Computational Physics

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Project 6, due December 1, 2021 at 11:59 p.m.
to be uploaded to https://elearning.jacobs-university.de

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6. Logistic map [10 points]

a) Write a computer program which iterates the logistic map. Submit the source code and report including graphs (in pdf-format, try to keep file sizes small) for the parameters ($r = 0.2$, $x_0 = 0.8$), ($r = 0.4$, $x_0 = 0.8$), ($r = 0.73$, $x_0 = 0.1$), and ($r = 0.88$, $x_0 = 0.09$) showing x as function of iteration index n for $n = 0, \ldots, 200$. Are the results in agreement with the general statements discussed in class?
b) Modify the code to yield the iterations for the maps $f(x) = x\exp(4r(1-x))$ and $f(x) = r\sin(\pi x)$. Submit the resulting plots for the same parameters as above.
c) Back to the logistic map: plot $\ln|\Delta x_n/\Delta x_0|$ as a function of n for $r = 0.92$, $x_0 = 0.6$ and $\Delta x_0 = 10^{-5}$ where Δx_n describes the difference between two trajectories.
d) Calculate the Lyapunov exponent λ using the $f'(x_i)$-formula and plot λ as function of r for all three maps above.

General remarks for all Projects

You will have to (i) analyze the problem, (ii) select an algorithm (if not specified), (iii) write a Python program, (iv) run the program, (v) visualize the data numerical data, and (vi) extract an answer to the physics question from the data.
Which checks did you perform to validate the code? State the results you got for these tests.
For each project you will submit a short report describing the physics problem, your way of attacking it, and the results you obtained. Provide the documented Python code in such a form that we can run the code. A Jupyter Notebook including the code and report is fine but not necessary.