



Offer #2023-06299

PhD Position F/M Understanding and addressing within-user variability in active Brain-Computer Interfaces

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Context

Brain computer interfaces (BCI) are communication and control tools that enable their users to interact with computers by using brain activity alone, typically measured using electroencephalography (EEG). A prominent type of BCI is active BCI (aBCI), that translates change in brain activity due to mental imagery tasks performed by the user (e.g., imagination of movements or mental calculation) into control commands for a computer. Such aBCIs are very promising for various applications, e.g., for post-stroke rehabilitation, hand-free control or assistive technologies for motor impaired users. However, current aBCIs are rather unreliable, and their reliability degrades even more when used across contexts (e.g., across days, for changing users' states or applications used) due to various sources of variabilities. Unfortunately, such variabilities are 1) often ignored in the literature, as most BCIs are assessed in a single context and 2) poorly understood. Thus, for BCIs to fulfill their promises and be used outside laboratories, we need to make them robust to such variabilities. In ANR (French National Research Agency) project PROTEUS (2023-2026) we propose to do so by 1) Systematically measuring BCI and brain signal variabilities across various contexts while sharing the collected databases; 2) Characterizing, understanding and modeling the variability and their sources based on these new databases; and 3) Tackling these variabilities by designing new machine learning algorithms optimally invariant to them according to our models, and using the resulting BCIs for two practical applications affected by variabilities: tetraplegic aBCI user training and auditory attention monitoring (passive BCI) at home or in flight. The present PhD project aims at understanding and addressing these variabilities for aBCIs in particular.

As part of this research, the goal of this PhD thesis would be to contribute to the measure, understanding and modeling of the variabilities affecting aBCI in particular.

Supervision:

Fabien Lotte, Research Director at Inria, Inria Center at the University of Bordeaux / LaBRI

□ Web site: <http://sites.google.com/site/fabienlotte/>

□ E-mail: fabien.lotte@inria.fr

Raphaëlle Roy, Associate Professor / HDR, ISAE-SUPAERO, University of Toulouse

□ Web site: <https://pagespro.isae-supaero.fr/raphaelle-n-roy-211/>

□ E-mail: raphaelle.roy@isae-supaero.fr

Related literature:

Benaroch, C., Sadatnejad, K., Roc, A., Appriou, A., Monseigne, T., Pramij, S., ... & Lotte, F. (2021). Long-term BCI training of a tetraplegic user: adaptive riemannian classifiers and user training. *Frontiers in Human Neuroscience*, 15, 635653.

Roy, R. N., Hinss, M. F., Darmet, L., Ladouce, S., Jahanpour, E. S., Somon, B., ... & Lotte, F. (2022). Retrospective on the First Passive Brain-Computer Interface Competition on Cross-Session Workload Estimation. *Frontiers in Neuroergonomics*, 3.

Fairclough, S. H., & Lotte, F. (2020). Grand challenges in neurotechnology and system neuroergonomics. *Frontiers in Neuroergonomics*, 2

Assignment

It will notably consist in designing and running a BCI research protocol in order to acquire EEG/aBCI data from healthy users to study various variability factors.

We should notably induce 3 such factors, which should be major sources of variability, in order to infer their possible causal effects. These are variabilities due to 1) cross-session aBCI use, 2) within-session use (time-on-task) and 3) environment (laboratory/low stimulating setting vs simulator/highly stimulating setting).

Such a competition consists in training a tetraplegic BCI user to compete in a BCI-controlled video racing game with other tetraplegic users. Besides the benefits of contributing to the development of BCIs for end-

users, this will enable us to validate our new BCI algorithms on real-life variabilities induced by training this user across multiple sessions (typically across months) and across environments (in the lab vs at the user's home vs at the competition venue).

Main activities

- The candidate should also measure various other variability factors, such as users' psychological states or EEG sensor positions, to infer their possible associations with EEG/aBCI variabilities.
- Then, from the collected database, the PhD candidate will aim at understanding and modeling variabilities in aBCI, e.g., by quantifying and characterizing the effect of the studied variability factors through statistical analyses and multivariate models at both the classification performance and the neurophysiological/feature levels. These models will be used by Machine Learning (ML) experts in the project to design new variability-robust EEG classifiers.
- Finally, the PhD candidate should incorporate these new ML algorithms into the design of a variability-robust aBCI application for the aBCI training of a tetraplegic BCI user. For instance, we could aim at participating in the next Cybathlon BCI competition (planned for the end of 2024) or a related Cybathlon BCI series.

Skills

Skills required:

- ☐ Experimental protocol design
- ☐ Modeling, statistical analysis and tools
- ☐ Basic usage of Machine Learning tools
- ☐ Ability to speak, write and work in an English speaking environment
- ☐ Skills in neuroscience, psychology, cognitive science is a plus
- ☐ Experience with ElectroEncephaloGraphy (EEG) and/or BCI experiments

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

2051€ / month (before taxes) during the first 2 years, 2158€ / month (before taxes) during the third year.

General Information

- **Theme/Domain** : Robotics and Smart environments
Instrumentation et expérimentation (BAP C)
- **Town/city** : Talence
- **Inria Center** : [Centre Inria de l'université de Bordeaux](#)
- **Starting date** : 2023-10-01
- **Duration of contract** : 3 years
- **Deadline to apply** : 2023-06-11

Contacts

- **Inria Team** : [POTIOC](#)
- **PhD Supervisor** :
Lotte Fabien / Fabien.Lotte@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Send to fabien.lotte@inria.fr and raphaelle.roy@isae-superaero.fr:

- CV
- Cover letter
- Recommendation letters
- Master degree's grade transcripts
- Any publication/achievement list

Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.