PRECISION MAPPING OF ELECTRICAL BRAIN NETWORK DYNAMICS WITH APPLICATION TO EPILEPSY

BACKGROUND: Human connectomics provide a biologically meaningful representation for complex brain data, in health and disorder. We aim to harness the latest cutting-edge mapping technologies, combining high density EEG with advanced diffusion MRI, and novel graph signal processing methods, to develop the next generation high-fidelity connectome framework. In particular, we aim to yield a tailored brain data representation as a large-scale directed graph. This precision neuroimaging framework will be clinically applied to focal epilepsy.

PROJECT AND OPEN POSITIONS: This Sinergia project, funded by the Swiss National Science foundation, is led by Prof. Patric Hagmann (CHUV-UNIL), Prof. Serge Vulliémoz (HUG-UNIGE) and Prof. Dimitri Van De Ville (EPFL-UNIGE), in collaboration with Prof. Pieter van Mierlo (Ghent University), Dr. Katharina Glomb (Charité Berlin), Prof. Ileana Jelescu (CHUV-UNIL) and Prof. Olivier David (Aix-Marseille University). Several positions are open at the doctoral and postdoctoral level, on a wide range of topics from diffusion MRI developments to EEG-MRI integrative analysis and graph signal processing.

While different positions are available at different labs in different institutions, all personnel hired in the context on of this project will closely collaborate. Doctoral students will be co-supervised by different PIs when appropriate and postdoctoral researchers will operate at the interface between the labs.

All open positions are listed hereafter.

Doctoral or Postdoctoral positions in diffusion MRI microstructure & tractography

PROJECT 1: **Axonal diameter mapping & conduction speed across the brain**

We propose to use the latest methodological developments in diffusion MRI to map axon diameters across the brain non-invasively, and relate them to conduction speed along individual white matter tracts. These quantitative maps will serve as priors for the analysis of cortical EEG data. Your mission will include MRI acquisition design, data acquisition and analysis, and integration between diffusion MRI and EEG data.

PROJECT 2: **High-fidelity tractography reconstruction**

We propose to develop novel tractography methods based on double diffusion encoding to disentangle curving and crossing fiber tracts, thereby improving the precision of white matter connectivity mapping. Accurate structural connectivity will be paramount for the development of precision connectomics. Your mission will include astute MRI acquisition and analysis designs.

START DATE: January 2023. The positions are open until filled.

SALARY: The project follows SNSF salary guidelines. Doctoral funding is available for four years, postdoctoral funding is initially available for two years, with possible extension.

REQUIREMENTS:

- Relevant degree (MSc or PhD) in physics, electrical engineering, biomedical engineering, or related field.
- The successful candidate will be an ambitious collaborative scientist with initiative, curiosity and rigor.
- Proficiency in programming is mandatory. Experience with typical neuroimaging software is a plus.
- Experience with Siemens MRI systems and/or diffusion MRI is a plus.
- Excellent written and oral communication skills in English. French is a plus.

ENVIRONMENT: Successful applicants will join a vibrant community that spans multiple disciplines, backgrounds and institutions, at the bleeding-edge of mapping brain dynamics. You will be part of the Radiology Research Unit at the Lausanne University Hospital (CHUV) and the University of Lausanne (UNIL), under the supervision of Profs. Hagmann and Jelescu. The group has access to state-of-the-art clinical MRI scanners (CHUV and Campus Biotech Geneva) and ample GPU computing.

INTERESTED? Please email your application (CV, brief statement of research interests, list of publications and contact information of two references) to patric.hagmann@chuv.ch and ileana.jelescu@chuv.ch.

Doctoral and Postdoctoral positions in brain graphs & graph signal processing

PROJECT 1: **Building directed connectome and validation using hdEEG**

We will develop a regression model to link microstructural properties with axonal conduction delays obtained from intra-cortical measurements (SEEG). The validated model will then be deployed to build the complete brain graph. Then the availability of hdEEG will be leveraged to translate conduction delays into meaningful edge weights on the directed connectome, and how it can serve to improve source localization methods.

PROJECT 2: **Directed GSP**

We then will extend graph signal processing operations for the directed brain graph, which involves a non-trivial extension to define the graph Fourier transform. Previously proposed GSP operations, such as filtering in the spectral domain and generation of surrogate data, will be revisited. These developments will be applied to EEG signals and quantify the interaction between brain activity and underlying anatomy in new ways.

START DATE: April 2023. The positions are open until filled.

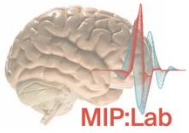
SALARY: The project follows SNSF and EPFL salary guidelines. Doctoral funding is available for four years, postdoctoral funding is initially available for two years, with possible extension.

