

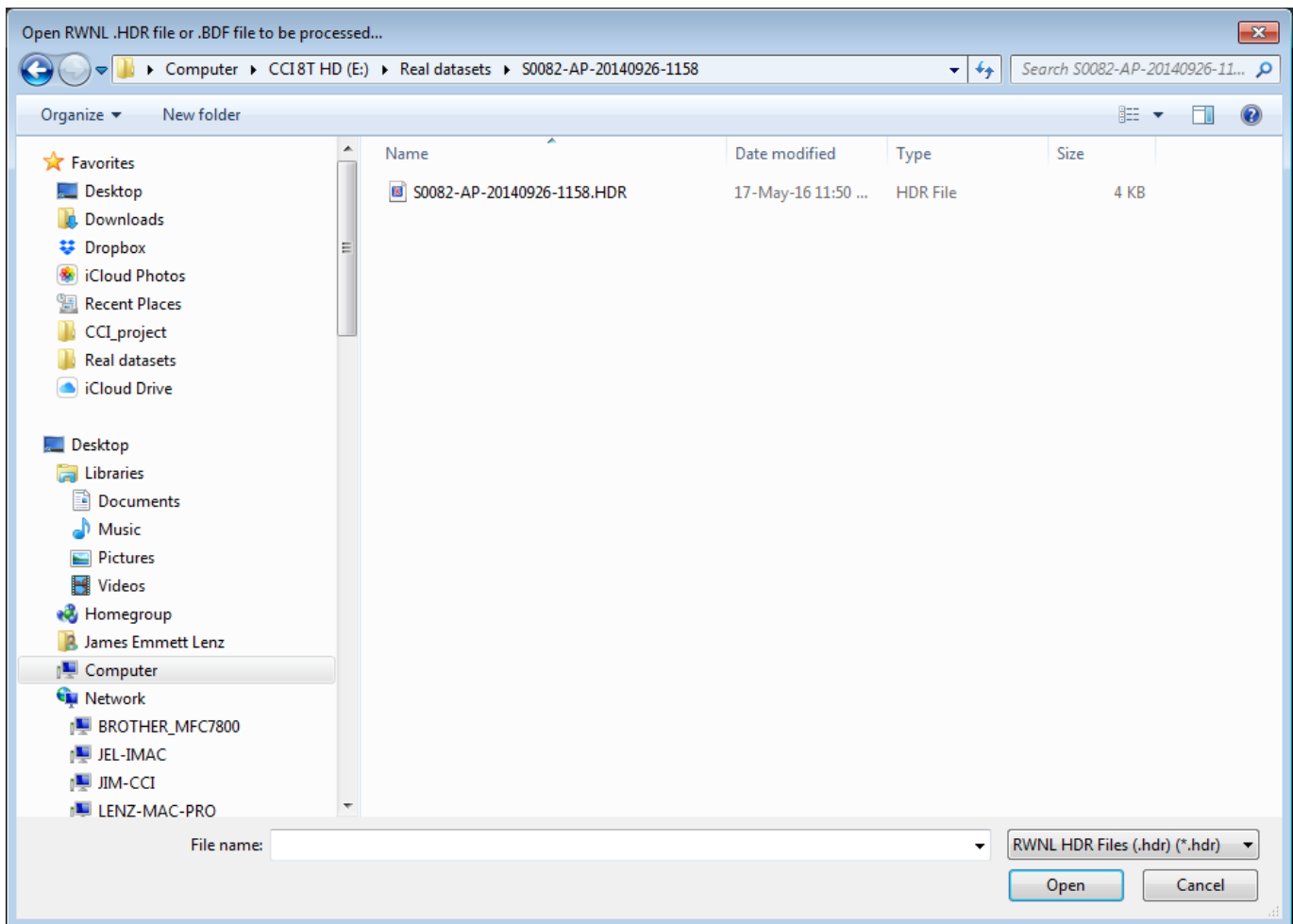
PreprocessDataset User Guide

Introduction

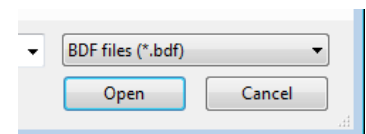
The PreprocessDataset (PD) application is intended to simplify and consolidate the early processing of physiological datasets acquired through the BioSemi system. The processing functions include simple channel selection and renaming, simple data decimation, global detrending of channel data, various referencing options, and IIR filtering of channel data. PD also can compute the surface Laplacian (SL) on interpolated (and smoothed) EEG data when electrode locations are known. PD accepts both RWNL complete datasets and “naked” BDF data. In the latter case, the SL calculation is unavailable since no electrode locations are available. [Future expansion information will be consistently shown in square brackets ([]) in the remainder of this document. PD will be expanded to accept exported EEGLAB datasets in the .SET (.MAT) format.]

