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ORIGINAL ARTICLE

SegSurvNet: SE-U-net-based glioma segmentation and overall survival prediction via MHA-NN and stacking regressor

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Abstract Glioma, particularly high-grade variants such as glioblastomas, are among the most aggressive and complex tumors, presenting significant challenges for diagnosis, treatment planning, and prognosis. Precise segmentation of key tumor subregions, including the core tumor, enhancing tumor, and whole tumor regions, is crucial for evaluating disease progression and tailoring targeted therapies. Traditional segmentation methods often encounter difficulties due to the inherent heterogeneity of glioma, imaging noise, and computational constraints. To overcome these challenges, we suggest a new framework that includes a robust preprocessing procedure followed by a 3D U-Net architecture enhanced with squeeze and excitation (SE) blocks. SE blocks recalibrate channel-wise feature responses, enhancing feature representation and mitigating noise, thereby improving overall segmentation accuracy and computational efficiency. Our advanced model, evaluated using the BraTS 2019 dataset, attained cutting-edge Dice scores of 0.88 for the whole tumor, 0.90 for the core tumor, and 0.85 for the enhancing tumor. Building on these segmentation results, we introduce a multi-head attention neural network (MHA-NN) and a stacking regressor model to predict overall survival. Our method not only enhances tumor segmentation but also significantly improves survival prediction capabilities. This end-to-end framework represents a significant advance in both tumor segmentation and survival prediction, marking a major step forward in glioma treatment planning and research.

Keywords Glioma tumor · Segmentation · 3D MRI · Deep learning · Machine learning · Survival prognosis

1 Introduction

The human brain is one of the most intricate and highly complex organs in the human body and serves as the command center for all bodily functions and cognitive processes (Liu et al. 2023; Rasool et al. 2024a). It is responsible for an extraordinary range of activities that are essential for life, encompassing both basic physiological functions and sophisticated cognitive abilities. The brain governs fundamental life-sustaining processes such as heartbeat, respiration, and homeostasis, ensuring the body's survival and maintaining its internal balance. At the same time, it orchestrates higher-order cognitive tasks, including reasoning, problem-solving, emotions, and memory formation, which are critical for learning, decision-making, and social interactions. The brain's remarkable capabilities are made possible by its complex network of neurons and glial cells, which communicate through intricate signaling pathways. Neurons, the primary signaling cells, transmit electrical and chemical signals across synapses, while glial cells provide support and protection, ensuring the optimal functioning of the neural network (Barker 2024). This elaborate structure allows the brain to process and integrate vast amounts of information, enabling humans to interact with their environment, adapt to changes, and engage in abstract thinking. Due to the brain's pivotal role in governing both physical and mental activities, its health and functionality are of utmost importance for overall well-being. Any disruption in the

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