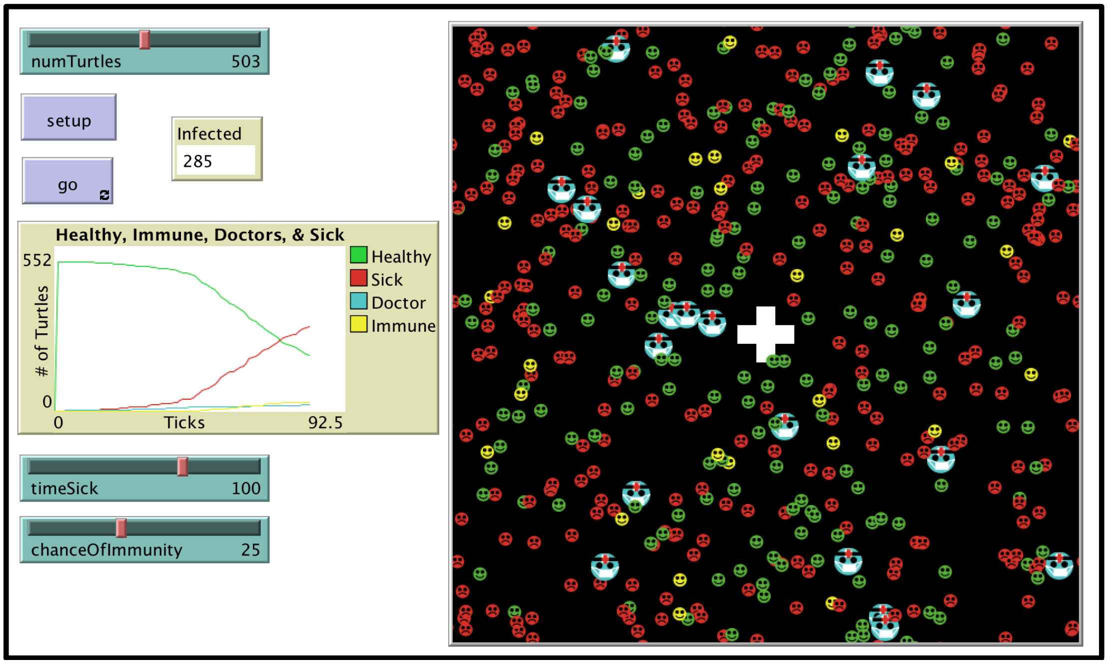
CS108L Computer Science for All
Module 7 Guide
Build Your Own Epidemiology Model



Module Overview:

In this lab, you will design and build a program that models the spread of a contagious disease through some population. You can choose the disease, an appropriate affected population, and the model's specific parameters. Some examples:

- Hantavirus in humans or mice
- Rabies in bats or raccoons
- Bird flu in humans or birds
- Root diseases in New Mexico pistachio trees

You will use the scientific method to investigate a specific aspect of your chosen disease and compose the results of your investigation into a brief report.

The Scientific Method

While the scientific method is a staple of science, the specific steps associated with the method vary slightly across researchers. For this module, use the 6 steps outlined below:

1. Make an observation
2. Ask a question
3. Form a hypothesis
4. Make a prediction based on the hypothesis
5. Test the prediction
6. Iterate (use the results to make a new prediction or hypothesis)

Normally you already have an environment or computer simulation you want to investigate prior to using the scientific method. However, in this case you will be building your own computer simulation and you will use the scientific method to ask your own question and test your own hypothesis. Keep the 6 steps above in mind as you write your code for the model. For example, your model will need to incorporate elements that allow you to answer the question you're asking and you will need to include a way to make a observations about those elements of your model.

