 Nir Getter, Aviv Dotan, Daniel Polyakov

# Exercise 1 – intra-cellular recordings in a current-clamped cell – submission until 31/3/2020

- You are given 2 mat files to be loaded by your MATLAB script:
  - When loading the files, you should see 2 vectors (**`S1, S2`**) in your workspace.
  - Another option is to use the MATLAB **`whos`** command to see the workspace variables and their dimensions.
- The given vectors are a product of intra cellular recordings performed *in vitro*:
  - The stimulus protocol in the experiment was a sequence of current steps ("0→dc step→0") for duration of 200 mSec repeated every 300 mSec with an increasing current step from segment to segment.
  - The recordings measure the membrane potential (in mV) as a function of the experiment time with a sampling rate of 10 KHz.

### *Coding requirements*

- Please use the suggested variable names whenever given (in brackets)
  - Note, that all mentioned variables are vectors.
- Write a "generic code", i.e., the code should process a chosen recording (**`Si`**) and the actual choice means a simple setting at the beginning of the code, e.g.:

```
load ('S1');
load ('S2');
% change the following line to Si = S2 to process the 2nd vector
Si = S1; % the remaining of the code processes Si
```

## 1. Qualitative observation of the given signals

- *Methodological remark*: this guidelines section is designed for the environment preparation and mind setup on the targeted data analysis. Whenever you encounter a new experimental dataset the first important action is to observe and understand the nature of it. In the submitted solution, you are not asked to address this section.
- Use the sampling rate to prepare a corresponding time vector, e.g.:

```
fs = 10000;       % sampling rate
dt = 1/fs;        % time step
N = length (Si); % number of components in Si
t = dt*(1:N);     % time vector
```

- Use **`plot(t,Si)`** to view the signals.
- Make sure you understand the events of start/stop times of the repeated current steps.
- Bonus: find the "unexpected" segments in each of the recordings and suggest an explanation for it.

## 2. Finding the spike times

- *Methodological remark*: this algorithm is explored step by step in the lesson slides.
- Choose a voltage threshold and create a binary "above threshold" signal (**`SaTH`**).
- Use **`diff(SaTH)`** to mark the state changes of **`SaTH.`**
- Use **`find`** on the resulting vector to detect "threshold crossing events":
  - "low to high" (**`L2H`**) events are the positions of 1
  - "high to low" (**`H2L`**) events are the positions of -1
- Find "Local maxima" (**`LM`**) between consecutive events of **`L2H`** and **`H2L.`** Use the **`max()`** function

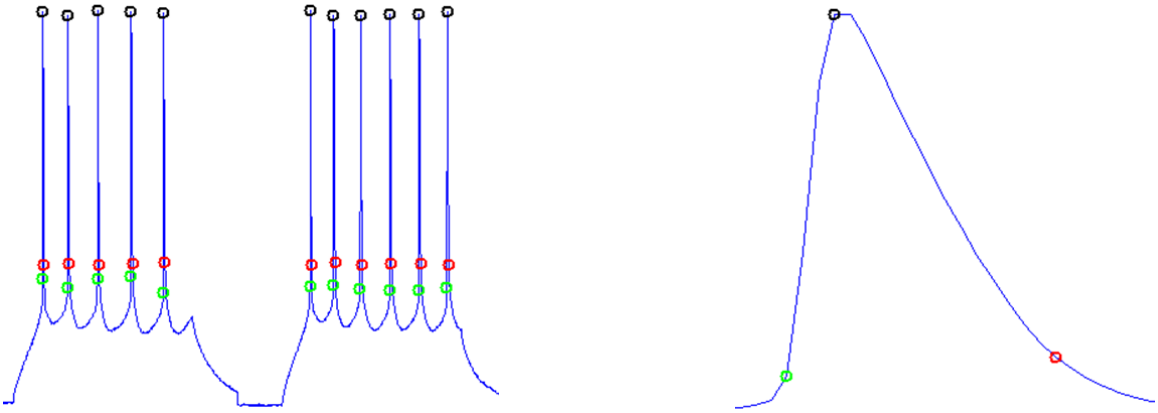
## 3. Finding the spike rate per segment

- *Methodological remark*: the pros and cons of each different methods for the rate calculations is discussed in the lesson slides. The slides also discuss the way to evaluate rate measurement error. In this assignment we will focus on only one method.
- For convenience use **`LM`** as the spike times for such calculations (without getting into the debate where the exact spike time should be measured).
- Count the spike events (**`SC`**) per dc step segment.
  - Note, that the exact position of the 200 mSec window of DC current inside the 300 mSec from segment to segment changes between the 2 recordings.
  - Nevertheless, this note should not influence your calculations, which should split the spikes according to the 300 mSec cycle.
- Translate into rate (**`R`**) in spikes/sec, by dividing the spike count by the duration of the current step (200 mSec)

## 4. Exercise deliverables

- The deliverable should follow the instructions given to you in the file 'MATLAB and Neural Data Analysis - Homework Instructions', and should include 2 files:

1. The MATLAB code you used, the file's name should be "EX1_ID1_ID2.m" (replace with your IDs). For each signal (S1 and S2) a figure should pop-up as specified below. Display the processed signal in a figure with the following objects:
   - The voltage signal as a function of time.
   - The detected events (**`L2H, LM, H2L`**) as markers on the signal – see example



- At each current segment (on top of the figure) write the firing rate.
  - Use the **`text`** command.
  - Use the **`num2str`** command to convert numerical variables into text.

2. A report of your work, as described in the instructions file. The file should be a PDF, and its name should be "EX1_ID1_ID2.pdf".