COMSW4995 Parallel Functional Programming Proposal
Galaxy Simulation

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Nov/22/2021

1 Introduction

`Galaxy` is a Haskell program which simulates celestial movement and, if time permits, visualizes the galaxy system with OpenGL. The visualization of the galaxy should be dynamic which represent the the whole program assuming the universe is a 2-D plane.

2 Model

2.1 Simplification

1. `Galaxy` assumes that the galaxy we simulate is an isolated system which is not affected by any other system.
2. Instead of 3-D which is the real world situation, `Galaxy` simulates 2-D world.
3. There are only two kinds of celestial body: star and planet.
4. All celestial bodies are considered as mass points which means `Galaxy` doesn't worry about collision between celestial bodies.
5. Gravitational constant G is equal to 6.67×10^{-11}.

2.2 Celestial Body

Celestial body has the following properties:

1. Coordinate: (`float`, `float`)
2. Mass: `float`
3. Velocity: (`float`, `float`)

2.3 Gravity

The equation of gravity is

$$F = G\frac{m_1 m_2}{r^2}$$

In `galaxy`, it computes F_x and F_y separately:

$$F_x = G\frac{m_1 m_2}{(x_1 - x_2)^2}$$
$$F_y = G\frac{m_1 m_2}{(y_1 - y_2)^2}$$

Because force is a vector, we define that for body 1, $F_x < 0$ if $x_2 < x_1$ and $F_x > 0$ othersize. The same for F_y.

2.4 Acceleration

We use Newton's second law to calculate acceleration:

$$F = ma$$

Then we can have acceleration in different dimension:

$$a_x = \frac{F_x}{m}$$
$$a_y = \frac{F_y}{m}$$

Because acceleration is a vector, we define that a_x has the same sign as F_x.

2.5 Velocity

Let Δt denote the smallest time interval defined by user or default. The velocity of body in `galaxy` should change as

$$v'_x = v_x + a_x \Delta t$$
$$v'_y = v_y + a_y \Delta t$$

3 Visualization

The result of visualization should be dynamic. After a certain time interval, the graph of current state of `galaxy` should update. It should show every existing celestial body as dot.