PH3205-Computational Physics

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Assignment 2

Aim

An object falls to the ground from a height of 30 meters. Its height as a function in time t is represented by y(t). At time t = 0, we have y(0) = 30, and at time t = 4, the object hits the ground. Assuming the object having a unit mass (m = 1), by Newton's law, its acceleration is determined by $\frac{d^2y}{dt^2} = -g$, where $g = 9.81 m/s^2$. Using shooting method, solve the ODE $\frac{d^2y}{dt^2} = -g$

Solution

We used the shooting method to solve the problem and implemented this in Python. We defined the set of 1st order differential equation:

$$\frac{dy}{dt} = v$$
$$\frac{dv}{dt} = -g$$

Then using *solve_ivp* from the *scipy.integrate* module, we obtain the solution for any given $\frac{dy}{dt}(t = 0)$. We then defined the objective function as a function of $\frac{dy}{dt}(t = 0)$ which returns the difference between the final position of the numerical solution and boundary value($y(4) = 0$). Then using $fsolve$ function from *scipy.optimize* we get the optimal value of the $\frac{dy}{dt}(t = 0)$ and get $y(t)$.

The required python files are : *Assignment2.ipynb* (Jupyter Notebook), *Assignment2.py*.

The plot in the next page shows the solution for 2 different guesses of $\frac{dy}{dt}(t = 0)$ and optimal solution. It can be found in the submission folder with the name *Freefall_Guess.jpg*, *Freefall_optimal.jpg*

