Chapter 7: Artificial Life

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Artificial life, or Alife is a term coined by Chris Langton [Langton] to describe a wide variety of computational mechanisms used to model natural systems. Artificial life has been used to model agents trading resources in artificial economies, ecologies of insects, the behavior of animals, and entities negotiating with one another to study models in game theory. In this chapter, we'll investigate artificial life and then implement a simulation that demonstrates agents within a food chain competing in an artificial environment.

Introduction

While artificial life is a large discipline with a variety of concerns, we'll focus here on what is called *synthetic ethology.* This is defined most succinctly by Bruce MacLennan:

> Synthetic ethology is an approach to the study of animal behavior in which simple, synthetic organisms are allowed to behave and evolve in a synthetic world. Because both the organisms and their worlds are synthetic, they can be constructed for specific purposes, particularly for testing specific hypotheses. [MacLennan]

Artificial life can then be described as the theory and practice for biological system modeling and simulation. One hope of researchers working with artificial life is that by modeling biological systems, we can come to a better understanding of why and how they work. Through the models, researchers can manipulate their environments to play "what if" games to understand how systems and environments respond to change.

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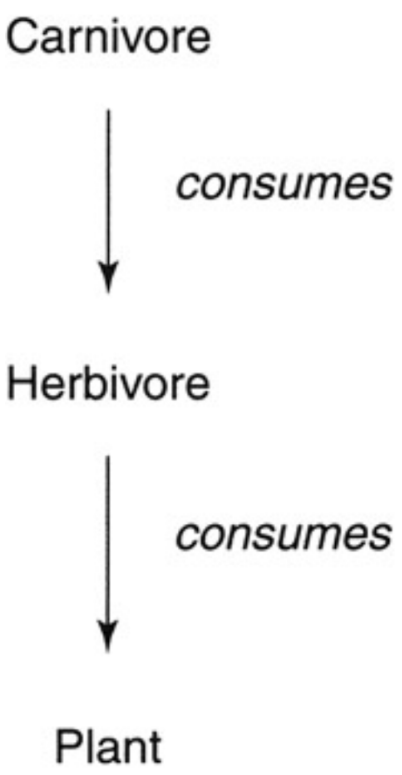
Simulating Food Chains 먹이 사슬 모의실험

A food chain describes the hierarchy of living organisms within an ecosystem. For instance, consider a very simple abstracted food chain made up of three entities. At the bottom of the food chain is the plant. It derives its energy from the environment (rain, soil, and the sun). The next level is herbivores—a herbivore consumes plant life to survive. Finally, at the top are carnivores. Carnivores, within this simulation, consume herbivores in order to survive. Ignoring the effect of dead herbivores and carnivores on the environment, the food chain can be illustrated as shown in Figure 7.1.



By viewing Figure 7.1 as a dependency graph, it should be very clear that a delicate balance exists between the entities. What happens if the abundance of plant life diminishes through a drought or other natural or artificial event? The lack of plant life affects the sustainability of herbivores within the environment, which results in a decrease in their population. This effect cascades up through the food chain, ultimately affecting the carnivore population at the top. This balance can be modeled and studied within the domain of artificial life and synthetic ethology.

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Food Chain Model 먹이 사슬 모델

To model a simple food chain, a number of aspects of the simulation must be defined. These include the environment (physical space in which the agents interact), the agents themselves (and their perception and actuation within the environment), and a set of laws that describe how and when interaction takes place. These elements will be described in the following sections.

Overview

Based upon our discussion of the simple food chain, our simulation will consist of an environment and three types of entities. A plant is a stationary food source that exists within the environment and exists as a food source for herbivores. Herbivores are migratory agents that sense their environment and can eat plants. The predators of herbivores are carnivores that are the other migratory agent within the environment. Carnivores can eat only herbivores, while herbivores can eat only plants. If either agent lives for a certain amount of time within the environment without eating, the agent dies of starvation. When an agent consumes enough food, it is permitted to reproduce which creates a new agent (of the particular type) in the environment. Through reproduction, evolution occurs through the mutation of the agent's brain (simple neural network).