1 Testing Izhikevich Model

Testing dynamics of one neuron with parameters and external input currents as described in the manuscript.

The Izhikevich model [1]:

$$\frac{dv}{dt} = \left[0.04v^2 + 5v + 140 - u\right] \cdot 0.05 + I + I_{syn} \tag{1}$$

$$\frac{du}{dt} = [a(bv - u)] \cdot 0.05 \tag{2}$$

where v is the membrane potential, u is the recovery variable, I is the external current to the neuron, I_{syn} is the synaptic current driven by the spikes of the presynaptic neurons. a is the time scale of the recovery variable u, b is the sensitivity of the recovery variable to sub-threshold fluctuations of the membrane potential, c is the reset value of the membrane potential after spike, d is the effect of slow K^+ and Na^+ conductances on the membrane potential recovery (u is increased by this amount after each spike), v_{thr} is the voltage threshold for spikes.

External input current is provided separately for each neuron and is given by:

$$I = I_0 + \sigma \cdot N(0, 1) \tag{3}$$

where I_0 is the mean intrinsic current, σ is the scale for the noise level, and $N(0, 1)$ is the standard normal distribution with mean 0 and variance 1.

For R5 cells the external input current I is reset after each spike. For helicon cells, I is reset at each time step of the simulation ($dt = 1ms$).

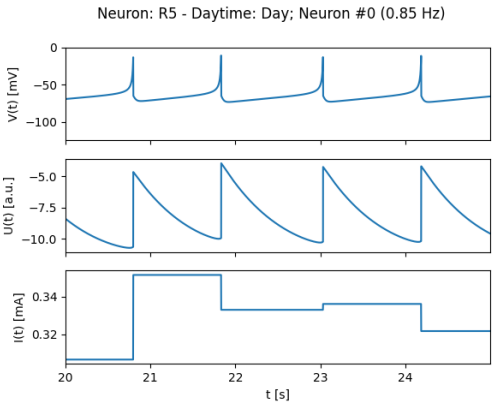
	a	b	c	d	I_0	σ	v_{thr}
R5 during day	0.02	0.2	-65	6	0.34	0.02	-10
R5 at night	0.02	0.3	-50	1.6	0.3	0.08	-10
Helicon during the day	0.02	0.2	-65	6	4.5	5	-10
Helicon during night	0.02	0.2	-65	6	-0.75	5	-10

Table 1: Parameters of the Izhikevich model for R5 and Helicon cells at morning and night

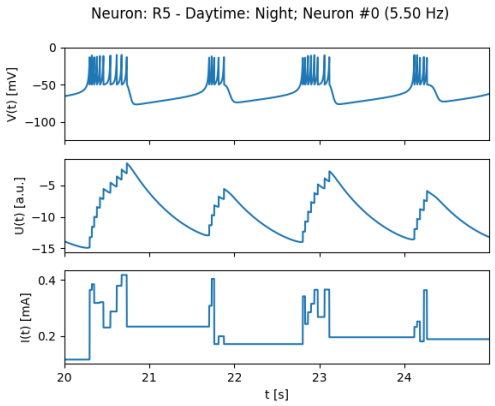
The results of the simulations are displayed in Fig. 1.

Remark 1. For the simulations, the standard deviation was normalized with regard to the simulation step size ONLY for helicon cells (see Remark 1 in the extended report).

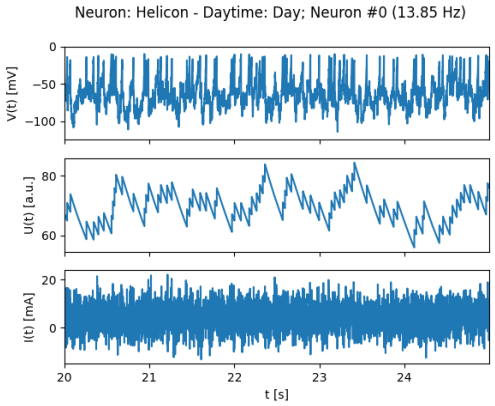
Note 1.



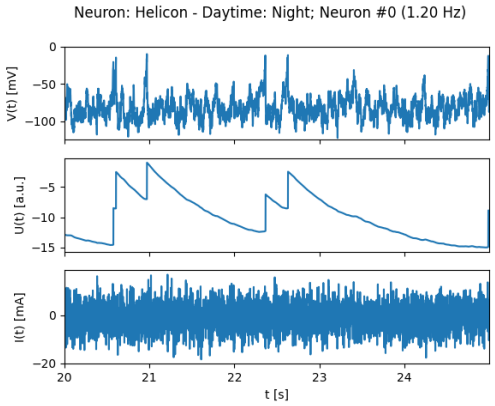
(a) R5 during the day



(b) R5 at night



(c) Helicon during the day



(d) Helicon at night

Figure 1: Comparison of R5 and Helicon at different times of day