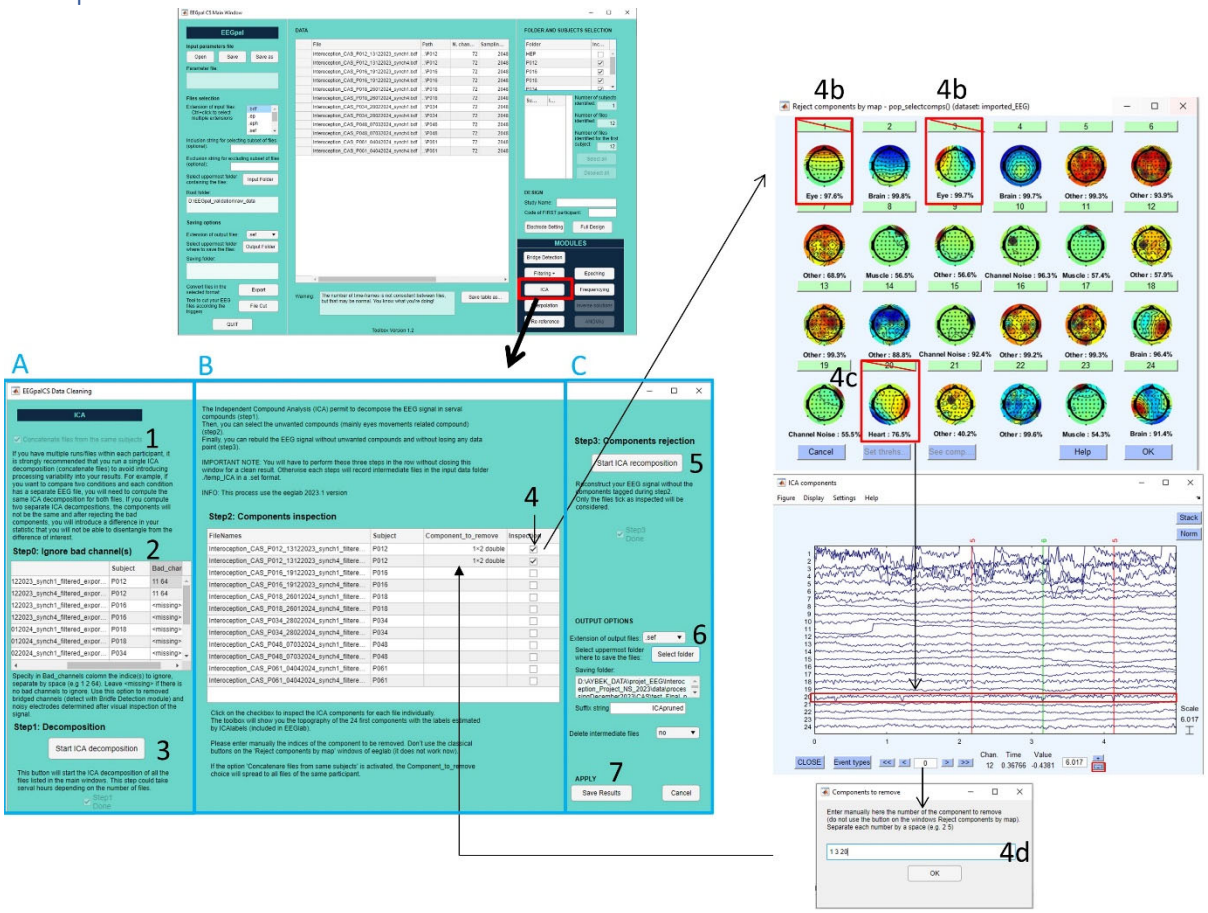
EEGpal: ICA module

Version 1.0, 28.09.2024

The module 'ICA' perform **an Independent Component Analysis**. The purpose is to decompose the EEG signal into independent components. This strategy is used to isolate and remove signals of no interest (artefacts) such as eye blinks.

This module use the function runica developed for eeglab using the infomax ICA algorithm of Bell & Sejnowski (1995) with the natural gradient feature of Amari, Cichocki & Yang, the extended-ICA algorithm of Lee, Girolami & Sejnowski, PCA dimension reduction, and/or specgram() preprocessing suggested by M. Zibulevsky.

Manipulation



Independent Compound Analysis (ICA) allows the EEG signal to be decomposed into several compounds (panel A). Then you can select the unwanted compounds (mainly the compound related to eye movements) (panel B). Finally, you can reconstruct the EEG signal without unwanted compounds and without losing any data points or electrodes (panel C).

