Chaos Session I – The Joys of Iteration

Goals for the session:

1. A discussion of virtual modeling with Luciana
2. Discuss the logistic map (an exercise provided by Peter)
3. Set up an EJS simulation on the web, using Google Pages
4. Modify the Mandelbrot set program to look at Julia sets
5. Spend some time working on your own simulation project

1. Virtual modeling and realism (15 minutes)

2. The logistic map (45 minutes)

3. Making your simulation available on the web (15 minutes)

One way to do this is to use the free web page hosting service provided by Google.

1. First, sign up for a gmail account, if you do not have one already. You can do this at: http://gmail.google.com

2. Then, go to http://pages.google.com and start the process to set up your own web pages.

3. I could not figure out a way to upload the EJS _library folder to google pages, so as an alternative we can all use the _library folder that is on the BU Physics server. When you have an EJS simulation that you're happy with, you will need to edit the .html file(s) that EJS has created for your simulation. These files should be a few levels down in the _apps folder in EJS. You will need to edit each of the html files you want in two places. Edit the <link> line so it reads exactly this:

```
<link rel="stylesheet" type="text/css"
href="http://physics.bu.edu/~duffy/_library/css/ejsSimulation.css">
</link>
```

   Then, edit the <applet> line so the archive part of it, up to ejsBasic.jar, reads

   ```
   archive="http://physics.bu.edu/~duffy/_library/ejsBasic.jar,
   ```

4. Use the Page Manager feature of Google Pages to upload the .jar file and the .html file(s) that EJS has created for your simulation.

5. That should be it! The web address for your simulation should be:

http://yourgooglename.googlepages.com/simulationfilename.html

Example: http://prof.duffy.googlepages.com/pendulum_v5_sim.html

4. The Mandelbrot set and Julia sets (30 minutes)

Start by loading into EJS the Mandelbrot.xml file in the examples folder. Try running it to see what happens. This complex picture is generated by iterating a rather simple equation.

To create the Mandelbrot set, we need to know a little bit about doing math with complex numbers. For a complex number of the form $z = a + ib$, where a represents the real part and b represents the imaginary part, find an expression for the real and imaginary parts of z^2.

Real part of z^2:

Imaginary part of z^2:

We will look at various points c in the complex plane, where the x-axis is the real axis and the y-axis is the imaginary axis. For each point c, we start with $z = 0$ and then iterate the equation:

$z = z^2 + c$.

If the magnitude of z gets above 2, then carrying out more iterations will eventually lead to the magnitude of z approaching infinity.

The Mandelbrot set is the set of all initial points c that do not lead to a magnitude of z approaching infinity. For those that do blow up to infinity, we color them based on how quickly their magnitude gets larger than 2.

The creation of a Julia set is similar, except that for each point z is the initial point in the complex plane and c is a fixed value of your choice. c values that are near the boundary of the Mandelbrot set can give particularly interesting results.

Modify the Mandelbrot set program to turn it into a program for generating Julia sets.

5. Spend time working on your own simulation project (45 minutes)

We can brainstorm together regarding any issues you have.