Abstract  Some reflections on Robert Rosen, Chu and Ho, and Louie.

The work of Robert Rosen polarizes: There are people who worship him, attracted by his bold claims and innovative ideas, while the occasional lack of detail in his arguments provides critics with opportunities to question his conclusions. Rosen addressed fundamental questions in biology in a novel way, but understanding his arguments, which are spread across numerous books and publications, is difficult.

The article by Chu and Ho [A category theoretical argument against the possibility of artificial life: Robert Rosen’s central proof revisited, Artificial Life, 12(4) (January 2006)] triggered a renewed debate on Rosen’s “Proof” that a living system is not a mechanism and consequently must have noncomputable models. A.H. Louie responded to Chu and Ho’s article, criticizing their interpretation of Rosen’s argument. The main problem in this debate is that we are not dealing with “proofs” or “theorems” in the conventional (mathematical) sense. As Louie writes, “Rosen often used category theory as a metalanguage in his discussion,” but neither Rosen himself, nor Chu and Ho, nor Louie provides a comprehensive mathematical argument. Maybe this is not possible when mathematical and philosophical reasoning merge.

Rosen’s modeling relation describes how a natural system is “encoded” by a formal system and how reasoning in the formal system can then be decoded into predictions about the natural system. The encoding of a natural system should establish a correspondence between the two worlds so that a mathematical argument (theorem, proof) allows us to make statements about natural systems. The difficulties we have with the “encoding” of natural systems into a formal representation are central to Rosen’s work. The success and widespread use of state-space models in engineering and the physical sciences can mislead us to think that the state space is the starting point for the analysis of a natural system. Instead of postulating a state space, on which we have little or no structural information, Rosen (1978) replaces the set of states with the set of real-valued mappings called “observables.” Evaluating an observable on a state describes the reading of a measurement device (“meter”). Conventional mathematical modeling ignores the measurement process and considers the model interchangeably with the natural system under consideration. Taking account of the difficulties we have in observing complex systems, Rosen not only develops a model of a natural system, but pulls the modeling process itself into the formal argument. The key to Rosen’s views on computability and complexity is that properties of a natural system are subsequently discussed in terms of the models a natural system can have. It is at this point that mathematical and philosophical positions merge; the interpretation of the formal argument becomes also a matter of belief.

Louie’s discussion of Cho and Ho’s article helps to clarify some of Rosen’s views and intentions, but cannot resolve the issue. To quote Louie:

All Rosen’s theorems have been mathematically proven (although Rosen’s presentations are not in the ordinary form of definition-lemma-theorem-proof-corollary that one finds in
conventional mathematics journals). Indeed, no logical fallacy in Rosen’s arguments has ever been demonstrated. Counterexamples cannot exist for proven theorems.

Indeed, counterexamples cannot exist for proven theorems, but only when the proofs are in the form one finds in mathematics. Since Rosen did not present his arguments in that form, counterexamples or alternative interpretations can exist. Lacking details should not be covered up with a call to the rigor or authority of mathematical reasoning.

The debate about Rosen’s work will and should continue. Indeed, the new fields of synthetic and systems biology require a discussion about the nature of living systems, about our ability to study cells through mathematical modeling and computer simulations. Robert Rosen was ahead of his time with his investigation into the dialectical relation between mathematical models and computer simulations of cells.

References