Title: Sensing When to Leave: An Agent-Based Approach to the Concept of Time

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Abstract: 2.58

The concept of time in animals has been a recurring topic of interest in the fields of evolutionary biology and psychology. In particular, scientists have explored the possibility for the concept of time to be adaptive in animals, benefitting the survival of a group of individuals.

In recent years, artificial life modeling has become popular to study the evolutionary conditions responsible for adaptive group behavior, a methodology that has been applied to the study of the concept of time. Nehaniv (1999, 2002) studies information-theoretic models of temporally grounded agents. Ching Ho et al. (2008) models how memory extends agents' temporal horizon to increase adaptability. Learning from environmental temporal patterns is beneficial to a broad spectrum of organisms, from amoebae (Saigusa et al. 2008) to human civilizations (Hassan 1997). Witkowski et al. (2012) show the emergence of a minimal notion of time based on periodicity in resource availability.

We present a minimalistic agent-based model with a limited concept of time emerging in a population of agents performing a blind resource gathering task in a two-dimensional environment. The behavior of agents is controlled by artificial neural networks, with the weights encoded in genotypes and evolved through mutation and crossover in a continuous Darwinian selection process. The number of agents on a resource patch defines its rate of depletion, making it eventually profitable to leave and explore for other patches. Unlike a previous iteration of this model (Witkowski et al. 2012), simulations do not rely on resource distribution seasonal change.

The model exhibits Lotka-Volterra dynamics (Lotka 1910, Volterra 1926). The model exhibits adaptive emotion-like neural patterns that modify agent sensorimotor responses, eventually leading to time-based strategies. We show a range of aggressive and cooperative strategies in agents, some of which ending in a Tragedy of the Commons (Hardin 1968).

References:


