Model for the solar system using ordinary differential equations

ANDREAS FAGERHEIM*

Department of Physics, University of Oslo, Norway

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Abstract

This article constructs a model for simulating the solar system. The Forward Euler and velocity Verlot methods will be used to solve the ordinary differential equations that describes the system. Taking an object oriented approach to implementation of the code makes for an more affordable task of expanding the system.

I. INTRODUCTION

II. THEORY

III. ALGORITHMS

i. Euler Forward algorithm

$$\vec{x_{i+1}} = \vec{x}_i + h\vec{v}_i \tag{1}$$

and

$$\vec{v_{i+1}} = \vec{v}_i + h\vec{a}_i \tag{2}$$

ii. Verlet method

$$x_{i+1} = x_i + hx_i^{(1)} + \frac{h^2}{2}x_i^{(2)} + O(h^3) \tag{3}$$

and

$$v_{i+1} = v_i + hv_i^{(1)} + \frac{h^2}{2}v_i^{(2)} + O(h^3) \tag{4}$$

Here we know all values except the second derivative of the velocity. By Taylor expansion of the first derivative of velocity:

$$v_{i+1}^{(1)} = v_i^{(1)} + hv_i^{(2)} + O(h^2)$$

$$hv_i^{(2)} \approx v_{i+1}^{(1)} - v_i^{(1)}$$

Using this and we can rewrite equations 3 and 4 containing only known values;

$$x_{i+1} = x_i + hv_i + \frac{h^2}{2}v_i^{(1)} + O(h^3) \tag{5}$$

and

$$v_{i+1} = v_i + \frac{h}{2}\left(v_{i+1}^{(1)} + v_i^{(1)}\right) + O(h^3) \tag{6}$$

Due to $v_{i+1}^{(1)}$ being dependent on x_{i+1} calculating position at updated time (t_{i+1}) is necessary for calculating the new velocity. In pseudo code this will look somthing like the figure below.

IV. RESULTS

V. CONCLUSION

REFERENCES

[Hjorth-Jensen, 2015] Hjort-Jensen, M. (2015). Computational Physics.

[Hjorth-Jensen] Hjort-Jensen, M. https://github.com/CompPhysics/ComputationalPhysics

*https://github.com/AndreasFagerheim/Project-4