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Clustering of ICA Components for efficient EEG artifact detection

Independent Component Analysis (ICA) is a statistical method that extracts statistically independent sources from a mixture of recorded signals, e.g. EEG signals. It enables the removal of artifactual signals (e.g. eyeblinks) while preserving the non artifactual part of the recorded signals. Based on blind source separation, ICA provides no clearly determined categorization of components as artifactual. Neither the order of the components nor the seemingly arbitrary weights in the ICA transformation matrix provide any information if a component should be rejected. Therefore, manual classification of components demands a reasonable level of personal experience. As it is necessary to keep track of all features of each component at all times, this classification process is time consuming and attention can decline continuously.

To address these issues, we developed a clustering tool that introduced several statistical measures to classify components semi-automatically, based on the trial rejection mechanisms included in EEGlab (Delorme, Makeig et al., 2001). The categorization process used the frequency spectrum (ratios of power at specific frequencies), the topographical distribution (deviations within the weight matrix), the activation structure over blocks (extracted by wavelets), and the ERPness (measured by kurtosis) of each component. These measures provided 10 dimensions describing each component. The derivied clusters reliably represented groups of artifactual or brain activity based signals.

A graphical tool, fully integrated into EEGLab, enables the user to get a gist of each cluster of components, making component rejection less time consuming, less arbitrary and more reliable. Therefore, this method contributes an improvement of the classical ICA rejection process described above and speeds up the preprocessing stage of EEG data.