Master 2 Internship: Improving Multiple Sclerosis Lesions Segmentation in 3D Spinal Cord Magnetic Resonance Images with Recent Advancements in Deep Learning

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General context
Multiple Sclerosis (MS) is a neurological disease that affects the central nervous system, including parts of the brain and the spinal cord, characterized by the formation of demyelinating lesions that disrupt nerve cell function, leading to various neurological impairments [1]. Lesions in the spinal cord often result in an increased risk of disability, hence accurate segmentation of these lesions is essential for disease understanding, treatment decisions, and therapeutic monitoring [1]. Manual segmentation is time-consuming and subject to variability, relying on the expertise of radiologists and neurologists [2].
While a large number of automatic deep learning methods have been proposed for brain lesion segmentation, automatic tools to segment MS lesions on spinal cord MRI are under-developed [3], [4].

The student will join the Empenn research team at Inria-Irisa lab. The team operates the Neurinfo imaging facility located in Pontchaillou Hospital, and has various ongoing research projects with several years of experience in developing deep learning solutions for MS lesion segmentation. The team is composed of engineers and research scientists with expertise in machine/deep learning and established collaborations with other Inria/Irisa research teams.

Scientific contributions expected from the student during the project
This project aims to investigate the use of recent advancements in network architectures, particularly attention mechanisms, to improve the segmentation of MS lesions from spinal cord MRI scans. Based on a comprehensive review of recent research in medical image segmentation,

computer vision, and the current state-of-the-art Unet architecture [5] and nn-Unet framework [6], the internship will focus on the following parts:

Part 1: Conduct a thorough literature review of the attention blocks, such as Transformer and non-Transformer based attention mechanisms to gain deeper insights into existing solutions applicable to our specific task.
Part 2: Building upon the insights gained from the literature review, the student will implement the selected methods within the existing MS spinal cord lesion segmentation pipeline developed by us.Indeed, our team has already developed a pipeline for this purpose,implemented inPython and utilizing the latest deep learning frameworks specific to medical imaging tasks, such as Pytorch Lightning and the Torchio library. Additionally, we have access to several computing facilities (such as the IGRIDA cluster) to conduct experiments.
Part 3: The student will be involved in the evaluation and the validation of the implemented methods and these analyses may result in publication to either a conference or a journal.

Bibliography

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