Title of the project:
Adaptive learning for selecting Brain Computer Interface tasks

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Description:
*Context***:** Brain Computer Interfaces (BCI) aim at establishing a connection between a human and a computer through the interpretation of brain activity. Motor imagery tasks can be recognized by such a system, and used to convey commands. The system must also be able to recognize when the user is in an idle state (not intending to issue any command). Motor imagery tasks typically involve imagining moving the right or left hand, or the feet. A screening session is necessary to select which tasks are best discriminated, as this is user-dependent. The naive screening approach is to ask the user to perform all tasks a great number of time and to evaluate offline which ones can best be recognized.
This project aims to optimize the screening, to avoid wasting time on tasks that are not well recognized. Adaptive learning techniques are very promising for optimizing the screening stage, making it possible to select efficiently the tasks to be used for BCI.

*Objective***:** The goal is to use an adaptive learning procedure to find the two best tasks that can be best classified (against the idle state, and against each other). An algorithm will be proposed and implemented, and simulations will be performed within the OpenViBE platform for Brain Computer Interfaces. In case of a successful outcome of simulations, an online experiment with an actual user can also be carried out.

Approach: The project will build upon existing work [Fruitet et al, 2013]: in we have shown that a multi-armed bandit algorithm [Auer et al, 2002] could be used to select the (single) motor task best classified against the idle state. The idea is to adapt this framework to selecting a couple of tasks. The classification method will be a simple two-class SVM.

Skills: algorithmics, statistics, programming either in matlab / python / c++

Schedule and sharing out of the work:
- *reading the reference paper [Fruitet et al, 2013];*
- *extending the initial algorithm (called UCB-classif) from one to two tasks;*
- *implementing and testing the new algorithm*

- *experimenting with UCB-classif within OpenViBE, on prerecorded BCI datasets*
- *experimenting with the newly developed algorithm within OpenViBE*
- *performance analysis, in comparison with a naive screening approach*

References:

P. Auer, N. Cesa-Bianchi and P. Fischer Finite time analysis of the multiarmed bandit problem Mach. Learn. ***47*** *235–56, 2002.*

J. Fruitet, A. Carpentier, R. Munos, M. Clerc. Automatic motor task selection via a bandit algorithm for a brain-controlled button. Journal of Neural Engineering, vol. 10, no. 1, 2013.

Y. Renard, F. Lotte et al, OpenViBE: An open-source software platform to design, test, and use brain–computer interfaces in real and virtual environments Presence: Teleoperators Virtual Environ. ***19*** *35–53, 2010 (http://openvibe.inria.fr)*