Title (tentative): Machine learning methods for reliable typewriting using a brain-machine interface based on error-related EEG potentials

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Description

Motivation and application domain
Brain computer interface systems can provide a communication channel to users with severe motor disabilities. Chavarriaga et al., (2016) developed a communication interface based on multimodal signals that allows users to communicate based on the decoding of error-related EEG activity. This thesis project aims at improving the current implementation of the system integrating machine learning algorithms that can increase both the speed and reliability of the interface.

General objectives and main activities
The general objective is to implement methods that use inferences from the language model to provide means for online adaptation of the ErrP decoders. Evaluation of real-time operation of the spelling application will be performed on healthy participants over multiple sessions to assess the stability of the system across days. If time provides, evaluation with a potential end-user with motor disability will be also performed. Specifically the student will be in charge of
• Perform experiments of closed-loop BCI operation to characterize the ErrP signals and evaluate their decoding during online operation.
• Improve the current language model used by the speller to allow (i) prediction of words based on the ErrP decoding of previous characters, and (ii) autocorrection of written words
• Implement algorithms that allow backtracking the written characters in order to re-train the ErrP decoder in a non-supervised manner during online operation.

Training Objectives (technical/analytical tools, experimental methodologies)
The student will learn:
• To perform experiments of closed-loop BCI operation to characterize the ErrP signals and evaluate their decoding during online operation.
• To analyze the error-related EEG potentials with respect to the characteristics of the task
• To improve the knowledge of Matlab, statistical analysis, machine learning and reinforcement learning algorithms.

Place(s) where the thesis work will be carried out: DIBRIS & Campus Biotech di Ginevra, nel CNBI lab dell'EPFL.

Additional information
Maximum number of students: 1