Description of the tutorial

Computational models of neuro-glia interactions are an important tool for researchers studying different levels of the central nervous system; from network level to single cell and sub-cellular. Astrocytes are the most abundant glial cell in the brain and in many brain regions, they come in close proximity to synapses and provide supporting roles like homeostasis. The tripartite synapse is a recent concept that acknowledges both the close proximity and the important contribution of astrocytes to neuronal synapses. The tripartite synapse is currently too small a region for experimentalists to probe, therefore, computational models of the tripartite synapse can provide an insight, and possibly predictions, into the signalling dynamics between astrocytes and neurons at the point of information transfer between neurons.

In this tutorial, we will construct a neuron-astrocyte model of ionic homeostasis (ionostasis) at the tripartite synapse, using the MATLAB language. First, the popular Hodgkin-Huxley action potential model will be solved using MATLAB's built-in ODE solver. Then, an astrocyte model will be constructed and solved using Euler's method. The full model will be simulated and results plotted to show the neuron-astrocyte interactions during neuronal activity.

By the end of the tutorial, participants will be familiar with some computational modelling techniques and will leave with a working model of astrocytic ionostasis at the tripartite synapse.

Software

MATLAB

Expected knowledge

Some familiarity with ordinary differential equations (ODEs) and solving systems of ODEs.

Some familiarity with MATLAB and how to use the built-in ODE solver.

References & Background reading

For information on how to format the equations for the MATLAB ODE solver, see https://uk.mathworks.com/help/matlab/math/choose-an-ode-solver.html

For examples of the ODE solver being used to solve different ODEs, see https://uk.mathworks.com/help/matlab/examples.html?category=ordinary-differential-equations

Slides/Code

Code and slides: https://github.com/MarinusToman/CNS_2022_Tutorial