CHDR – Research Proposal Capita Selecta 17 July -17 August

Supervisors:

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Hours: 168

The Centre for Human Drug Research is an institute that specializes in clinical drug research. CHDR combines innovative methods and technologies in the development of new research tools.

Problem description

One of the methods used in the CHDR to assess the effect of a drug is resting state EEG. For the duration of a few minutes, cortical activity is measured in subjects who close and open their eyes. From the power spectrum some indications about the state of the central nervous system can be extracted. However, these measurements are often influenced by artefacts (e.g. eye and muscle movements). Parts of the EEG recording are rejected when an artefact has been (sometimes manually) detected.

Within CHDR there is a growing interest in acquiring Machine Learning techniques to analyse data. One possibly interesting application of such techniques is the automatic detection and correction of artefacts in EEG recordings.

The aim of this research project is to provide an overview in the form of a report of methods to analyse data from functional brain imaging (EEG) in the presence of (ocular) artefacts, using Machine Learning and pattern recognition. The purpose of these methods is to detect the presence and correct the effects of such artefacts. Besides providing an overview of methods, this report will recommend performance measurements and a modelling/experimental set up, and establish the amount of data needed to assess and implement such methods. Based on the report an (prototype) implementation of a filter or algorithm will be constructed.

Research topic

The development of new methods to analyse data from functional brain imaging (EEG with EOG) in the presence of ocular artefacts, using Machine Learning (ML) and pattern recognition, with the goal to automatically and instantly detect, reject and/or correct such artefacts. Methods can be based on:

Machine Learning:

- Artificial Neural Networks (ANN's, i.e. Autoencoders (Schwenk, 1998), Radial basis function networks (Bishop, 1995), Hopfield networks (Hopfield, 1982), Boltzmann machines (Ackley, Hinton, & Sejnowksi, 1985))
- Supervised/Unsupervised Machine Learning (Blind Source Separation (BSS), with Independent Component Analysis (ICA) and Bayesian Classification (Joyce, Gorodnitsky, & Kutas, 2004) (Delorme, Makeig, & Sejnowski, 2007) (Nolan, Whelan, & Reilly, 2010) (LeVan, Urrestarazu, & Gotman, 2006))
- Filters (Adaptive filter, Wiener filter, Bayesian filter, Kalman or Particle filter (Sweeny, Ward, & McLoone, 2012))

And/or based on standard industry protocols for removing EOG artefacts (BSS, Least Mean Squares (LMS), Regression techniques (Klados, Papadelis, Lithari, & Bamidis, 2008) (Sadasivan & Dutt, 1996) (Avalos, Sanchez, & Velazquiez, 2014) (Beng Gan, Zahedi, & Alauddin, 2011)).

Objective

Develop automatic and efficient method that can be applied in real time. Prefer correction over rejection of epochs. End product is a working (prototype) filter implemented in Python and a report that includes extensive literature reviewing and method recommendations.

Methods

Literature review, develop Python scripts, testing on available data.

References

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