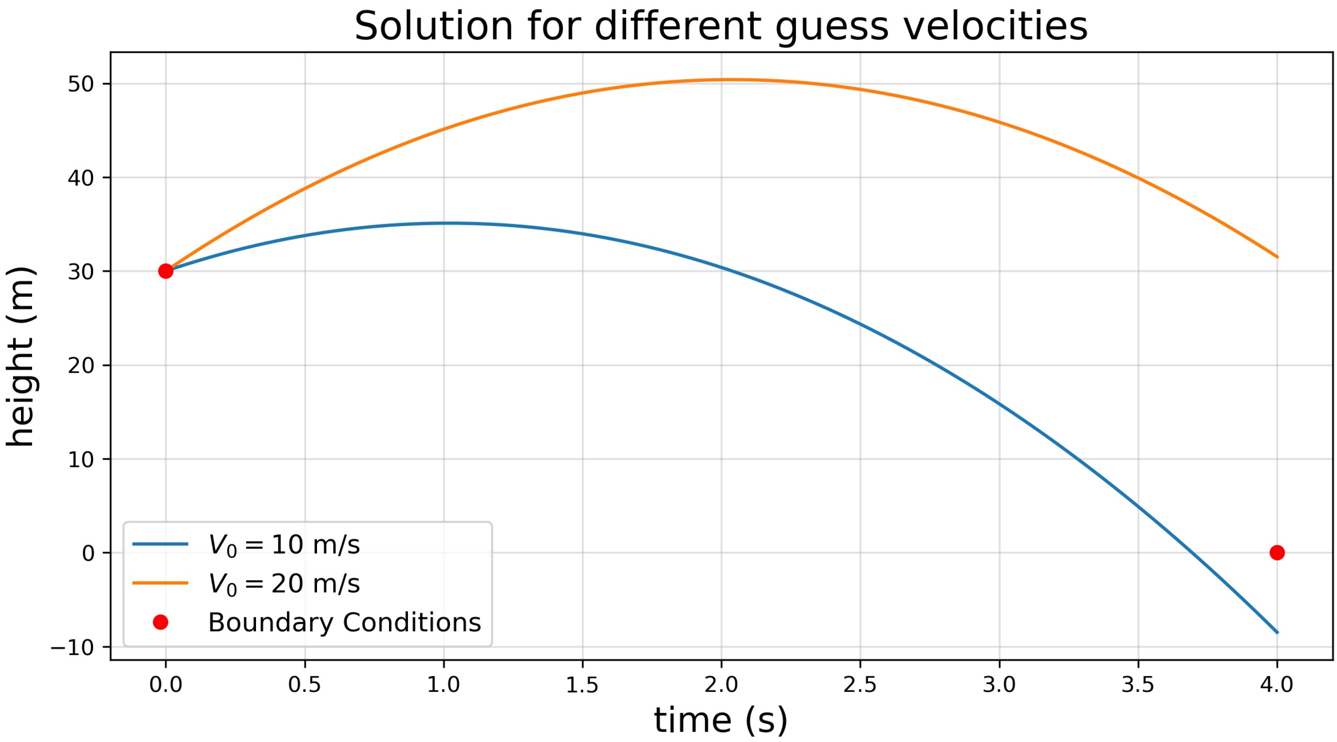

Figure 1: $y(t)$ for different guess

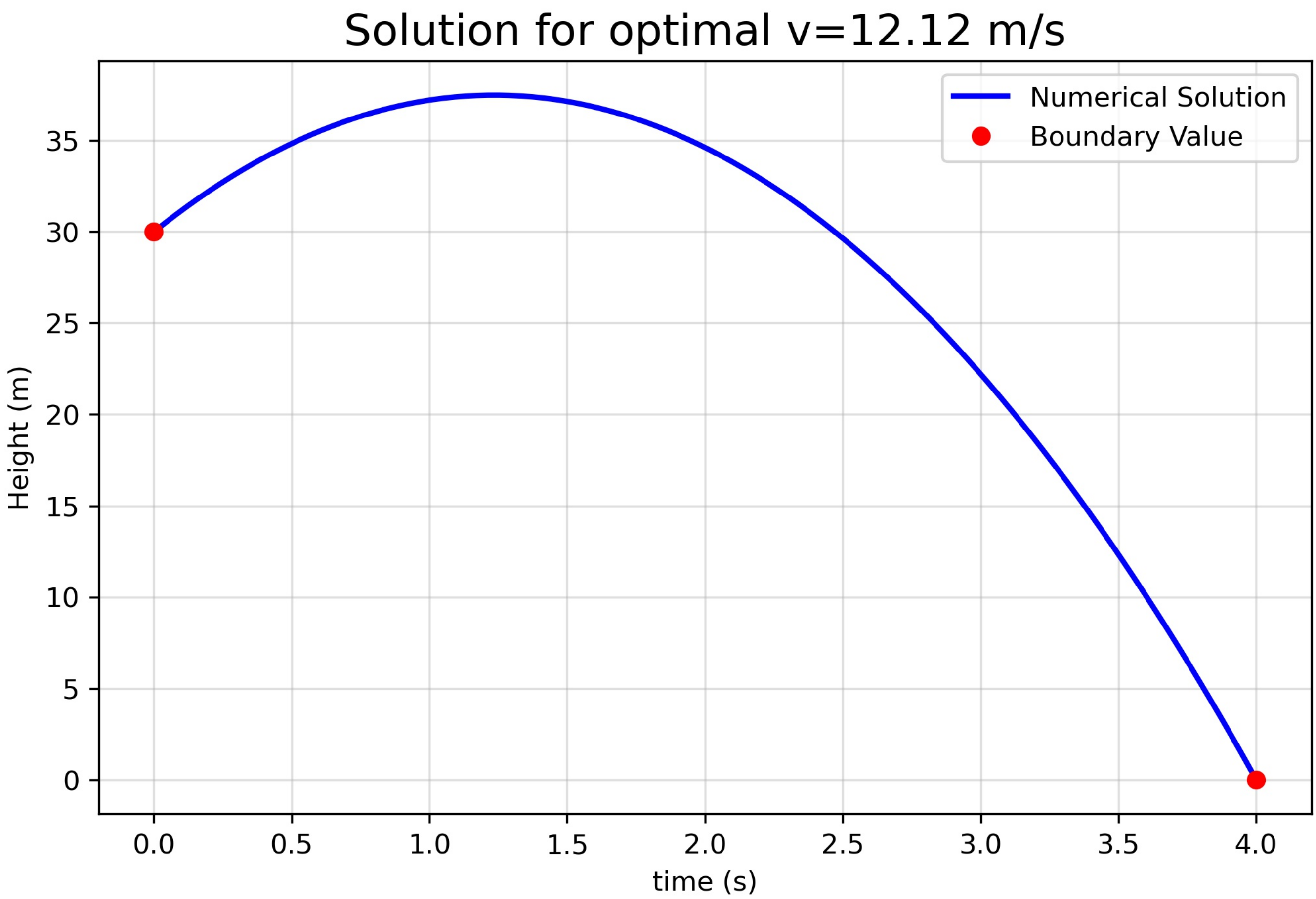

Figure 2: $y(t)$ for optimal $y'(t = 0)$