Tutorial Introduction to Computational Physics SS2011

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Sheet 11 (June 30, 2011)

1 Discrete Maps (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 Logistic map continued (homework)

For this exercise you can choose how you want to solve it - traditionally, using your codes developed in the previous sheet, by substituting Singer's function for the logistic map, or by using the new mathematica tools presented above. In the second case you should submit a mathematica notebook or a complete printout of the mathematica input and output to your tutors.

1. Singer's function is given by $f = cF(x)$ $(0 \leq c \leq 1.06)$,

   $$F(x) = 7.86x - 23.31x^2 + 28.75x^3 - 13.3x^4$$

   $(0 \leq x \leq 1)$. Plot f and $f^{(2)}$ for $c = 0.95$ and $c = 0.9916$. Where are the fixed points of f and the periodic orbits (fixed points of $f^{(2)}$). Are they stable or unstable? How many periodic solutions are there? (6 pt)

2. Plot the bifurcation diagram of the discrete map $x_{k+1} = f(x_k)$ using Singer's function f $(0 \leq c \leq 1.06)$. (7 pt)

3. Plot the Liapounov coefficients of this discrete map. (7 pt).