Hand-in exercise about N-body simulations

To pass this exercise, you have to hand in a pdf-file of 2-3 pages addressing the tasks below.

- Run a simulation with $N = 512$ particles, $dt = 0.01$ and $tmax = 30$. (Hint: see Simulation0.py from the examples/lectures as inspiration). Show the x, y distrubution of particles at four times, which you can select yourself. Describe the plots.
- Run simulations with $N = 32, 64, 128, 256, 512, 1024$ and 2048. Use $dt = 0.01$ and $tmax = 2$. Measure the mean time it takes to do a calculation of accelerations in each case, and plot (N,mean time to calculate acceleration) – use plt.loglog() to make axes logarithmic. Show that the time of an acceleration calculation scales approximately as N^2. (Hint: see example in video lecture 10.)

Takeaway message: Because the CPU time scales as N^2 it is not practically possible to run extremely large N-body simulations with the acceleration calculation algorithm used in this N-body simulation code. A scaling of CPU time $\propto N$ would be necessary to be able to run arbitrarily large simulations. In a future lecture I will outline algorithms for gravity calculations, which has a weaker scaling than N^2.