Eco-Simulator

An Artificial Life Simulation Program

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https://github.com/BLayman/Artificial-Life-Simulator

Summary

Eco-Simulator is an ecologically inspired system for training neural network based agents. Agents move through a two dimensional space where they can detect and consume resources in order to survive. Populations of agents evolve via reproduction and natural selection, where the weights from their neural networks serve as their genetic material. An agent's behavior is guided by their neural networks. The networks take inputs from the environment, other agents, and the agent's internal state, to produce outputs corresponding to actions such as: movement, reproduction, and consumption. One goal of the system is to observe improvements in agent behavior as their networks evolve.

Details

Simulation Steps

During each step of the simulation, every creature is given the opportunity to process inputs and carry out actions. This happens in a turn-based fashion.

Neural Networks

Each agent has a set of neural networks to determine what actions they will take, or attempt to take. The neural networks can receive a variety of inputs including: internal resource levels, external resource levels, and phenotypes of neighboring agents. The inputs are passed through a recommendation network, which then passes its output to a final decision network. The decision network typically receives recommendations from several recommendation networks, and combines those inputs to decide whether or not to take an action.

Resources

This system supports multiple customized resources. Resources can be distributed in different patterns across the two dimensional grid of land squares. Agents can be given the capacity to store resources, and benefit from an excess of a resource and/or be punished for lacking it. Actions have a resource cost, and resources can effect a creature's health. Agents can be given the ability to consume and deposit resources, or convert one set of resources to another.

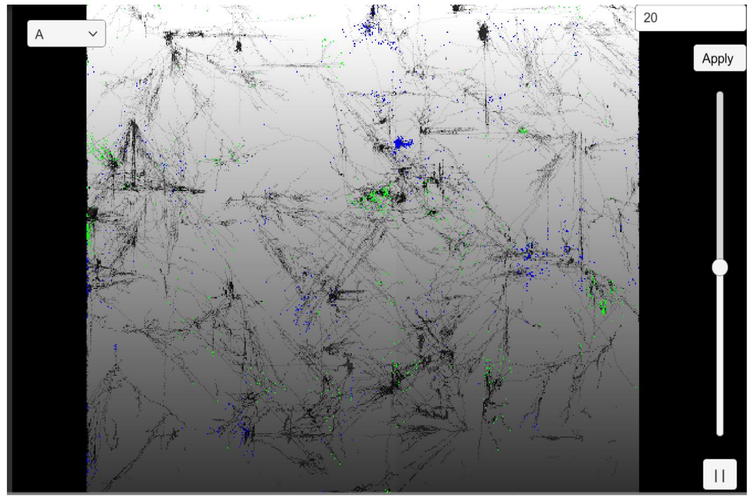
Genetic Variability

The weights of an agent's neural network serve as the agent's genetic material. There are two sources of variability for these genes: the initial variability in the population, and variability resulting from mutation (which occurs during reproduction). These parameters can be set so that different populations have different mutation rates and initial levels of variability. It's easy to observe levels of variability for each weight, and for the population as a whole through the user interface.

Features

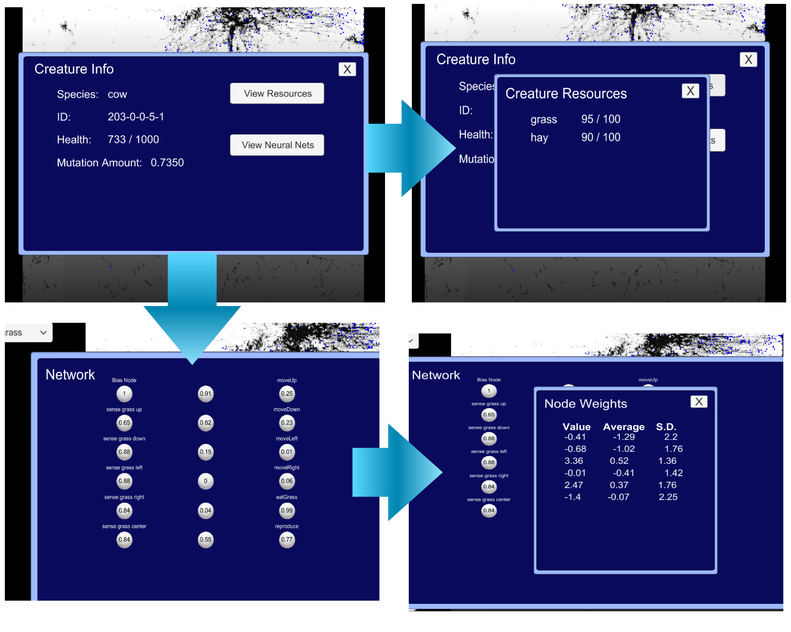
System Visualization

- Switch between visualizing different resources.
- Explore the map with pan and zoom controls.
- Populations are displayed across the map by color.
- Levels of resources are displayed with grayscale values.



Agent Information

Click on agents to get information about their: health, resources, neural networks, mutation rate, and more.



Simulation Control

- Pause and continue the simulation.
- Set number of simulation steps and refresh rate between each display.
- Note that the simulation and user interface are run on separate threads.

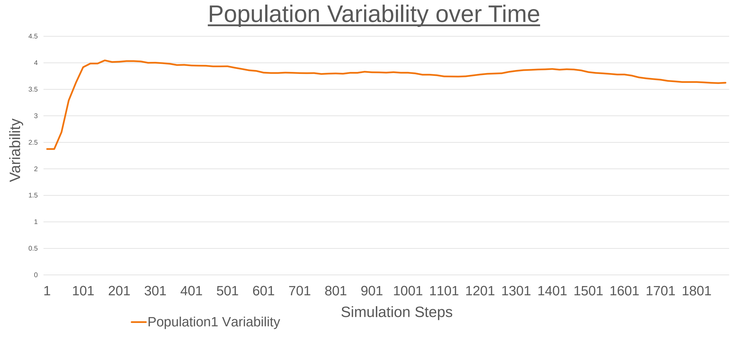
Experiment Design

- Run experiments to compare hundreds of simulations.
- Experiment results are written to a file for further data analysis.

Applications

Academic Research

- Model complex multi-agent systems.
- Research properties of artificial life as they relate to evolution.



Education

- Teach students about neural networks and evolutionary algorithms.
- Explore the properties that make a system stable or unstable.