Project Proposal Final Version 1st Quarter 2008

Computer Systems Project Proposal - September 2008

A Cellular Automata Approach to Population Modeling

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This project provides an agent-based model of 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. 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).

Extra conditions may also be introduced to the model: an initial number of individuals can be selected; birth and/or death rates can be established which will determine a cell's probability of birth or survival given the correct conditions for a state change and these birth and death rates can be displayed either as constants or as the result of several environmental factors such as food availability or climate.

The language used in this project is NetLogo, an extension of the Java language, created by Uri Wilensky. Specifically, this project will be written in NetLogo 4.0.3. In addition to the ability to view the interactions of cells in 'real time' in NetLogo's graphics window, NetLogo also provides charts and graphs. By observing both the behavior of individual cells in the graphics window and the changes in population and population density as shown by graphs and charts, the project's performance can be verified and results can be observed.

It is expected that after various factors are introduced, optimal conditions for population growth will be observed and that these will in some way model the observed behavior of populations. Results can be obtained by comparing graphs and population data based on changes in factors to see what initial values cause the most rapid population growth and longest sustained growth of populations.

Background work:

Papers:

Individual-Based Artificial Ecosystems for Design and Optimization
Srinivasa Shivakar Vulli and Sanjeev Agarwal

A Hybrid Agent-Cellular Space Modeling Approach for Fire Spread and Suprression Simulation
Xiolin Hu, Alexandre Muzy, Lewis Ntaimo

Projects:

The Game of Life
John Conway

Rumor Mill
Uri Willensky

Brian's Brain
Brian Silverman