

Lab 1: Dynamics

DUE: Monday, October 11, online on Blackboard by 4pm.
(Your report should be in Word format with a *.doc or *.docx extension.)

In this lab you will investigate the dynamics of the logistic map and, in particular, the degree of sensitive dependence on initial conditions at different values of the control parameter R. You will then extend your studies to the sine map.

1. Download “Lab1 logistic.nlogo” from the class web page. Open it in the same directory in which you downloaded Netlogo.
2. Set the switch “plot x_0?” to on, so you will have plots from two initial configurations.
3. Once you are ready to record data from the experiments below, clear the Command Center and turn on the output_x_values switch. After a run you can cut and paste the data into an Excel spreadsheet to make the required graphs. See the handout “Lab1 HowToCreatePlotsInExcel.pdf” which is also available on the course website.
4. For each of R=3.6, 3.7, 3.8, 3.9, 4.0 (five different values), create plots (x_t versus time) as follows:
 - a. set x_0 to .2
 - b. set x_0' to .20000001
 - c. click the “setup” button
 - d. repeatedly click the “go” button until you can see that the plots corresponding to the two initial conditions have clearly separated
 - e. Include each of these plots in your writeup.
5. For each of the five R values, record the time (number of times “go” pressed) at which the plots corresponding to the two initial conditions have clearly separated. Create a single graph that plots this value (“time to separation”) versus R for the five R values.
6. Make a copy of “Lab1 logistic.nlogo” and rename it “Lab1 sine.nlogo”. Modify the procedures so that the model implements the “sine map”, as discussed in class:
$$x_{t+1} = \frac{R}{4} \sin(\pi x_t),$$
 where x is between 0 and 1 and R is between 0 and 4. Redo steps 1-4 above using your sine map model. Note that NetLogo’s sine function expects degrees, but the formula above uses radians. One radian equals $180 / \pi$.
7. For your writeup (to be done in Word or another word-processing program and exported as a Word file), include all your plots, each with captions saying what the plots are. At the end, write a paragraph summarizing your observations from your plots — that is, what happens to “sensitive dependence on initial conditions” as R is increased. Also include in your writeup your Netlogo code for the sine map model.