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
Supervisor : 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 2019.
Gratuity : ~560 euros/month.

Scientific context

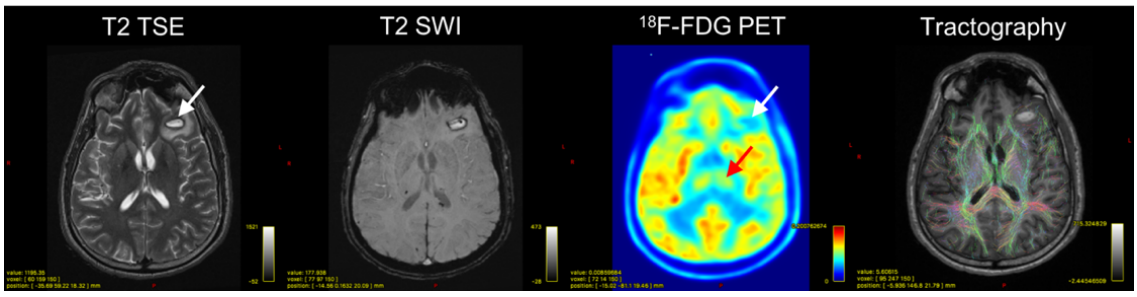

Figure 1: Preliminary results assessing the feasibility of the PET-MR imaging in acute comatose patients. White arrow: focal cortical 18F-FDG PET hypometabolism centred on a left orbito-frontal lesion. Red arrow: global thalamic hypometabolism ipsilateral to the lesion. courtesy : CERMEP

Machine Learning (ML) has emerged as a field of **artificial intelligence** (AI) that develop inference models of complex phenomena based on learning samples. In recent years, machine learning, and more recently deep learning, has received a lot of attention to explore and structure multidimensional and multimodality medical imaging data for the purpose of automated diagnosis and prognosis. CREATIS has developed a strong expertise in the domain of machine learning for image processing as well as computer-aided diagnosis [1, 2, 3, 4, 5] and prognosis.

The IMAGINA project recently funded (oct 2018) by the french National Research Agency (ANR) targets the challenging question of providing an accurate diagnosis of patients being in acute coma. Clinical (behavioral) scales are notoriously insufficient and error prone [6]. This project gathers specialists with complementary expertise in image processing and machine learning (CREATIS), computational neurosciences (CRNL), medicine (HCL) and medical imaging (CERMEP). CREATIS is responsible for developing an automated diagnosis tool that will evaluate the patient coma status (degree of consciousness disorder) by combining the information provided by multimodality imaging with the most advanced machine learning methods.

Objective of the internship

The objective of this master project is to initiate the first developments in machine learning for the statistical analysis of the coma patient database. The objective is to predict patient coma outcome based on the series of images provided

by different imaging modalities as shown on Figure 1.
Two ways will be investigated

- The first one will address the problem from the classical machine learning perspective. A series of manually engineered featured will be extracted from the different series of images and a statistical inference model will be trained to output a score referred to as the *coma recovery scale*. The feature extraction step is currently being developed by the CERMEP partner and will be made available for this master project.
- As an alternative to the handcrafted feature engineering described above, we propose to develop a data driven feature extraction strategy based on the most recent advances in statistical deep learning strategies. Deep learning-based methods incorporate feature extraction and model learning into a unified framework and have achieved impressive performance in various medical applications (e.g., disease diagnosis, tumor detection, and landmark detection).The challenge is to define the optimal strategy to combine the massive and heterogeneous data information acquired for each patient, including multimodality imaging dynamic and static data of different spatial and time resolution as well as different format (3D imaging volume versus graphs).

The experimental work will be based on a preliminary multimodality image database consisting of 40 acute comatose patients and 25 healthy subjects.

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).

References

[1] C. Lartizien, M. Rogez, E. Niaf, and F. Ricard. Computer aided staging of lymphoma patients with fdg pet/ct imaging based on textural information. *IEEE Journal of Biomedical and Health informatics*, 18(3):946–955, 2014.

[2] E. Niaf, R. Flamary, O. Rouviere, C. Lartizien, and S. Canu. Kernel-based learning from both qualitative and quantitative labels: Application to prostate cancer diagnosis based on multiparametric mr imaging. *IEEE Transactions on Image Processing*, 23(3):979–991, 2014.

[3] M. El Azami, C. Lartizien, and S. Canu. Converting svdd scores into probability estimates: Application to outlier detection. *Neurocomputing*, 268:64–75, 2017.

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