Imperial College London

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Training coursework 2

Algorithmic implementation of the deterministic Euler method

Although the Runge-Kutta numerical integration method (used by `ode45`) is most useful in practice, you will now implement the simplest algorithm to obtain the numerical solution of discrete-time equations: *Euler's method*. Euler-type algorithms must be used when computing the numerical solution of stochastic differential equations, which we will see later in the Training Coursework 3.

Write a short Matlab code to implement Euler's method and solve numerically for $t \in [0, 10]$ the recursive equation:

$$x(t+h) = x(t) + h\,[-k\,x(t)] \tag{1}$$

with $k = 0.25$, $h = 0.01$ and initial condition $x(0) = 5$.

1. Plot the numerical solution and the analytical solution[1]. Calculate the mean squared error of the numerical solution.
2. Repeat the numerical calculation with $h = 0.001$ and calculate the mean squared error. Explain the differences for both values of h.

> In this coursework you may need to use the following Matlab commands: `function`, `plot`, `hold`. You can check the Matlab help by using `help COMMAND`.

[1]By analytical solution, we mean here the analytical solution of the corresponding continuous-time Ordinary Differential Equation, i.e. the analytical solution of $\dot{x} = -kx$.