GENERALIZED EEG CLASSIFICATION FRAMEWORK

Gopika Gopan K

International Institute of Information Technology,
Bangalore, India

ABSTRACT

Electroencephalographic (EEG) signals are produced in brain due to firing of the neurons. The efficacy of automated analysis of EEG depends on features chosen to represent the time series and the classifier. In this work, we present a generalized framework of EEG analysis to achieve best classification performance. The time series undergo extensive feature extraction followed by feature ranking and selection. This results in optimal choice of features that best represent the given time series. An ensemble of classifiers enables accurate distinction between the classes of EEG . When a new EEG is presented to the algorithm, it computes the features specific to known classes and then classify as belonging to one of the known classes or declares it to be an entirely new class.

Index Terms— EEG, Features, Classification

1. SUMMARY

Electroencephalography (EEG) signals are the electrical signals generated in the brain as a result of firing of neurons and hence provides a non-invasive measure of brain functioning. EEG is an important tool used in the diagnosis of various brain conditions as well as in non-invasive Brain Machine Interface. EEG time series classification involves feature extraction followed by classification using an appropriate classifier. The information content in EEG may not be completely exploited in this scenario since the features and the choice of classifiers are limited by the user' expertise and assumptions about the data. This leads to customizing algorithms for EEG classification scenarios, which may be specific to that problem.

The proposed approach of EEG classification would enable a generalized classification framework formulation based on the given EEG characteristics. This framework of EEG classification is a generalized method that can be used to distinguish between classes of EEG. This framework will be effective especially, when new situations that lead to anomalies in EEG are encountered. A single algorithm for any classification problem of EEG, whether disorder detection or identifying different tasks as in Brain Machine Interface is proposed here.

During training phase, the EEG time series of known classes are presented to the algorithm. Various categories of features such as statistical, chaotic, measured are computed. The features then undergo ranking based feature selection process to determine the best set of features that represent the given time series. The well known methods, Genetic Algorithm and ReliefF are used here. Another important aspect is the use of hybrid features, i.e., an effective combination of the given time series with the derived feature to form a feature set that effectively represent the given time series. The representative and distinctive features for each class are then given to an ensemble of classifiers to achieve as accurate classification as possible.

When a new EEG time series is presented, features are computed, ranked and selected. Based on the selected features representing this new time series, the ensemble of classifiers determine if this belongs to one of the known classes (learnt during training) or an as-yet unknown class. In the event of this time-series being declared as belonging to an unknown class, the signature characteristics will be learnt by the algorithm, and this new class will be appended to the list of known classes.

This generalized framework doesn't limit the analysis to the expertise of the user, but instead is data-driven. Such a generalized framework would not only be useful in detection of various disorders like seizure, schizophrenia and dementia, but also can be used in non-invasive Brain Machine Interface for controlling prosthetics or robots for remote sensing. Monitoring of a patient in coma, or in intensive care unit after a trauma can also benefit from this algorithm since the obtained EEG can indicate the physiological condition of the patient, for example, whether patient is awake or asleep or in-between, sleeping well or not and does the brain function properly or not.

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