**THESIS TOPIC**

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<th>Subject N° (to be completed by the ED):</th>
<th>FUNDING:</th>
<th>Requested Acquired</th>
<th>Funding origin: Contrat doctoral ordinaire UR1</th>
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<td>3 keywords: Deep learning, deep brain stimulation, micro-electrode recording</td>
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**Thesis title:** Deep Learning based Analysis of Intra-Operative Electrophysiology

**Unit / team:** LTSI UMR1099

**Supervisor’s name:** Pierre Jannin

**Co supervisor’s name:**

**Phone number:**

**Email address:** pierre.jannin@univ-rennes1.fr

**Socio-economic and scientific context (approximately 10 lines):**
Deep-brain stimulation (DBS) is a common treatment for patients suffering from a number of neurophysiological disorders such as Parkinson’s disease. Patients undergoing DBS are implanted with electrodes at particular locations in their brain, called targets, which can then be used to help regulate that regions neural activity. These targets are identified pre-operatively using MRI, but due to a number of factors such as limited imaging resolution, brain shift, and slight differences in alignment of surgical instruments, inter-operative methods for identifying these structures must be used as well. The goal of this project is to characterise the electro-physiological signatures of these targets using recordings from the implanted electrodes.

**Working hypothesis and aims (approximately 8 lines):**
The objectives of this project are threefold:
1. Develop machine learning methods to analyze retrospective electrophysiological signals, determining characteristic features that can be used to distinguish different regions of interest.
2. Develop machine learning methods to synthesize electrophysiological signals from different neuroanatomical regions for use in simulation, the difficulty of which can be regulated to better ease novice clinicians into training for difficult surgical scenarios, and
3. Implement these methods in two separate systems capable of performing, in real-time, the analysis and synthesis tasks respectively. These systems will act as a proof-of-concept for integration into the neurosurgical workflow. Their acceptability can then be determined through creating synthetic neurosurgical procedures and performing analysis on this synthetic electro-physiological signals.

Altogether, these three objectives would contribute to both our capacity to better target these structures interventionally as well as to train novice neurophysiologists to better identify them.

**Main milestones of the thesis (approximately 12 lines):**
As a part of this thesis, the doctoral student will develop statistical and machine-learning based methods to analyze and visualize electro-physiological signals from within the brain, focusing on the subthalamic nucleus. These methods will then be correlated with annotations by an expert neurophysiologist in order to develop characteristic signatures of these regions which can be used to identify them with higher certainty. This project will be carried out in the context of actual deep brain stimulation data collected by Department of Neurosurgery at the Centre Hospitalier Universitaire Pontchaillou in Rennes. These methods will be tested on retrospective data given the sensitive nature of neurosurgical guidance systems, but a proof-of-concept

**Scientific and technical skills required by the candidate (2 lines):**
Data science, Machine learning, Programming, Data analysis

**3 publications from the team related to the topic (last 5 years):**


### National and international collaborations:

- **National**: ICM, Paris, CEA Orsay
- **International**: University of Western Ontario (Canada), ...