

## Project — Math 414 — Spring 2009

This project must be your own work. No collaboration is allowed. It MUST be in my possession by the start of the final exam. No late projects will be accepted at all since grades have to be submitted within two days of the final exam so there is absolutely no flexibility in this deadline. I prefer to have a hardcopy but will accept electronic submissions if they are in the form of a single pdf file.

You may use any programming language you like but Matlab/Octave will be more than sufficient, although much slower than a compiled language like C or Fortran.

### The bifurcation diagram for the logistic equation

a)

The first part is basically to reproduce the bifurcation diagram on the back cover of the textbook for the logistic equation  $u_{n+1} = au_n(1 - u_n)$ . The parameter  $a$  should vary between 2.9 and 4.

b) When  $a = 4$ , compute as many iterates as you need to plot a histogram that shows how often the iterates land within a particular part of the interval  $[0, 1]$ . The height of the bars should be normalized so that the total area is 1. This density function is known as the ‘invariant measure’.

There are a few things you should note:

- You should choose a random initial point for each value of  $a$ . Don't choose a special point such as  $u_0 = \frac{1}{2}$ .
- The first iterates will need to be thrown away as they are the ‘transient’ that depends on the initial conditions. The author throws away the first thousand points but this is probably too many.
- You will need to experiment a little to find the right compromise between computer time and accuracy. Make sure that all the parameters you eventually use are clearly listed on your work.