##

1. Exercise: Exponential Population Growth. See the class Brightspace page for the due date.

In order to learn to use the Stella programming environment, we will begin by working with a simple model of population growth.

Working with others. You are encouraged to work with others from class on this exercise but you must turn in your own model. If you do collaborate with others, you should build your own model though sharing ideas and techniques with others is great, but do not copy code or files. **Please post questions or seek help from others using Yellowdig with the topic 'Get Help From Others'.**

The basic model is that the change in population is a function of the size of the population. In calculus, dN/dt = r*N. In words, the change in population size (N) is equal to r (called the intrinsic growth rate) multiplied by the current population size N. The change in population is then added to the current population N to update the population size. This is done at a very small time step to simulate the population dynamics over time. Read about models of population growth here. You don't need to be familiar with calculus to simulate this model in Stella.

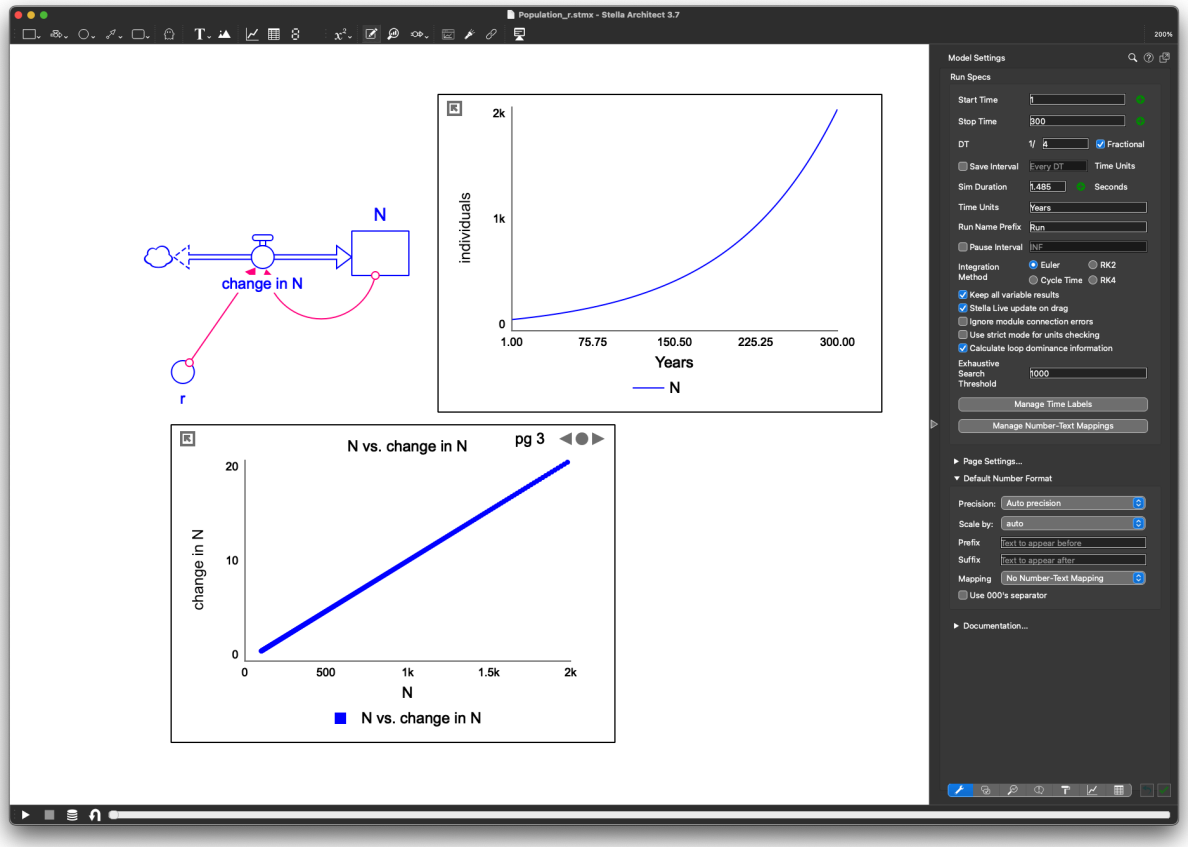
1. We will create a Stella model of population growth.
    a. Open Stella, create a new model, name it YourLastName_wk3_PopGrowth. Hint: Choose File->New Model to create a new model file.
    b. Using the graphical interface, select and place a non-negative stock in the canvas and label it N.
    c. Set its initial value to 100. Let's label the units 'individuals'.
    d. Place a bi-flow (looks like a two way valve) in the canvas and attach it to the stock. Label it 'change in N'
    e. Use a connector to connect the stock to the flow.
    f. Place a converter in the canvas and label it r.
    g. Set the initial value of r to 0.01.
    h. Use a connector to link r to the flow 'change in N'.
    i. Double click on the flow and then in the menu that appears on the right hand side of the canvas, select 'model view' and x^2.

j. In the box labeled ‘equation’, select r and then N from above, and the set the equation to r*N. Click the green checkmark on the bottom right to save these changes.
k. Simulate the model by clicking the run button in the bottom left (rightward facing triangle button) of the canvas.
l. Click on the r converter and rotate the knob to change r and to see how the population growth changes with changes in r.

2. Things to do with this model.

    a. Add units to the converters, stocks and flows.
    b. Set the time units to years and change the length of the simulation to 300 years. You can access this menu by double clicking anywhere on the canvas and this will open a menu to the right with run specs.
    c. Create a plot of N vs time. How would you describe this growth?
    d. Create a plot of r vs time. Does it change over time? Why or why not?
    e. Plot ‘change in N’ vs N. Interpret this figure. Hint: Choose a ‘scatter chart’ as the chart type to allow you to choose both the X and Y variables.
    f. How long does it take the population to reach 500 individuals? 1000 individuals?
    g. What are the units of r?
    h. Address the questions in a text box (large T icon in menu) inserted into the model canvas.

Below is an example of how the model might look.



What to turn in:

Please turn in a Stella file of your model. Please turn in a Stella file of your model through the Assignment tool in BrightSpace. **Attached files should be of the following format: YourLastName_Ex1_PopGrowth.stm.**

Grading rubric. I will assess this Stella exercise using a simplified scale of Satisfactory or Unsatisfactory. Satisfactory indicates that the student made a strong attempt to solve the problem and made substantial progress towards solving the problem, including arriving at or near the correct solution. Unsatisfactory means that low effort was made to solve the problem and limited progress was made towards solving the problem. A satisfactory will earn 10 of 10 points, and an unsatisfactory will earn 5 of 10 points. Failure to turn in the model or very little effort invested in the model will result in 0 of 10 points.

Learning. We will go over the model in class as needed and I will post a solution. Please study the solution to address questions or uncertainties in your own proposed solution. Future exercises will build on the skills you develop in this exercise.

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