Tutorial Introduction to Computational Physics SS2012

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Sheet 10 (June 28, 2012)

Return by noon of July 6, 2012)

1 Discrete Maps, Mathematica Exercises (continued)

Manipulation of lists in Mathematica, logistic and other discrete maps

In this exercise you will see how powerful algebraic software like Mathematica can be. The goal is to plot bifurcation diagrams and Liapounov coefficients by just a few Mathematica commands, rather than writing and running a computer program yourself.

- Creation of lists from recursive functions (`NestList`)
- `Thread, Flatten`: Creation and Removal of parts of lists.
- Functions applied to elements of the list
- Using Mathematica Lists for the logistic map, plotting the points with e.g. `ListPlot`
- Exercise the graphical presentation of the bifurcation map and the Liapounov coefficients.
- Plot the lines $f^p(0.5)$ as a function of r, to see the attractive lines in the bifurcation diagram. Superstable points exist where these lines cut the $x = 0.5$ line.

2 Probability distribution functions (Homework)

Consider a probability distribution function $p(x)$ given in the domain $[0, a\rangle$ by

$$p(x) = bx \tag{2.1}$$

Assume that $\{r_i\}$ is a random set of numbers, distributed uniformly between 0 and 1.

- Give the proper value of b as a function of a such that the probability distribution function is properly normalized.
- Use the rejection method to make a set $\{x_i\}$ that obeys Eq.(2.1) for $a = 0.5$.
- Make a histogram of the resulting numbers and check that the histogram indeed follows Eq.(2.1), i.e. overplot Eq.(2.1). Tip: Find the correct normalization to be able to compare the histogram to Eq.(2.1). Experiment with the size of the set (the number of random numbers drawn), to find out how large you have to make it to get (by eye) a reasonable fit.

Now let's use the transformation method:

- Give an expression for x_i as a function of r_i such that the set $\{x_i\}$ is distributed according to Eq.(2.1).
- Now create a set $\{x_i\}$ using this transformation method. Also plot the histogram of this case, and compare to Eq.(2.1).

(Each item: 4 points)