交点を有する新しい階層的クラスタリングアルゴリズムを用いた機能的MRIデータ解析に関する研究

Abstract

Title **Functional MRI Data Analysis Using New Hierarchical Clustering Algorithm with Intersection Points**

Functional magnetic resonance imaging (fMRI) is a powerful tool to study human brain in action and in recent years number of neuroimaging studies performed by using fMRI has been increased significantly. Functional MRI data analysis is intrinsically interdisciplinary in nature and collaboration of researchers in neuroscience, psychology, physics and statistics is needed. Statistics plays an important role in understanding the nature of data and obtaining a relevant result that can be interpreted by neuroscientist. Aim of this dissertation is using statistical data analysis techniques to estimate psychological information related to human traits of an individual from functional brain networks by resting-state fMRI data (functional networks which are used in this study are reported by Kansei Fukushi Research Institute, Sendai, Miyagi). Estimation by the functional brain networks can save time in many studies, because the time which is needed to measure psychological information by the rs-fMRI is greatly shorter than time needed by behavioural measurements and it can also be applied to some individuals whom the behavioural measurements cannot be applied to, such as patients with brain dysfunctions of Autism Spectrum Disorder (ASD), Attention deficit/hyperactivity disorder (ADHD), Schizophrenia etc. For this purpose several classification and clustering algorithms are used and their results are evaluated. Comparing the results, the new bottom-up hierarchical clustering algorithm with intersection points (proposed in this study) outperforms other hierarchical clustering algorithms and provides good clustering quality with low computational time. In addition to classification and clustering algorithms, outlier detection methods are also used to improve the classification accuracy. The new proposed algorithm is used for the purpose of outlier detection too.

In this dissertation, classification and clustering algorithm are used with two different strategies. First, we used only classification algorithms to estimate psychological information from brain networks by rs-fMRI. Edges values of functional network are used as feature matrix and behavioural scores as target values to train classifiers. The average of classification accuracies is about 30% which is above the chance level (12.5%), but not sufficient for practical applications. Therefore, widely used outlier detection methods are used to increase the classification accuracy, but increment was not very significant. In the second strategy, we used clustering algorithms to label fMRI data and then we used clustering results as target values to train classifiers. In this way we separated the uncertainties originated from MRI measurement and the one originated from psychological information measurement. Hence we could increase the classification accuracies of classifiers. After classification, we relabelled fMRI data according to behavioural scores and calculated the accuracies. The average accuracy of classifiers that we made by only MRI data was more than 80% when they were evaluated with test data which is much higher than about 30% by the first strategy. This result suggests that most of uncertainty contributing to the prediction error in the classifiers in the first strategy attribute to the behavioural measurement. The advantage of this method is that the classifiers with improved accuracy may be used for evaluation of plasticity changes of the brain by learning/training or detection/diagnosis of brain disorders.

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