IMPORTANT NOTE: You must perform these three steps in sequence without closing this window for a clean result. Otherwise, each step will record intermediate files in the *.\temp_ICA* folder in a .set format. If you want to repeat steps B and C without repeating step A (very long), load the files saved

in .*temp_ICA**decomposed* in the main windows and then open the ICA module, which will automatically detect that the decomposition is already done. **StepA**

1. Select the "concatenate files from the same subjects" option if you have multiple runs/files within each subject. It is strongly recommended to perform a single ICA decomposition (concatenate files) to avoid introducing processing variability into your results. For example, if you wish to compare two conditions recorded in separate EEG files, you must compute the same ICA decomposition for both files. If you compute two separate ICA decompositions, the components will not be the same and after rejecting the bad components, you will introduce a difference in your statistic that you will not be able to disentangle from the difference of interest.
2. In this table, enter the indices of all the bridge channels (because the input channels must be independent which is not the case of bridged electrodes) and of bad channels (after visual inspection of the signal) in order to have a clean input signal. Warning: don't put the electrode name (for example A11 B32) but the numerical indices of channels (11 64), indicating the 11th and the 64th channel. If several channels, separate them by a space.
   If no channels have to be ignored, leave as it is "<missing>" or leave it empty.
3. Start the ICA decomposition of your EEG files (take a long time). In the actual version, the user has to specified a **.locs* coordinate file generate for eeglab. This is needed for compounds visualization. For now, the official Biosemi 64 configuration is included in the Resources folder of EEGpal (*biosemi64_officialAB_update.locs*).
   The intermediate results of the ICA decomposition will be recorded in the folder .*ICAtemp**decomposed***_ICAdecomposed.set*.

StepB

Note: The path of the input files in the central table are automatically updated after the execution of stepA. In the case of crash or if you need to reprocess your files afterwards, you don't need to recompute the ICA decomposition (stepA). You can import the .*ICAtemp**decomposed***_ICAdecomposed.set* generated by step A in the main EEGpal windows (section Import Data and Loading the electrode coordinate file step of this manual) and directly perform this stepB.

4. Click on the checkbox to inspect the ICA components for each file individually.
   a. The toolbox will show you the topography of the 24 first components with the labels estimated by ICAlabels (included in EEGlab).
   b. In the current example the compound 1 (blink = vertical movement) and the compound 3 (horizontal movement) are clearly associate with eye movement.
   c. Look also to heat -beat activity. The best way to found is to found regular peak in the trace of ICA component. In this example, you see the compound 20 has this pattern.
   d. Please enter manually the indices of the component to be removed, separated by a space ('1 3 20' in this example). The specify value will be added in the coloumn *Components_to_remove* of the central table. If the option 'Concatenare files from same subjects' is activated' (point 1), the components to be removed and the inspection tick will spread to all files of the same participant.

BE AWARE: you must tick each file because only those one will be taken into account in the following steps, even if you don't select any component to remove.

StepC

5. When all the files of the central table are inspected (tick), press on the button *Start ICA recomposition* Reconstruct your EEG signal without the components tagged during stepB. The intermediate results will be recorded in the folder *.\ICAtemp\recomposed*_ICArecomposed.set*.
6. Now, we are going to export these results in the format you want. Create an 'ICA' folder. Select it as output folder
7. Press on *Save Results* to perform the export of the result with the option you have chosen in previous step. It will automatically update the table of the main EEGpal window and close the ICA module + write a log file with the different option you have selected.

If I select "concatenate files from the same subjects" in option 1, why I still get serval file in the table and not only one?

The eeglab algorithm will concatenate the file to perform the ICA decomposition. However, it will record independent files as output, but with the same decomposed components in each of these files. For this reason, step 2 of the ICA module automatically propagates the selection of removed components to all files that have been concatenated.

What happen to a bad electrode specified in 2?

Bad electrodes are simply ignored from the ICA decomposition. In the file output, these electrodes are not removed but record with the exact same signal as in the input files. It is why these electrodes must be interpolated in further steps.

Can I apply ICA decomposition after interpolation of bad electrodes or re-referencing the signal?

No. It is not recommended. When the raw data are first re-referenced or interpolated in preparation for ICA decomposition, they are made rank deficient. ICA algorithms (and, in particular, the Infomax ICA algorithm) will fail, as they are not designed to handle rank-deficient data.

For example, in the common average reference procedure, at each data sample, the sum of all channels is subtracted from each channel. The sum of all channels at any sample is thus 0, for example, with 3 channels A, B, and C, then at each time point A + B + C = 0. This makes the data rank deficient, as each channel is equal to minus the sum of all others (for example, A = –B – C), and Infomax ICA was not designed to process rank-deficient data.

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