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Comparative Deep Learning Models for Aortic Aneurysm Segmentation in CT Imaging

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This research investigates deep learning approaches for the automated detection and segmentation of aortic aneurysms from CT imaging. The project initially focuses on the development of a custom deep learning pipeline designed for medical image preprocessing, training, and evaluation. The baseline model used in this pipeline is the widely adopted U-Net, which has become a standard architecture for biomedical image segmentation due to its encoder–decoder structure and ability to capture spatial features in volumetric data.

Building on this initial implementation, the study explores architectural improvements and alternative segmentation approaches. Variants such as Attention U-Net and automated configuration frameworks such as nnU-Net are evaluated to determine how architectural modifications and automated hyperparameter optimization influence segmentation performance in vascular CT datasets.

In addition to convolutional models, the research also investigates transformer-based segmentation architectures such as Swin-UNETR, which incorporate attention mechanisms capable of modeling long-range dependencies within medical images. These models have shown promising results in complex anatomical segmentation tasks.

To further extend the experimentation framework, the study proposes integrating GPU-accelerated medical imaging tools from the NVIDIA Clara Train and MONAI ecosystems. These platforms provide optimized pipelines for large-scale medical imaging workflows and facilitate the implementation, training, and benchmarking of multiple architectures on high-performance hardware.

The performance of the evaluated models is compared using common segmentation metrics such as the Dice coefficient and Intersection over Union. Through this comparative analysis, the study aims to identify architectures and frameworks that offer improved segmentation accuracy and computational efficiency.

Ultimately, this work highlights the importance of combining custom research pipelines with modern AI frameworks in order to develop scalable and reliable tools for automated medical image analysis, supporting clinicians in the early detection and monitoring of aortic aneurysms.

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