2-years Postdoctoral Position

Separating Healthy from Pathological Patterns in Neuroimaging

Keywords: Deep learning, Contrastive Analysis, Medical Imaging, Neuroimaging, Generative models

Introduction The unsupervised separation of the healthy latent patterns from the pathological ones is not a trivial task in medical imaging. In neuroimaging, pathological brain signatures of psychiatric or neurodevelopmental disorders are not easily visible with the naked eye, even for experienced radiologists. In particular, psychiatry lacks objective, quantitative measures (such as blood dosage) to guide clinicians in choosing a therapeutic strategy. The identification of prognostic brain signatures of clinical courses or responses to treatment would pave the way towards personalised medicine in psychiatry.
In this project, following the recent contrastive analysis (CA) setting [1,2], we wish to discover in an unsupervised way what is added or modified on images of a target dataset of psychiatric patients compared to a control dataset of healthy subjects, as well as what is common between the two domains. Current state-of-the-art (SOTA) methods are latent variable models based on Variation Auto-Encoder (VAE) that estimate *generative* latent factors *common* to both domains or *distinctive* of the target domain. However, they all either ignore important constraints or they don't enforce fundamental assumptions. This may lead to sub-optimal solutions where distinctive factors are either mistaken for common ones (or viceversa) or not correctly captured. Furthermore, the generated images have a rather poor quality, typical of VAEs, decreasing their interpretability and usefulness.

Objectives The objective of the candidate will be to propose a novel CA statistical method that will: 1- leverage the high-quality synthesis of Generative Adversarial Networks (GAN) and 2- integrate new information-theoretic regularizations to better separate and estimate common and salient generative factors. The proposed method will be tested on MR images of patiens with three different psychiatric diseases: autism, schizophrenia and bipolar disorder.

When Deadline to candidate: 02/06/2023. Final response: 05/07/2023. Position must start before: 12/2023.

Team This project will be carried out under the supervision of P. Gori (Télécom Paris, IPParis) in collaboration with researchers and clinicians from NeuroSpin (CEA).

Salary Salary will depend on experience and academic background (Starting salary: 34800 euros/year).

Required background PhD in applied mathematics, statistics, computer science, engineering with a good knowledge of Python and deep learning.

How to apply Candidates are invited to send a CV to pietro.gori@telecom-paris.fr detailing their academic background and publications.

References

[1] Abid, A., Zhang, M. J., Bagaria, V. K., and Zou, J. Exploring patterns enriched in a dataset with contrastive principal component analysis. *Nat Commun 9*, 1 (2018), 2134. 1

[2] Weinberger, E., Beebe-Wang, N., and Lee, S.-I. Moment Matching Deep Contrastive Latent Variable Models. In *AISTATS* (2022). 1