

University of Colorado
Department of Computer Science
Chaotic Dynamics – CSCI 4446/5446
Spring 2022
Problem Set 1

Issued: 11 January 2022
Due: 18 January 2022 *via the course Canvas page*

Reading: *Strogatz, chapter 1 and sections 10.1-10.2; section 1 of ODE Notes.* The first few pages of section 3 of Liz’s TSA Notes (on the course webpage, which is **not** the same as the course Canvas page!) may also be useful. **Note:** required readings are in italics and optional readings in plain text.

Online assignment: Tuesday: unit 1.1, 1.5, 3.1 and 3.4 videos. Thursday: unit 1.2-1.4 videos. Friday: quizzes 1.2-1.4

Bibliography:

- J. Gleick, *Chaos: Making a New Science*, Viking, 1987.
- I. Stewart, *Does God Play Dice? The Mathematics of Chaos*, Blackwell, 1989.

Problems:

1. Read the CSCI 4446/5446 syllabus carefully. No deviations from the policies and procedures laid out therein will be made without prior arrangement.
2. Go to the Complexity Explorer page (www.complexityexplorer.org) and register for the course “Nonlinear Dynamics: Mathematical and Computational Approaches.” We will be using material from this MOOC in a number of ways this semester. I will assign a couple of short videos for you to watch before each class. (These are listed in the “Online assignment” item above.) The associated online quizzes will be due on Friday. These quizzes will not count as part of your grade, but they will give you a good ‘read’ on your understanding—and prepare you for the unit tests, which are part of your grade. Please see www.cs.colorado.edu/~lizb/chaos/videos.html for more information on these procedures and expectations.
3. Write programs that display the first m iterates of the logistic map

$$x_{n+1} = Rx_n(1 - x_n)$$

on the following axes:

- (a) x_n versus n

(b) x_{n+1} versus x_n

(c) x_{n+2} versus x_n

Use $x_0 = 0.2$ as the initial condition. Do *not* connect the dots on your plots or you will obscure the very behavior that you're trying to see.

You do not have to turn in anything for problems 0–3.

4. Play with R and describe some of your results, *using the language of dynamical systems*. Turn in two or three interesting plots at different values of R —ones produced by *your* code, not the Complexity Explorer app—including at least one on each of the three sets of axes in problem 2, and at least one time-domain plot that demonstrates chaotic behavior. (You may check this, if you'd like, by trying out $x_0 = 0.200001$ and tracking how the resulting trajectory differs from $x_0 = 0.2$.) Some interesting R -values are at and near 2, 3.3, 3.6, and 3.83. What happens when $R > 4$?

Now fix $R = 2.5$ and try different initial conditions. Does the trajectory do the same thing for different initial conditions? What is the dynamical systems terminology for a set of initial conditions that acts like this?

Turn in your answers — numbers, plots, thoughts, interpretations, etc. — in hardcopy at the beginning of class.