PHYS 105: Computational Physics I

Spring 2015

In-class exercise #2

A particle moves in one dimension under the influence of an external force. At time $t = 0$, the particle has position x_0 and velocity v_0, and its position at any time t is given by

$$x(t) = x_0 + v_0 t + \alpha t^2 + \beta t^3.$$

(a) Write a program to evaluate the particle's position x at discrete times $t_i = i\,\delta t$, where the time step δt is specified as a variable (`dt`) in the program. If you use C++, use the `double` data type to represent all quantities. Choose

$$\begin{aligned} x_0 &= -1 \\ v_0 &= 6 \\ \alpha &= -5 \\ \beta &= 1 \\ \texttt{dt} &= 0.1 \end{aligned}$$

- In Python, plot the trajectory $x(t)$ of the particle for $0 \le t \le 4$.
- In C++, start at $t = 0$, use a `while` loop to continue your calculation until $t = 4$, and print out the values of t and x (one pair per line) after every step. Use `gpl` to plot the particle's trajectory.

(b) Now modify your program to stop not at a fixed time but instead when the particle returns to $x = 0$ with negative velocity. Specifically, stop the calculation when $x \le 0$ and the previous value of x was ≥ 0. Print out the value of t when this occurs. Demonstrate graphically that the trajectory has indeed returned to $x = 0$.