FYS3150 Computational Physics - Project 3

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This is an abstract

INTRODUCTION

Lastly, the source code for any code discussed in this report can be found on my Github at: https://github.com/nicholaskarlsen/FYS3150

THEORY, ALGORITHMS AND METHODS

Discretizing Newton's law of universal gravitation

Between every body, there is a force of attraction inversly proportional to the square of the separation, or more precisely

$$\mathbf{F} = G\frac{m_1 m_2}{|\mathbf{r}|^2}\hat{\mathbf{u}}_{\mathbf{r}}, \quad \hat{\mathbf{u}}_{\mathbf{r}} = \frac{\mathbf{r}}{|\mathbf{r}|} \qquad (1)$$

Where m_1, m_2 denote the mass of the bodies, G is the gravitational constant and $\mathbf{r}$ denotes the vector from body $1 \rightarrow 2$.

If we choose to work in the cartesian coordinate system centered on body 2, then $\mathbf{r} = (x, y, z)$ and $|\mathbf{r}| = \sqrt{x^2 + y^2 + z^2} = r$.

By Newtons second law, the acceleration on body 1 due to the gravitational pull of body 2 can then be written as

$$\mathbf{a} = \frac{1}{m_1}\mathbf{F} = G\frac{m_2}{r^3}\mathbf{r} = G\frac{m_2}{r^3}(x, y, z) \qquad (2)$$

Euler-Cromer Algorithm

```
1  for  i = 0, ..., N − 1
2      v_{i+1} = v_i + a_i Δt
3      r_{i+1} = r_i + v_{i+1}
```

Velocity-Verlet Algorithm

```
1  for  i = 0, ..., N − 1
2      r_{i+1} = r_i + v_i Δt + ½ a_i (Δt)²
3      v_{i+1} = v_i + ½ (a_{i+1} + a_i) Δt
```

RESULTS AND DISCUSSIONS

CONCLUSIONS

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[1] M. Hjorth-Jensen, Computational Physics - Lecture Notes 2015, (2015).

Fetching data from Horizons using horizons.py

In order to streamline the process of fetching data from the Horizons system i created a small script, horizons.py that utilizes the Astroquery python package and returns only the select data that i am interested in. The function, fetch_data takes input as a dictionary, rather than a list of id numbers. Whilst this may not be as extensible or practical, it makes the code easier to read and understand, by making the instant connection between the planet name and id. For the purposes of this project, i find that much more valuable since i am only dealing with a limited ammount of planets anyway.