The Aramis team at the Brain Institute is recruiting a PhD student

PhD thesis: Deep learning for rating of atypical anatomical patterns on MRI data

General information

Workplace**: Brain Institute, ARAMIS Team, Pitié Salpêtrière Hospital, 47 Bd. de l'hôpital, 75013 Paris**
Name of the scientific supervisor: **Olivier Colliot (olivier.colliot@sorbonne-universite.fr)**

Mission

Incomplete hippocampal inversion (IHI) is an atypical anatomical pattern of the brain. Although quite common in the general population (15%-20%), it has been linked to several major neurological and psychiatric disorders, mainly epilepsy and schizophrenia. The causes of this atypical pattern remain mostly unknown. We recently published a study suggesting a potentially strong effect of genetic factors (Cury et al, 2020). Nevertheless, the study included a moderate sample size and larger scale studies are needed. The presence of the IHI pattern can be assessed on magnetic resonance imaging (MRI) data. This is currently done using visual inspection using standardized scales. Such scales assess different features of IHI, their combination being used to determine the presence of absence of IHI. Such approach is reliable and reproducible. However, it does not scale to very large samples.

The aim of this project is to design and validate a deep learning method for automatic assessment of IHI from MRI data and apply it to study the genetic bases of IHI. The project may start as a Master internship.

The first objective will be to develop a deep learning method for detection of IHI. We propose to set-up the problem as a joint training task, predicting simultaneously individual anatomical criteria as well as the overall presence of the whole IHI. Such an approach has the advantage of making the trained model potentially more interpretable. We will perform ablation studies to understand the importance of the different components of our model. In order to train and validate the model, we have a dataset of around 2000 subjects with annotations. Our collaborators also have

annotated datasets in different diseases (schizophrenia, depression…). We will aim to extend the model to make it robust to variations of the MRI acquisition sequences.

Then, we propose to apply the model to several datasets in order to study the genetic bases of IHI. More specifically, we plan to apply the model to the UKBIOBANK comprising over 20,000 participants with MRI and genetic data, to the Queensland Twin Imaging Study as well as to some datasets of the ENIGMA consortium. The developed tool will be distributed as Open Source software following the framework developed in our previous research (Wen et al, 2020).

- Burgos N, Bottani S, Faouzi J, Thibeau-Sutre E, and Colliot O. Deep learning for brain disorders: from data processing to disease treatment. Brief Bioinform. 2020 Dec 15:bbaa310. doi: 10.1093/bib/bbaa310. Online ahead of print
- 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. 2020 Jul;63:101694. doi: 10.1016/j.media.2020.101694. Epub 2020 May 1.
- Cury C, Scelsi MA, Toro R, Frouin V, Artiges E, Grigis A, Heinz A, Lemaître H, Martinot J-L, Poline J-B, Smolka MN, Walter H, Schumann G, Altmann A, and Colliot O, Genome wide association study of incomplete hippocampal inversion in adolescents, PloS One, 15:1, e0227355, 2020.

Activities
- Develop research in the field of deep learning for brain imaging
- Write scientific articles for publication in international journals and conference proceedings
- Present results at international conferences
- Contribute to the implementation and dissemination of open source software

Working context
You will work within the ARAMIS lab (www.aramislab.fr) at the Paris Brain Institute. 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 computational approaches for the analysis of large neuroimaging and clinical data sets. With about 35 people, the lab has a multidisciplinary composition, bringing together researchers in machine learning and statistics and medical doctors (neurologists, neuroradiologists).

The project will be conducted in collaboration with the Empenn team at Inria Rennes (Claire Cury). We also have close links with the University of Southern California at Los Angeles, USA (Ho-Sung Kim, Paul Thompson) and with the University of Queensland at Brisbane, Australia (Peter Visscher, Naomi Wray) which are relevant to the topic. Part of the research done in this project could be done in collaboration with these two universities.

The internship/thesis will be directed by Olivier Colliot (Research Director, HDR) and co-supervised by Claire Cury (Research Scientist, Inria Rennes) and Baptiste Couvy-Duchesne (Postdoc, AramisLab).

We have access to a supercomputer with 1044 nVIDIA V100 GPU.

Additional information
Desired skills

- Master or engineering degree with a specialization in machine learning
- Strong interest for applications in neuroscience
- Good programming skills in Python
- Knowledge in digital image processing and medical imaging
- Good writing skills
- Good relational and communication skills

Contact
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