

Numerical Analysis and Programming

Final

In this final project, we want to study the motion of a particle under a certain force field. Your group is asked to complete 5 modules and a main program.

1. Module 1: I/O Module

This module reads in a data file and split them into several lists. You are required to read in a data formatted as

$$\begin{array}{ccc} t_1 & x_1 & v_1 \\ t_2 & x_2 & v_2 \\ \vdots & \vdots & \vdots \\ t_n & x_n & v_n \end{array}$$

and output them as threw numpy arrays.

2. Module 2: Differentiation Module

This module takes data from module 1 and perform 1st derivatives to obtain the acceleration $a(t)$.

3. Module 3: Polynomial Fit Module

This module fits the data $v(t)$ and $a(t)$ from Module 2 and perform a polynomial fit

$$a(t) + bv = P_2(x) = c_0 + c_1x + c_2x^2 + \cdots + c_nx^n$$

for a given b to obtain the coefficients $c_0, c_1, c_2, \dots, c_n$.

4. Modules 1-3 are repeated 20 times to obtain an estimate of c_0, c_1, c_2 by average.

5. Module 4: ODE solver Module

Using $c_0, c_1, c_2, \dots, c_n$ obtained previously, and find the solution of

$$\ddot{x} = c_0 + c_1x + c_2x^2 - b\dot{x} + A \cos(\omega t)$$

for given A and ω .

6. Module 5: Solution Module

Using data obtained from Module 4 to obtain the time t_0 for the particle to first reach $x = x_0$. Use this information to find the firing time t_f of a bullet located l away firing along the y -axis with velocity c (Fig.1).

7. Repeat module 4 and 5 to increase the accuracy.

