

### Summary of example:

The input data file (ca3\_pc\_v2\_4.csv) contains 4 voltage traces, corresponding to the responses of a CA3 pyramidal neuron to current steps of different amplitudes. The traces are 1100 ms long, the step starts at 100ms and lasts for 900 ms. The amplitudes are the following:

0.30 nA

0.35 nA

0.40 nA

0.45 nA

The sampling frequency was 5 kHz.

The model to be optimized is an adaptive exponential integrate-and-fire (AdExpIF) neuron. The model is implemented using the Python interface to the NEST simulator (see teststeps\_optim5.py), and is handled as a black box by Optimizer. Specifically, the following 10 parameters are the subject of optimization, and are passed to the Python script (along with an extra parameter corresponding to the index of the stimulus) through the file "params.param":

g\_L

tau\_m

E\_L

t\_ref

V\_reset

V\_th

a

b

delta

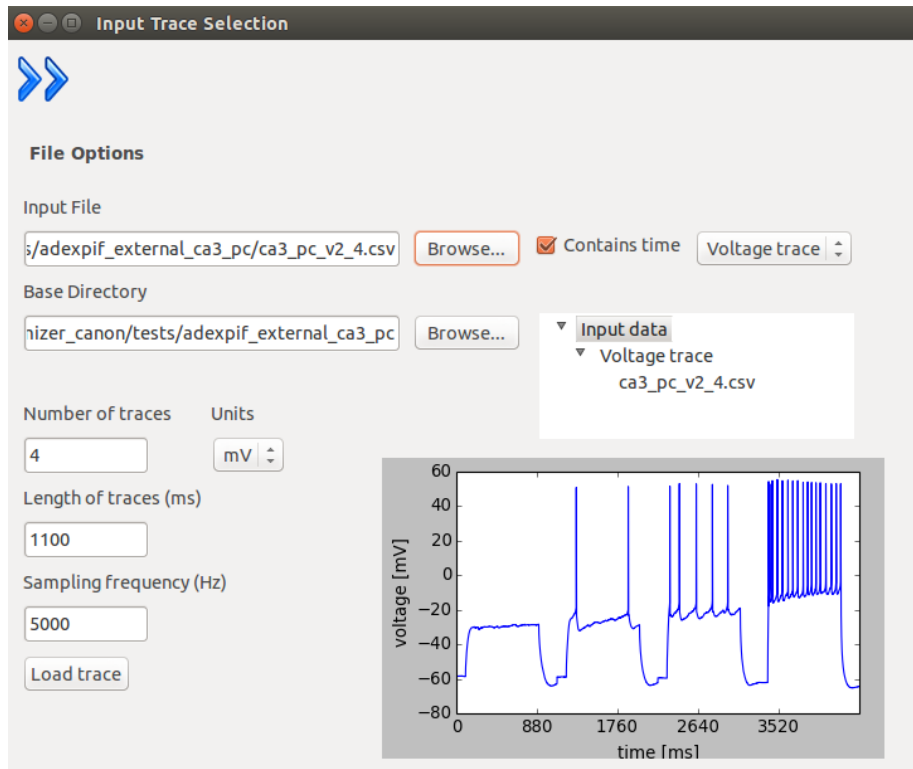
tau\_w

Some additional parameters ( $C_m$  and  $V_{peak}$ ) of the model are calculated from these parameters in the Python script.

