# EEGpal: **Filtering+ module**

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The 'Filtering+' module can be used to resample the data and filter the unwanted frequency in the EEG signal. The user can choose between two different algorithms to perform this filtering. By default, it uses the Signal Processing Toolbox from Matlab, but it can also call the filtering function used in EEGLAB. In addition, the module can call several EEGLAB tools to clean the data (such as CleanLine, ASR or automatic bad channel detection).

A screenshot of a computer

Description automatically generated

Pannel A

1. You can remove channel from the processing.
2. You can resample your data to another sampling frequency (new frequency must be specified in Hz). This is typically used when you want to downsample your data.

Pannel B

1. Activate of deactivate the filtering (to clean and remove frequency of no interest)
2. Choose between the two modes of filtering:
   1. Matlab mode: It will use the *filtfilt* function include in the Signal Processing toolbox (addone to Matlab)
   2. eeglab mode: It will use the *pop\_eegfiltnew* function include in the eeglab toolbox (include in EEGpal)
3. The parameters of the filter depend on the mode:
   1. In Matlab mode, the user can choice between **High+Low pass** which correspond to a passband filter (apply successively a high pass then a low pass), **Low pass** or **High Pass**. You can also specify the order of the filters. This determines how sharp the cut-off frequency will be. The higher the value, the sharper the cut-off frequency and the longer the processing time. You can see the effect of the order on the graph in position **6**. WARNING: If you choose a filter order that is too high, you will have more problems with phase shift (temporal distortion we don't want in the EEG) or Gibb's ringing artefact (creates unwanted oscillations in the EEG signal).
   2. In eeglab mode, the high+low pass is replaced by a **bandpath** (more detail in FAQ). You still have the option to perform a **Low pass** or **High Pass** independently**.** In this mode, the filter order will be determined automatically (more details in FAQ). This order will depend on cutting frequency and the sampling rate. If these two values are identical through your dataset, the order will remind the same across participants. This value is displayed on the Matlab consol windows during the processing.
4. View the cut-off behaviour according to the threshold and order of the filter (only available in Matlab mode).
5. The notch filter is disabled for eeglab. It is recommended to use cleanline instead to remove power line noise.

**Should I use Signal Processing Toolbox (*filtfilt* function) or EEGLAB (*pop\_eegfiltnew* function) to perform my filtering?**

Difficult questions. The results are similar for these two options. The authors found that the quality of the filtfilt Matlab filter was slightly better. However, the EEGLAB filters can be used without the Signal Processing Toolbox license and are more widely cited in the scientific literature.

**Why I can choose the filter order in Matlab mode and not in eeglab mode?**

The two filtering functions use filter order with different scales. To avoid confusion, the authors decided to impose an automatic choice of these values by EEGLAB (default option).

**Why is the high+low pass has been replaced by a bandpass option in eeglab mode?**

The authors observed a weird result when applying a high pass then a low pass filter with the function *pop\_eegfiltnew*. It is why they have decided to propose a bandpass filter as in the original filtering GUI in EEGlab.

**In Matlab mode, why the option passband has been replaced by High-pass + Low-pass?**

This is a choice of Michael De Pretto after reading of this reference: XXXX. The result is better by applying successively a high pass filter then the low pass filter.

**Why doesn't the toolbox offer the option of DC removal of the baseline shift, which is common in other EEG processing software?**

In standard EEG pre-processing, we recommend always applying a high pass filter to remove low frequency noise such as signal drift and others. The baseline shift due to DC is included in this type of noise (very low frequency). So, DC removal is useless if you apply a high pass filter with a cut-off between 0.3 and 0.5 Hz.