Subject:
Automatic segmentation of structures of the human deep brain from nuclear magnetic resonance imaging

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Abstract (up to 10 lines):

The objective of this thesis is to allow the identification and automatic localization of deep brain structures from 3D MRI imagery. The challenge is to get as close as possible to the individual architecture, taking into account intra-class variability for more precise clinical targeting. The difficulty in obtaining large datasets pushes us to favor unsupervised methods. We will thus consider of proposing an original method combining the anatomical preconceptions with the machine learning methods to obtain a fine 3D segmentation. Data fusion methods will also be considered in order to take advantage of the complementarity of the different types of imagery.

Skills:

- MS Degree or equivalent with major in Image processing, Machine learning, or other related subjects
- Experience in medical imaging processing and 3D segmentation are highly desirable
- Strong programming skills (C/C++, Python) and experience with deep learning framework (TensorFlow/Keras/PyTorch...)
- Interest in medical applications and collaboration with clinicians
- Good spoken and written English

Keywords: 3D segmentation, Deep learning, MRI imaging, Deep brain, Data fusion
Description (up to 1 page):

In brain MRI analysis, image segmentation is commonly used to measure and visualize the anatomical structures of the brain, to analyze brain changes, to delineate pathological regions and for surgical planning and image-guided interventions. In last decades, various segmentation techniques of different precision and degree of complexity have been developed and reported in the literature. Recently, new methods using deep learning techniques for brain MRI segmentation have been proposed [1-4]. They usually focus on well-known and identified structures of the brain.

The objective of the Ptoleme project, which brings together clinicians and researchers in image analysis, is to map the deep and little-known regions of the brain. In this context, the objective of this thesis is to develop an automatic segmentation method using a deep learning approach based on a limited dataset of MRI images manually contoured by expert clinicians. The dataset is necessarily limited because the manual contouring of these large and complex MRI data is a tedious and difficult task for clinicians. The solution developed must therefore rely on learning techniques while making the best use of more formal state-of-the-art models in order to minimize the need for supervision.

First, the candidate will have to acquire the state of the art on brain MRI segmentation methods. This step will be based on work currently in progress within the Institut Pascal.

In a second step the candidate will have to propose and implement original methods of segmentation of the deep brain, taking into account the specificities of this dataset. Particular emphasis will be placed on the combination of the a priori information provided by an accurate atlas of the deep brain [5] and data-based deep learning approaches.

Finally, the contribution of the fusion of different imaging modalities for this segmentation will be studied.

Références (up to ½ page):

- [1] Coupé et al., « AssemblyNet: A large ensemble of CNNs for 3D Whole Brain MRI Segmentation », 2019

How to candidate?
Send CV, motivation letter and Master transcript to omar.ait-aider@uca.fr and celine.teuliere@uca.fr