Predicting the Onset of Alzheimer's Disease Using Graph Neural Networks and Diffusion Tensor Imaging

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Approximately 44 million people worldwide live with Alzheimer’s disease or a related form of dementia. Alzheimer’s is particularly difficult to diagnose because the symptoms occur after the onset of the disease and thus makes it nearly impossible to detect preemptively. My project aims to address these problems by creating an algorithm to predict the onset of Alzheimer’s disease in a patient using neural network algorithms. I utilized Diffusion Magnetic Resonance Imaging (dMRI), a particular type of physiological imaging that tracks the diffusion of water molecules in the brain to develop a connectivity matrix of the neuronal connections in the brain. Subsequently, I used a graph neural network (GNN) and trained to predict the progression of the disease off of the connectivity matrices. I used publicly available datasets (OASIS3 and ADNI) and preprocessed each image with white matter segmentation, skull stripping, affine transformations, ROI selection, and streamline tracking. Multiple iterations of the model were attempted. The final model was trained on a Tesla V100 GPU for 250 epochs over a period of 5 hours on an Adam optimizer using a learning rate of 1E-3. The model was able to successfully predict the progression of Alzheimer’s with an accuracy of .735, an F1 score of .72, and an AUC-ROC of .786, achieving significantly better results than the previous baseline algorithm. The contributions of this project include aiding in the diagnosis of Alzheimer’s as well as detecting its onset and severity earlier.

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