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An Ensemble Learning System for a 4-Way Classification of Alzheimer's Disease and Mild Cognitive Impairment

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Highlights

- We propose a new feature selection algorithm based on relative importance.
- Hierarchical progress is helpful to solve 4-way classification on AD-related problem.
- This paper summarizes our response to the Kaggle competition.

Abstract

Discriminating Alzheimer's disease (AD) from its prodromal form, mild cognitive impairment (MCI), is a significant clinical problem that may facilitate early diagnosis and intervention, in which a more challenging issue is to classify MCI subtypes, *i.e.*, those who eventually convert to AD (cMCI) versus those who do not (MCI). To solve this difficult 4-way classification problem (AD, MCI, cMCI and healthy controls), a competition was hosted by Kaggle to invite the scientific community to apply their machine learning approaches on pre-processed sets of T1-weighted magnetic resonance images (MRI) data and the demographic information from the international Alzheimer's disease neuroimaging initiative (ADNI) database. This paper summarizes our competition results. We first proposed a hierarchical process by turning the 4-way classification into five binary classification problems. A new feature selection technology based on relative importance was also proposed, aiming to identify a more informative and concise subset from 426 sMRI morphometric and 3 demographic features, to ensure each binary classifier to achieve its highest accuracy. As a result, about 2% of the original features were selected to build a new feature space, which can achieve the final four-way classification with a 54.38% accuracy on testing data through hierarchical grouping, higher than several alternative methods in comparison. More importantly, the selected discriminative features such as hippocampal volume, parahippocampal surface area, and medial orbitofrontal thickness, etc. as well as the MMSE score, are reasonable and consistent with those reported in AD/MCI deficits. In summary, the proposed method provides a new framework for multi-way classification using hierarchical grouping and precise feature selection.

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