Offre n°2024-07914

PhD Position F/M Deep learning for assisting clinical decisions in brain imaging: trustworthy validation and benchmarking

Le descriptif de l'offre ci-dessous est en Anglais

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Doctorant

Contexte et atouts du poste

A vibrant scientific, technological, clinical and ethical environment

You will work within the ARAMIS lab (www.aramislab.fr) at the Paris Brain Institute (http://www.icm-institute.org), one of the world top research institutes for neurosciences. The institute is ideally located at the heart of the Pitié-Salpêtrière hospital, downtown Paris.

The ARAMIS lab, which is also part of Inria (the French National Institute for Research in Computer Science and Applied Mathematics), is dedicated to the development of new machine learning and statistical approaches for the analysis of large neuroimaging and clinical data sets.

This PhD is funded as part of the Paris Artificial Intelligence Research Institute (PRAIRIE https://prairie-institute.fr/). O. Colliot holds a research Chair within the PRAIRIE institute. Within the PRAIRIE Institute, the PhD candidate will have access to a rich scientific environment covering all aspects of AI, including many seminars, workshops and gatherings for PhD candidates and postdocs.

To perform large scale experiments, the PhD candidate will have access to the Jean Zay supercomputing infrastructure which comprises about 2,000 V100 GPUs and about 400 latest generation A100 GPUs.

The PhD candidate will be interacting frequently with other PhD students as well as with engineers working on the ClinicaDL software platform. In particular, the PhD candidate will receive the help of engineers for data management and implementation.

Finally, this project is part of a large-scale collaboration on validation of AI algorithms in medical imaging conducted with the German Cancer Research Center at Heidelberg and at the Soda Team at Inria Saclay.

Mission confiée

Deep learning-based analysis of brain imaging data holds great promises for assisting clinical decision in brain disorders (e.g. Alzheimer's disease, Parkinson's disease...). This is a very active research field with many papers published each year (Colliot, 2023). However, the real medical impact in terms of translation to patient care has been so far limited. Experimental results presented in research papers are most often inadequate for answering two key questions for clinical translation: i) do we have solid guarantees on the performance of the proposed approach?; ii) among different deep learning approaches, do we have strong evidence to select the one which performs best? There are several underlying reasons: i) irreproducible research procedures and results; ii) inadequate experimental set-ups which don't account for the specificities of brain imaging; iii) biased validation procedures; iv) inadequate or lack of inferential statistics.

Our team has been a pioneer and has produced highly-cited work on reproducible and trustworthy evaluation of machine learning for computer-aided diagnosis of Alzheimer's disease (e.g. Samper-Gonzalez et al, 2018; Wen, Thibeau-Sutre et al, 2020). In particular, we have unveiled biased validation procedures, proposed frameworks to avoid them, performed large-scale benchmarks and created an Open Source software platform for reproducible deep learning in brain imaging, ClinicaDL (https://clinicadl.readthedocs.io/en/latest/). However, important questions remain unanswered including integration of inferential statistics into the framework, generalization across different disorders, accounting for dependent data (e.g. patient/scanner/hospital hierarchical data structure), and generalization across datasets.

Building upon these efforts, this PhD project aims at obtaining a general methodological and experimental framework for trustworthy and reproducible validation and benchmarking of deep learning methods in brain imaging and performing large-scale experiments.

References

- Colliot O (editor), *Machine Learning for Brain Disorders*, Springer, 2023. https://hal.science/hal-04225627/document
- Wen J, Thibeau-Sutre E, Diaz-Melo M, Samper-González J, Routier A, Bottani S, Dormont D, Durrleman S, Burgos N, and Colliot O, Convolutional neural networks for classification of Alzheimer's disease: Overview and reproducible evaluation, *Medical Image Analysis*, 63, 101694, 2020. https://hal.science/hal-02562504
- Samper-González J, Burgos N, Bottani S, Fontanella S, Lu P, Marcoux A, Routier A, Guillon J, Bacci M, Wen J, Bertrand A, Bertin H, Habert M-O, Durrleman S, Evgeniou T, and Colliot O, Reproducible evaluation of classification methods in Alzheimer's disease: Framework and application to MRI and PET data, *NeuroImage*, 183:504–521, 2018. https://inria.hal.science/hal-01858384v2/file/AD_ML_manuscript_postprint.pdf

Principales activités

Specific objectives are as follows:

- enrich the framework with more advanced deep learning models, more tasks and more datasets
- better account for specificities of brain imaging (multiple acquisitions over time, multiple scanners, multiple hospitals, multiple datasets, multiple disorders)
- propose an adequate inferential statistics framework for both model validation and model comparison
- perform benchmarking experiments across deep learning (and also standard machine learning) models, tasks, diseases and datasets to create a new standard for the community
- demonstrate the importance of accounting for brain imaging specificities when evaluating models
- implement the approaches in open-source software, in particular ClinicaDL (https://clinicadl.readthedocs.io/) so that they can benefit the entire scientific community

Compétences

- Excellent background in machine learning
- Excellent programming skills in Python
- Strong interest for experimental aspects of machine learning
- Good background in statistics
- Knowledge of the specificities of computer vision and medical image processing would be a plus
- Good writing skills
- Good relational and communication skills
- Ability to collaborate efficiently with other team members

Avantages

- 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 (after 12 months of employment)
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Informations générales

- **Thème/Domaine** : Neurosciences et médecine numériques
- **Ville** : Paris
- **Centre Inria** : Centre Inria de Paris
- **Date de prise de fonction souhaitée** : 2024-10-01
- **Durée de contrat** : 3 ans
- **Date limite pour postuler** : 2024-09-27

Contacts

- **Équipe Inria** : ARAMIS
- **Directeur de thèse** :
  Colliot Olivier / Olivier.Colliot@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires

académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

- Master or engineering degree with a specialization in machine learning

Note that the starting date is flexible.

Also, do not hesitate to contact directly Olivier Colliot olivier.colliot@inria.fr by email, attaching your CV, to know more about the project.

> **Attention**: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.