Opening a dataset

To open an RWNL dataset, open its .HDR file using the file selection dialog.



To select a “naked” BDF file change the filter via the dropdown, and select a .BDF file.



Some assumptions are made about the form of the underlying BDF files. All EEG electrode channels should have a “Transducer type” of “Active Electrode” in the BDF header (called AE channels hereafter). If location data is available in the form of an .ETR (electrode) file in the RWNL dataset (i.e., not a “naked” BDF file), the electrode names in the .ETR file and the BDF header record must match, including capitalization. Those AE channels having a matching location are termed “EEG channels”. Note that some data acquisitions have non-EEG channels that are AE. These should be carefully considered, particularly when performing referencing functions (see below). In “naked” BDF datasets, all AE channels are assumed to be EEG channels (though without location, so SL can’t be performed) and thus non-EEG channels should be manually eliminated in the channel selection function.

The primary dialog box is then displayed. One sets the various parameters to describe the preprocessing functions to be performed, including setting the “File sequence” which is used to extend the dataset name. There is a warning if this results in a clash with another dataset, which is overwritten if one proceeds. One then clicks the “Process” button in the lower right corner. This button will only be enabled if all the various parameters are correctly and

consistently set. A progress dialog is displayed while processing is underway. If a RWNL dataset is being processed, a new, valid, RWN dataset is created and if a “naked” BDF file is processed, only a BDF file is created.

PreprocessDataset: E:\Real datasets\S0082-AP-20140926-1158

Input decimation factor Sampling frequency = 512.00

Select channels for processing

26 EEG channels selected out of 26

55 channels selected out of 55

☒ Exclude eliminated Active Electrode channels from reference calculations

☐ Global detrending

Detrending order <= 8

☐ Reference

☒ Selected channel(s)-> 32 channels

☐ Reference expression->

☐ Reference matrix file->

☐ Filtering

☐ Forward and reversed filtering for zero phase

Output decimation factor Sampling frequency = 512.00

☐ Laplacian

Head shape

☒ Fitted order=

☐ Sphere R = 10.000

Methodology

☒ Polyharmonic spline

Order=

Osculating polynomial degree=

Regularization factor=

☐ New Orleans method (Nunez)

Looseness of fit: lambda= cm

Output locations

☒ Current electrode locations

☐ Artificial array: nominal distance = cm => points

☐ Use electrode file:

Output

File sequence

E:\Real datasets\S0082-AP-20140926-1158\S0082-AP-20140926-1158.SurfLap

Decimation

PD performs N-decimation by including every N^{th} data point. No filtering or moving average is used. For this reason there are two types of decimation: decimation before any processing occurs and decimation that is performed after IIR filtering, but before SL. If N_1 -decimation is used in the first case and N_2 -decimation in the second, the final result will be $N_1 \times N_2$ -decimation in the final output. It is the user's responsibility to assure that aliasing around the Nyquist frequencies is controlled by appropriate filtering. Note that, in the first decimation, aliasing is controlled by the prefiltering of the signal by BioSemi data acquisition system and in the second by the IIR filtering performed in PD. Only integer decimation is allowed. The final output BDF file will have a record length with the same number of data points, but with an expended duration of $N_1 \times N_2 \times (\text{original record duration})$. This is usually $N_1 \times N_2$ seconds.

Channel selection

Channel selection (and renaming) is performed in a secondary dialog by clicking the "Select channels" button in the main dialog.

