PHYS-E0412 Computational Physics :: Homework 1

Due date 15.1.2019 at 10:00 am

Practical intructions:

- The homework problems in this course should be solved using a computer. Unless otherwise stated, you can use any programming language or tools you prefer.
- You can collaborate with your friends when solving the problems, but *everyone should submit their own code and solution.*
- The problem solutions are to be submitted to MyCourses before the following exercise session. The format can be e.g. a pdf file or the answer can be entered as simple text and separate image files can be attached to the submission. **Remember to also attach your code**!
- If you do not know what tools to use to solve the homework problems, one good option is Matlab. You should be able to install it to your home computer from `http://download.aalto.fi` website. Alternatively, you can connect to the university computers using ssh, and run "matlab -nodesktop", or just "matlab", if you have X forwarding enabled ("ssh -X").
- Start early! The assistant (Jouko Lehtomäki, jouko.lehtomaki@aalto.fi, Undergraduate Centre room Y426c) is happy to help you if you cannot get your code working, but most likely does not have time to do so on the last evening before the deadline.
- Provide us with an approximation on how many hours you used on the exercise set. This makes it easier for us to monitor and adjust the work load.

Random walk on real axis.

Consider a random walker that takes random steps, not of integer length but real numbers, uniformly distributed between -1.0 and 1.0. Such a step can be written as $x(t+1) = x(t) + \Delta$, where $x(t)$ is the walker position at time t, and Δ is a random step.

Random walks can correspond to diffusion processes. Let us define the diffusion constant D as

$$D = \frac{\mathrm{Var}(x(t))}{2t} \quad \text{(for large } t\text{)},$$

where the variance can be evaluated as $\mathrm{Var}(x(t)) = \langle x(t)^2 \rangle - \langle x(t) \rangle^2$.

(i) Write a piece of code that simulates the random walk described above. Roughly, what is the value of the diffusion constant D in this case? (2p)

(ii) If you compute the diffusion constant multiple times, how are the values distributed? Plot the distribution. (1p)

(iii) Having many values for the diffusion constant, what is the mean and the corresponding error estimate? (2p)

(iv) How many hours you used for problems in this exercise set?

Upload your solution in MyCourses (mycourses.aalto.fi) to the corresponding assignment. Please remember to attach your figures and codes as well!