Final Project For N-Body

One possible final project - of course, others are acceptable, just check in with the professor.

Please get the project in no later than mid-December (to be discussed). If you need more time, you'll need to arrange for an extension.

Make a 2-D nbody code (3-D if you're feeling awesome) that calculates the forces by computing the potential, where the potential is found by convolving the density with the (softened) potential from a single particle (For a particle to feel no force from itself, you probably want to make the potential flat for the inner few cells). The acceleration is then found by taking the gradient of the potential. You will probably wish to use a leapfrog solver with fixed timestep, at least initially. Please save the output of your simulations in animated gif's/mp4's *etc.* and print the energy in each frame. Instructions on how to do this can be found on the web, including at `https://tinyurl.com/5ecjvkfc`. Please also save your random seeds for your starting conditions so the TA's can reproduce your results.

Part 1: Using this code, show that a single particle starting at rest remains motionless. Output should be in "one_particle.gif".

Part 2: Next, show that a pair of particles placed in a circular orbit continue to orbit each other, for at least some reasonable length of time. Output should be in "two_particles.gif".

Part 3: Set up both periodic and non-periodic boundary conditions. Set up a problem where hundreds of thousands of particles are initially scattered randomly throughout the domain. Show the evolution with time for both periodic and non-periodic boundary conditions. Track the total energy - how well is it conserved? Outputs should be in "leapfrog_periodic.gif" and "leapfrog_nonperiodic.gif".

Part 4: Switch to an RK4 integrator from a leapfrog. At *fixed computational work per unit time* in the simulation, which integrator preserves energy better? You may assume the work is dominated by the calls to get forces. Output should be in "rk4_periodic.gif" and "rk4_nonperiodic.gif". Please use the same initial conditions (and starting seeds) as in part 3.