Lecture October 8

Earth-Sun case

2-dimension

$$r = \sqrt{x^2+y^2}$$

Force on Earth from sun

$$F_x = -\frac{GM_G M_E}{r^2}\cos\theta = -\frac{GM_G M_E x}{r^3}$$

$$F_y = -\frac{GM_G M_E y}{r^3}$$

$$F_x \rightarrow a_x = -\frac{4\pi^2 x}{r^3} - \frac{4\pi^2\left(\frac{M_J}{M_\odot}\right)x_{EJ}}{R_{EJ}^3}$$

$$F_y \rightarrow a_y = -\frac{4\pi^2 y}{r^3} \sim \left(\sqrt{x_i^2+y_i^2}\right)^3$$

Euler's method

$$x_{i+1} = x_i + h v_i$$

$$v_{i+1} = v_i + h a_i \quad \left\{ a_i = \begin{cases} a_{x_i} \\ a_{y_i} \end{cases} \right.$$

Velocity-Verlet

$$x_{i+1} = x_i + h v_i + \frac{h^2}{2} a_i \quad [O(h^3)]$$

$$v_{i+1} = v_i + \frac{h}{2}\left[a_{i+1} + a_i\right] \; ?)$$

First calculate x_{i+1}, keep q_i for v_{i+1} and calculate q_{i+1}

Object-oriented strategy:

- write once and run many times

- Solver(s): complex set of first-order ODEs
  ODE solver
  Euler
  Velocity solver
  RK2
  RK4
  :

  ⇒ Solver class

- System: class
  Solar system class

- Forces class: Gravitational force.