Ministry of Education and Science of the Russian Federation
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Institute of Computer Sciences and Technologies
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Practice Task – Ch 7

Artificial Life
Discipline: Intellectual Computing
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Contents

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Introduction

Chapter 7 of "AI Application Programming" by M. Tim Jones is about artificial life, genetic evolution, and neural networks. A simulation is created with plants, herbivores, and carnivores to represent to investigate the development of life. Artificial neural networks are also used to control the herbivores and carnivores, and through reproduction and genetic evolution, the fittest survive. The animals must learn to move, turn, find food, eat, and avoid death.

A sample C# program has been created to show this methodology and development. The program allows the user to specify the initial world conditions such as percentage of plants, herbivores, and carnivores. Additionally, energy parameters such as initial energy and reproduction energy can be modified. Finally, the simulation length can be specified. After the simulation is run, The herbivore population/births and carnivore population/births are displayed versus time.

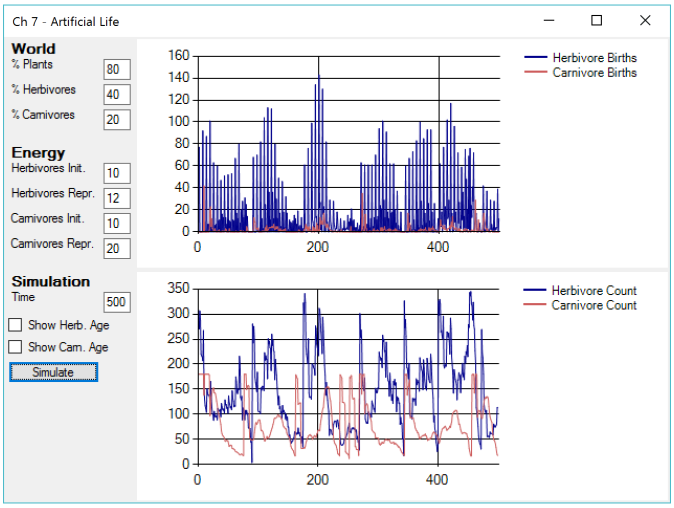

Figure 1: C# Program - Artificial Life

Background

Energy, Reproduction, and Death

Because the herbivores and carnivores move about the environment, they expel and must collect replacement energy. Energy is depleted during each time step and energy is collected when the animal successfully eats food. If a herbivore or carnivore is unable to find and eat foot and reaches zero energy, it dies. It is then removed from the simulation. If a herbivore or carnivore reaches a specified reproduction threshold, it produces a new, possibly mutated, clone of itself. Half of its energy is passed to the new offspring. The possibility of the mutation is 20% and the affected node is random within the artificial neural network.

Visibility

The herbivores and carnivores are capable of moving about the environment. As such, they have a field of vision nearest them, depending on which way they are facing. This can be seen in figure 2. The space is split into 4 regions, Front, Left, Right, and Proximity. The objects (Plants, Herbivores, Carnivores) found in each of these regions are counted and then sent to the artificial neural network to decide which action to take.

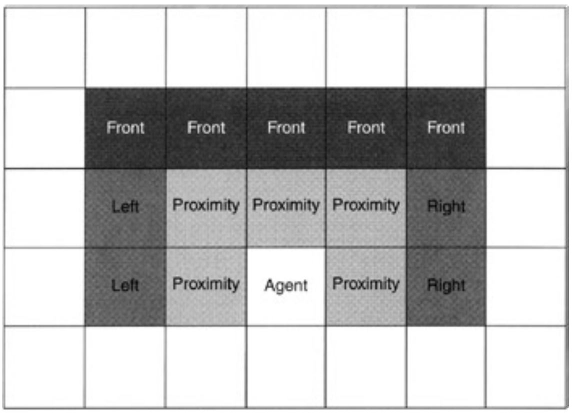

Figure 2: Animal visibility (Facing: North)

Thinking and Decision Making

The herbivores and carnivores must make a decision based on the objects they can see. There are 4 regions (front, left, right, proximity) around an animal and 3 different objects (plant, herbivore, carnivore). Hence, there are 12 different input nodes for the neural network (see figure 3). These different inputs are connect to 4 possible actions: turn left, turn right, move, and eat.

