PhD position at CREATIS lab

Pushing the performance limits of deep diagnosis and prognosis models based on multimodality medical imaging.

Keywords : Deep Learning, Multiview Learning, Transfer Learning, Diagnosis and Prognosis Models, Multimodality Neuroimaging (MRI, PET..)

Scientific context

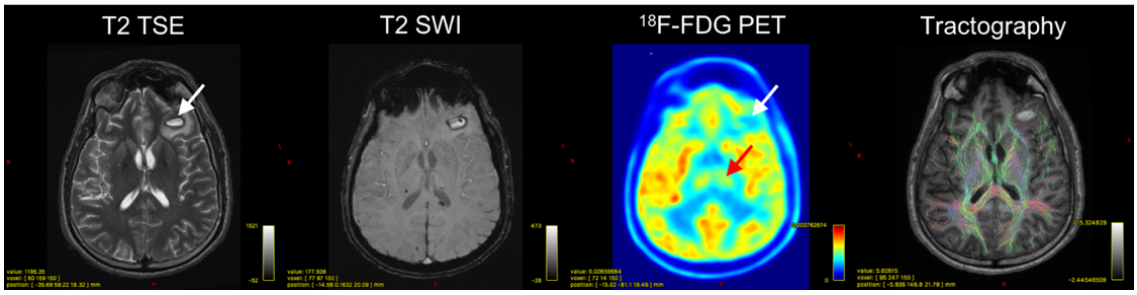

Figure 1: Preliminary results assessing the feasibility of the PET-MR imaging in acute comatose patients. White arrow: focal cortical 18F-FDG PET hypometabolism centred on a left orbito-frontal lesion. Red arrow: global thalamic hypometabolism ipsilateral to the lesion. courtesy : CERMEP

In recent years, **deep machine learning** has received a lot of attention to **explore and structure multidimensional and multimodality medical imaging data**. The 'Images and Models' team from CREATIS lab (www.creatis.insa-lyon.fr) in Lyon (France) has developed a strong expertise in the domain of machine learning for the design of diagnosis [1, 2, 3, 4] and prognosis models [5]. While these models target different objective

- **Prognosis models** aiming at **predicting the course and outcome of disease** processes,
- **Diagnosis models** aiming at **detecting, localizing and characterizing pathological patterns** in the data,

they both rely on similar theoretical foundations in machine learning.

PhD project

The objective of this PhD project is to **perform upstream research in deep learning to push the performance limits of the prototype models** we have designed so far. Different research axes may be investigated, e.g.:

- **Accounting for the complementary information provided by different imaging modalities** appears as an appealing alternative to increase the discriminant power of deep architectures. Most of the current prototype models, however, use standard fusion strategies consisting either in concatenating the different types of images at the entrance of one unique model (early fusion) or designing separate models for each modality and merging the output layers (late fusion). Such strategies may not be optimal, especially when considering heterogeneous types of data (eg voxel matrices, graphs etc) as illustrated on figure 1. We propose to consider this problem from the **multiview learning** perspective by proposing efficient ways to **encode end fuse the heterogeneous information provided by different imaging modalities**. Such developments should take into account that some patients may have incomplete exams, and thus be also considered from the perspective of **learning models with incomplete data**.

- Standard deep learning tools for regression and classification do not capture model uncertainty. Confidence in the output prediction of medical diagnosis and prognosis models, however, is crucial when considering transfering these models to the clinical practice. The machine learning community is currently investigating ways to **estimate model confidence from deep architectures**. We'll leverage on this recent work to derive tailored architectures for the diagnosis or prognosis models at hand.

The research axes to explore will be defined and prioritized according to prevailing methodological challenges to tackle at the beginning of the PhD project. These challenges will be defined from the state-of-the art bibliography as well as from the perspective of two ongoing clinical projects of our group. The first one concerns the prototyping of a **diagnosis model of epilepsy lesions in multiparametric *negative* MRI** [4]. The second one is a research project granted by the french research agency (ANR) that has just been launched for 5 years (2019-2023) to develop a **prognosis model of patient coma outcome based on multimodality imaging** (see figure 1).

We expect to propose novel solutions that will allow a performance gain compared to the current prototypes.

Scientific coordination and collaborations

The candidate will be supervised by Carole Lartizien from CREATIS who has an acknowledged experience with multi-modal medical image processing and have developed skills in machine learning for medical imaging (creatis.insa-lyon.fr/∼lartizien).

The PhD candidate will benefit from ongoing collaborations with external experts in the machine learning domain, neurologists from Hospices Civils de Lyon (HCL), as well as the scientific emulating environment of the 'Images and Models' team which currently explores the potential of machine and deep learning for medical image processing.

She/he will have access to multimodality imaging databases that have been collected for the two clinical projects as well as the prototype models that have been developed so far.

Profile of the applicant

The candidate is expected to have strong knowledge either in machine learning or image processing and a good experience in both fields. Some prior experience with medical image processing would be appreciated but is not required. Good programming skills are also required. We are looking for an enthusiastic and autonomous student with strong motivation and interest in multidisciplinary research.

Work environment and salary

- The doctoral position will take place at the CREATIS laboratory (www.creatis.insa-lyon.fr). The succesful candidate will join the 'Image and Models' team(https://www.creatis.insa-lyon.fr/site7/en/Images_Models)
- Employment would ideally start in **Summer or Fall 2019** and is funded by the french national scientific research (CNRS)
- Salary is around 1700 euros net per month (+ teaching)

Application

For more details on the position, please contact **carole.lartizien@creatis.insa-lyon.fr**
Interested applicants are required to send a cover letter, CV and any other relevant documents (reference letter, recent transcripts of marks,...) to **carole.lartizien@creatis.insa-lyon.fr**

References

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