avoid the underlying metaphysics. By the way, the paper by Sulis in the Philosophy Section below also touches on similar epistemological issues by way of his mathematical formalism.

References