Repository Notes

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

1st Order Differential Equations

The first problem we are working on, is the mos simple differential equation we can have, in general is like follows

$$\frac{dx(t)}{dt} = f(x(t), t) \tag{1}$$

to solve this numerically, we have to approximate at some point, to do so, we consider

$$x(t) = x(t_0) + \frac{dx}{dt}\bigg|_{t=t_0} (t - t_0) + \frac{1}{2} + \frac{d^2x}{dt^2}\bigg|_{t=t_0} (t - t_0)^2 + \cdots \tag{2a}$$

so if we take the interval of integration to be small $(t - t_0 = \Delta t)$[2]

$$x(t) = x(t_0) + \Delta t f(x(t), t) \tag{2b}$$

[2] We are taking this consideration in order to get an application that can be used easily as a first example.

Nuclear Decay

There is a immediate application of this, and that is a nuclear decay model, this can me thought on two different ways, the first one, looking up the number of atoms that haven't decayed or looking at the probability of decay, the difference is a normalization constant. If we take N as the number of radioactive nuclei on a sample they follow the differential equation

$$\frac{dN}{dt} = -\frac{1}{\tau} N \tag{3}$$

where τ is called the *Mean lifetime* of the nuclei. The analytical solution for this is an exponentially decaying function

$$N(t) = N(t_0) \exp\left(-\frac{t}{\tau}\right) \tag{4}$$

Note: When working with codes, it is necessary to have some way to test it, in our case this model is the battle horse.