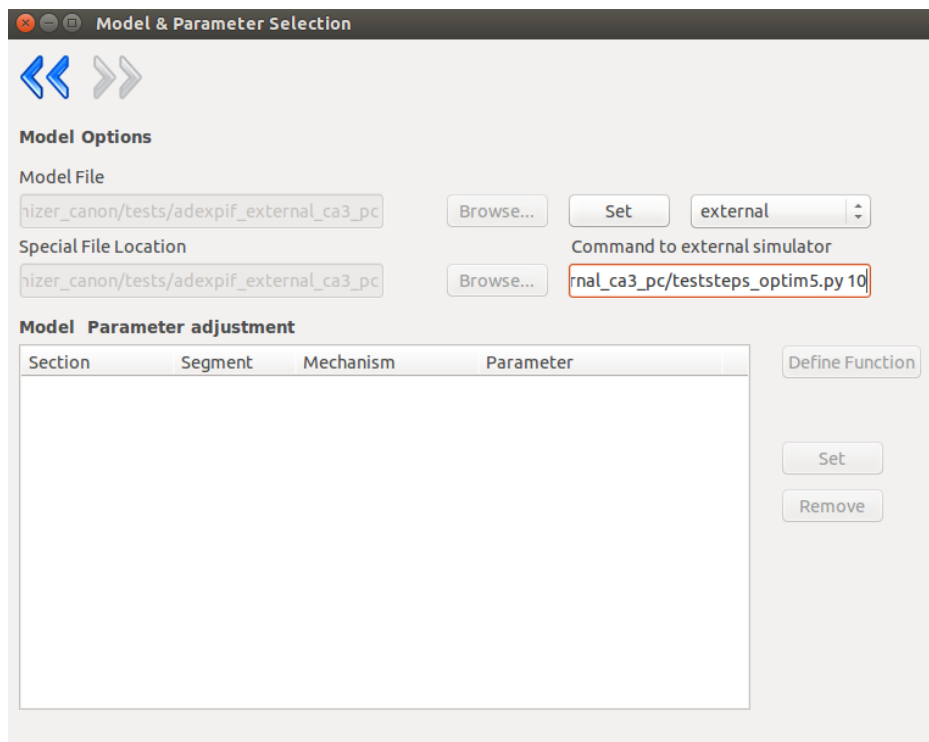
The model script saves the results of the simulation in the files trace.dat (containing the voltage trace) and spike.dat (containing explicit spike times from the same run), which are then used by Optimizer to compute the corresponding cost (fitness) value.

## Step-by-step instructions to run the example from the Optimizer GUI:

Run „python optimizer.py -g” to start the GUI



At 'Input File' load the target data, at 'Base Directory' choose the directory where you wan't to save the results. Fill out all the cells and press 'Load trace'. Go on by pressing the blue arrow.



For model type choose 'external'. To 'Command to external simulator' type:

"python /FULL/PATH/TO/MODEL/SCRIPT 10", where /FULL/PATH/TO/MODEL/SCRIPT points to the location of the Python script implementing the model

(for example: " python /home/parallels/Desktop/optimization/test/ca3\_pc\_v2\_1/teststeps\_optim5.py 10", where 10 is the number of parameters subject to optimization)

Press 'Set' and go on by pressing the right arrow.

The 'Select Fitness Function' dialog box features a title bar with standard window controls and three blue navigation arrows (left, center, right). It is divided into three main sections: 'Fitness Functions', 'Weights', and 'Function Parameters'. The 'Fitness Functions' section on the left contains a list of checkboxes: MSE, MSE (excl. spikes) (checked), Spike count, Spike count (stim.) (checked), ISI differences, Latency to 1st spike (checked), AP amplitude, AHP depth, AP width, Derivative difference, and PPTD. The 'Weights' section in the middle has input fields for each selected function, all containing the value '0.3333'. The 'Function Parameters' section on the right includes 'Spike Detection Thres. (mv)' (0.0), 'Spike Window (ms)' (1.0), and another 'Spike Detection Thres. (mv)' (0.0). A 'Normalize' button is located at the bottom center.

Choose fitness function(s), and define their weights. Go on by pressing the right arrow

The 'Select Algorithm' dialog box has a title bar with window controls and three blue navigation arrows. It is divided into 'Optimizer Settings' and parameter input fields. Under 'Optimizer Settings', there is a 'Random seed' field with '1234', an 'Algorithm' dropdown menu set to 'Classical EO', and two buttons: 'Boundaries' (highlighted with a red box) and 'Starting Points'. Below these is a 'Run' button. To the right, there are input fields for 'Size of Population' (200), 'Number of Generations' (200), and 'Mutation Rate' (0.25). At the bottom left, it states 'Number of parameters to optimize:10'.

Select an algorithm, and press the 'Boundaries' button to define the boundaries of the parameters to be optimized:

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Boundaries

parameter0	0.001	0.01
parameter1	10	100
parameter2	-70	-40
parameter3	-40	-10
parameter4	-40	-10
parameter5	0.5	5
parameter6	-5	5
parameter7	0	1
parameter8	0.5	5
parameter9	10	500

Save

Load

Set

Boundaries can be loaded from the file boundaries3.txt

Press 'Set'.

Start the optimization pressing the 'Run' button.