A review of classification algorithms for EEG-based brain-computer interfaces

Most pattern recognition/machine learning pipelines not only use a classifier, but also apply feature extraction/selection techniques to represent EEG signals in a compact and relevant manner.

EEG signals are typically filtered both in the time domain (band-pass filter), and spatial domain (spatial filter) before features are extracted from the resulting signals.

Next, feature selection algorithms, used to train a classifier.

* Figure 1

Represent EEG signals = Frequency band power features and time point features.

First: Power of EEG signals for a given frequency band in a given channel, averaged over a given time window.

Second, concatenation of EEG samples from all channels.

Also, by covariance matrices or by tensors

**Spatial filtering** consists of combining the original sensor signals, usually linearly, which can result in a signal with a higher signal-to-noise ratio than that of individual sensors.

Data independent:

* Laplacian filter
* Inverse solution

Data-driven and unsupervised:

* Principal component analysis (PCA)
* Independent component analysis (ICA)

Data-driven with supervised learning:

* Common spatial patterns (CSP)
* xDAWN
* Fisher spatial filters

**Feature selection** approaches:

* The filter
* Wrapper
* Embedded

Performance measures:

* Kappa metric
* Confusion matrix
* Receiver operating characteristic (ROC) curve
* Area under the curve (AUC)

Linear classifiers:

* Linear discriminant analysis (LDA)
* Regularized LDA
* Support vector machines (SVMs)

LDA and SVM still are most popular types of classifiers for EEG based BCIs.