Exosim: Math

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The website runs a real time simulation of planets and a star where each celestial object asserts gravitational pull on all the others (so planet-planet interactions are taken into account) according to the Newton's law of universal gravitation:

$$\vec{F_{ij}} = G\frac{M_i M_j}{r_{ij}^2}\frac{\vec{x_i} - \vec{x_j}}{|\vec{x_i} - \vec{x_j}|}$$

where M_i and M_j are the masses of the two objects, x_i and x_j are their three-dimensional positions, and r is the distance between the two objects:

$$r_{ij} = \sqrt{(\vec{x_i} - \vec{x_j})^2}$$

This is then turned into a system of differential equations:

$$\begin{cases} \dot{\vec{x_i}} = \vec{v} \\ \dot{\vec{v_i}} = \frac{1}{M_i}\sum_{j \neq i} \vec{F}_{ij} \end{cases}$$

Here, v_i is the velocity of the planet (in three dimensions).

All units are to scale. The website comes loaded with our solar system in it, so you can see the Earth orbit the sun in precisely a year! The solver uses an Euler step; one thing we want to do for the final project is improve this to the Runge-Kutta solver to improve long term behavior.