CS / SySc 346U

Exploring Complexity

Some Ideas for Projects

Here are some ideas for projects. You can choose one of these, or design your own project (possibly using one or more of these for inspiration).

1. **Dynamics:** Use the NetLogo sound extension (http://ccl.northwestern.edu/netlogo/docs/sound.html) to create "music" from a dynamical system like the logistic map, in which the music is generated from the iteration of the map with a given set of parameters (initial x, R)

2. **Dynamics:** Create a NetLogo simulation in which individuals move or "dance" in a way that is generated from the iteration of a dynamical system like the logistic map . (See, e.g., http://www.cs.colorado.edu/~lizb/chaotic-dance.html for inspiration.)

3. **Fractals:** Use BoxCountingApplied.nlogo to see if fractal dimension can distinguish between two categories of images (e.g., photos of natural objects versus photos of human-made objects).

4. **Fractals:** Learn about the Mandelbrot Set fractal, and create a NetLogo program to generate it.

5. **Information:** Read about various ways in which Shannon information measures are used to classify text documents into different categories, and implement a Netlogo program to compute these measures

6. **Information:** Read about how Shannon information is used in compression algorithms, and implement a compression algorithm in NetLogo.

7. **Genetic algorithms**: Extend the Robby the Robot genetic algorithm model so that Robby can see his diagonal neighboring sites, and/or so that Robby has additional actions he can take, and/or his rewards and punishments are different. Do experiments to assess how the changes you make affect his behavior and performance on his task.

8. **Genetic algorithms**: Implement a genetic algorithm to evolve cellular automata rules to have a particular kind of behavior that you specify.

9. **Cellular Automata**: Implement a netlogo model like ElementaryCAs.nlogo but which iterates elementary cellular automata with asynchronous updates. Which Wolfram classes do these asynchronous elementary CAs fall into?

10. **Cellular Automata:** Consider two-dimensional cellular automata (black and white states) with the von Neumann neighborhood: Each cell's neighborhood consists of itself and four neighboring cells: north, south, east, and west. This gives 2^5 = 32 possible cellular automata rules. Create a NetLogo program that simulates these cellular automata, and for each of the 32 possible rules, investigate which Wolfram state the rule's behavior falls into.

There are also many possibilities for our last three topics: Self-Organization, Cooperation, and Networks. I will talk about some of these on Wednesday Nov. 13 in class.

11. **Self-Organization:** Create a simplified simulation of ant task-allocation, as described in Deborah Gordon's paper, Interaction patterns and task allocation in ant colonies: http://www.stanford.edu/~dmgordon/old2/Gordon1999Interaction.pdf

12. **Self-Organization:** Read about synchronization of cricket chirping, and create a NetLogo simulation. Perform a set of experiments to explore the effects of different parameters.

13. **Cooperation:** Implement a NetLogo simulation of an evolutionary *N*-player Prisoner's Dilemma game. Perform a set of experiments to explore the effects of different parameters.

14. **Cooperation:** Modify the Spatial Prisoner's Dilemma model to allow for asynchronous updates and non-local connections. Investigate how this and other parameter changes affects the behavior of the model.

15. **Cooperation:** Implement a simulation of Axelrod's Norms and Metanorms models.