What can we learn from the Big History view of Major Transitions?

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Abstract

One issue that arose at the first workshop on Open-Ended Evolution (OEE) was whether or not major transitions should be considered as hallmarks of OEE. Within the emerging discipline of Big History, major transitions have been studied across overlapping disciplines, at different scales, revealing that major transitions exist on a continuum across material, biological, cultural and technological eras.

It is computationally infeasible for an open-ended evolutionary simulation to start in a state analogous to a sparse fog of hydrogen and helium (i.e. prior to any subsequent major transition) and transition to a biological-level era. So it is necessary to skip over or engineer in at least some complex features that arose through major transitions in our universe, to start closer to the kinds of phenomena of interest (perhaps including further specific major transitions) and run (currently hypothetical) OEE systems over a finite window of time. Therefore, it is clearly not desirable to consider any *specific* major transition as a hallmark of OEE.

It is arguably also not desirable to define open-ended evolution as requiring major transitions to be exhibited (i.e. as a hallmark of OEE): better perhaps to ask "what else" is required for major transitions (or certain classes of major transitions) to arise in an open-ended evolutionary system. However, this is merely a matter of definitions and their effect on how key questions are phrased. There is no doubt that the development of an OEE system in which we can observe major transitions would be a major achievement.

Major Transitions

There is considerable interest in constructing open-ended evolutionary systems as tools for studying the emergence of both specific major transitions (as we cannot replay the tape of nature), including the emergence of life and a hierarchy of artifacts and behaviors, and major transitions in general: "life-as-it-could-be" (Langton, 1992).

This leads to two kinds of interesting questions:
1. Under what conditions does an OEE system give rise to a (any) major transition?
2. Under what conditions does an OEE system give rise to a specific (or similar) major transition?

Of course, answering such questions first requires that we develop an OEE system in which not only major transitions could take place but also we could feasibly detect and *observe* them.

Big History and Major Transitions

Following its very earliest phases, our Universe has evolved from a sparse fog of hydrogen and helium atoms. Its history includes the emergence of complex molecules, replicators, single- and multicellular life, brains, sociality, users and manufacturers of simple and compound tools, cultural learning and technology, to highlight just a few of the major transitions (Aunger, 2007a, table 1). Aunger divides big history into four eras: material, biological, cultural and technological (Aunger, 2007b, table 2). Some evolutionary innovations increase the evolvability (capacity for adaptive evolution) of their lineages (Sterelny, 2011).

Computationally Feasibility

Vidal argues that "the path towards a simulation of an entire universe is an expected outcome of our scientific simulation endeavors" (Vidal, 2014) but offers no guess as to when this might be possible, and acknowledges that even the most basic questions of computational requirements remain open questions.

For now, it is not computationally feasible (even if we knew how) for an open-ended evolutionary simulation to start from a sparse fog of hydrogen and helium and transition to a biological-level era. So it is necessary to skip over or engineer in at least some complex features that arose through major transitions in our universe, to start closer to the kinds of phenomena of interest (perhaps including further specific major transitions) and run (currently hypothetical) OEE systems over a finite window of time.

(My) Conclusions for research into OEE

For this reason, and because we would like to leave room for the development and study of open-ended evolutionary systems and major transitions in the biological, cultural and technological eras, including lifetime learning and other non-Darwinian adaptive processes, with appropriate (feasible) models, it is clearly not desirable to define open-ended evolution as requiring *specific* major transitions to arise.

It is arguably also not desirable to define open-ended evolution as requiring major transitions to be exhibited (i.e. as a *hallmark* of OEE): better perhaps to ask "what else" is required for major transitions (or certain classes of major transitions) to arise in an open-ended evolutionary system. However, this is merely a matter of definitions and their effect

on how key questions are phrased. There is no doubt that the development of an OEE system in which we can observe major transitions would be a major achievement.

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