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NPXLab Suite 2016: tools for BCI signal analysis

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Introduction: The NPXLab Suite is a collection of easy to use free software tools aimed at analyzing physiological signals acquired during either clinical or experimental protocols. Brain-Computer Interfaces could also benefit from this framework as several facilities are provided, such as ICA, CSP, ERP and spectral analysis, classification, statistics and metrics computation. The main guidelines that inspired their implementation and some of their features are here briefly outlined.

Material, Methods and Results: There are several frameworks aimed at handling BCIs protocols, such as BCI2000, OpenVibe, BF++ [1] to name few, but because they do not share a common functional model they can hardly interact, especially in real-time: today it is really difficult to have widely accepted standards that allow to mix BCI software modules from different frameworks as this would require to rewrite relevant portions of the software, breaking existing implementations. However, a different approach could be to try to share at least some off-line analysis tools, thus standardizing just the “static” functional model and not also the “dynamic” mechanisms that would permit to share information across modules in real-time.
NPXLab goes in this direction, as it allows to analyze different bio-signals (e.g. EEG, ERP, MEG, NIRS, etc...), from different acquisition devices and vendors (it supports more than 15 different file formats) with a very friendly user interface. It implements a native file format (NPX, based on XML) which can be easily extended without breaking the backward compatibility so that it can be extended in a painless way. It also comes with 7 different classifiers for BCI (SWLDA, SVM, BLDA, Neural Networks, SRLDA, RLDA, FLDA), several time domain and spatial filters, including ICA (Fig. 1), Laplacian and CSP (Fig. 2), and can perform classical and advanced analyses on protocols like P300, N400, Steady State EP and all kinds of ERPs. A previously released version was also adopted by several laboratories in the EU Decoder Project for performing ERP analysis, metrics computation and statistical validation of the analysis results from NIRS, fMRI and ERPs. An Italian EEG systems manufacturer (EBNeuro, Florence, Italy) has also integrated the NPXLab Suite within its system through a commercial plug-in mechanism. Completely written in C++ programming language it implements the functional model described in [2] and performs faster than many similar and expensive commercial products.

Fig. 1 – ERP module view in which an averaged ICA component relative to target (orange) and non-target (blue) stimuli in a P300 protocol of a patient are shown. Dark pink bubbles indicate statistical significance ($p<0.05$) after sample by sample t-test and False Discovery Rate statistical correction for multiple comparisons.

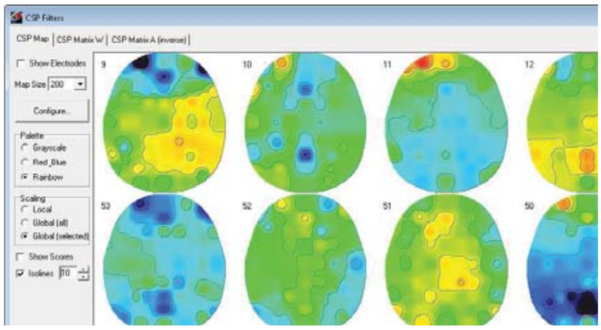

Fig. 2 – A partial screenshot from the common spatial pattern tool. All the supported file formats could take advantage of it after conversion to native NPX format. This operation can be easily performed with the File Converter software facility.

Discussion: The NPXLab Suite is a features rich and easy to use collection of tools for the analysis and processing of physiological signals. It allows to quickly perform classical analyses (e.g. Averaging, Spectral Analysis, time domain-filtering, etc...) as well as more advanced ones (e.g. ICA, Common Spatial Patterns, classification, etc...). In the BCI research field it has been successfully used in several laboratories to pre-process, review, remove artifacts and classify signals from various systems and to compute various metrics.
It can also be used to compare the performances of BCI systems from different protocols [3] and acquisition devices (e.g. EEG, fMRI, ERP, NIRS, etc.) in a simple way as it is based on the model described in [2].
Born in 2002, this project is continuously improved, updated and extended, and it will be also supported in the following years. It is available for downloading at http://www.brainterface.com.

[1] Brunner C, et al. (2012). BCI Software Platforms. In: Allison, B.Z., Dunne, S., Leeb, R., Millan, J., and Nijholt. Toward Practical BCIs: Bridging the Gap from Research to Real-World Applications. BERLIN: Springer-Verlag

[2] Quitadamo LR, Marciani MG, Cardarilli GC, Bianchi L. (2008). Describing different Brain Computer Interface Systems through a unique model: a UML implementation. Neuroinformatics. vol. 6:2, pp. 81-96.

[3] Quitadamo LR, Abbafati M, Cardarilli GC, Mattia D, Cincotti F, Babiloni F, BianchiL L. (2012). Evaluation of the performances of different P300 based brain–computer interfaces by means of the efficiency metric. J Neurosci Methods, vol. 203, p. 361-368.