A Cellular Automata Approach to Population Modeling

Alexa Silverman, TJHSST Computer Systems Lab, 2008-2009

Abstract

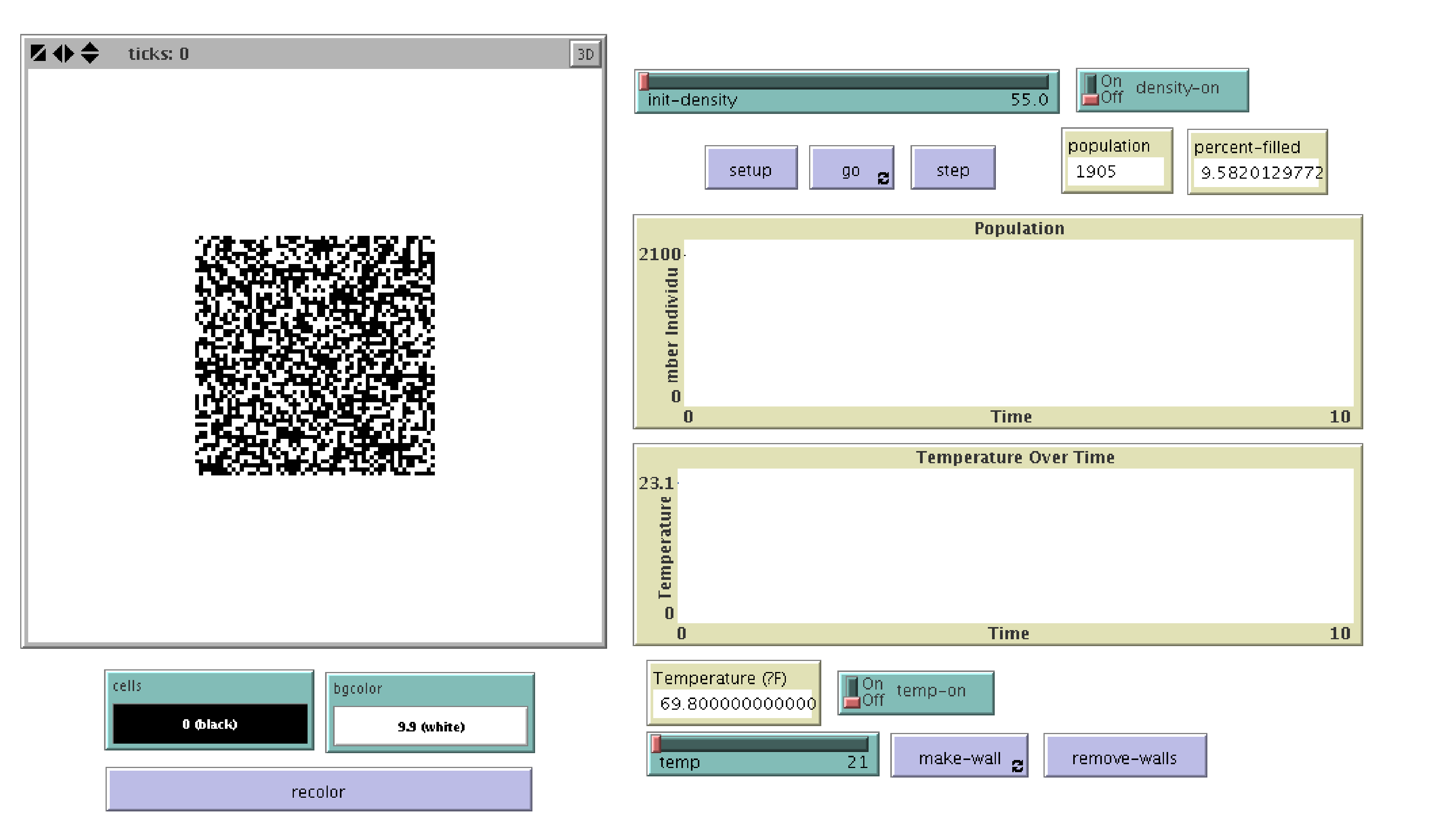
This project provides an agent-based model of the effects of temperature on population growth and change using a 2D cellular automata algorithm to predict behavior. The purpose of this project is to demonstrate how the behavior of a group is dependent on the interactions between individual group members, and to show that a cellular automata approach is valid in modeling ecosystem behavior. It will model a system in which temperature and population changes have mutual effects on one another. The use of cellular automata as agents has not been thoroughly explored, and it is hoped that this research will be useful to researchers in the field of computer modeling as well as that of ecosystems science.

Background

Cellular automata exist as 'cells' on a grid, wherein the behavior of each cell is determined by the states of its eight neighboring cells. The "Life" collection of automata rules is based on the idea that survival of individuals in a population requires an adequate number of neighbors; that an individual can die due either to loneliness or overcrowding, and that an individual is only born when a "family" of individuals is already present.

