Offer #2024-08341

PhD Position F/M PhD Position F/M - Higher-order interactions for brain-computer interfaces

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Context

This PhD project will be realized in the Inria NERV team, a research lab supported by the French institutions Inria, Inserm, CNRS, and Sorbonne University. The team is located in the Paris Brain Institute (ICM) within the Pitie-Salpetriere hospital.

The NERV team pursues a multidsciplinary research program at the intersection between biomedical engineering, complex systems and clinical neuroscience. NERV proposes new computational frameworks to analyze and model the spatiotemporal complexity of brain networks from multimodal and longitudinal neuroimaging data, and we design noninvasive intervention strategies based on brain-computer interfaces. Furthermore, the team ejoys a privileged position within a unique scientific and technological environment including comprehensive experimental core facilities (eg, neuroimaging, genetics, cellular), several animal models (eg, from nematodes to humans) and powerful centralized cluster computer system to realize big-data analysis and simulations.

Assignment

This PhD project aims to explore the role of higher-order interactions in the development of advanced brain-computer interfaces (BCIs).

Current BCI systems often rely on linear models and first-order relationships to decode brain signals, which often leads to limitations in accuracy and adaptability. This research seeks to move beyond these constraints by investigating how higher-order interactions among neural signals can improve the performance and functionality of BCIs

Main activities

The first phase will focus on developing a theoretical framework for understanding and quantifying higher-order interactions in neural data. In a second phase, novel machine learning algorithms will be designed to leverage the insights gained from the theoretical framework. This will include implementing advanced techniques such as deep learning architectures that can automatically discover and model these higher-order interactions in real time.

The final phase will involve validating the developed models through experiments with human participants using EEG data. The goal will be to assess improvements in BCI performance, such as more accurate intention decoding, ultimately enhancing user experience and efficacy in applications ranging from assistive technologies to neurofeedback.

Skills

Required skills

The ideal candidate should have a solid background in experimental physics, machine learning and data analysis, as well as experience in laboratory projects and simulations (Python, MATLAB). The ability and willingness to learn will do equally well.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours)

+ possibility of exceptional leave (sick children, moving home, etc.)
- 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

General Information

- **Theme/Domain :** Computational Neuroscience and Medicine
  Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city :** Paris
- **Inria Center :** [Centre Inria de Paris](#)
- **Starting date :** 2024-12-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-12-06

Contacts

- **Inria Team :** [NERV](#)
- **PhD Supervisor :**
  De Vico Fallani Fabrizio / fabrizio.de-vico-fallani@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.

The keys to success

Expected results and valorization

The expected results will shed light on the mesoscale network properties which are needed to achieve generalizable artificial intelligence. These will be evaluated with respect to those obtained with state-of-the-art approaches and interpreted from a theoretical and practical perspective. As such this project is expected to provide fresh knoweldge on the emergent structures of complex interconnected systems and their implication in biological and artificial scenarios, identifying at the same time the strong aspects and the weak points that can be addressed in the future. All the conducted research activity will be reported and shared with the PI's team and submitted for publications in peer-reviewed journals (eg, IEEE, APS) and/or presented in relevant international conferences (eg, NetSci, IEEE).

> **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

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.