CNS2025: Homework 6

Due: 2025-10-15 23:59

Consider the FitzHugh–Nagumo model

$$\frac{dv}{dt} = v - \frac{v^3}{3} - w + RI_{\text{ext}}$$
$$\tau\frac{dw}{dt} = v + a - bw$$

as described in the lecture and implemented in code06.ipynb. With the given parameter values, the neuron fires spikes periodically when the parameter a is set to 0.5 and will become quiet when the the it is set to $a = 0.66$.

```
mr = 5       # Membrane resistance
ie = 0       # External current
fa = 0.66    # Parameter a
fb = 0.5     # Parameter b
tw = 10      # Slow time scale
```

Exercise 1

Calculate and plot the firing rate of the neuron for a values from 0.55 to 0.7 in 0.01 increments (`a_values = np.arange(.55,.71,.01)`), using the integration time step $\Delta t = 0.1$. What is the threshold of $a = a_{\text{th}}$ to stop the periodic firing of the neuron? Run simulations for at least 10000 time units after warming up for 300 time units for a good accuracy.

Exercise 2

Repeat the above calculation and plot using $\Delta t = 1$ as the integration time step. How are the results different from the previous?

Exercise 3

Repeat the calculation of Exercise 2 using Runge–Kutta integrator (use `itg=runge_kutta` when running `get_traces`). How does it differ from previous results?
