The idea would be to create computational models of BCI user training that could predict the learning rate and the performances of various BCI users, over training time, based on their traits, states and skills over time, and based on the feedback they receive and on the training tasks they perform. Different models will be created to account for different aspects and time scale of learning, e.g., to predict the overall performances, but also the performances variability between sessions/runs, as well as to predict whether a given trial is going to be successful or not. Understanding and modeling how the BCI users exploit and learn from the feedback they receive is also of high interest.

More particularly, we are interested in identifying how different properties of the feedback affect BCI learning and performances. Such properties could include the feedback visual characteristics, update rate, bias, the fact of being positive/negative or positive only, its modality, etc. By combining these various models (models of performance, of feedback processing, of performance variability across runs and trials, etc.), we hope to be able to successfully predict performances and learning at any time. This would enable us to identify the factors to consider in order to improve user training, and how to manipulate them to optimize such training.

The goal would be to develop these models both for the healthy user population, but also for the BCI end users population, in particular for stroke patients (based on data from the BCI end users population, in particular for stroke patients).
from such users). Such models could be statistical/probabilistic model. They could be based on regression, hidden markov model, Bayesian networks, control theory or other generative machine learning/statistical tools. They could also be based on computational implementation of theoretical models of BCI performances or models of learning in general, from the psychology literature.

We already have data from multiple BCI users who trained over multiple days with MI-BCI, and for which we measured the traits using psychological questionnaires. We also have data sets from MI-BCI users who trained with different feedback characteristics such as visual or tactile feedback, positive only feedback, and various feedback biases. These data sets will be the basis for creating, testing and validating different initial models.

The PhD thesis could also include designing and running MI-BCI experiments to acquire additional data to refine the initial models (e.g., to include missing factors), to validate them on different MI-BCI training tasks.

Main activities

- Be able to successfully predict performances and learning at any time
- Develop models (models of performance, of feedback processing, of performance variability across runs and trials, etc.) both for the healthy user population, but also for the BCI end users population, in particular for stroke patients (based on data from such users).
- Design and run MI-BCI experiments to acquire additional data to refine the initial models

Skills

Skills required:

- Modelling, statistical analysis and tools, and/or machine learning
- Python / Matlab programming
- Able to speak, write and work in an English speaking environment
- Skills in neurosciences, psychology, cognitive science appreciated
- Experience with ElectroEncephaloGraphy (EEG) and/or BCI experiments appreciated

Related literature:


C. Jeunet, F. Lotte, JM. Batail, P. Philip, JA. Micoulaud-Franchi, "Using recent BCI literature to deepen our understanding of clinical neurofeedback: A short review", Neuroscience, 2018

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport

Remuneration

1982€ / month (before taxes) during the first 2 years, 2085€ / month (before taxes) during the third year.