Repository Notes

Mauricio Sevilla[1]

[1] Email: jmsevillam@unal.edu.co

November 10, 2018

This is done to understand better the codes on this repository.

2nd Order Differential Equations

At some point it gets necessary to use higher order differential equations, specially on physics it is extremely important to solve second order ordinary differential equations (ODE)

$$\frac{d^2x(t)}{dt^2} = f(x(t), x'(t), t), \tag{1}$$

where $x'(t)$ denotes the first derivative of $x(t)$ respect to t.

To solve this numerically, we cannot use the same strategy used for the first order, because we have to know the first derivative, which not always happen. To solve this, we can use the fact that one second order differential equation can be decomposed on two first order coupled EDO,

$$\frac{dv(t)}{dt} = f(x(t), v(t), t), \tag{2a}$$

$$\frac{dx}{dt} = v \tag{2b}$$

So, now each can be solved as the before.

NOTE: This have to be done carefully, because as the two equations are coupled, they have to be solved simultaneously[2]

As the two of them have to be solved simultaneously, some questions arise, for instance, the computer only can perform one numeric operation at a time[3], which operations should we do first?, the order is important?, there is any physical consideration that can help us to solve those questions?. The answer to the last question es *yes*, so, on the road we'll point out which physical considerations we are taken in order to choose the method.

[2] This can be proofed easily, and it totally worth it as an exercise.

[3] This can be different when paralleling, I hope that we can discuss this part further on the notes.