Computational Physics

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Project 1, due September 22, 2021 at 11:59 p.m.
to be uploaded to https://elearning.jacobs-university.de

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1A. Falling body [6 points]

Write a computer program implementing the Euler algorithm for a falling body which includes a velocity-dependent damping as well the height-dependent gravitational field of the earth.
Give the results for a drag force of the form kv^2 with k=10^{-4}kg/m and for a body of mass $m = 50$ kg falling from a height of 5000 m. Plot the results for $x(t)$, $v(t)$, and $a(t)$.

1B. Harmonic oscillator [4 points]

Modify the code to solve the equations of motion for a simple harmonic oscillator for which $F = -kx$. For simplicity, choose units such that $k = 1$ and $m = 1$. Moreover, set the initial velocity to zero and choose a non-zero initial position. Determine the numerical error in the position of the simple harmonic oscillator by comparing to the analytic solution after the particle has evolved for several cycles. Is the Euler algorithm stable for this system?

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.