Programming Assignment 2 - N-body Simulation

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Abstract

The n-body problem is a famous problem regarding approximating the motion of particles. The main idea is using the Newtonian gravitational force equation to simulate the motion. In this project, we try to parallelize the n-body simulation program and we will give a benchmark on both the serialized version and parallelized version.

1 Introduction

First let's shed a light on what n-body simulation acutally is. An N-body simulation of a dynamic system of particles, usually under the influence of physical forces, such as gravity. The default number of particles in the system is 200 and the user can specify the number of particles by explicitly input an argument to the program. Another important parameter is the number of iterations and the default value is 10000.

2 Implementation

In the N-body simulation, the core function is `position_step` which calculates the forces of bodies and update the positions of the bodies and we are going to analyze this function both on a sequential manner and parallel manner.

2.1 Sequential Version of `position_step`

The sequential version of function `position_step` is rather simple. What it does is update the positions of each body in this world:

1. Allocate memory for `force_x` and `force_y` and initialize them to 0.
2. Compute the force on each body. Since each body has a force on all other bodies except itself, thus this computation is a two-level loop. In the outer loop we traverse all the bodies and in the inner loop we traverse all the body except the ith body.

3. Update the velocity and position of each body according to related physical laws.

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