Master student training course at CREATIS lab

(Deep) Machine learning for the prediction of patient coma outcome based on multimodality neuroimaging

Host laboratory : Laboratoire CREATIS, 69 Villeurbanne
Supervisors :
Emmanuel Roux - emmanuel.roux@creatis.insa-lyon.fr
Carole Lartizien - carole.lartizien@creatis.insa-lyon.fr
Keywords : Medical Image analysis and Modeling, Machine Learning, Diagnosis model
Duration : 6 months.
Starting date : february/march 2020.
Gratuity $\sim$ 560 euros/month

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1 Scientific context

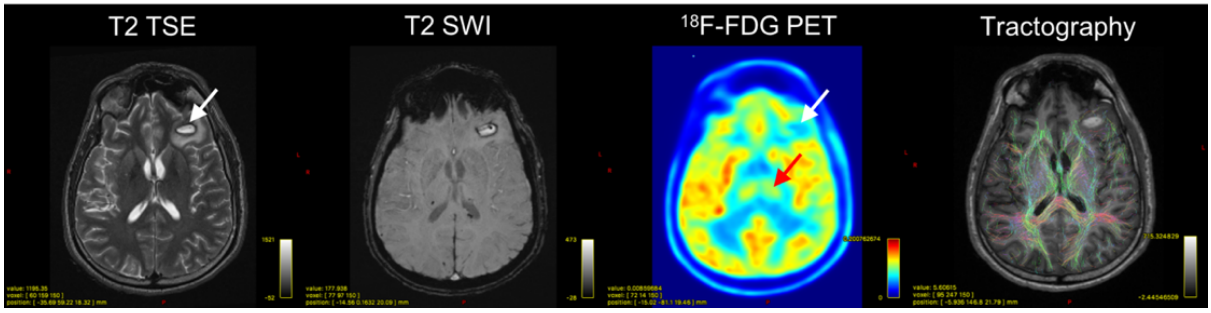

Figure 1: Preliminary results assessing the feasibility of the PET-MR imaging in acute comatose patients. White arrow: focal cortical 18F-FDG PET hypometabolism centred on a left orbito-frontal lesion. Red arrow: global thalamic hypometabolism ipsilateral to the lesion. courtesy : CERMEP

Machine learning has emerged as a very promising field to develop inference models of complex phenomena based on learning samples. In particular, **deep models** have achieved impressive performance in various medical applications (e.g., disease diagnosis, tumor detection, and landmark detection) and CREATIS has developed a strong expertise in deep/machine learning for image processing and computer-aided diagnosis tools [6, 8, 5, 4, 1].
The IMAGINA project funded in October 2018 by the french National Research Agency (ANR) targets the **challenging issue of providing an accurate diagnosis of patients being in acute coma**. Clinical (behavioral) scales are notoriously insufficient and error prone [7]. IMAGINA gathers specialists with complementary expertise in image processing and machine learning (CREATIS), computational neurosciences (CRNL), medicine (HCL) and medical imaging (CERMEP). CREATIS is in charge of developing an automated diagnosis tool that will evaluate the patient coma status (degree of consciousness disorder) by combining the information provided by multimodal imaging with the most advanced machine learning methods.

2 Objective of the internship

- The objective of this master project is to **encode** (i.e. to find a proper representation) the **multidimensional and multimodal** medical images of a coma patient database into a unified

framework in order to **initiate the development of an automated diagnosis tools predicting the patient coma outcome**.

- The candidate will **train deep models** on series of multimodal images (Figure 1) to predict the patient coma outcome. A starting step will be the prediction of the ***Coma Recovery Scale*** (RCS), a reference score associated to each patient by the clinicians.
- The deep models will be specifically designed to handle the challenging specificity of **3-D medical data fusion [3]** (high dimensionality, multimodality, static and dynamic data, heterogeneous spatial and time resolution) using **sparse convolutional networks** [2].
- Improving the interpretability of deep predictive models could strongly increase their use in clinical practice. Hence the candidate will explore existing interpretation tools such as attention networks and activation mapping techniques [9] to **provide visual insights** about the origin of the model predictions.
- Moreover, a **confidence score** will systematically be computed along with the model predictions to quantitatively inform the clinicians about the quality of the prediction.

3 Skills

Candidate should have strong background either in **machine learning** and/or **deep learning** or **image processing** and some experience in both fields as well as **good programming skills**. We are looking for an enthusiastic and autonomous student with strong motivation and interest in multidisciplinary research (image processing and machine learning in a **medical context**). The candidate will also have the opportunity to interact with a PhD student also working within the IMAGINA project.

References

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[3] X. Cheng, L. Zhang, and Y. Zheng. Deep similarity learning for multimodal medical images. *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*, 6(3):248–252, May 2018.

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