Toward Robotic Intelligence: Evolution of Memory Use in Digital Organisms

Laura Grabowski
University of Texas-Pan American

The ability to use past experience is a cornerstone of complex adaptive behavior. Memory allows organisms to make predictions about the world and make behavioral decisions based on those predictions. Studying the evolution of memory use in nature is problematic. The fossil record leaves little evidence about the structures that enable memory or the behaviors produced by memory use. The study of evolutionary questions in living specimens is limited to only the most recent stages of evolution, and the long time scales required for evolving any degree of complexity prevent us from re-evolving such capabilities in a laboratory setting.

In this talk, I will discuss the evolution of memory use in digital organisms, self-replicating computer programs that are subject to mutations and selection. The digital organisms are placed in a range of environments that require the evolving organisms to use memory in different ways by gathering information from the environment and making decisions based on that information and past experience.

Our results demonstrate that remarkably flexible behaviors evolve even in simple environments. In addition, the use of *in silico* evolution allows us to analyze the evolved algorithms in depth and trace the evolutionary transitions that produced the mechanisms. Analysis of underlying algorithms reveals features of particular interest, such as simple step-counting odometry, parsimonious low-level computation, and modularity. Examining the evolution of complex features such as odometry supports theoretical views of how complexity evolves in nature, building sophisticated and specialized capabilities from the simplest components. Such complex capabilities may arise only rarely, but they are of great interest in the context of evolving intelligence.