1.3 Integration time step

(Video 1.3) We have made some simulations of the neuron using various inputs. We can make a small sidestep to ensure our simulation is precise enough. Let us test the influence of the integration time step by looking at the excitatory conductance g_e. The analytical solution of the differential equation of g_e, assuming $g_\mathrm{e} = 1$ at t=0, is

$$g_\mathrm{e}(t) = e^{\frac{-t}{\tau_\mathrm{e}}}. \tag{1}$$

Plot the analytical solution in a graph. Now integrate the equation by using the Euler method, assuming

$$g_\mathrm{e} \rightarrow g_\mathrm{e} + 1, \tag{2}$$

at t=0. This corresponds to the response to a single input spike at t=0, and a synaptic weight of 1. In the same graph, let us plot g_e obtained from the Euler integration, in a different colour. While keeping a fixed simulation time step of 1 ms, you can try an integration step of 0.001 ms, 0.01 ms, 0.1 ms, and 1 ms. Finally, select the optimal time step based on accuracy and computation time. Do not forget to zoom in closely to the curve in your figure to observe smaller inaccuracies.

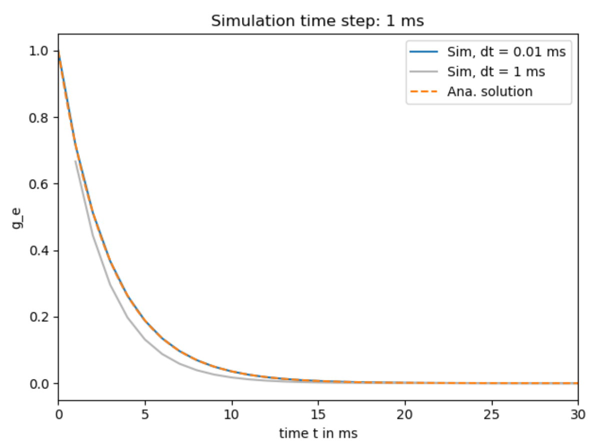

Figure 1: When testing the accuracy of the simulation with different integration time steps, the accuracy is high when the exact solution and the simulation yield a highly similar or identical result, as visualised here by the integration time step of 0.01 ms (blue). On the other hand, an integration time step of 1 ms is highly inaccurate (grey).