**MATLAB Application “Neuronal Signal Estimation”: Documentation**

*The application allows to upload the BOLD-signal and estimate the underlying neuronal activity signal. Application allows to filter the signal from the white noise and use three different methods for estimation the neuronal signal.*

**1. Import data**

For uploading data ***panel “Import data”*** should be used. Measured BOLD-signal and haemodynamic response function should be downloaded.

“Import data” button allows to download “.dat” file with the input signal. File should contains one time series which is supposed to be measured BOLD-signal.

“Import HRF” button should be used for loading the form of the haemodynamic response function. ***It is assumed that the sampling rate of input signal is equal to the sampling rate of HRF***.

The check box “Use default kernel” allows to use predefined haemodynamic response function which is saved in the file “Input/HRF/hrf.dat” (its sample rate is 2.5s).

***Technical details.***

“Import data” button: BOLD-signal is a numerical column vector Nx1 which is saved in “.dat” file.

“Import HRf” button: “.dat” file should contain the numerical column vector Mx1. It should be shorter than the input signal.

Data should be encoded in ASCII standard; as a decimal separator should be used dot (.), no digit grouping is assumed, leading negative sign (-) is used for negative numbers indication, optional leading sign (+) can be used for positive numbers indication.

The command *save(‘filename.dat’, ’variableName’, ‘-ascii’)* can be used for creating an appropriate file.

***Examples “Import data”.***

Two time series are saved in “Input/Time series/” as the examples of the input signal. The input signals are the BOLD-signals measured during subject was watching the movie. Each file contains the number of the corresponding movie in its name (121\_1 and 123\_1).

***Panel “Load”***. Also the panel “Load” can be used for importing earlier saved data and application settings. The button “Load input settings” load the input signal, haemodynamic response function and the spectrum (if needed).

The button “Load calculations” can be used for uploading calculations which were saved before.

***Examples “Load”.***

Two input settings collections and corresponding calculation collections are available as the example. It is located in “Input/Saved settings/Import settings” and “Input/Saved settings/Calculations”. ***The input settings should correspond to the loaded calculations!***

**2. Calculations**

After downloading the input data it is necessary to configure the panel “Calculations”. It contains 3 deconvolution methods and 2 possibilities for the signal (original and filtered). User should choose what deconvolution methods are interesting for him. Also user should specify if input signal should be filtered or not. After choosing the options button ***“Calculate”*** should be pressed. In case of changing any of previous information (importing another data, choosing another filtering option) the calculation should be repeated.

**3. Filtering of the signal**

The application allows to reduce white noise by filtering the input signal. Panel “Filtering of the signal” can be used for it. It contains three possibilities: to use the default spectrum, to use the input BOLD-signal for estimating the spectrum and to download user’s spectrum.

The default spectrum is generated using saved parameters (Input/Spectrum/defaultParameters.mat) and shape of uploaded kernel (HRf). Fitting the spectrum from the data uses the same approach as the previous option, but use the parameters obtained from the input signal. The option “Load user’s spectrum” allows to upload user’s power spectrum after pressing “Calculate” button. User’s spectrum should be the numerical non-negative column-vector which ***has the same dimension as the input signal.***

**4. Save**

The panel “Save” allows to save input settings, all calculations and estimated (deconvolved) signal. Saved data can be later used for uploading.

**5. The chart**

Input signal and estimate of neuronal signal are shown on chart in blue and red color respectively. BOLD-signal appears after uploading the data. Estimate of neuronal signal appears after choosing the deconvolution method on the panel “Deconvolution methods”. BOLD-signal can be filtered or not filtered depends on the option on panel “Signal Type”. BOLD-signal is rescaled after uploading to have range [0,1].

Chart title contains details about the estimated neuronal signal. It consists of the name of used deconvolution method, information whether input signal was filtered or original input signal was used, and the number of non-zero peaks in the estimate.

**6. Signal Type**

Panel “Signal Type” contains options for input signal. If ***“Original signal”*** option is chosen then the estimate will be shown for the not-filtered signal. If ***“Filtered signal”*** option is chosen then filtered signal will be shown and the estimate will be for the filtered signal.

**7. Deconvolution methods**

Panel “Deconvolution methods” is intended for working with different methods of neuronal signal estimation. Three methods are presented on the panel. Also it is possible to set the number of non-zeros peaks in the estimate using “Set number of peaks” check box. Then the application will choose the closest estimate to the needed condition.

**8. Movie**

Panel “Movie” can be used (optionally) for additional analysis of the signal. Movie can be imported and a few possibilities to use it are implemented.

Panel “***Import movie data”*** contains two possibilities to load frames from the movie. Collection of frames can be directly uploaded using the button ***“Import frames”***. The file should contain the cell-array named “frames”. Each cell should contains 3 2D numerical matrices describes pixels in the movie. Another possibility to load the movie information is to load the movie and exact frames from it. The button “***Import movie, exact frames***” should be used for it. The movie format should be “.mp4”. ***The procedure of exacting frames from the movie can take a lot of time.***

***Frames Rate.*** Rate of frames is needed for correct working with movie material. Frame rate should be set in seconds. Its default value is 2.5 seconds. It means that uploaded collection of frames should contains frames with timing 0s, 2.5s, 5s, 7.5s, so on. If movie is loaded then frames will be exacted with the specified frames rate.

***Sampling Rate.*** The sampling rate is used for building the correct correspondence between measured signal and collection of frames. It should be set in seconds and it should correspond to the loaded input data (BOLD-signal).

The panel ***“Show frames”*** is used for the analysis of the estimated neuronal signal.

***“Show the current frame”*** button shows the frame corresponds to the Data Cursor. ***“Show the current and the previous frame”*** button shows the frame corresponds to the Data Cursor and the previous one (according to the frames rate). ***“Show frames for the positive peaks”*** button shows the collection of frames corresponds to all positive peaks in current estimate of neuronal signal.

Panel ***“Show particular frame”*** allows to show the frame corresponds to the needed point in the signal (field “Point”) or to the time point in seconds (filed “Second”). Fields “Point” and “Second” are connected using sampling and frames rates, thus it is enough to change one of them.

Panel ***“Show frames for the period”*** allows to show frames from the period specified using fields “From” and “To” which should be specified in points as well as the measured signal.