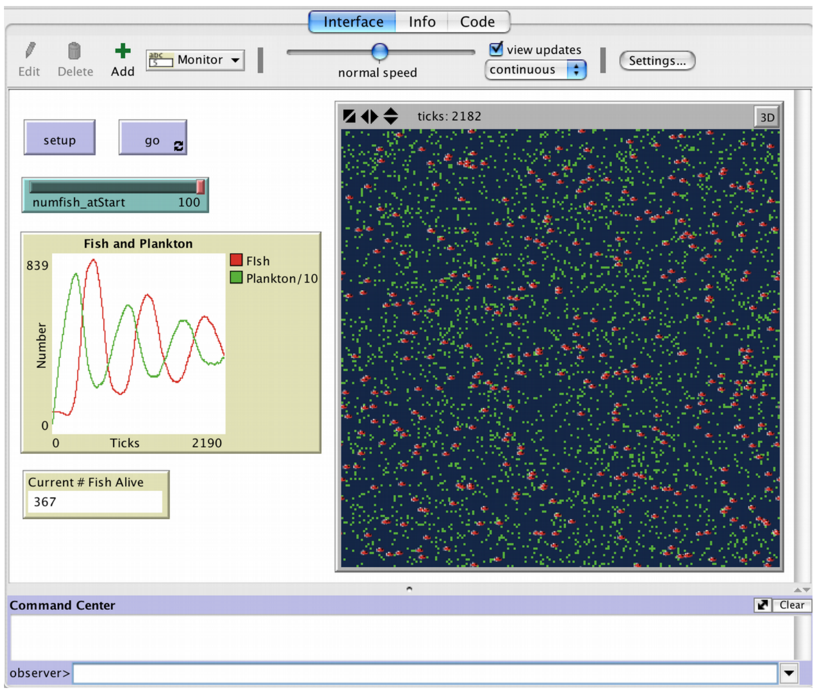
CS108L Computer Science for All

Module 5: Saving Nemo: An Ecosystem Model



In this lab, you will be creating a model that represents a simple (but complex!) ecosystem. You will create fish that swim around and eat plankton. Your fish will die if they can't find enough plankton to eat, and will have baby fish if they can eat enough food.

You will need to balance your ecosystem so that neither your fish nor plankton populations die out completely. This could look like oscillating populations (see the graph in the above image) or stable populations (where both lines are mostly horizontal).

Part 1 (Week 1):

- On the Interface tab, change the max-pxcor and max-pycor to 100. Change patch size to 3. Set the world to wrap both vertically and horizontally.

- Change world color to blue.
- For the fish:
    - Create one breed of fish.
    - Add a slider to adjust the initial fish population.
    - Make fish size $1 < \text{size} <= 5$, set them all to the same color, and set the shape to fish.
    - Fish have a breed variable that monitors each fish's energy (initial energy $\neq 0$).

- For the plankton:
    - Create a slider for the initial plankton population.
    - Set random patches in the world green to represent plankton. Use the slider you created to set the initial number of random green patches, and every tick give each patch a 1/100 chance of becoming a green patch (a plankton).
- Fish behavior constants:
    - With each tick, fish move forward 1 step in a wiggle walk, and lose a constant amount of energy (you specify how much).
    - When fish are on a green patch, they eat the plankton, gain a constant amount of energy (you specify how much), and the patch turns back to blue.
    - When fish reach a certain constant energy level (you specify what level), fish reproduce (make another fish).
    - When they reproduce, fish lose a constant amount of energy (you specify how much).
    - A fish dies when its energy = 0.
- Create a graph on the Interface that records the population of fish and plankton over time. Make sure you label the graph appropriately, and use different line colors for fish and plankton.
- Create a monitor that keeps track of the number of fish currently alive in the simulation.
- Balance your ecosystem:
    - Manipulate the values for the fish behavior constants listed above until your fish and plankton populations both survive until at least 10,000 ticks at at least one value of the initial population variables.
    - Record all of these constant and variable values on the Info tab so we can reproduce your results.

