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Functional PCA-Based Classification of Alzheimer's Disease from Resting-State Connectivity Curves †

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Abstract

Alzheimer's Disease (AD) is a challenging and currently incurable neurodegenerative disease, necessitating the study of the brain to understand its pathogenesis. Previous studies have identified changes in functional connectivity (FC) among AD patients, leading to Resting-State fMRI (RS-fMRI) to investigate these brain regions. However, earlier research did not fully account for continuity in brain regions during FC analysis. We adopted a similar approach and generated FC curves from a study incorporating Euclidean distance into FC analysis. These continuous function curves were analyzed using functional data analysis (FDA). In particular, functional principal component analysis (FPCA) was applied to derive function principal component (fPC) scores from each brain region. We used these scores as covariates in classification models. In these models, to leverage the grouped nature of brain regions, group penalties were applied to logistic regression modeling. Our method demonstrated a higher classification rate for distinguishing between normal controls and AD patients compared to previous methods. Additionally, our best model selected brain regions significant to neurodegenerative research, although in some instances only one side of the region was selected. Further research is needed on these regions in our future studies.

Keywords: Alzheimer's Disease, Resting-State fMRI, Functional Connectivity, Euclidean Distance, Functional Data Analysis

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