**PHYS2100: Investigation of chaotic maps, Wednesday 18th October 2006.**

Today we are going to investigate the properties of the logistic map,

$$x_{n+1} = \mu x_n(1 - x_n).$$

starting from $x_0$, which should be between 0 and 1. You can show that for $0 \leq \mu \leq 4$ then $0 \leq x_n \leq 1$ for all $n$.

To do this we will be using matlab: the functions you need can be downloaded as a zip file from the PHYS2100 web page at `http://www.physics.uq.edu.au/people/mdavis/phys2100/` Extract these to a directory, and begin matlab in that directory.

In particular, you will be using the functions `plot_map.m` and `bifurcation_diagram.m`. To find out how to use these, type `help plot_map` on the matlab command line.

If you need help getting started, either ask your friend who has used matlab before, or ask the lecturer.

1. Begin by looking at the logistic map for $\mu = 1.5$, $x_0 = 0.3$, and $n = 20$ iterations by running the command `plot_map('logistic_map',0.8,0.3,20);` Try increasing $n$. What happens?
2. Try changing the initial value $x_0$. What happens when you do this?
3. Now try increasing $\mu$ to 1.5. What happens now? What about when you change $x_0$?
4. Try other values of $\mu < 2.5$. Can you see a trend? Can you identify the value of mu for which $x_\infty > 0$?
5. Now try `plot_map('logistic_map',3.1,0.3,20);` What is the behaviour now? Keep increasing $n$ to see what happens. Again, try other values of $x_0$.
6. Increase $\mu$ to 3.5. Can you see a pattern here?
7. Next try $\mu = 3.56$. How many distinct values of $x$ are there for large $n$?
8. Look for the pattern for $\mu = 3.71$. What do you think has happened?
9. Finally try $\mu = 3.74$ Does this behaviour make any sense given what you have been seeing?
10. Now run `bifurcation_diagram('logistic_map',0,4,1e3);` Hopefully this will help you understand what you have seen previously. Zoom in by changing the parameters.

There are other mapping functions that you might like to investigate. They are `sine_map, tent_map, power_law_map, shift_map, matt_map`. Use the matlab `help` function to find out more about how they work.

We will investigate these maps analytically in lectures this afternoon.