REQUIREMENTS:

- Relevant degree (MSc or PhD) in physics, electrical engineering, biomedical engineering, or related field.
- The successful candidate will be an ambitious collaborative scientist with initiative, curiosity and rigor.
- Proficiency in programming is mandatory. Experience with typical neuroimaging software is a plus.
- Experience with graph signal processing is a plus.
- Excellent written and oral communication skills in English. French is a plus.

ENVIRONMENT: Successful applicants will join a vibrant community that spans multiple disciplines, backgrounds and institutions, at the bleeding-edge of mapping brain dynamics. You will be part of the Medical Image Processing Lab at the Ecole Polytechnique Fédérale de Lausanne (EPFL) and the University of Geneva, under the supervision of Prof. Van De Ville. The lab has access to state-of-the-art neuroimaging equipment and high-performance computing.

INTERESTED? Please email your application (CV, brief statement of research interests, list of publications and contact information of two references) to Dimitri.VanDeVille@epfl.ch.



Doctoral or Postdoctoral positions in spatio-temporal connectomics of EEG using advanced graph signal processing

PROJECT:

We propose to use the latest joint time-vertex graph signal processing methods on the human connectome to discover not only novel spatio-temporal characteristics of brain functional activity but also to develop breakthrough tomographic reconstruction methods of brain electrical source signals form Electro-Encephalo-Graphy (EEG). Your mission will include the development of the computational methods enabling the analysis of such complex space-time data and the design of related tomographic reconstruction methods.

START DATE: January 2023. The positions are open until filled.

SALARY: The project follows SNSF salary guidelines. Doctoral funding is available for four years, postdoctoral funding is initially available for two years, with possible extension.

REQUIREMENTS:

- Relevant degree (MSc or PhD) in mathematics, physics, electrical engineering, biomedical engineering, or related field.
- The successful candidate will be an ambitious collaborative scientist with initiative, curiosity and rigor.
- Proficiency in programming is mandatory. Experience with typical neuroimaging software is a plus.
- Experience with EEG and/or diffusion MRI is a plus.
- Excellent written and oral communication skills in English. French is a plus.

ENVIRONMENT: Successful applicants will join a vibrant community that spans multiple disciplines, backgrounds and institutions, at the bleeding-edge of mapping brain dynamics. You will be part of the Radiology Research Unit at the Lausanne University Hospital (CHUV) and the University of Lausanne (UNIL), under the supervision of Prof. Hagmann and co-supervised by Dr Katharina Glomb in La Charité Hospital, Berlin.

INTERESTED? Email patric.hagmann@chuv.ch. To apply, please send us your CV, a brief statement of research interests, list of publications and contact information of two references.

Doctoral or Postdoctoral positions in EEG source imaging and connectivity analysis

PROJECT:

We propose to apply new methods based on structure-function relationships to perform EEG source analysis, connectivity and network analysis. We will assess their added value for the localisation of epileptic activity, the identification of abnormal activity in the absence of classical markers of epilepsy and the prediction of the outcome of epilepsy surgery. Validation will be obtained with intracranial recordings and post-operative lesion mapping.

Your mission will include active participation in recording of high density EEG and high field MRI in patients and controls, and adaptation of new analysis tools at different levels (source analysis, connectivity, network) to the study of EEG in patients with epilepsy. This will require intense collaboration with other experts in the consortium who will develop and improve these methods of EEG and MRI processing.

This project has the particularity that it involves co-supervision in Geneva and Ghent, with main location in Geneva and research stays in Gent.

START DATE: between January and April 2023.

SALARY: The project follows SNSF salary guidelines. Doctoral funding is available for four years, postdoctoral funding is initially available for two years, with possible extension.

REQUIREMENTS:

- Relevant degree (MSc or PhD) in mathematics, physics, electrical engineering, biomedical engineering, or related field.
- The successful candidate will be an ambitious collaborative scientist with initiative, curiosity and rigor.
- Proficiency in programming is mandatory. Experience with typical neuroimaging software is a plus.
- Experience with EEG analysis is highly desirable. Expertise in advanced signal processing is a plus.
- Excellent written and oral communication skills in English. French and/or German is a plus.

ENVIRONMENT: Successful applicants will join a vibrant community that spans multiple disciplines, backgrounds and institutions, at the bleeding-edge of mapping brain dynamics. You will be part of the Epilepsy Unit at the University Hospitals (HUG) and Faculty of Medicine of Geneva (UNIGE), under the co-supervision of Prof. Vulliemoz in Geneva and Prof van Mierlo in Ghent (Belgium).

INTERESTED? Email serge.vulliemoz@hcuge.ch and pieter.vanmierlo@ugent.be. To apply, please send us your CV, a brief statement of research interests, list of publications and contact information of two references.