Introductory Lab

ISRC-CN^3 Lab - Day 1

1. A spiking neuron (Dayan & Abbot, 2001) can be described using the following:

$$dV/dt = (-gL\ (V - vR) + I) / C$$

where dV/dt is the change in voltage over time, gL is the leak conductance, V is the membrane potential, vR is the resting membrane potential, I is the injected current, and C is the membrane capacitance.

You have been provided with a class called neuron which you will use to instantiate a object/neuron. The class contains some functions (methods) that allow us to model a spiking neuron and see the impact different currents can have. The class also contains some parameters (properties) for a single neuron i.e. leak conductance (represents how much the negative charge happens to spill out of the cell if not at its resting voltage), resting membrane potential (is the voltage across the membrane of the neuron, hovers around some characteristic value based on neuron to neuron, typically -60mV), spike threshold (the minimum voltage needed to create a spike) and capacitance (amount of charge that a membrane can hold).

Using the code provided, complete the following:

i) Run and observe at what point the injected current causes the neuron to produce a spike?

ii) Can you change the voltage threshold required for a neuron to produce a spike, at lower or higher currents?

iii) Can you extend the current injection plot up to 2.5nA?

iv) If you extend it with a greater current injection, can you see if according to the equation that the neuron can or cannot spike any faster? Why?

References

- Dayan, P., & Abbot, L. F. (2001). Theoretical Neuroscience. In *Theorectical Neuroscience* (pp. 162–165). MIT Press.