Introduction to Computational Physics

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1 Administration

Recieve Homework assignment on wednesday, hand in next week's Friday. Tutorials will start 26.04.2019

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220 Points - 60% required on the exercise Sheets

The art of scientific Computing (Literature recommendation)

This lecture is all about making good choices. For example we can approximate π by creating a geometric shape and counting the circumference while adding corners. For the algortihm we should use only additions, no substractions , since that will midigate rounding errors better.

Ordinary Differential Equations

1. Example: **Gravitational 2-Body Problem**
   Look at relative Position between two bodies

$$\vec{r} = \vec{r}_1 - \vec{r}_2$$

Newton:

$$\ddot{\vec{r}} = \frac{\partial^2 \bar{r}}{\partial t^2} = -G\frac{M}{r^2}\frac{\bar{r}}{r}$$

$$r = |\bar{r}|; G = 6.67 \cdot 10^{-8}\mathrm{cm}^3/\mathrm{gs}^2$$

Force 2 on 1:

$$\bar{F}_{12} = m_1 \bar{a}_1$$

Force 1 on 2:

$$\bar{F}_{21} = m_2 \bar{a}_2$$

Newton:

$$\bar{F}_{21} = -\bar{F}_{12} \rightarrow \bar{a}_2 = -\frac{m_1}{m_2}\bar{a}_1$$

$$\bar{a} = \bar{a}_1 - \bar{a}_2 = \bar{a}_1 + \frac{m_1}{m_2}\bar{a}_1 = \frac{m_1 + m_2}{m_1 m_2} m_1 \bar{a}_1 = \frac{m_1 + m_2}{m_1 m_2}\bar{F}_{12}$$

$$\mu = \frac{m_1 + m_2}{m_1 m_2}$$

$$\mu\ddot{\bar{r}} = -G\frac{m_1 m_2}{r^2}\frac{\bar{r}}{r}$$

How t simplify?

$$\dot{\bar{r}} = \bar{u}$$

$$\dot{\bar{u}} = -\frac{GM}{r^2}\frac{r^2}{r}$$

ODE of order N $\rightarrow$ system of 1st order ODEs