Project Abstract

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Cellular Automata : Application of Movement of Ants—Taking the Right Steps

A simulation with visualization involving wolves, sheep, and grass on a grid. A cell is empty or contains one of the following items: a male wolf, a female wolf, a female wolf with pup, a male sheep, a female sheep, a female sheep with lamb, or grass. Associated with each animal is an integer food ration, or amount of stored energy from food, up to some maximum value. Assume a population density for each item. The rules are as follows (He et al. 2003):

• A sheep moves into a neighboring empty site, preferring one with grass.
• A lamb leaves its mother and moves into a neighboring empty site. At random this new sheep is a male or female, and its food ration is the same as that of the mother.
• A wolf moves into a neighboring empty site.
• A pup leaves its mother and moves into a neighboring empty site. At random, this new wolf is a male or female, and its food ration is the same as that of the mother.
• If its ration of food is less than the maximum, a sheep eats neighboring grass and increases its ration to the maximum amount.
• If a female sheep has at least a designated amount of food ration (such as 2), is of reproduction age (such as 8), and has a male sheep of reproduction age as a neighbor, she becomes a female sheep with lamb.
• If its ration of food is less than the maximum (such as 3), a wolf eats a neighboring sheep and increases its ration to the maximum amount.
• If a female wolf has at least a certain amount of food ration (such as 2), is of reproduction age (such as 8), and has a male wolf of reproduction age as a neighbor, she becomes a female wolf with pup.
• An independent baby matures in a certain number of time steps, such as 8.
• An animal’s food ration decreases by 1 at each time step.
• An animal dies when its food ration becomes 0.
• Grass grows in a certain number of time steps, such as 4. Avoid collisions as in the text of Module 10.4, “Movement of Ants— Taking the Right Steps.” Initialize the grid at random with certain densities of each item and with random food rations and ages for each animal.

Run the simulation a number of times, obtaining situations in which the sheep, wolves, and grass coexist with oscillating densities; in which the sheep become extinct; and in which all animals die.

Graph the population densities of sheep, wolves, and grass versus time.. Adjust the program to run the simulation a number of times, computing and storing the average number of sheep, wolves, and grass at each time step. Plot these averages versus time. Discuss the results.

Reference:

Module 14.8 Project 4 Introduction to Compuationtional Science:Modeling and Simulation for the sciences: Angela B. Shifet, George W. Shifet