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Gaussian Discriminant Analysis for Optimal Delineation of Mild Cognitive Impairment in Alzheimer's Disease

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Abstract

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Over the past few years, several approaches have been proposed to assist in the early diagnosis of Alzheimer's disease (AD) and its prodromal stage of mild cognitive impairment (MCI). Using multimodal biomarkers for this high-dimensional classification problem, the widely used algorithms include Support Vector Machines (SVM), Sparse Representation-based classification (SRC), Deep Belief Networks (DBN) and Random Forest (RF). These widely used algorithms continue to yield unsatisfactory performance for delineating the MCI participants from the cognitively normal control (CN) group. A novel Gaussian discriminant analysis-based algorithm is thus introduced to achieve a more effective and accurate classification performance than the aforementioned state-of-the-art algorithms. This study makes use of magnetic resonance imaging (MRI) data uniquely as input to two separate high-dimensional decision spaces that reflect the structural measures of the two brain hemispheres. The data used include 190 CN, 305 MCI and 133 AD subjects as part of the AD Big Data DREAM Challenge #1. Using 80% data for a 10-fold cross-validation, the proposed algorithm achieved an average F1 score of 95.89% and an accuracy of 96.54% for discriminating AD from CN; and more importantly, an average F1 score of 92.08% and an accuracy of 90.26% for discriminating MCI from CN. Then, a true test was implemented on the remaining 20% held-out test data. For discriminating MCI from CN, an accuracy of 80.61%, a sensitivity of 81.97% and a specificity of 78.38% were obtained. These results show significant improvement over existing algorithms for discriminating the subtle differences between MCI participants and the CN group.