M2 internship in

Segmentation of Chronic Stroke Lesions in Brain MRI with Deep Learning

Position type: M2 research internship

Starting date: beginning 2024

Duration: 5 to 6 months

Research team: Empenn, Inria-Irisa Rennes, FRANCE

Gratification: 500-700 euros

Application Deadline: End of November 2023

Supervisors:
Stephanie LEPLAIDEUR stephanie.leplaideur@vyv3.fr
Elise BANNIER elise.bannier@irisa.fr
Elisa FROMONT elisa.fromont@irisa.fr
Francesca GALASSI francesca.galassi@irisa.fr

Keywords: Stroke, MRI, Neuroimaging, Segmentation, Deep Learning, U-net, Transformers

Context of the Internship

The Empenn research group is located in Rennes, France. It comprises a diverse and talented team of over 30 researchers, including faculty members, PhD students, engineers, and interns, all dedicated to advancing the field of neuroimaging. Empenn is part of the Irisa Institute for Research and Innovation in Digital Science and Technology in Brittany, and it is also affiliated with Inria (National Institute for Research in Digital Science and Technology), Inserm (National Medical research institute), the CNRS (National Center for Scientific Research) and the University of Rennes.

Our team benefits from access to advanced computing facilities, and maintains close collaborations with other Inria/Irisa teams in computer science, such as Lacodam. Furthermore, Empenn operates the Neurinfo imaging facility in partnership with the University Hospital of Rennes, Inria, the CNRS and the Cancer Research Center. Empenn is involved in several ongoing imaging projects with the University Hospital in Rennes and the Kerpape Rehabilitation site in Lorient. These collaborations not only allow data access but also aid in identifying crucial clinical requirements and validation of the developed tools.

This internship offers a unique opportunity for personal and professional growth, and, depending on the candidate's aspirations and skills, it has the potential to lead to a PhD program.

Research motivation

Chronic stroke segmentation remains a significant challenge for researchers and clinical practitioners. It serves as the foundational step preceding any form of image analysis, including lesion symptom mapping or analysis of functional MRI. Furthermore, the application of chronic stroke lesion segmentation in clinical practice, when integrated into stroke prognostic algorithms, holds the promise of optimizing rehabilitation management.

Medical imaging, especially MRI, is essential for stroke evaluation in the acute phase, serving diagnostic purposes, and in the chronic phase. However, manual segmentation of chronic stroke lesions, due to complex brain anatomy, lesion characteristics, and patient variability, is a time-consuming and error-prone process. Recent developments in deep learning offer the potential for automation of this task.

Our research is dedicated to advancing chronic stroke lesion segmentation by leveraging cutting-edge architectures and utilizing a combination of publicly available [1] and in-house datasets.

Internship plan

The student will begin by conducting an in-depth literature review, focusing on recent advancements in solutions for image segmentation, particularly within the field of medical imaging but not restricted to medical imaging, trying to bridge the gap between new methods proposed in the field of deep learning research and application to clinical data. Selected papers show the current trend towards Transformer-based approaches [2, 3, 4].

Next, the student will proceed with the evaluation of the chosen architecture(s) for our specific task. This phase involves adapting the current UNet-based pipeline, which is implemented in Python, to accommodate the new architecture. It will entail a comprehensive comparison with the existing pipeline using the relevant performance metrics.

Last, there is the potential to publish results and findings in academic journals or conferences. Ideally, the internship project will further develop into a PhD program.

Required Skills

The internship requires the student to possess and/or develop the following skills:

- Thorough and in-depth literature review capabilities, including finding and analyzing

relevant papers;

- Understanding of deep learning methodologies and techniques;
- Competence in programming, with a focus on Python and its libraries for deep learning;
- Proficiency in data handling, particularly in processing medical imaging data;
- Quick adaptability and learning;
- An interest in the medical domain and pursuing the development of methods for use in clinical research and eventually clinical workflow.

Bibliography

[1] Liew, Sook-Lei, et al. "A large, curated, open-source stroke neuroimaging dataset to improve lesion segmentation algorithms." Scientific data 9.1 (2022): 320.

[2] Liu, Ze, et al. "Swin transformer: Hierarchical vision transformer using shifted windows." *Proceedings of the IEEE/CVF international conference on computer vision*. 2021.

[3] Petit, Olivier, et al. "U-net transformer: Self and cross attention for medical image segmentation." *Machine Learning in Medical Imaging: 12th International Workshop, MLMI 2021, Held in Conjunction with MICCAI 2021, Strasbourg, France, September 27, 2021, Proceedings 12*. Springer International Publishing, 2021.

[4] Xiao, Hanguang, et al. "Transformers in medical image segmentation: A review." *Biomedical Signal Processing and Control* 84 (2023): 104791.