Neuroprothetik Exercise 2

Aleksandra Teska

12. May 2018

1 Plot slope fields and isocline

The goal of this exercise was to plot the slope fields for $t \in [5, 5]s$ and $V \in [5, 5]V$ as well as the isocline for (-2, -1, 0, 1, 2) $\frac{V}{s}$, for the following differential equations.

$$\frac{dV}{dt} = 1 - V - t \tag{1}$$

$$\frac{dV}{dt} = \sin(t) - \frac{1}{1.5}V \tag{2}$$

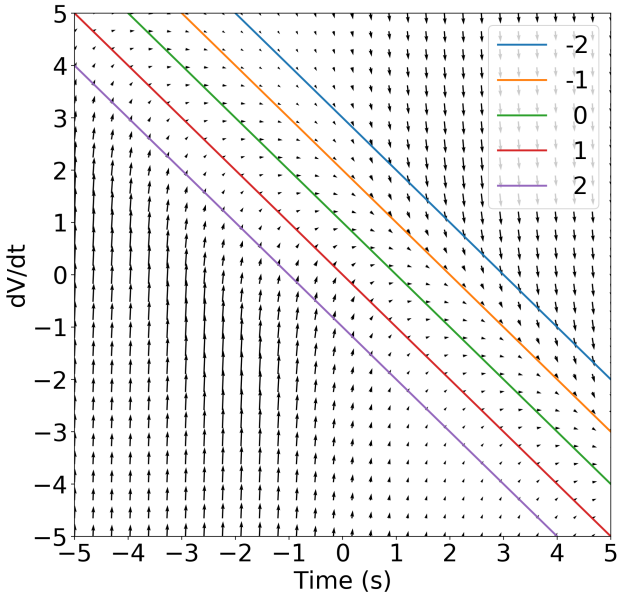

Figure 1: Slope field and isoclines for equation (1)

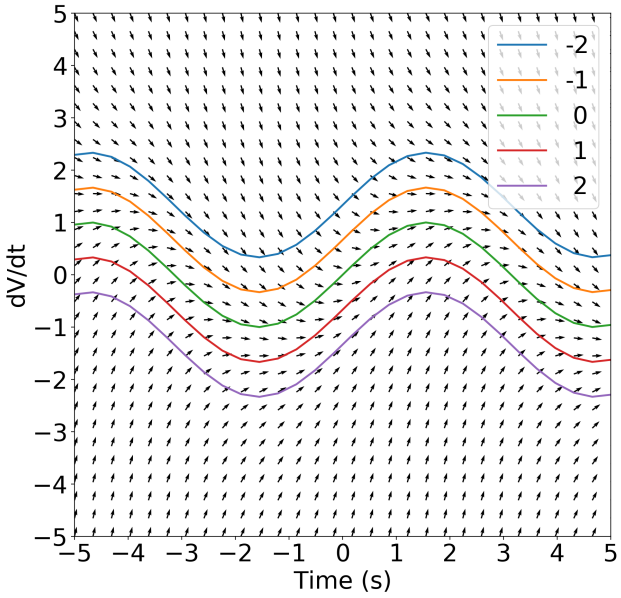

Figure 2: Slope field and isoclines for equation (2)

2 Differential equations of a simple cell model

Derivation of the differential equation for the following equivalent circuit of a leaky integrate and fire neuron. Following implementation was used to solve the exercise:

```
I_calD = lambda t, Imax: Imax * np.sin(t) + D
ode_rhs_cell = lambda V, I: (-V + R * I)/ R * C
```

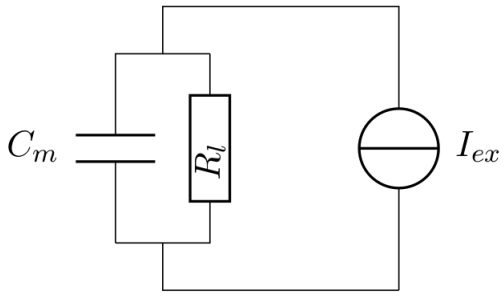

Figure 3: Equivalent circuit of a leaky integrate and fire neuron

$$I_{max} = I_{ex} \sin(t) \tag{3}$$

2.1 Plot the slope field

Plots of the slope field for:

- $R_l = 1\ \Omega$; C=1 F; I_{max}=0 A
- $R_l = 1\ \Omega$; C=1 F; I_{max}=1 A

Add another constant term D=2 A to the differential equation and plot:

