GlioGrade: Using 3D Convolutional Neural Networks to Type and Grade Gliomas within Human MRI Scans

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Introduction

Gliomas are the most common form of cancerous tumor with 6 cases per 100,000 people. There are 4 major types of glioma: Astrocytoma (IDH-Wildtype), Astrocytoma (IDH-Mutant), Oligodendroglioma, and Glioblastoma. The types are determined by genetic and histological characteristics. There are three different grades of glioma: 2, 3, and 4, which describe the severity of the tumor. These two metrics help doctors diagnose and treat gliomas accurately.

Novelty

There have been previous attempts at grading and typing gliomas, however these have only involved 2D images which doesn't take the whole brain into consideration as a doctor would. Our tool would be the first to type and grade using 3D Convolutional Neural Networks (CNN) Models. The World Health Organization (WHO) reclassified the glioma identifications in 2021 and our tool is the first tool to be trained for the new classification.

Methods

As shown in *Figure 2*, the 3D MRI Scan undergoes preprocessing steps to normalize and extract information and then goes to two separate 3D CNN models which type and grade the given tumor. We tested different approaches like Geodesic CNNs, pre-trained 3D Medical CNNs, and Segmented and Modified Data before achieving the highest accuracies. *Figure 1* (a-d) shows multiple views of a glioma segmentation file; (e) shows the small range of values from the MRI mask; and (f) shows the result when the segmented mask is merged with the Flair MRI to create a wide range of values for easier feature detection.

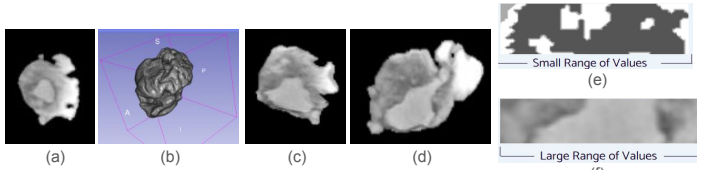

Figure 1 (a-f): Segmentation Preprocessing

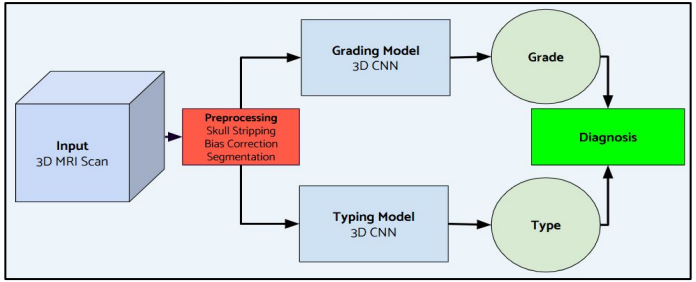

Figure 2: Systems Architecture

Results

Our 3D CNN models have achieved accuracies of 84.57% and 83.84% for Typing and Grading respectively on the UCSF Dataset with 541 data points.

Figure 3 shows the predicted diagnosis displayed on the website. The website will be a locally hosted within an institution for increased patient privacy.

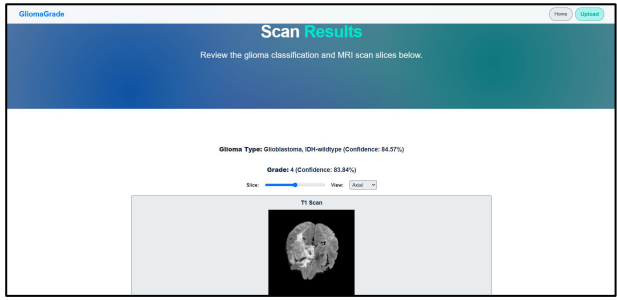

Figure 3: Website

Impact & Future Work

The tool operates on a locally hosted website and can be easily deployed by institutions for their use. As seen in *Figure 3,* our web layout is user-friendly. We implemented views into the MRI scan from all three axes to help the doctor better see what our ML models see. Our future work would be to train bigger 3D CNN models with larger datasets to achieve accuracies high enough for a medical standard. We could also implement more explainable ML Models which would help provide increased interpretability for clinical verification. We hope to peer review our work to get feedback on how to improve our process.