A measure for natural selection's contribution to the origins and maintenance of organismal complexity

Alastair Channon

University of Keele
alastair@channon.net

The aim of Artificial Life research into Open-Ended Evolution is, initially at least, to develop artificial evolutionary systems in which new adaptive traits continue to evolve and the maximum complexity of organisms, ecosystems or behaviours continues to increase. The main proponents of this approach have presented systems that invoke natural or biotic selection, as opposed to artificial or abiotic selection, as the drive for both the generation of new adaptive traits and (potentially) a sustained increase in complexity. However, within both Biology and Artificial Life, doubts have been raised as to natural selection's role as the drive for increasing complexity (Lynch, 2007, Proc. Natl. Acad. Sci., 104, p.8597; Miconi, 2008, Artif. Life, 14, in press), with the suggestion put forward that nonadaptive evolutionary forces (such as mutation, recombination and genetic drift) or mathematical/statistical constraints may be the primary drives, through either a passive increase in variance of complexity in the presence of a lower bound, or a constraint-driven drive toward complexity. The question therefore arises, how to determine natural selection's contribution to increases in complexity?

This work introduces first a measure for the phenotypic complexity of an individual, based on the class of components previously used in the population-level analysis of an Artificial Life system classified as exhibiting unbounded evolutionary dynamics (Channon, 2006, Genet. Program. and Evolvable Machines, 7, p.253): components that are approximately equivalent to the biological notion of a gene or coding DNA; and second a measure for the contribution made by selection to increases in complexity, based on the mechanism and methodology used in the development and application of component-normalised activity statistics to that system. These measures enable us to address the question posed above, about a fundamental aspect of evolution in general, in a way that would not be possible given the biological world alone. They also provide a mechanism for detecting increases in phenotypic complexity and attributing them to either adaptive or nonadaptive forces.

Results from the application of the measures to evolution in runs of the above system suggest that, according to these definitions, natural selection initially (but only briefly) opposes the level of increases in complexity (new active/coding DNA) that would be brought about by the nonadaptive forces alone, presumably because the new active/coding DNA would be nonadaptive; but that as evolution progresses, natural selection maintains and drives the increase in adaptive complexity with remarkable consistency: natural selection can (and does, in this system at least) provide a sustained drive toward increasing complexity.