Predicting the eye state of a subject from EEG data using neural networks

1 Description

Electroencephalogram (EEG) are one of the most common recording of the brain activity. They can provide information about the mental processes which are expressed in the electrical activity of the brain. EEG data are at the core of disruptive technology as brain computer interfaces (BCIs) and also serve to diagnose mental and neurological conditions in humans. Different variants of neural networks have been applied to classify EEG data [1, 2, 3, 4, 5].

2 Objectives

The goal of the project is to predict the eye state of a subject (eye-open versus eye-closed) from the analysis of its EEG data using a neural network. One single subject is involved in the experiment. A database will be used for the analysis [1]. A neural network (not a deep neural network since a similar project using this type of network is proposed) should be created to predict the activity. Since a high variability between individuals is possible, a different classifier could be learned for each individual.

The student should: 1) Design any preprocessing of the time series in the dataset. 2) Design the validation method to evaluate the accuracy of the proposed approach. 3) Answer to the following questions in the report:

- What class of problems can be solved with the NN? (e.g., supervised vs unsupervised problems)
- What is the network architecture? (e.g., type and number of layers, parameters, connectivity, etc.).
- What is the rationale behind the conception of the NN?
- How is inference implemented? (e.g., How is the information extracted from the network?). Type of prediction or type of inference process.
- What are the learning methods used to learn the network ? Algorithms used for learning the network.

As in other projects, a report should describe the characteristics of the design, implementation, and results. A Jupyter notebook should include calls to the implemented function that illustrate the way it works.

3 Suggestions

- See relevant literature related to the general problem of EEG classification using neural networks.

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[1] The "EEG Eye State Data Set" dataset can be downloaded from `https://archive.ics.uci.edu/ml/datasets/EEG+Eye+State#`

- Find an appropriate way to split the data between train and test sets. One suggestion is to use a contiguous set of observations (e.g., the first half of the dataset) for training and the other half for testing the classifier.

- Extracting features is a key question for this type of problems.

- Implementations can use any Python library.

- If classes are not well balanced you may use performance measures different to the accuracy.

References

[1] E. Haselsteiner and G. Pfurtscheller. Using time-dependent neural networks for EEG classification. *IEEE Transactions on Rehabilitation Engineering*, 8(4):457–463, 2000.

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[3] F. Lotte, M. Congedo, A. Lecuyer, F. Lamarche, and B. Arnaldi. A review of classification algorithms for EEG-based brain–computer interfaces. *Journal of Neural Engineering*, 4:R1–R13, 2007.

[4] Tobie Erhard Olivier, Shengzhi Du, Barend Jacobus van Wyk, and Yskandar Hamam. Independent components for EEG signal classification. In *Proceedings of the 2016 International Conference on Intelligent Information Processing*, page 33. ACM, 2016.

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