University of Colorado
Department of Computer Science

Chaotic Dynamics – CSCI 4446/5446
Spring 2019

Problem Set 1

Issued: 15 January 2019

Due: 22 January 2019

Reading: *Strogatz, chapter 1 and sections 10.1-10.2; section 1 of ODE Notes.* Chapter 1 of Parker and Chua, which is on reserve in the Engineering Library for this course, has some nice pictures of different kinds of attractors. The first few pages of section 3 of Liz's TSA Notes (on the course webpage) 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 (on reserve in the Engineering Library).
- I. Stewart, *Does God Play Dice? The Mathematics of Chaos*, Blackwell, 1989 (also on reserve in the Engineering Library).

Problems:

0. Read the CSCI 4446/5446 syllabus carefully. No deviations from the policies and procedures laid out therein will be made without **prior** arrangement.

1. Email me (`lizb@cs.colorado.edu`) your preferred email address so I can make an email alias for the class. Please mention in your message which version of the class you're enrolled in — grad or undergrad.

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. (Check out 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 $x_0 = .2$ 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—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 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.