Bachelor Project Contract

Multiscale Brain MRI Segmentation with Deep Generative Models

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Title

Multiscale Brain MRI Segmentation with Deep Generative Models

Project Description

Segmentation of T1-weighted brain MRIs is a crucial task in medical imaging, with applications in disease diagnosis, treatment planning, and research into neurological conditions. However, this task comes with challenges, including high computational demands, the need for expert-annotated datasets, and variability in image resolutions and structures. Addressing these challenges requires innovative approaches that can adapt to varying input characteristics while delivering precise and robust segmentation results.

In this project, we aim to leverage deep generative models, specifically Variational Autoencoders (VAEs) and Denoising Diffusion Probabilistic Models (DDPMs), to perform multi-level segmentation of 3D T1-weighted brain MRIs. These models are particularly well-suited for handling the complexities of 3D medical imaging tasks due to their ability to learn latent representations and generate detailed outputs. Our focus will be on developing a multiscale convolutional neural network (CNN) architecture capable of processing images at different resolutions, which will enable flexible and effective segmentation of brain structures.

To further enhance the segmentation process, we also propose exploring a hierarchical segmentation approach. This method involves dividing regions into left and right subregions in a tree-like structure, enabling fine-grained analysis and incorporating spatial relationships between regions. This hierarchical framework could also provide a systematic way to handle missing labels and improve segmentation accuracy.

If time permits, we will validate our proposed methods on benchmark datasets and compare their performance against state-of-the-art (SOTA) models. This will include tasks

such as dataset preparation, literature review, reproducibility of existing models, architecture design, implementation, and evaluation of results.

Our ultimate goal is to address the challenges of multiscale segmentation by combining multiresolution analysis with hierarchical segmentation techniques, thereby contributing to the growing field of brain MRI analysis using deep generative models.

Timeline

Below is the proposed project timeline:

Week	TODO	Group Diary
5	Create project contract, review papers, and outline timeline.	
6	Begin implementation of initial model and gather data.	

Notes

Add any additional notes or tasks here.