Channel Selection

Channel Summary		
	Total	Selected
ETR locations	32	
BDF channels	55	55
Active Electrodes (AE)	32	32
Located AE signals	26	26
Non-located AE	6	6
Non-AE	23	23

Sel	Num	Name	EEG	Type
<input checked="" type="checkbox"/>	1	FP1		Active Electrode
<input checked="" type="checkbox"/>	2	AF3		Active Electrode
<input checked="" type="checkbox"/>	3	F7		Active Electrode
<input checked="" type="checkbox"/>	4	F3		Active Electrode
<input checked="" type="checkbox"/>	5	FC1		Active Electrode
<input checked="" type="checkbox"/>	6	FC5		Active Electrode
<input checked="" type="checkbox"/>	7	T7		Active Electrode
<input checked="" type="checkbox"/>	8	C3		Active Electrode
<input checked="" type="checkbox"/>	9	CP1		Active Electrode
<input checked="" type="checkbox"/>	10	CP5		Active Electrode
<input checked="" type="checkbox"/>	11	P7		Active Electrode
<input checked="" type="checkbox"/>	12	P3		Active Electrode
<input checked="" type="checkbox"/>	13	PZ		Active Electrode
<input checked="" type="checkbox"/>	14	PO3		Active Electrode
<input checked="" type="checkbox"/>	15	O1		Active Electrode
<input checked="" type="checkbox"/>	16	OZ		Active Electrode
<input checked="" type="checkbox"/>	17	O2		Active Electrode
<input checked="" type="checkbox"/>	18	PO4		Active Electrode
<input checked="" type="checkbox"/>	19	P4		Active Electrode

Buttons: Select all, Select none, Select all AE, Select all Non-AE, Select all EEG, Cancel, Save and close

Here is an example of the selection dialog for an RWNL dataset. Note the summary of the number of channels available and the number selected. This is updated whenever changes are made. BDF channels are classified as AE, EEG, non-located AE, and non-AE. The number of available electrode locations is shown form reference.

Channels are selected for inclusion in further processing by using the checkbox in the first column. The BDF channel number is in the second column. The third column is initially the name of the channel in the underlying BDF file, but may be edited to change the name in the output record. Name change can also be used to match to a name in the .ETR file.

The fourth column indicates if the channel is currently considered an EEG (located AE) channel and thus can be used in any SL calculation.

The fifth column lists the channel transducer type as listed in the BDF header record.

The buttons under the channel list can be used to quickly select various subsets of channels.

Close the dialog by clicking "Save and close" to save any changes or by clicking "Cancel" to ignore any changes.

If one opens a "naked" BDF file, the channel selection is similar, but there are no "located AE" channels, so the EEG column is not displayed.

Select channels for processing

Select channels

26 EEG channels selected out of 26

55 channels selected out of 55

☒ Exclude eliminated Active Electrode channels from reference calculations

In the main dialog, there is a checkbox labeled "Exclude eliminated Active

Electrode channels from reference calculations”. This is checked by default. If referencing is performed, AE channels that are not selected are automatically eliminated from the referencing calculation. This is what is usually required, since these are often eliminated because of noise.

Here is an example of changes made in the previous channel selection dialog. Selection of all AE channels has been performed and all the “misnamed” BDF channels have been changed to match the .ETR file names (note again that capitalization counts!). We thus now have 32 selected channels, all of which are EEG (located AE) channels.

Channel Selection

Channel Summary		
	Total	Selected
ETR locations	32	
BDF channels	55	32
Active Electrodes (AE)	32	32
Located AE signals	32	32
Non-located AE	0	0
Non-AE	23	0

Sel	Num	Name	EEG	Type
<input checked="" type="checkbox"/>	1	Fp1	•	Active Electrode
<input checked="" type="checkbox"/>	2	AF3	•	Active Electrode
<input checked="" type="checkbox"/>	3	F7	•	Active Electrode
<input checked="" type="checkbox"/>	4	F3	•	Active Electrode
<input checked="" type="checkbox"/>	5	FC1	•	Active Electrode
<input checked="" type="checkbox"/>	6	FC5	•	Active Electrode
<input checked="" type="checkbox"/>	7	T7	•	Active Electrode
<input checked="" type="checkbox"/>	8	C3	•	Active Electrode
<input checked="" type="checkbox"/>	9	CP1	•	Active Electrode
<input checked="" type="checkbox"/>	10	CP5	•	Active Electrode
<input checked="" type="checkbox"/>	11	P7	•	Active Electrode
<input checked="" type="checkbox"/>	12	P3	•	Active Electrode
<input checked="" type="checkbox"/>	13	Pz	•	Active Electrode
<input checked="" type="checkbox"/>	14	PO3	•	Active Electrode
<input checked="" type="checkbox"/>	15	O1	•	Active Electrode
<input checked="" type="checkbox"/>	16	Oz	•	Active Electrode
<input checked="" type="checkbox"/>	17	O2	•	Active Electrode
<input checked="" type="checkbox"/>	18	PO4	•	Active Electrode
<input checked="" type="checkbox"/>	19	P4	•	Active Electrode

