Utilizing Multi-Agent Reinforcement Learning With Encoder-Decoder Architecture Agents to Identify Optimal Resection Location in GBM Patients

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Currently, there is a noticeable lack of AI in the medical field to support doctors in treating heterogenous diseases such as Glioblastoma Multiforme (GBM), which has a five-year survival rate of just 5.1%. This project develops an AI system offering an end-to-end solution by aiding doctors with both diagnosis and treatment planning. In the diagnosis phase, a sequential decision-making framework consisting of 4 classification models (Convolutional Neural Networks and Support Vector Machine) is used. Each model progressively classifies the patient's brain into increasingly specific categories, with the final step being diagnosis. For treatment planning, a Reinforcement Learning system consisting of 3 generative models is used. First, the resection model analyzes the diagnosed GBM MRI and predicts a possible resection outcome. Second, the radiotherapy model generates an MRI of the brain's progression after a user-defined number of weeks. Third, the chemotherapy model produces the post-treatment MRI. A survival rate calculator then checks if the generated treatment plan's survival rate is within 15% of the target. If not, a feedback loop using proximal policy optimization iterates over this system until an optimal resection location is identified. When compared to existing solutions, this project found 3 key findings: (1) Using a sequential decision-making framework consisting of 4 small diagnostic models reduced computing costs by 22.28x, (2) Transformers regression capabilities decreased tumor progression inference time by 113 hours, and (3) Applying Augmentations resembling Real-life situations improved overall DICE scores by 2.9%. These results project to increase survival rates by 0.9%, potentially saving ~2,250 lives.

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