Part 2 (Week 2):

- Add a switch to the Interface tab that determines whether the invasive species model is On or Off. When On, the below additional features should be included in your model.
- Add a second fish breed to your ecosystem model:
    - Create a slider on the Interface to set the invasive species' initial population.
    - Make invasive fish all the same color, and different from your first breed.
    - Give invasive fish their own breed variable to track their energy.
- Add a second plankton type to your model:
    - Create another slider for the initial population of the second plankton.
    - Set random patches in the world red to represent plankton. Use the slider you created to set the initial number of random red patches, and every tick give each patch a 1/100 chance of becoming a red plankton.
- Invasive fish behavior constants:
    - Invasive fish eat both green and red plankton; the first species still eats only green.
    - Invasive fish move differently from the first fish species (they turn left and right in the wiggle walk by a different maximum angle).
    - They have different initial energy.
    - They gain or lose energy differently (at least two constants must be different). For example, invasive fish might move faster but lose more energy from moving. Or the new breed might need less energy to reproduce, but the baby fish start their life with less energy than the baby fish of the first breed.
- Create a graph that plots the first species of fish, second species of fish, and each species of plankton over time (you will have 4 different lines on the same plot).
- Create monitors that record the population of the first species of fish, second species of fish, and each species of plankton.
- Write a short paragraph on your Info tab that describes what happens when you introduce these other species to your first model. Did anything change? Is all or part of your model still balanced? Why or why not?

Part 3 (Week 2):

For this section, we are going to run a series of experiments using the model you've created, and then we're going to graph the data so it's easy to analyze. You can choose to run your experiments in your Part 1 or Part 2 model, but be clear about which you have chosen.

- Select one constant to parameter sweep. This may be anything from first fish species' breeding threshold to the red plankton regeneration probability.
- Holding all other parameters constant, run at least 10 simulations for at least 10,000 ticks each. The first simulation should be run at with a parameter value of 0, and the other 9 should be at regular intervals over the range of reasonable values for that parameter.
- Sample (record) the four population measures every 100 ticks (green & red plankton, first & invasive fish), and log the data in a spreadsheet. You can use Excel, Google Sheets, or any other program with this ability. You will have 100 samples of 2 or 4 data points for each simulation, depending on whether you are using your Part 1 or Part 2 model.
- Example: To parameter sweep the energy of your initial fish population, run the simulation for 10,000 ticks with an initial energy of zero. Record the number of plankton and fish every 100 ticks. Then, repeat the simulation with an initial energy of 20, 40, 60, 80, 100, 120, 140, 160, and 180. You will have 100 samples that include each species' populations.
    - Be reasonable with your sweep. If your population is balanced when the parameter is 100, the 0-180 range makes sense. If your population is balanced when the parameter is 500, you may want to sweep the parameter in increments of 100 (sampling in the range 0-900).
- Finally, graph the data in your spreadsheet program. Use different colors for each of the 10 simulations, and plot them all on the same graph.
- Write a short paragraph of analysis. Can you conclude anything from this graph? What analysis can you do? How could this type of experiment be used in a real-world setting?

Module 6: Saving Nemo Grading Rubric (40 Points Total)		
Done	Points	Task
	15	A: • Check in with your instructor at the end of the first week of this assignment. All requirements listed under Part 1 must be completed to receive full points (including the balanced ecosystem).
	2	B: • Submit the NetLogo source code named: M6.*firstname*.*lastname*.nlogo to your instructor: • The first few lines of your code are comments including your name, the date, your school, and the assignment name. • Initialize the procedures you have written (using comments).
	3	C: • In-line comments are present and informative. • Your program has separate procedures for fish eating, moving, reproducing and dying. You call each of these procedures in your "go" procedure. • The Info tab describes the details of your model including a general description, how it works, how to use it, and the settings you used to balance your ecosystem.
	3	D: • Your program is set up with the required world settings. • World's patches are blue. • You start with 100 random green patches (for plankton) • You created two fish breeds. • Fish and invasive fish are two different colors. • Agents' shape changed to fish. • A slider is used to manage initial fish populations.

		• Fish are set to the appropriate size and initial energy is greater than 0.
	3	E: • Fish lose energy when they move. • Fish eat plankton and gain energy when they get to a green patch. • Fish die if they reach 0 energy, and they reproduce if they have enough energy.
	3	F: • Plankton patches turn blue when consumed. When random plankton are generated, they turn a random patch green or red.
	5	G: • You have two sliders that input the number of initial fish and initial invasive fish. • You have a graph on the Interface that shows the number of fish, invasive fish, and plankton as the model progresses. • You have two monitors that display the number of fish and invasive fish currently alive. • You have a short paragraph on your Info tab that describes what happens when you introduced the invasive species.
	6	H: • You turn in a Spreadsheet that includes data from your parameter sweep, including all 10 simulation runs and clearly labeled data. • You have an informative graph that visually represents the data from your experiments. Axes are labeled and there is a legend that shows which line represents which data. • You have a thoughtful short paragraph of analysis, as described in the assignment.