PhD position (DC13)

Deep structural causal modelling framework for the longitudinal analysis of Multiple Sclerosis through brain MRI

Location:
Lausanne University Hospital (CHUV)
Campus Biopôle, Bâtiment Proline
Route de la Corniche 10
CH-1066 Epalinges, Switzerland

Starting / Duration:
Immediately / 3 years, annual renewal

BRIDGE-AI is a Doctoral Network funded through the EU's Marie Skłodowska-Curie Actions, aimed at training a new generation of innovative and entrepreneurial-oriented doctoral candidates at various locations in Europe (Finland, the Netherlands, Belgium, Germany, Switzerland and Austria). The aim of the network is to develop new and trustworthy AI methods for longitudinal neuroimage analysis, helping clinical experts assess temporal changes in patients with chronic brain disorders.

Background

Multiple sclerosis (MS) is a complex neurodegenerative disease traditionally diagnosed through intermittent clinical episodes and longitudinal MRI monitoring of brain lesions and atrophy. However, this binary classification approach—relapsing vs. remitting, active vs. inactive—fails to capture the continuous spectrum of brain degradation increasingly revealed by recent biopathological research. Current monitoring methods rely on limited observational markers that cannot explain disease mechanisms or predict individual trajectories. This PhD project aims to transform MS characterisation from categorical labels to continuous quantification by developing a Deep Structural Causal Model (DSCM) framework that integrates observational data with expert clinical knowledge to uncover disease mechanisms.

Project description (DC13)

This project will tackle the prevalent problem of technical variability in clinical brain MRI. Images acquired across different scanner vendors, protocols, contrasts, and resolutions create distribution shifts that introduce errors in automated biomarker extraction, requiring costly and unreliable model retraining. The candidate will explore two complementary state-of-the-art approaches: (a) SO(3)-equivariant deep learning models capable of handling varying resolutions across different scanner field strengths (0.5T–7T) (in co-supervision with Dr Richard McKinley Inselpital Bern), and (b) brain MRI foundation models with rapid task adaptation capabilities. A key innovation will be investigating how incorporating the longitudinal dimension can enhance both approaches and create synergies between them.

The candidate will also develop a comprehensive causal framework for MS. Derived imaging biomarkers, alongside multimodal data (omics, demographics, clinical assessments), will be integrated into a SCM guided by clinical expert knowledge. This SCM will provide an explicative skeleton of the MS data generation process (from underlying pathology to observable imaging features and diagnosis), enabling mathematical characterisation of disease mechanisms through causal theory. While traditional causal models require abundant observations, longitudinal imaging studies face inherent data limitations. The candidate will also explore other advanced methods (e.g., GLACIAL) to address this constraint.

Expected outcomes include:

- Novel equivariant and foundation model architectures robust to multi-site, multi-contrast, and multi-resolution MRI data
- A DSCM framework linking imaging biomarkers to disease mechanisms through causal relationships, validated against clinical expert knowledge
- Methodological advances for causal inference from limited longitudinal imaging data
- Open-source modules integrating longitudinal constraints for improved MS characterisation
- Validated tools for continuous MS quantification that move beyond binary disease categorisation

Your profile

- A master's (MSc) degree in physics, computer science, or electrical engineering, or similar degree with an equivalent academic level.
- You have experience in machine learning and deep learning with applications in medical imaging.
- A strong will to develop clinically actionable methods and to interact with clinicians is required.
- Good programming skills Python, including full stack and deep learning frameworks (PyTorch or TensorFlow).
- Experience with brain MRI data, or longitudinal analysis or causal theory is a plus but not mandatory.
- Good English skills (oral and written) are required.

We offer

- A multidisciplinary project jointly with Lausanne University Hospital between cutting-edge brain imaging and advanced image processing, machine learning, and clinical applications.
- A dynamic, interdisciplinary, and international team of very motivated people.
- A stimulating work environment.
- Access to cutting-edge technology and state-of-the-art resources.

How to apply

- Applications can only be submitted through Aalto University's online job platform until 30 January 2026 at 23:59 Finnish time (GMT +2), or until all positions have been filled (whichever comes first).
- Screening and filling of the positions will start as soon as applications are received. Therefore, it is recommended to apply as early as possible.
- We strive to ensure diversity and gender equality in the BRIDGE-AI network through an open, transparent, and merit-based recruitment. Women and others underrepresented in the field of computational neuroimaging are particularly encouraged to apply.
- In order to apply, you should include: (1) a cover letter explaining your motivation for applying; (2) your CV; (3) relevant transcripts of studies and certificates of your degrees; and (4) the names and contact information of at least two professional references who may be contacted regarding your application. You should indicate which position(s) you

are applying to (maximum 3), and indicate the order of preference within the selected positions (1 = highest preference).
- We reserve the right to leave positions open, to extend the application period, and to reopen the application process.
- For more information about the application and selection procedure, please see the FAQ page.

IMPORTANT:

- Applicants can be of any nationality, but must not have resided or carried out their main activity (work, studies, etc.) in the country of employment for more than 12 months in the 36 months immediately before their date of recruitment. Compulsory national service, short stays such as holidays, and time spent as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account.
- At the date of the recruitment, applicants can not already be in possession of a doctoral degree. Researchers who have successfully defended their doctoral thesis but who have not yet formally been awarded the doctoral degree are also not eligible.
- Successful applications are subject to academic approval from the University of Lausanne and the Doctoral School; the selected candidate will be enrolled in the Life Science Doctoral School at the Faculty of Biology and Medicine of the Lausanne University. Funding is secured for three years, with a strong intention to seek additional funding for a fourth year.

About CIBM

The CIBM Center for Biomedical Imaging was founded in 2004 and is the result of a major research and teaching initiative of the partners in the Science-Vie-Société (SVS) project between the Ecole Polytechnique Fédérale de Lausanne (EPFL), the Université de Lausanne (UNIL), Université de Genève (UNIGE), the Hôpitaux Universitaires de Genève (HUG) and the Centre Hospitalier Universitaire Vaudois (CHUV), with the generous support from the Fondation Leenaards and Fondation Louis-Jeantet.

CIBM brings together highly qualified, diverse, complementary, and multidisciplinary groups of people with common interest in biomedical imaging.

We welcome you in joining the CIBM Community.

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