HPP A3

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1 Introduction

The N-body problem is about predicting the individual motion of a group of objects interacting with each other in a gravitational space, for example the motion of the sun, stars and planets. By using Newtons law of gravitation, eq 1, describes the force two particles i and j exert on each other.

$$\mathbf{f_{ij}} = -\frac{Gm_i m_j}{r_{ij}^3}\hat{\mathbf{r_{ij}}} \tag{1}$$

For a space consisting of N bodies, eq 1 can be rewritten to eq 2, where ϵ_0 is a small number, here 10^{-3}.

$$\mathbf{F_i} = -Gm_i \sum_{j=0, j\neq i}^{N-1} \frac{m_j}{(r_{ij}+\epsilon_0)^3}\mathbf{r_{ij}} \tag{2}$$

By using the symplectic Euler time integration, the velocity $\mathbf{u_i}$ and position $\mathbf{x_i}$ of particle i can be determined by the following formulas:

$$\mathbf{a_i^n} = \frac{\mathbf{F_i^n}}{m_i} \tag{3}$$

$$\mathbf{u_i^{n+1}} = \mathbf{u_i^n} + \Delta t \mathbf{a_i^n} \tag{4}$$

$$\mathbf{x_i^{n+1}} = \mathbf{x_i^n} + \Delta t \mathbf{u_i^{n+1}} \tag{5}$$

This straight forward solution becomes computationally expensive for large values of N, the total number of calculations will grow as $\mathcal{O}(N^2)$. This assignment is about implementing a code that performs a simulation of N particles for a certain number of time steps in a two dimensional space. The initial position and masses of the particles will be read from a file, after the simulation the final result will be written to a file which then can be compared with the re

2 Solution

3 Performance and Discussion