KØBENHAVNS UNIVERSITET

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 manually labeled datasets by medical experts, 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 to perform multi-level segmentation of 3D T1-weighted brain MRIs. These models are well-suited for handling the complexities of 3D medical imaging tasks due to their ability to capture detailed patterns and relationships within the data [3]. 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. Multiscale feature aggregation in image segmentation has been shown to improve segmentation accuracy, particularly in models such as UNet++ and UNet 3+, which refine how features are combined from different resolutions [4, 2].

If time permits, to further enhance the segmentation process, we also propose exploring a hierarchical segmentation approach. This method involves dividing regions into left and right sub-regions in a tree-like structure, enabling more fine-grained analysis and incorporating spatial relationships between regions [1]. This hierarchical framework could also provide a systematic way to handle missing labels and improve segmentation accuracy.

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.

Bibliography

[1] Mostafa Mehdipour Ghazi and Mads Nielsen. Fast-aid brain: Fast and accurate segmentation tool using artificial intelligence developed for brain. *arXiv preprint*, 2022.

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[3] Junde Wu, Rao Fu, Huihui Fang, Yu Zhang, Yehui Yang, Haoyi Xiong, Huiying Liu, and Yanwu Xu. Medsegdiff: Medical image segmentation with diffusion probabilistic model. *arXiv preprint*, 2023.

[4] Zongwei Zhou, Md Mahfuzur Rahman Siddiquee, Nima Tajbakhsh, and Jianming Liang. Unet++: Redesigning skip connections to exploit multiscale features in image segmentation. *IEEE Transactions on Medical Imaging*, 39(6):1856–1867, 2020.