ARAMIS LAB
Brain and Spine Institute (ICM)
CNRS UMR 7225 – Inserm U1127
Sorbonne Université
Inria – Paris Research Center
www.aramislab.fr

The Aramis Lab at ICM/Inria is recruiting a Master student with a possible extension to PhD position

Pseudo-healthy image synthesis for the detection of anomalies in the brain, a deep learning approach

Beginning of the internship: **Spring 2020**
Duration: **6 months**
Financial support: **regular internship gratification**
Location: **Institut du Cerveau et de la Moelle Épinière, ARAMIS team,**
Hôpital Pitié Salpêtrière, 47 Bd. de l'hôpital, 75013 Paris

Keywords: deep learning, convolutional neural networks, generative adversarial networks, auto-encoders, image analysis, medical imaging, dementia, Alzheimer's disease, Python, PyTorch

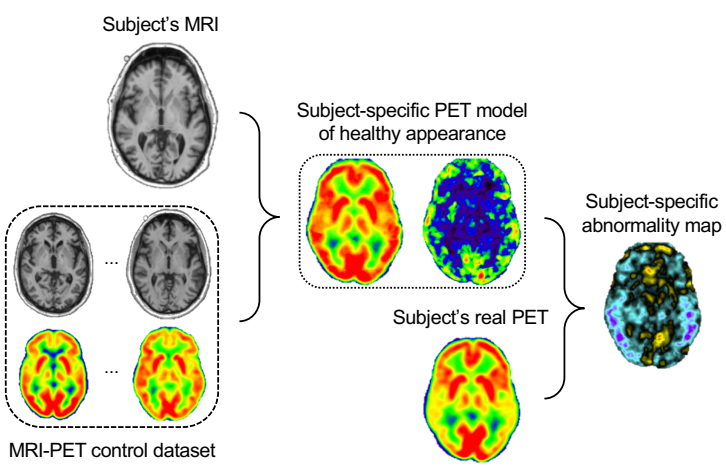
The topic:

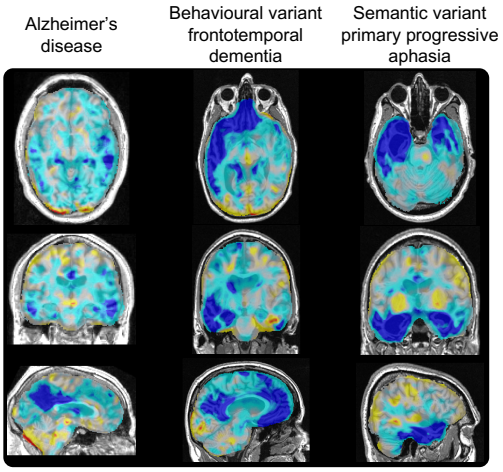
Neuroimaging offers an unmatched description of the brain's structure and physiology, which explains its crucial role in the understanding, diagnosis, and treatment of neurological disorders. However, identifying subtle pathological changes simply by looking at images of the brain can be a difficult task. For this reason, images are often transported to a standard space where they can be visually or quantitatively compared to images of normal controls. The main limitation of this approach is its lack of sensitivity due to variabilities between subjects in non-pathological areas.

A solution has been proposed by our team to mitigate this limitation [1,2]. The approach consists of generating a healthy-looking image specific to the patient under investigation. When compared to the real image of the patient, the pseudo-healthy model can be used to detect the areas of the image that show abnormalities. These abnormality maps could help clinicians in their diagnosis by highlighting pathological areas in a data-driven fashion, and improve the interpretability of subsequent analyses, such as computer-aided diagnosis or spatio-temporal modelling.

[1] Burgos, N., Cardoso, M.J., …, Hutton, B.F., and Ourselin, S.: 'Subject-Specific Models for the Analysis of Pathological FDG PET Data'. In Medical Image Computing and Computer-Assisted Intervention – MICCAI 2015, LNCS, 9350: 651–658, Springer, 2015. hal-01827208

[2] Burgos, N., Samper-González, J., …., Cardoso, M.J., and Colliot, O.: 'Individual Analysis of Molecular Brain Imaging Data through Automatic Identification of Abnormality Patterns'. In Molecular Imaging, Reconstruction and Analysis of Moving Body Organs, and Stroke Imaging and Treatment, LNCS, 10555: 13–22, Springer, 2017. hal-01567343





Anomaly detection framework for the individual analysis of PET images in the context of dementia
Subject-specific abnormality maps that summarise the pathology's topographical distribution in the brain are created by comparing the subject's positron emission tomography (PET) image to a model of healthy PET appearance that is specific to the subject under investigation. This model is generated from demographically and morphologically-matched PET scans from a control dataset. The approach is able to identify the areas characteristic of different dementia subtypes.

The project:

The image synthesis approach currently used to generate the pseudo-healthy models is based on a registration and fusion algorithm. The aim of the project is to implement a deep learning approach to synthesise pseudo-healthy images. Strategies that can be explored include the use of generative adversarial networks and auto-encoders. The approach developed will be applied to neuroimaging data for the computer-aided diagnosis of dementia (such as Alzheimer's disease). The generated abnormality maps will be evaluated and compared with the ones obtained with the current approach.

A vibrant scientific, technological and clinical environment:

You will work within the ARAMIS lab (www.aramislab.fr) at the Brain and Spine 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 Digital Science and Technology), is dedicated to the development of new computational approaches for the analysis of large neuroimaging and clinical data sets.

You will interact locally with the PhD students, postdoctoral fellows and engineers of the lab, as well as our medical collaborators at the Pitié-Salpêtrière hospital.

If successful, the internship could be extended to a PhD position, funded by PR[AI]RIE, the PaRis AI Research InstitutE (https://prairie-institute.fr).

Your profile

- Master's degree or engineering degree with computer science, image analysis and/or applied mathematics profile
- Knowledge of deep learning
- Programming skills in Python
- Good relational and communication skills to interact with professionals from various backgrounds

Ready to take up the challenge?

Send your CV to Ninon Burgos (ninon.burgos@icm-institute.org) explaining your motivations.