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ORIGINAL ARTICLE

Alzhinet: an explainable self-attention based classification model to detect Alzheimer from 3D volumetric MRI data

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Abstract Alzheimer's Disease is a significant global healthcare challenge that requires early and accurate diagnosis for better patient care and a deeper understanding of its pathology. In this study, we introduce "AlzhiNet", an advanced deep learning model designed to diagnose Alzheimer's Disease by using 3D Volumetric MRI data for multi-class diagnosis. AlzhiNet uses self-attention mechanisms to distinguish between Alzhimer's Disease stages like Mild Cognitive Impairment, and Alzheimer's Disease including subjects who are Cognitively Normal as a control group. It is a pioneering step towards explainability and helps bridge the gap between Artificial Intelligence and clinical expertise by unveiling the slices that are essential to diagnostic decisions. We describe AlzhiNet's architecture, training methodology, and evaluation results, drawing insights from a dataset of 2098 MRI volumes. AlzhiNet's impact extends far beyond being just a diagnostic tool, as it signifies a significant stride towards improved patient care and deeper insights into the complex pathology of Alzheimer's disease.

Keywords Attention networks · Deep learning · MRI · Alzheimer · Explainability · ADNI

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1 Introduction

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that affects millions of individuals worldwide, making it one of the most pressing challenges in healthcare today (Zeliger 2023). Characterised by cognitive decline, memory loss, and impaired daily functioning, Alzheimer's poses a substantial burden on patients, caregivers, and healthcare systems (Castro et al. 2010). Early and accurate diagnosis is essential for providing timely interventions, improving patient care, and advancing our understanding of this debilitating condition for which Magnetic resonance imaging plays a significant role.

The advent of medical imaging techniques, mainly 3D Volumetric Magnetic Resonance Imaging (MRI), has revolutionised the field of Alzheimer's diagnosis. These advanced imaging modalities can capture detailed structural information about the brain, enabling clinicians and researchers to explore subtle anatomical changes associated with the disease. However, the sheer complexity and volume of data generated by 3D MRI scans necessitate the development of sophisticated machine learning models to assist in accurate and efficient diagnosis (Singh et al. 2020). Besides, the subjective bias of the experts heavily influences diagnostic assessments, and MRI scans lack the sensitivity required to