CNS2025: Homework 7

Due: 2025-10-22 23:59

Exercise 1

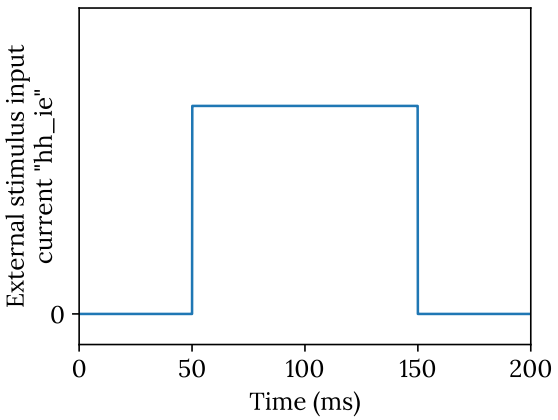
The the code in `code07.ipynb` uses `euler_step_ABi()` which requires `A=hh_A` and `B=hh_B` to integrate the Hodgkin–Huxley model. Similar calculations can be performed with `euler_step_exp()` which requires setting `yinf` and `tau` to `hh_yinf` and `hh_tau` respectively. The functions `hh_yinf(t,y)` and `hh_tau(t,y)` are not provided in the code file `code07.ipynb`. Please refer to the lecture slides and complete the two functions. Get the input current and protocol parameters from the file `hw07-data.npz` with, e.g., the code below:

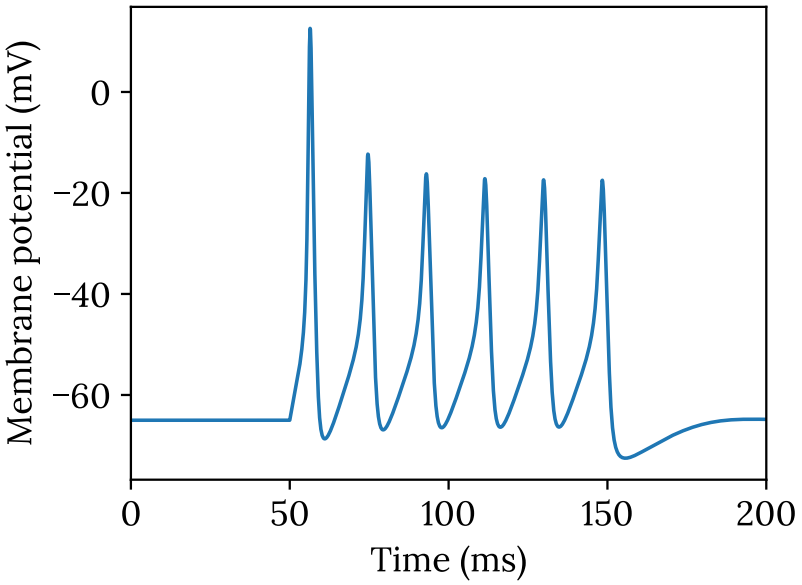
```
with np.load('hw07-data.npz',allow_pickle=True) as f:
    ii = f['ii']
    dt = f['dt'][()]
    y0 = f['y0']
nt = len(ii)-1
T = dt*nt
ie = lambda t:ii[int(t/dt)]
ts = np.arange(nt)*dt
```

Perform exponential Euler integration using the `euler_step_exp()` function with the current and parameters from the file and plot the resulting membrane potential. You can check your results by comparing to what you can get from `euler_step_ABi()` on the same input.

Exercise 2

Drive the same Hodgkin–Huxley model with a square current pulse of 100 ms from $t = 50$ ms to $t = 150$ ms. Simulate the system for 200 ms. The current is zero for both before $t = 50$ ms and after $t = 150$ ms (as shown to the right). And, the current stays at a constant amplitude during the pulse duration. Adjust your pulse current amplitude so that the model produces six action potentials similar to the following plot





What is the value of this pulse current amplitude?

Exercise 3

Install `Brian2` in your `jupyter` environment. Download and run the code `b2test.ipynb` to check the installation. Save the final plot as an image to a file. Attach the image to a markdown cell of your homework. (You can drag an image file to a being-edited markdown cell in `jupyter-lab`.)