Buttons: Select all, Select none, Select all AE, Select all Non-AE, Select all EEG, Cancel, Save and close

Global detrending

This function eliminates long-term trends over the entire dataset for each selected AE channel. The trends are

☒ **Global detrending**

Detrending order ≤ 8

polynomials of the selected order. Thus, 0 implies removal of offsets only, 1 removes linear trends (and offsets), 2 is quadratic, etc. based on least-square curve fit of the entire dataset (after the first decimation).

Referencing

General referencing of the selected AE channels is performed using this section of the main dialog box. If all the

☒ **Reference**

☒ **Selected channel(s)->**

☐ **Reference expression->**

☐ **Reference matrix file->**

selected AE channels are to have the same reference, use the first selection. Common average reference would use (an average of) all the channels for the reference signal. The second option permits use of multiple reference signals. See other documents for further explanation. The third option is currently not implemented. [This option permits the use of a general matrix to form the reference signal for each channel individually based on a weighting of the other signals.] Note that if the “Exclude eliminated ...” option is selected, only selected channels will be used in the calculation of the reference.

IIR filtering

DP allows any of three classes of infinite impulse response (IIR) filters. These are Butterworth, Chebyshev II, and

☒ **Filtering**

☒ **Elliptical filter**

☒ **High pass** ☒ **Pass band freq** **Hz** ☐ **Stop band frequency** **Hz**

☐ **Low pass** ☒ **Pass band ripple** **%** ☒ **Stop band attenuation** **dB**

☒ **Number of poles** ●

☒ **Elliptical filter**

☐ **High pass** ☒ **Pass band freq** **Hz** ☐ **Stop band frequency** **Hz**

☒ **Low pass** ☒ **Pass band ripple** **%** ☒ **Stop band attenuation** **dB**

☒ **Number of poles** ●

☐ **Forward and reversed filtering for zero phase**

elliptic. Any number of high or low pass filters may be included and these are performed in series on the data channels. [Inverse filters are not currently available, so band stop filtering cannot be performed.] Thus, by combining two filters one may achieve a band-pass filter. Filters are added by clicking on the buttons at the bottom and individual filters can be removed by clicking the “X” button in the upper left corner of each filter panel.

The “Forward and ...” checkbox is selected when one wishes to perform both forward and reverse filtering of the data to achieve zero phase shift, but this results in an acausal filter.

The individual filters added each have a “design panel” in the list of filters. Once a correct set of parameters have been entered for a given filter, a green dot will appear in the lower right hand corner of the panel. Each filter type also has a radiobutton to select high or low pass design.

Elliptic filter

Here is the design panel for the elliptic filter. There are a set of 5 different parameters, but the filter design requires that only 4 to be set and the fifth calculated from those values. The 4 parameters are chosen by the checkboxes.

In this case, one selected “Pass band frequency”, “Pass band ripple”, “Number of poles”, and “Stop band attenuation” as the set parameters and this resulted in the “Stop band frequency” being calculated at 0.01Hz. One has chosen 0.05Hz for the pass band with a ripple (difference between highest and lowest amplitudes) of 0.5%. The stop band attenuation is a minimum of 40dB and the filter is designed with 3 poles.

Alternatively, one might wish to control the width of the transition band (between stop and pass bands). By selecting the “Stop band frequency” as a parameter, setting it to 0.03Hz and letting “Number of poles” be selected by the application, one sees that 5 poles achieves the design and results in an actual stop band attenuation of 45.7dB (calculated by the application), greater than the design (minimal) attenuation of 40dB.

Chebyshev II filter

Three of four parameters need to be specified for the Chebyshev filter. The Chebyshev II filter is similar to the elliptic filter, but with the pass band ripple forced to be equal to zero.

Butterworth filter

The Butterworth filter design requires selection of two parameters from a choice of 3. The two usually selected are “Cutoff frequency” and “Number of poles”. An arbitrary point of 20dB down is then used to calculate the “Stop frequency”.

Surface Laplacian

[Description to be supplied at a later date.]