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Inria / LaBRI (CNRS, Univ Bordeaux, Bordeaux INP)

Although promising, BCIs are still barely used outside laboratories due to their poor robustness. Moreover, they are sensitive to noise, outliers and the non-stationarity of electroencephalographic (EEG) signals. This lack of robustness is notably due to inefficiencies in different steps of the BCI process, going along data acquisition, signal processing, and classification. We propose two distinct approaches, both aiming at improving a particular step of this BCI process.

The first approach focuses on signal processing and classification methods: choosing the best algorithm for decoding signals requires multiple scripts, resources and time. We propose BCPy, an open-source python platform for offline EEG decoding, that contains many tools for EEG signals decoding. BCPy comprises four main independent modules: 1) reading different EEG data formats, e.g. ".gdf", “.mat" and “.pkl"; 2) filtering and representing EEG signals, e.g., Common Spatial Pattern (CSP) or Filter Bank CSP (FBCSP), mutual information feature selection; 3) classifying EEG signals, e.g. Linear Discriminant Analysis (LDA), Riemannian Geometry or Convolutional Neural Network (CNN); 4) visualizing statistics on the analysis results. All algorithm examples mentioned above are already implemented. Each module can be used independently. Moreover, BCPy has a jupyter notebook GUI, allowing users to test and compare algorithms with various parameters on their data, without any programming.

The second approach focuses on BCIs protocols: a better understanding of human learning-related mental states could lead to a personalized training for each subject, possibly improving BCI reliability altogether. We analyzed two main learning-related mental states: workload and attention, and are currently focusing on new one: emotions. We have been using BCPy's machine learning tools to estimate such states from EEG signals in these three studies.