

## **Assignment Goals**

The goal of this assignment is to give you a chance to do a hands-on exploration of the behavior of a simple decentralized system. The aim is for you to gain a deeper understanding of some key principles of distributed cognition.

## **Source Material**

To do this project, you should draw on the following source materials:

An annotated version of the article titled “Learning About Life” by Mitch Resnick at <http://hci.ucsd.edu/102a/readings/LearningAboutLifeAnnotated.pdf>

The NetLogo browser-based simulation of an Ant Colony at <http://ccl.northwestern.edu/netlogo/models/Ants>

The material presented in lectures on 9/22, 9/27, and 9/29/2011.

## **Student Instructions**

If you have not already done so, take the Plagiarism tutorial and quiz. Read the Learning about Life article. Be sure to read the annotations in the sticky notes as you go along. Those annotations will help you understand the article, understand the course, and understand this assignment. Take notes on the reading. Write down questions you think of while reading.

Go to the NetLogo Ant Colony model. Read the paragraphs titled “WHAT IS IT?”, “HOW IT WORKS”, “HOW TO USE IT”, “THINGS TO NOTICE”, AND “HOW TO CITE.”

Click on the “Run Ants in your browser” link to explore the Ants simulation model. Experiment with changing the parameters (population, diffusion-rate, evaporation-rate) and observing the behavior of the colony to figure out what the parameters do. Keep a record of your actions and their consequences while you are exploring. When you are trying to understand what the parameters do it is a good idea to change just one parameter at a time while holding the others constant.

Note both quantitative and qualitative outcomes. Quantitative outcomes include things like the number of ticks (cycles of the model) until some interesting condition is reached. (Hint: Turn on the plot? switch to see a graph of the amount of food in each source at each tick of the model.) How many ticks until the first food source is exhausted? How many ticks until all of the food has been exhausted? Qualitative outcomes include things like the development of a “stable trail.” Keep a record of

how the quantitative and qualitative outcomes are affected by changes in the parameters. Hint: it is useful to slow the simulation down to examine the details of behaviors of interest. Use the slider to the top of the ant space to control the model speed.

Resnick presented five heuristics for overcoming the centralized mindset. Apply each of Resnick's heuristics to the Ant colony model. Hints about how to apply the heuristics are provided in the five paragraphs below. Use the simulation model to verify your claims. Write a paragraph about how you applied each heuristic and what you learned by doing so.

The ant simulation exhibits **positive feedback**. Describe the positive feedback loop. What is the signal? How is the signal amplified? Can you think of a way to break the positive feedback loop? If you can, try your idea with the simulation and describe what you did and your result.

There are elements of **randomness** in the simulation. Find and describe a random process in the behavior of the model. Hint: Slowing the model down so you can observe in detail is very helpful in this task.

The NetLogo Ants page says that "the colony as a whole acts in a sophisticated way." Since we know that the individual ants are not sophisticated, this implies that the **properties of different levels of the system are different**. Describe an aspect of the behavior of the colony that is different from the behavior of any individual ant.

The **ant membership of a stable trail changes continuously** with new ants joining and old members leaving. If a stable trail is not defined by a particular collection of ants, what does a stable trail consist of? Hint: Think in terms of relations among elements rather than in terms of the elements alone. What relations (in space and time) compose the stable trail?

The ant colony makes use of a very obvious sort of dynamic **structure in its environment**. Describe this structure. Resnick observes that "People often seem to think of the environment as something to be acted upon, not something to be interacted with." Interaction is a two-way street and implies mutual causality. The creatures' actions change the environment and at the same time, the changed environment shapes the creatures' actions. The idea that many important aspects of cognition emerge from interactions between creatures and their environments is a central part of the distributed cognition approach.

## Guiding Questions

A question we will ask on every assignment is this: What information goes where, when, and in what form? Be thinking about this while you explore the decentralized system of the ant colony.

Simulated ants are not real ants, nor are they neurons, nor are they people. However, can you now see how the general principles of decentralized systems might be applied to the function of a brain as a colony of neurons or applied to a social group as a colony of people?

Be on the lookout for these phenomena: self-organization, emergence, decentralized local interactions, mutual causality, and levels of organization.

Regarding levels of organization, remember that the agent level consists of processes inside the creature, the creature level in this case is an individual ant, and the colony level is the group of ants. Note that with the ant simulation, unless you have access to the program code you cannot see the level that Resnick calls the 'agent' level.

## Writing Prompt

Write up your exploration of the decentralized system as a text. Your final text must be **at least 500 words and no more than 800 words in length.**

When you mention ideas that you got from other sources (lectures or readings, for example) be sure to provide appropriate references. Note: When referring to an assigned reading a simple citation in the text giving the name of the primary author and the date is sufficient. Thus, you might say "Resnick (1994) describes five heuristics for overcoming the centralized mindset." Or, "As we learned in lecture distributed cognition is an approach to all of cognition (Hutchins, Lecture 9/22/11)." References to sources outside of this class should include a citation in the text as well as an entry in a list of references. For example,

Clark, Andy (2001) *Mindware: an introduction to the philosophy of cognitive science*. Oxford University Press.

or

Wilensky, U. (1997). NetLogo Ants model.

<http://ccl.northwestern.edu/netlogo/models/Ants>. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Do your composing and editing in a text editor and save the file frequently. Be sure

to use simple HTML tags to format your text for easier reading. For formatting help see: <http://hci.ucsd.edu/102a/HTMLTutorial.pdf>.

When you have finished your text, including the formatting, log on to CPR and copy your text and paste it into the text window to submit it to CPR.