Lab exploration 1 Math 309 Fall 2016
Deadline: 12N Friday 9 September
Late deadline: 12N Friday 16 September

Writing

- Conduct experiments as directed.
- **Journal entry.** Respond to each of the "journal queries." Using *concise and clear sentences*, incorporate data, symbols, and illustrations into your text. Have an audience in mind. Focus on *developing* an explanation or argument that stems from your simulations.

  Submit 300-400 words 2-3 pages double-spaced in **hard copy**.
- **Recommended.** Work in groups of 2 or 3. Submit one journal entry for the group.
- *Net Logo* models are available either in the Models Library or on the course website.

Model: Tent map. The model presents a family of dynamical systems that you can iterate using a range of initial points. Setting a value for the parameter R specifies the map expressed by

$$T_R(x) = \frac{R}{2}(1 - |2\,x - 1|) \qquad 0 \le R \le 2 \qquad 0 \le x \le 1.$$

The point x0 specifies a starting point for the iteration. The setup button reads the set values of R and x0. The button labeled go computes the orbit

$$x_0,\ T_R(x_0),\ T_R^2(x_0),\ \ldots$$

and reports the data numerically, graphically, and as a time series (thinking of an iteration as a time step.

Journal query. Compute orbits for several initial points and for values of R close to 0. Briefly describe the orbit's behavior: attraction to a fixed point? to a cycle? wandering? As R increases what happens to the rate at which the orbit develops? Increase the value of R until the previous behavior stops. At what value of R does this change occur? Describe the dynamics when R is a little bit greater than this value.

Journal query. Gradually increase R and look for *qualitative* changes in dynamical behavior. Describe one or two cases. Discuss how the time series plot changes as R increases.

Journal query. Set $R = 2$ and plot several orbits. Discuss the behavior (especially in light of class discussion).

Journal query. Now set $R = 1.99$ and plot some orbits. Compare the results to those for $R = 2$. What might explain the difference between the two cases?

Model: Logistic map. Motivated by ecological considerations the logistic family of maps has the form

$$L_R(x) = R\,x\,(1 - x) \qquad 0 \le R \le 4 \qquad 0 \le x \le 1.$$

The model runs in the same way as that of the tent map. Run experiments similar to those done with the tent maps–noting that R varies from 0 to 4.

Journal query. Describe the long-term behavior of orbits for values of R slightly **smaller than** 3 and then for values slightly **larger than** 3.

Journal query. Find another value of R where the dynamical behavior changes qualitatively. Describe the change.

Journal query. Compare the logistic family to the tent family. Discuss some similarities and differences.