- $R_l = 1\ \Omega$; C=1 F; I_{max}=0 A
- $R_l = 1\ \Omega$; C=1 F; I_{max}=1 A

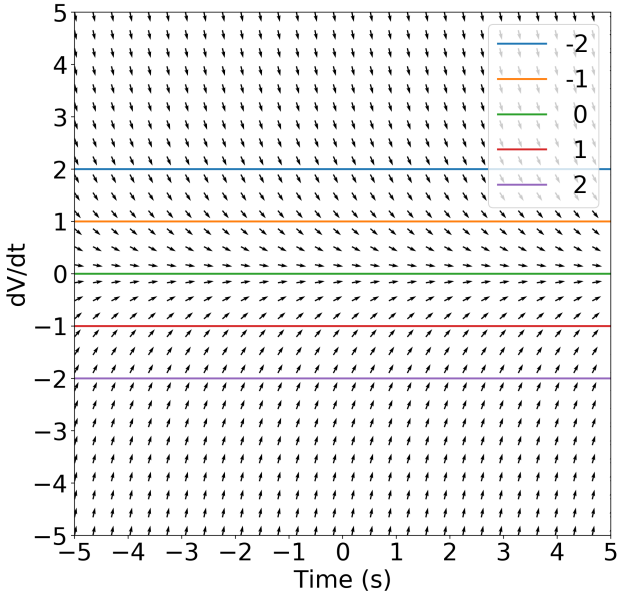

Figure 4: Slope field and isoclines for simple cell model, $R_l = 1\ \Omega$; C=1 F; I_{max}=0 A

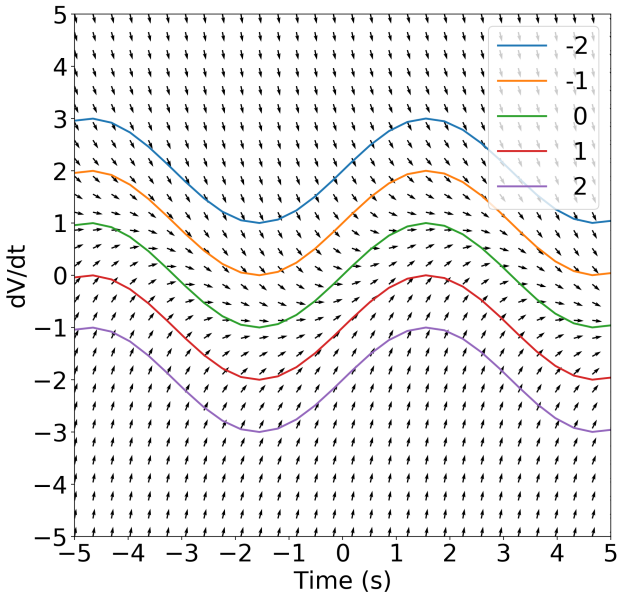

Figure 5: Slope field and isoclines for simple cell model, $R_l = 1\ \Omega$; C=1 F; I_{max}=1 A

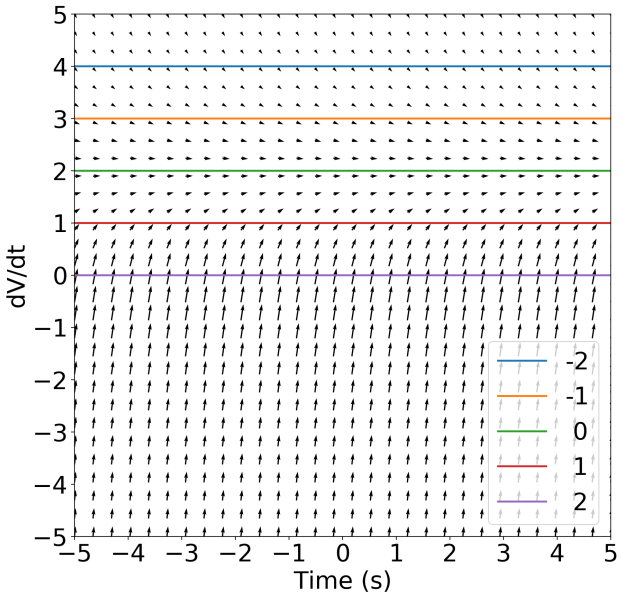

Figure 6: Slope field and isoclines for simple cell model, $R_l = 1\ \Omega$; C=1 F; I_{max}=0 A, D=2A

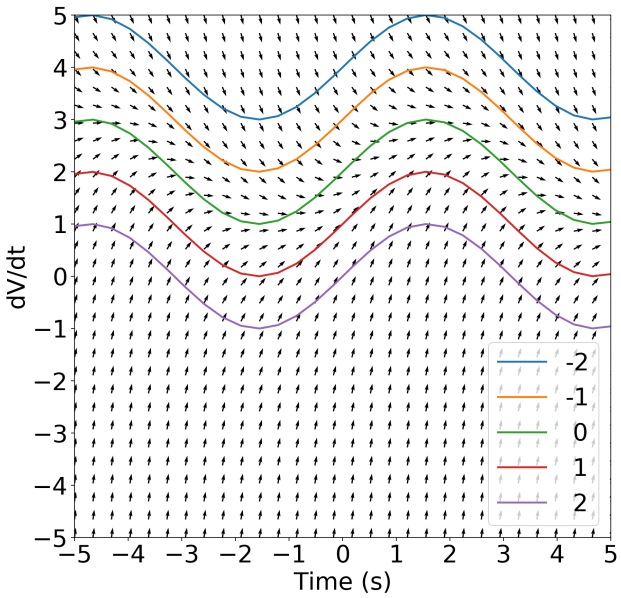

Figure 7: Slope field and isoclines for simple cell model, $R_l = 1\ \Omega$; C=1 F; I_{max}=1 A, D=2A