Deep Learning Approaches To Automated Stroke Lesion Localization and Segmentation in 3D FLAIR MRI Images - Project Proposal

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Summary

Localization and segmentation of lesions in stroke patients plays a vital role in the diagnosis and treatment of stroke. In this project, we propose to use various deep learning architectures to localize and segment lesions in 3D MRI Images using the FLAIR modality. We propose six different deep learning architectures to perform this task.

Model	Year	Reference
U-Net	2015	[9]
SegResNet	2022	[10]
Factorizer	2023	[2]
nnU-Net	2021	[4]
V-Net	2016	[7]
Mask-RCNN	2018	[3]

Background

Stroke is currently the second leading cause of death worldwide. Early localizaiton of lesion plays a vital role in prediction of the final infarct volume and the clinical outcome of the stroke patient. As demonsrated in [11], growth of the lesion volume during the initial MRI screenings, demonstrates a strong coorelation with the final infarct volume. However, prediction of the final infarct volume can be challening due to numerous factors including timing and the extent of reperfusion. Additionally, determining volume in FLAIR images can be particularly challenging due to the signficantly lower sensitivity to ischemic lesions in comparison with DWI images [5][8]. Nonetheless, the ability to accurately predict the final infarct volume can result in life saving decisions for the patient.

Current techniques involving thresholding and Voxel-Based Morphometry [1] for segmentation of stroke lesions can prove to be time consuming, requiring manual input from a trained professional. Deep learning techniques were first applied to stroke lesion segmentation in 2016 using a dual CNN model architecture with results comparable to manual techniques. Since then, there have been a number of attempts to improve upon the original model architecture, and with the release of the nnU-net[4] architecture, there has been a significant improvement in the accuracy of these models.

Datasets

We will train our models using data from our local dataset, as well as data from the ISLES 2022 challenge. The ISLES dataset consists of 250 subjects, with ADC, DWI, and FLAIR images. The dataset is split from two centers, with 200 subjects from center one (*University Hospital of the Technical University Munich, Munich, German*), containg acute to early sub-acute stroke data, and 50 subjects from center two (*University Medical Center Hamburg-Eppendorf, Hamburg, Germany*), containing hyper-acute to acute stroke data.

Plan

Our plan is to gather data from our locally sourced dataset containing labeled FLAIR MRI images as well as data from the ISLES 2022 stroke segmnetation challenge. We will then preprocess the images, by injesting the Nifti files, and extracting regions which could potetionally contain stroke lesions, as well as normalizing the image intensities. The preporcessed data will then be used for training with the proposed models. We will be using the frontera system from the Texas Advanced Computing Center, equipped with 4 NVIDIA RTX Quadro 5000s. We will then evaluate the performance of our models using the five-fold cross validation, and evaluate metrics such as the DICE coefficient, lesion count, and F1 score.

Conclusion

Early prediction of final infarct volume can be vital in life-saving clinical decisions. Our project can help clinicians make these decisions, as well as aid researchers to better understand the progression of stroke lesions in reference to additional factors such as gender, age, and time[6].

References

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