Introduction to Complexity

Unit 1 Homework

Note: All homework in this course is optional, and is not turned in or graded. However, you are strongly encouraged to do at least some of the homework in order to better understand the course topics. Solutions to homework questions will be posted on the course web pages.

This assignment is meant for people who want to go further in learning how to use and/or create models in NetLogo. You can choose whether you want to do the Beginner, Intermediate, or Advanced options, depending on your level of familiarity and comfort with NetLogo. Feel free to discuss this part of the homework with anyone, or to ask questions about it on the Course Forum.

To learn NetLogo's programming language, like any other language you'll have to try unfamiliar things and make lots of mistakes! Don't worry, NetLogo won't break if you write something it doesn't understand—instead, it will just give an error message explaining (as best it can) what the problem is.

If you get stuck, or aren't sure what a command does, try using it from the Command Center (see the link on the Supplementary Materials page on How to Use the Command Center), and don't forget to use the Netlogo Dictionary (http://ccl.northwestern.edu/netlogo/docs/dictionary.html) to look up the meanings of keywords. In the NetLogo code tab, you can right-click on any command and select "Quick Help" to go to the NetLogo Dictionary entry for that command.

Note that we have renamed "Ants1.nlogo" from the videos to "OneAnt.nlogo", and "Ant2.nlogo" to "MultipleAnts.nlogo". You can download both of these models from the Supplementary Materials page on the course site.

Video solutions to these three options will be posted on the Lectures page.

Beginner Option

1. Open MultipleAnts.nlogo. Using the sliders, set the population to 50, max-step-size to 4, and max-turn-angle to 60. Run the model five different times (each time clicking on "Setup" and "Go"), and, for each run, record how many ticks it takes for the ants to eat all the food. What is the average? Do you think that doubling the population (to 100) will speed up the average time by a factor of two? Test this by performing the same experiment with population set to 100.

2. Set the population back to 50. Do you think increasing the max-step-size to 8 will speed up or slow down the average time it takes for the ants to eat all the food? Do an experiment to test your hypothesis.

3. Set the max-step-size back to 4. Do you think increasing the max-turn-angle from 60 to 120 will speed up or slow down the average time it takes for the ants to eat all the food? Do an experiment to test your hypothesis.

4. Modify MultipleAnts.nlogo to change the ants' size to 2.

5. Next modify MultipleAnts.nlogo to **get rid of** the command that labels ants with a number (representing the amount of food they have eaten)

6. Finally modify MultipleAnts.nlogo to make the ants change color depending on how much food they have eaten. That is, if they have eaten more than 2 food patches, they should turn blue, and if they have eaten more than 4 food patches they should turn yellow. Hint: Use a statement like

```
if (food-eaten > 2) [set color blue]
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It's up to you to figure out where to put this, and then how to make them turn yellow if they've eaten more than 4 food patches.

Intermediate Option:

Implement the following: The nine center patches form the ant nest. Ants wander around as in the MultipleAnts model, but when an ant finds a patch of food it collects it and returns to the nest before it wanders out again.

Advanced Option

Implement the following, which is similar to the Ants model from the Netlogo Models Library: Same as the Intermediate Option, but when returning to the nest, the ant leaves a pheromone trail—that is, the patches that it traverses each gain a unit of pheromone. The pheromone evaporates over time—that is, at every time step each patch with pheromone has a probability of losing its pheromone. If a wandering ant encounters a patch with pheromone, it follows the trail as long as it can sense pheromone.

Experiment with this model to see if adding the pheromone mechanism speeds up the ants' process of gathering all the food.