These connections are initially completely random, so many herbivores and carnivores will initially die. The connection weights are simply not configured in a way to allow appropriate actions at appropriate times. The few that are randomly configured properly, will survive, and potentially become better through mutation.

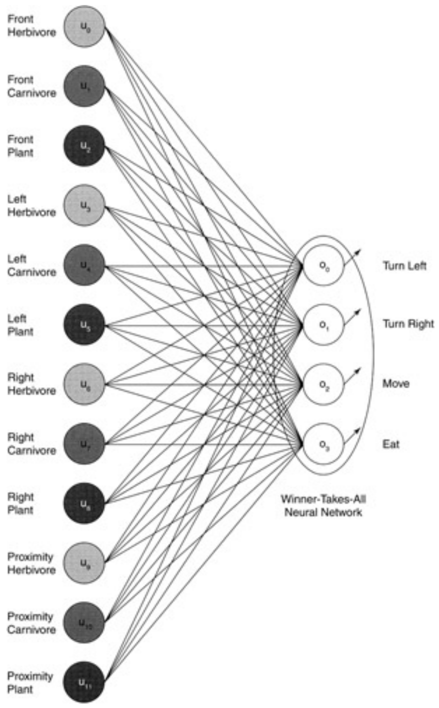

Figure 3: Artificial Neural Network Nodes

Results

Many combinations of parameters were attempted. The goal was to find a stable scenario where the herbivores and carnivores do not die out.

The best parameter combination, so far, to achieve this goal is shown below. This produces the well expected circular graph (or cyclic nature), showing the dependent nature between the herbivores and carnivores.

% Plants: 80

% Herbivores: 40	Initial Energy: 20	Reproduction Energy: 12
% Carnivores: 20	Initial Energy:10	Reproduction Energy: 20

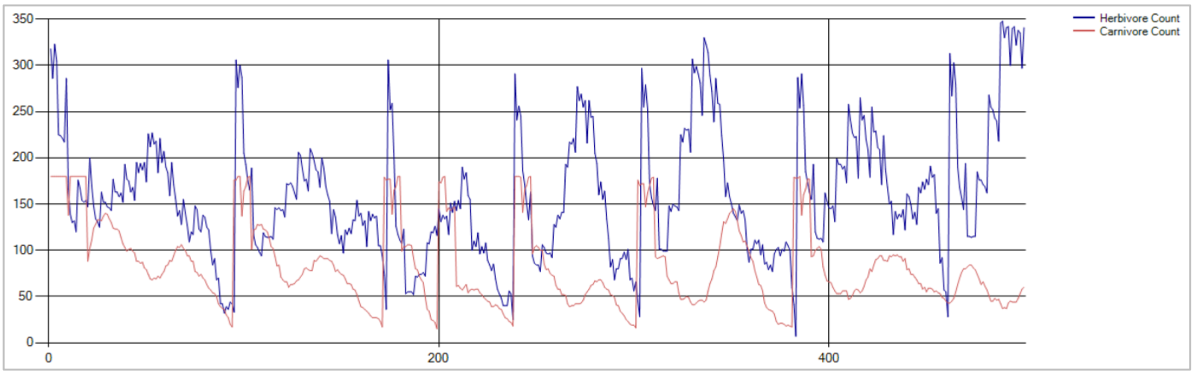

Figure 4: Population of Herbivores and Carnivores vs Time

Conclusion

A simulation was produced to mimic life between plants, herbivores, and carnivores. Herbivores must learn how to move, find, and eat plants. Carnivores must learn how to move, hunt, and eat herbivores. Additionally they must avoid death and try to gain enough energy to reproduce, thereby passing on their genes. The previously discussed simulation shows that, this is possible and the expected dynamic cyclic nature between herbivores and carnivores. It also shows the increasing intelligence as the herbivores learn to avoid carnivores and the carnivores learn to hunt better.