Presentation Title: The Importance of Brain-Body Coevolution in the Natural Selection of AI-Life.

Abstract:

This presentation explores some of the limiting factors identified in my experiments into the natural selection of AI-Life. From two conclusions, each concerned with separate shortcomings in the results, two main issues facing such research can be separated out. In both cases brain-body coevolution presents a promising resolution.

Conclusion 1 (from my ALife VI paper):
"This work has made it clear that the specification of `actions', even at a low level, results in the organisms being constrained around these actions and limits evolution. Alternatives in which the embodiment of organisms is linked to their actions need to be investigated."

By using natural selection, as opposed to artificial selection, one can aim beyond the evolution of simple prescribed behaviors, toward the open-ended evolution of emergent behaviors. However, if only the "brains" of agents can evolve, then the range of resulting behaviors will be limited by the body design. This is especially true at the current (early) level of research into AI-Life, where we should expect most evolved behaviors to be motor-based: following, fleeing, circling, flocking, running, jumping, etc.. By allowing bodies to coevolve with their brains, the range of possible motor-behaviors could cease to be a limiting factor. So resolution 1 is to use brain-body coevolution to help make the natural selection of AI-Life open-ended.

Conclusion 2 (from my SAB '98 paper):
"Whether or not emergence is continuing in Geb [the artificial world in question] is hard to tell, for it soon becomes difficult to identify behaviors. This was a less significant problem in the evolution of program code but evolved neural networks are hard to understand and so offer little help. Constructing systems such that behaviors will be more transparent is likely to be the most productive way forward. … alternatives in which the evolvable embodiment of an organism gives rise to its actions will need to be considered."

The evolution of AI-Life must involve emergent behaviors; It is not be possible to simply specify increasingly complex behaviors. So the problem of understanding, or even identifying, novel behaviors arises. With relatively simple agents, we can analyze their controllers (programs, neural networks, or other) directly to determine the resulting behaviors. But as the complexity of evolved controllers has increased, this has become less and less possible. So, until the agents themselves can help us understand what they are up to (a very distant prospect), we can only observe the resulting behaviors and attempt to identify innovation. An embedded presence, and more so a body, can provide us with the ability to observe the resulting movements of our agents. The logical aim is therefore to allow a range of body possibilities that will make it easier for us to analyze behavioral observations. So resolution 2 is to use brain-body coevolution to aid in the observation (identification and analysis) of emergent behaviors.

The question of how to achieve these two resolutions remains. What degree of freedom in body evolution is required for the open-ended evolution of AI-Life? How close should the physics of an artificial world be to our own, in order for us to best observe emergent behaviors? Thanks to Karl Sims' artificial selection of "blockies", we do at least have an idea of where to start.