In this lab, you will be creating a more advanced model that represents a fish ecosystem.

Your model will include the following features:

- Fish swimming and eating plankton (as seen in Module 6)
- Fish die if their energy depletes. Energy is connected to movement and food consumption.
- Fish reproduce if they pass a certain threshold of energy.
- Ecosystem must have sharks that prey on the fish.
- Sharks die if their energy depletes and reproduce if they exceed a certain energy threshold.
- Both fish and sharks decrease their energy after they reproduce.
- You must add one of two extra features:
  - Fish and sharks grows as they age.
  - Fish and sharks swim faster as they gain energy.

The Ecosystem Model:

The model has the following requirements:

- Set max-pxcor and max-ycor = 100.
- Set size of patches = 3
- Set the world to wrap around.
- Change the color of the interface to blue.
- For your agents:
  - Create two agents and set both shapes to fish.
  - Add two sliders that allow you to change the initial number of fish and sharks.
Fish are big, but NOT too big (size 3 or less) and they are all the same color.

Sharks are bigger than fish but not too big either (size 5 or less) and they are all one color that is different from the fish!

Each fish and each shark has its own variable to monitor its energy and the initial energy is not zero.

- Create a graph that will plot the population of fish and sharks at any given time.
- Create a monitor that will record the population of fish and sharks.

**Module 10: Eating Nemo Grading Rubric (20 Points Total)**

<table>
<thead>
<tr>
<th>Done</th>
<th>Points</th>
<th>Task</th>
</tr>
</thead>
</table>
| 1    | A:     | - Submit a NetLogo source code with the file name: M1firstname.lastname.nlogo.  
- The first few lines of your Code tab are comments including the following:  
  ;Student’s Name:  
  ;School:  
  ;Teacher’s Name:  
  ;Date: |
| 3    | B:     | - The code in the Code tab of your program is appropriately documented with “in-line comments”. |
| 2    | C:     | - Your program includes a detailed Info tab with all the appropriate information. See Coding Standards Guidelines for more information. |
| 2    | D: Setup | - Your program is set up with the required world settings (must exceed the default 33x33 patch world).  
- Interface background is blue.  
- Model should initialize with a few plankton randomly dispersed.  
- You have a slider that inputs the initial number of fish and shark in the model.  
- You created a fish and a shark breed and they have a fish shape.  
- The fishes and sharks are two distinct colors.  
- Two sliders are used to specify how many fish and sharks are created with your setup procedure.  
- Each fish is set to a size larger than size 1 but no greater than size 3 and has an energy variable that has an initial value that is greater than zero.  
- Each shark is set to a size larger than the fish but no greater than size 5 and has an energy variable that has an initial value that is greater than zero. |
### E: Your fish, sharks and plankton behave correctly:
- The fish and sharks loose energy when they move.
- The fish eat plankton and gain energy when on a green patch, then patch turns blue.
- The sharks eat fish when they share a patch. The sharks gain energy and the fish die.
- Fish and sharks die if they do not have enough energy and reproduce if they have enough energy.
- The plankton disappears (patches turn blue) when they are eaten and the plankton reproduces at a set rate (patches turn green).
- You have a graph that shows the number of fish and the plankton as the model progresses.

### F: Stable (Oscillating) Population:
- When your model is run, neither the fish, the sharks nor the plankton die out completely right away.
- There should be fish and plankton after 5,000 ticks.
- **Please make sure to write down the values used to run the model in the Info section of the NetLogo program.**

To get 20 points for the lab you only need to do one of the following two activities (G or H) – if you do both you get extra credit for the second activity (which is worth 1 point not 4, the 4 pts is only for the initial choice).

### G:
- The fish and sharks grow as they age until they reach the maximum size for that type of agent!

### H:
- The fish and sharks swim faster as they get more energy. However, the faster they swim the more energy they lose.

### I: (Extra Credit)
- Your program has separate procedures for fish and sharks eating, moving, reproducing and dying. You call each of these procedures in your “go” procedure.

### J: (Extra Credit)
- Add a second species of fish.
- The second species of fish must have the same procedures as your first species of fish.
- However, these fish must behave differently from the first species (e.g. faster/slower initial speed, faster/slower digestion rate, etc.).
- Plot the population of your second species of fish on your graph.