

Classification of Alzheimer's Disease Stages using Weighted Brain Connectivity based Graph Convolutional Neural Network

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Abstract: Alzheimer's disease (AD) is a progressive neurodegenerative disorder that manifests in distinct stages, including cognitively normal (CN), mild cognitive impairment (MCI), and severe AD. An early and precise classification of these stages is critical for effective treatment and patient care. While neuroimaging and machine learning have advanced AD diagnosis, significant challenges remain, such as data variability, the need for large datasets, and the intricate nature of brain connectivity. This study addresses these challenges by introducing a Weighted Graph Convolutional Neural Network (W-GCNN) that utilizes weighted structural brain networks derived from diffusion MRI. Unlike traditional unweighted brain networks, the weighted brain network captures the varying connection strengths between brain regions, offering a more nuanced representation of brain connectivity. The proposed W-GCNN architecture employs advanced techniques like graph convolution and sort pooling to classify individuals into CN, MCI, and AD stages. Using a dataset from the Alzheimer's Disease Neuroimaging Initiative (ADNI) that includes 116 CN, 130 MCI, and 112 AD subjects, the proposed W-GCNN model achieves an accuracy of 91% in distinguishing among the three categories. This approach not only enhances the accuracy of stage classification but also provides a robust framework for the early diagnosis of AD, supporting the development of personalized treatment plans. The results highlight the potential of weighted GCNNs in automated AD classification, offering clinicians a more reliable tool for patient management and improved treatment outcomes.