Offer #2026-10454

PhD Position F/M Pretrained models of multimodal neuroimaging for predicting individual cognition

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

Created in 2008, the Inria Saclay Center is located at the heart of the Paris-Saclay scientific and technological excellence cluster, which alone accounts for 15% of French research. Serving the development of the Université Paris-Saclay and the Institut Polytechnique de Paris, the Inria Saclay center employs 80 people in research support services and 500 scientists of 54 nationalities.

Benefiting from continuous growth, the center now has a total of 42 project-teams and two in the process of being created, including 21 jointly with the Institut Polytechnique de Paris, 16 with the Université Paris-Saclay, as well as 7 Inria EPs, including one in collaboration with Onera and one with the Pôle Universitaire Centre Val de Loire. These research teams are spread over more than ten sites.

Context

Within the framework of a partnership (you can choose between)

- public with French National Research Agency (ANR), and the Neurofunctional Imaging Group in Bordeaux, France

Is regular travel foreseen for this post ?

Yes. The consortium meets in person quarterly, alternating between Saclay and Bordeaux, and the student will present the work at international conferences (NeurIPS, ICML, MICCAI, OHBM). Travel expenses are covered within the limits of the scale in force.

The student will become a member of the MIND Inria team, hosted at CEA NeuroSpin on the Paris-Saclay campus. He or she will have office space at NeuroSpin and be provided the necessary materials (workstation with GPU, access to the Inria Saclay and NeuroSpin GPU clusters, and to the national Jean Zay supercomputer) to conduct the described research. The student will work in close interaction with the GIN Bordeaux team, which brings its expertise in white matter anatomy, lesion mapping and cognitive neuroscience to the project.

Assignment

With the help of D. Wassermann the recruited person will conduct a PhD thesis on the following research:

After fifty years of neuroimaging, the relationship between brain organisation and primary sensorimotor function is well characterised: replicable, lesion-validated and spatially precise. Higher-order cognition is a different matter. Working memory, executive control, spatial attention and language recruit the same distributed regions across entirely different paradigms, producing overlapping activation maps that resist segregation. Large-scale databases such as the Human Connectome Project (n ? 1,200) and the UK Biobank (n > 40,000) show that multimodal neuroimaging phenotypes predict composite cognitive scores with correlations approaching r = 0.5. However, the experiments with the highest cognitive specificity rarely exceed 50–200 participants, a regime in which deep learning models cannot be trained from scratch. Cognitive neuroscience needs pretrained neuroimaging models that transfer to any dataset, however small.

The MIND team and the GIN Bordeaux team are building such models within an ANR-funded collaboration. The recruited PhD student will develop the machine learning core of this effort: pretrained models of multimodal neuroimaging (functional MRI, diffusion MRI and structural MRI) that predict individual cognitive phenotypes and quantify the uncertainty of their predictions.

The thesis has three objectives. First, the student will build the data infrastructure on which the models are trained: open preprocessing and harmonisation pipelines for large multimodal databases such as the Human Connectome Project and the UK Biobank, covering functional, diffusion and structural MRI together with their cognitive batteries. Second, the student will design and benchmark deep generative and self-supervised models that learn representations of the multimodal brain phenotype from these databases and predict cognitive outcomes from them, with principled uncertainty quantification. Third, the student will study how these representations transfer to the small and medium-sized datasets that make up most of cognitive neuroscience, comparing transfer learning and domain adaptation strategies under rigorous cross-validation, and release the resulting benchmarks openly.

The central methodological challenge of the thesis is to learn representations that are both faithful to the neuroimaging signal and relevant to cognition, at the scale of tens of thousands of subjects, while keeping the uncertainty of the resulting predictions calibrated. Reaching this goal draws on the MIND team's experience in

amortised variational inference (PAVI), likelihood-free inference for brain microstructure, and transfer learning of individualised functional parcellations, and on the joint work of the two teams on the geometry of brain–cognition organisation (Pacella et al., 2024).

At the end of the thesis, the student will have produced openly released pretrained multimodal models with uncertainty quantification, the open preprocessing and training code that reproduces them, and an open transfer learning benchmark with practical recommendations for deploying the models on small cognitive neuroscience datasets.

A short video presenting the overall project is available at https://lnkd.in/p/efNwKsm3.

