Multi-agent Communication Disorders: Dynamic Breeding Networks in Genetic Algorithms

Forrest Sondahl and William Rand
Center for Connected Learning and Computer-Based Modeling
and Northwestern Institute on Complex Systems
Northwestern University

Corresponding author: Forrest Sondahl
EECS Tech Institute C359
2145 Sheridan Rd
Evanston IL 60208
Email: *forrest@northwestern.edu*
Preferred presentation: Oral

Abstract

Our research has applications in three different disciplines: machine learning, social science, and agent-based modeling. From a machine learning perspective, we investigate the effect of various breeding networks in a genetic algorithm. From a social science perspective, we examine the diffusion of innovation in changing social networks. From an agent-based modeling perspective, we consider how several types of agent interaction dynamics affect the exchange of information.

In the standard genetic algorithm, agents in the population may breed with any other agents to create offspring. In this work, we restrict the breeding neighborhoods by imposing several types of network structure on the population. In particular, we consider Erdős-Rényi random networks and "geographically" defined proximity networks among agents distributed on a torus world. For these two topologies, we present three main results. First, the genetic algorithm is robust (maintains optimal performance) for a large range of network densities ($\gtrsim 1\%$), but below a certain density threshold the performance decreases sharply (i.e. there is a phase transition). Second, this threshold is lower when using dynamic (rather than fixed) versions of these network topologies. Third, this threshold is lower for the random topology than the proximity topology. These results may have applications in the design of robust distributed genetic algorithms.

This system can also be viewed as a social network where agents may copy a neighbor's strategy (cloning), combine neighbors' strategies (crossover), or slightly change strategies (mutation) while solving some problem. Our results provide information about necessary connectivity thresholds for the diffusion of innovation in these social networks. Within ABM, our model examines properties of the implicit networks that are formed by agents interacting locally in a spatial environment. Studying the movement of information on networks facilitates a common understanding of processes found in the disciplines of machine learning, social networks, and agent based modeling.