Part 1 (Week 1)

Step 1: Make an Observation

- Pick your disease and note why you think it is interesting.
- How does your disease work?
    - Does it transmit via physical contact or is it airborne?
    - Does it only spread from person to person or is it spread by a "vector" such as ticks, fleas or mosquitos?
    - What does it infect (everything, just humans, birds, fish, pistachio trees, etc.)?
    - How difficult is it to treat? What treatments or preventative measures are available (for example vaccines, medication, quarantine, etc.)?
- Outline your model, but don't get overwhelmed. Use abstraction to simplify your model and focus only on the components and parameters you find interesting. Remember that "ALL MODELS ARE WRONG, BUT SOME ARE USEFUL."
    - What does your world need to represent, and what is its size? Is your disease's environment a pond, lake, or ocean? Is it rural farmland, a dense urban area, a university campus, or perhaps the whole world?
    - What do your agents represent? Only humans or animals trying to get cured? Do you have more than one kind of agent like patients, doctors, and mosquitos?
    - What does the spread of disease or its treatment look like in your model? Do people need to visit specific locations like a doctor's office to be treated? How likely are agents to be infected if they are exposed to the disease? How likely are they to be cured if they are given the treatment?
    - What are good abstractions for these components and parameters? Patches? Multiple breeds of turtles? Agent variables to track health, vaccination status, or immunity?

Step 2: Ask a Question

Now that you have an idea of your disease and how it works, consider what question you want to ask about it. Which specific question you ask will guide the form your model takes and the parameters you'll need access to. Some example questions:

- Does the disease spread faster when it's airborne or when it requires physical contact to spread?
- Does the density of agents affect how rapidly the disease spreads?
- How does the location of treatment facilities affect the spread of the disease?
- If a treatment is 50% effective, how does that impact the spread of the disease? Will it eradicate the disease entirely? What if it's 30% or 80% effective?
- If your disease is very lethal and spreads quickly, how quickly must treatment be administered before it wipes out the entire population?

- Are preventive measures or cures more effective in controlling the spread of the disease?

Narrow your questions into just one that is specific, simple, and answerable in two weeks. Check with your instructor and classmates to help you nail down your choice. Finally, go back to your model, look at it in reference to your question. Are there things you don't need in the model anymore? Go ahead and cross them out. If there are things you need to add, list them now.

Steps 3: Propose a Hypothesis

After you have picked a question to investigate, propose a likely answer to it. A hypothesis is a *testable* explanation for a phenomenon that a scientist (you!) attempts to prove incorrect. Your explanation may or may not be the right one, but you won't know until you test it! Some example hypotheses:

- Rabies would spread twice as fast if it became airborne rather than spreading only by direct contact.

- One hospital in a city with 5 doctors who can travel to patients to cure them will cure the disease faster than 5 hospitals that patients have to visit to be treated.
- 30% effective treatments will never fully eradicate a measles outbreak in a town.
- If people are vaccinated, fewer people will be sick with pneumonia than if they are only treated post-infection.
- Curative measures that occur post-infection are more effective in controlling the spread of disease than preventive measures.

Step 4: Make a Prediction

Given the hypothesis you selected, what do you predict your model will do? What do you expect to observe in your model based on this prediction?

- By becoming airborne the disease will spread more rapidly and over a larger area, and more agents will become infected.
- More people in urban areas will be sick with the disease.
- If a vaccine is administered to every other tree in the orchard, the disease will not spread.

Finish the outline of your model and start coding! Make sure your model is designed to test your prediction, and that its output is *measurable*, e.g. the number of agents infected, the number of ticks before the disease spreads to the 5th agent, the number of agents who become immune, the number of pathogens in the system, etc.

Turn in:

1. A brief report with a sentence or two for each step of the scientific method (1 – 4) discussed above.
2. An outline or description of your proposed Netlogo model designed to test your prediction, including parameters, variables, agents, etc.
3. A rough first draft of your .nlogo model. The more you code now, the less you'll need to do next week.

Part 2 (Week 2)

Step 5: Test Your Prediction

Complete your model in Netlogo, and run at least 5 experiments

- For each experimental run, change only the parameters that test your prediction.
- Make a table of your results, properly labeled, in spreadsheet software.
- (Optional): Create graphs that illustrate the important points of your data.

Step 6: Iterate

In your report, write one or two sentences to address each of the following questions:

- Was your prediction accurate? How did the results of your model support or disprove your hypothesis? (minimum 1 paragraph)
- What worked well in your model and what did not?
- How, if at all, did you use randomness in your model? Why?
- How could you extend this model to a new disease, a new environment, etc.?
- What other hypotheses/predictions could you use it to test (either with or without modification)?

Turn in:

- Your .nlogo model. Make sure the Info tab is clear and complete, and that it includes the disease you modeled, the abstractions you made, and instructions for how to use it to reproduce your results.
- The spreadsheet of your experimental data and any graphs you created
- Your report