The rule used in this project to predict behavior is 14/3; in the terminology of Life rules, this means that a live cell with one or four live neighbors will survive a generation, and a dead cell with exactly three live neighbors will be replaced with a new live cell. This inherently suggests that two types of individuals exist: one which is less social (prefers one neighbor) and one which is more social (prefers four neighbors).

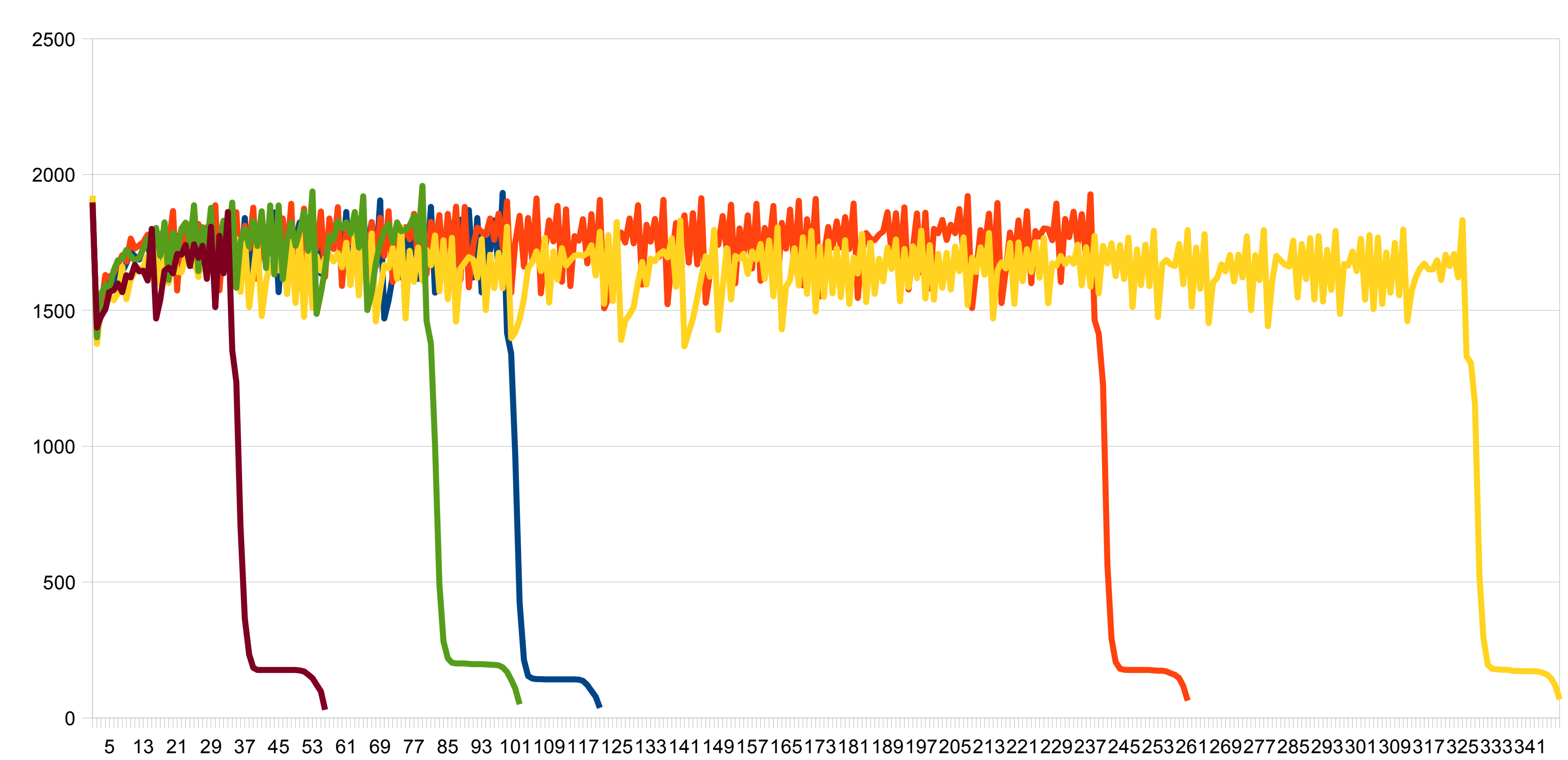
This program models the effects of temperature and population and vice versa; population varies quadratically with temperature and temperature varies linearly with changes in population.



The program in the NetLogo interface.

Results

With default settings (temperature of 21 degrees Celsius, population density of 55 percent), the population eventually dies off. This may provide a (highly simplified) explanation for the phenomenon of global warming. This result is not always produced if the initial parameters are changed. The amount of time after which the population takes a sharp decline varies from run to run due to the nature of cellular automata to produce heterogeneous results. However, the trend remains the same.



Test results showing several test runs.