

Functional Biomarkers of Alzheimer's Disease: Explainable AI using Resting-State fMRI

Pavithira Sivasothy^{1*}, Logiraj Kumaralingam², Tuvensha Jegatheeswaran¹, Subaramya Srivishagan¹, Thanikasalam Kokul³, and Nagulan Ratnarajah¹

¹ Department of Physical Science, University of Vavuniya, Sri Lanka

² Department of Radiology and Diagnostic Imaging, University of Alberta, Canada

³ Department of Computer Science, University of Jaffna, Sri Lanka

[*pavithirasivasothy@gmail.com](mailto:pavithirasivasothy@gmail.com)

Abstract: Alzheimer's disease (AD) is a progressive neurodegenerative disorder affecting millions worldwide, highlighting the urgent need for early and reliable diagnostic tools. Biomarkers, measurable indicators of disease presence or progression, are crucial for early detection and treatment evaluation. This study uses resting-state functional MRI (rs-fMRI) data to investigate the role of explainable artificial intelligence (XAI) in identifying functional biomarkers of AD. We construct functional brain networks for AD patients and cognitively normal (CN) individuals and employ a custom-designed Convolutional Neural Network (CNN) for classification. The model achieved a high accuracy of 98.5% in distinguishing between AD patients and CN subjects. Beyond its high predictive performance, the study's core contribution lies in the explainability of CNN classification decisions through the Guided Grad-CAM technique. This approach identifies discriminative changes in functional connectivity associated with AD. The cortical regions involved in the identified discriminative functional connectivity, which are associated with cognitive decline, memory impairment, and other functional deficits characteristic of AD progression, help prove the reliability of the proposed approach. The proposed automated system provides a unique method for identifying functional biomarkers in AD, transforming biomarker detection and enhancing clinicians' understanding of the disease's functional changes.