 DOI: 10.3217/978-3-85125-962-9-99

Pseudo Online Framework

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Introduction: A BCI technology can operate in 3 different modalities: *online* mode which requires analyzing the new real-time EEG data while acquiring it, *offline* mode where data is acquired and saved to a file and then analyzed afterwards (giving access to the data as a whole) and *pseudo-online* mode, which is a mix between the previous two modes, where stored acquired data is processed as if in *online* mode, but with the relaxation of the real time constraint. Currently, many studies concerning Brain Computer Interfaces (BCI) are tested in the *offline* mode. This thus leads to unrealistic performance compared to real-life online scenarios [1]. The MOABB [2] framework typically provides tools to evaluate algorithms in this *offline* mode. Other studies propose *online* algorithms evaluation, but often do not disclose the datasets and/or nor the code used for data analysis. There are other frameworks for *online* processing [3, 4], but they do not focus on the statistical evaluation over several sessions/subjects as MOABB does.
Material, Methods and Results: The objective of this research is to extend the current MOABB framework, which is currently limited to *offline* mode to allow comparison of different algorithms in a *pseudo-online* setting. We focus on asynchronous BCI where data is typically analyzed in overlapping sliding windows. This requires the addition of an *idle* state event to the datasets to mark signal pieces not related to an actual BCI task(s). Doing so generates datasets that are usually highly unbalanced in favor of this *idle* event, generating problems with some of the standard metrics used in BCI evaluation. We thus use the normalized Matthews Correlation Coefficient (nMCC) [5] and the Information Transfer Rate (ITR) [6]. We applied this pseudo-online framework to evaluate the state-of-the-art algorithms over the last 15 years over several Motor Imagery (MI) datasets composed by several subjects.
Discussion: Usually *offline* modality set an upper bound to the performances, while a *online* signal analysis approaches generally produce results that are less accurate but more representative of a therapeutic application usage [7]. The *pseudo-online* implementation can be used as a methodology that best approximates the *online* process while still processing the data after complete recording. It still represents an upper bound on performance (as real time time is not required) but a more realistic one that can be reached with more powerful computing resources.
Significance: The possibility of analyzing the performance of different algorithms first *offline*, followed by subsequent validation of performance in *pseudo-online* mode, will be enable more representative reports on the performance of classification algorithms for the BCI community.
Acknowledgements: This work has been partially financed by a EUR DS4H/Neuromod fellowship. The authors are grateful to the OPAL infrastructure from Université Côte d'Azur for providing resources and support.

Keywords BCI-EEG, Asynchronous BCI, MOABB, Pseudo Online BCI, Deep Learning, Machine Learning.

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