

 Presentation + Paper

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Deep learning-based end-to-end scan-type classification, pre-processing, and segmentation of clinical neuro-oncology studies

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Abstract

Modern neuro-oncology workflows are driven by large collections of high-dimensional MRI data obtained using varying acquisition protocols. The concomitant heterogeneity of this data makes extensive manual curation and pre-processing imperative prior to algorithmic use. The limited efforts invested towards automating this curation and processing are fragmented, do not encompass the entire workflow, or still require significant manual intervention. In this work, we propose an artificial intelligence-driven solution for transforming multi-modal raw neuro-oncology MRI Digital Imaging and Communications in Medicine (DICOM) data into quantitative tumor measurements. Our end-to-end framework classifies MRI scans into different structural sequence types, preprocesses the data, and uses convolutional neural networks to segment tumor tissue subtypes. Moreover, it adopts an expert-in-the-loop approach, where segmentation results may be manually refined by radiologists. This framework was implemented as Docker Containers (for command line usage and within the eXtensible Neuroimaging Archive Toolkit [XNAT]) and validated on a retrospective glioma dataset ($n = 155$) collected from the Washington University School of Medicine, comprising preoperative MRI scans from patients with histopathologically confirmed gliomas. Segmentation results were refined by a neuroradiologist, and performance was quantified using Dice Similarity Coefficient to compare predicted and expert-refined tumor masks. The scan-type classifier yielded a 99.71% accuracy across all sequence types. The segmentation model achieved mean Dice scores of 0.894 (± 0.225) for whole tumor segmentation. The proposed framework can automate tumor segmentation and characterization – thus streamlining workflows in a clinical setting as well as expediting standardized curation of large-scale neuro-oncology datasets in a research setting.

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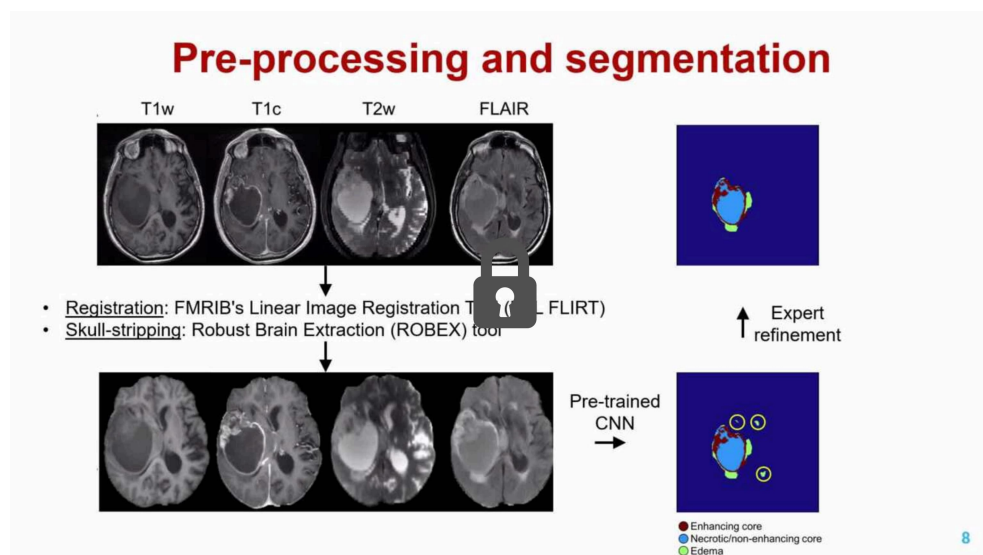
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