For a better knowledge of the proposed research subject we recommend the following literature:

1. Pacella, V.; Thiebaut de Schotten, M.; Wassermann, D. et al. The morphospace of the brain–cognition organisation. Nature Communications 2024, 15, 8452, DOI: 10.1038/s41467-024-52186-9.
2. Rouillard, L.; Moreau, T.; Wassermann, D. PAVI: Plate-Amortised Variational Inference. Transactions on Machine Learning Research 2022, DOI: 10.48550/arXiv.2206.05111.
3. Le Bris, A. et al. Improving Individual-Specific Functional Parcellation Through Transfer Learning. Preprint 2024.
4. Jallais, M.; Rodrigues, P. L. C.; Gramfort, A.; Wassermann, D. Cytoarchitecture Measurements in Brain Gray Matter Using Likelihood-Free Inference. In Information Processing in Medical Imaging (IPMI), Springer, 2021, pp 191–202, DOI: 10.1007/978-3-030-78191-0_15.
5. Abdallah, M.; Zanitti, G. E.; Iovene, V.; Wassermann, D. Functional Gradients in the Human Lateral Prefrontal Cortex Revealed by a Comprehensive Coordinate-Based Meta-Analysis. eLife 2022, 11, e76926, DOI: 10.7554/eLife.76926.
6. Menon, V.; Gallardo, G.; Pinsk, M. A.; Nguyen, V.-D.; Li, J.-R.; Cai, W.; Wassermann, D. Microstructural Organization of Human Insula Is Linked to Its Macrofunctional Circuitry and Predicts Cognitive Control. eLife 2020, 9, e53470, DOI: 10.7554/eLife.53470.
7. Ooi, L. Q. R. et al. Comparison of individualized behavioral predictions across anatomical, diffusion and functional connectivity MRI. NeuroImage 2022, 263, 119636, DOI: 10.1016/j.neuroimage.2022.119636.
8. Ooi, L. Q. R. et al. Longer scans boost prediction and cut costs in brain-wide association studies. Nature 2025.
9. Glasser, M. F. et al. A multi-modal parcellation of human cerebral cortex. Nature 2016, 536, 171–178, DOI: 10.1038/nature18933.
10. Tavor, I. et al. Task-free MRI predicts individual differences in brain activity during task performance. Science 2016, 352, 216–220, DOI: 10.1126/science.aad8127.
11. Van Essen, D. C. et al. The WU-Minn Human Connectome Project: an overview. NeuroImage 2013, 80, 62–79, DOI: 10.1016/j.neuroimage.2013.05.041.
12. Miller, K. L. et al. Multimodal population brain imaging in the UK Biobank prospective epidemiological study. Nature Neuroscience 2016, 19, 1523–1536, DOI: 10.1038/nn.4393.

13. Poldrack, R. A. Can cognitive processes be inferred from neuroimaging data? Trends in Cognitive Sciences 2006, 10, 59–63, DOI: 10.1016/j.tics.2005.12.004.

Main activities

Main activities (5 maximum) :

- Build and release open preprocessing and harmonisation pipelines for large multimodal neuroimaging databases (fMRI, diffusion MRI, structural MRI and cognitive batteries)
- Design, train and benchmark deep generative and self-supervised models of the multimodal brain phenotype that predict cognitive outcomes with calibrated uncertainty
- Evaluate transfer learning and domain adaptation strategies on small and medium-sized cognitive neuroscience datasets and release an open benchmark suite
- Validate the advances and write scientific literature on them, targeting NeurIPS, ICML, MICCAI, OHBM and journals such as Nature Methods or NeuroImage
- Release models and code openly and interact with the GIN Bordeaux partner team

Skills

Technical skills and level required :

- Good mastery of Python programming and of at least one deep learning framework (PyTorch or JAX)
- Comfortable with mathematical formalisms and the formal background of machine learning and AI: probability, statistics, variational inference and representation learning
- Experience with neuroimaging data (fMRI, diffusion MRI) and their analysis tools (e.g. nilearn, fMRIPrep, MRtrix, DIPY) is desirable
- Experience with large-scale computing (SLURM clusters, multi-GPU training) is desirable

Languages :

- The candidate is expected to be able to communicate proficiently in English. French is not required.

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
- Access to vocational training
- Social security coverage

Remuneration

2300€ gross/month

General Information

- **Theme/Domain :** Computational Neuroscience and Medicine
- **Town/city :** Palaiseau
- **Inria Center :** Centre Inria de Saclay
- **Starting date :** 2027-01-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2026-11-30

Contacts

- **Inria Team :** MIND
- **PhD Supervisor :**
  Wassermann Demian / demian.wassermann@inria.fr

About Inria

Inria, the French national institute for research in digital science and technology, supports the French government in national research and innovation strategies in the digital field, acting as Digital Programs Agency. Inria leads over 300 research and innovation projects with its 3,500 scientists, engineers, and support staff, in partnership with universities and the digital ecosystem (businesses, entrepreneurs, and public stakeholders). Together, we explore strategic fields such as artificial intelligence, cybersecurity, quantum computing, cloud technologies, digital transformation in healthcare, digital twins, and digital technologies for defence. We develop practical solutions such as software, tech startups, partnerships with national companies, and cutting-edge training programmes. Our goal is to drive scientific, technological, and industrial excellence to ensure France’s digital sovereignty.

The keys to success

There you can provide a "broad outline" of the collaborator you are looking for what you consider to be necessary and sufficient, and which may combine :

- a passion for AI and ML but also for neuroscience
- comfortable with tools such as PyTorch and mathematical basis of AI.

- a preference for teamwork
- This section enables the more formal list of skills to be completed and 'lightened' (reduced) :

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.