The systemic complexity of the social and ethical debate about artificial life

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Synthetic biology and "wet" artificial life has spawned a debate about how society and the international community should go about policy-making, especially given the potential for both transformative benefits and existential threats. The unpredictable and complex causal webs in synthetic biology and wet artificial life are one key driver of the proper methodology for addressing its ethical and public policy issues, and analogously complex causal webs underlie the vast majority of systems created in artificial life.

"Complexity" in this context refers to the organization of the causal web among all of its material chemical components. We can call a causal web "complex" if it is highly parallel (has many nodes) with many local and loopy links (positive and negative feedback loops), if nodes have many upstream and downstream links (context-sensitive, synergistic), and if node response is nonlinear.

Complex causal webs are characterized by what we can call "weak emergence." That is, some of the properties of the web are generated by the web itself—by the rules that govern the response of each node and by the web's initial and boundary conditions—and the quickest way to determine the web's precise global state is to simulate (or observe) the web. Complex causal webs with weak emergent properties are found throughout life-like systems (Bedau 2013).

Given this complexity, it is perhaps no surprise that the precise global behavior of a complex causal web is unpredictable, even given complete information about the state and rules governing all of the parts of the web. The methodological consequences for complex causal webs are also perhaps no great surprise, and some are especially worth emphasizing here. First, we should *expect the unexpected* in the behavior of a complex causal web. Their behavior is difficult to predict and control, except by extensive and systematic observation, experimentation, and computer simulation. As a result, we must *learn from experience* if we want to discover the typical global behavior patterns of complex causal webs, and we must *remain flexible* if we are to adapt as circumstances and contexts continually change over time. Furthermore, *it takes a plurality* of hypotheses and experiments to disclose subtle patterns in the behavior of complex causal webs; pluralistic methods promote the diversity of perspectives that enable us to triangulate and discover complex patterns.

We should distinguish two different theses about complexity and artificial life. One concerns the "local" complexity of the systems created today or tomorrow. The second concerns the "systemic" complexity of the societal debate about the proper deployment and use of artificial life systems, including especially the social, economic, and political factors that influence its ethical evaluation and public policy implications.

The ethical and public policy debate itself involves many complex causal webs, so the three methodological lessons about complex causal webs apply to them as well. The debate should expect the unexpected and continually learn and revise on the basis of a growing plurality of experiences. The methodological lesson from systemic complexity advocates pluralism about the methods used for ethical and policy evaluations.

Kaebnick, Gusmano, and Murray have called for "an established social mechanism for evaluating the possible outcomes of synthetic biology, incorporating iterative investigation" (2014) and the US Presidential Commission has advocated "prudent vigilance" for the development of synthetic biology (PCSBI 2010). Prudent vigilance involves promoting a broad view of public welfare and balancing risks and benefits in a way that is scientifically informed and that acknowledges and copes with the uncertain and unexpected, including regularly iterating and updating any ethical and policy assessments and recommendations, and in this way keeping them renewed and revised. All of this makes perfect sense for those who expect the unexpected and must continually learn and relearn from a growing plurality of new experiences. The plurality of recommendations about policies and ethical issues takes advantage of the power of collective intelligence and provides a variety of new opportunities for discovery.

Complexity is a familiar theme in discussions of artificial life, but the focus in the past has been on local complexity of artificial life systems themselves. What is less well known – and what I have been emphasizing here – is how the methodology for ethical evaluation and policy formulation concerning artificial life and synthetic biology is driven also by *systemic* complexity. The scientific and epistemological implications stem from its local complexity, but the social and ethical implications depend also on complexity that is also systemic.

Systemic complexity helps illuminate both the importance of "upstream" bioethics and its limits. Anticipating and coping with the potential consequences of new technologies is especially important when those consequences are complex and opaque. A plurality of approaches would provide some protection from methods that are too myopic, and it would provide the flexibility needed for upstream ethics to adapt and change as social and political contexts evolve.

References.

Mark A. Bedau. 2013. "Weak emergence drives the science, epistemology, and metaphysics of synthetic biology." *Biological Theory* 8: 334-345.

G. E. Kaebnick, M. K. Gusmano, and T. H. Murray. 2014. "The ethical issues of synthetic biology: next steps and prior questions." This volume.

Presidential Commission for the Study of Bioethical Issues (2010) *New directions: the ethics of synthetic biology and emerging technologies*. Presidential Commission for the Study of Bioethical Issues, Washington, D.C.