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METHODS - ANALYSIS

Classification of brain image data using measures of distributional distance

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Purpose:

To facilitate the process of discovering brain structure-function associations from image and clinical data and to make the retrieval of similar brain scans possible, we have developed classification tools for brain image data that are based on measures of dissimilarity between probability distributions.

Methods:

We developed a method for classifying spatial distributions of regions of interest (ROIs) in brain images. The proposed method is based on computing the Mahalanobis distance between a new sample and datasets related to each considered class (condition). We predict that the new sample belongs to the class corresponding to the dataset that has the smaller Mahalanobis distance from the given subject. We also compared this method to an alternative classification method based on computing the Kullback-Leibler probabilistic distance between distributions estimated through a non-parametric procedure. After the normalization of image data to a common coordinate system, the proposed method can be applied to both structural and functional brain imaging.

Here, we applied it to lesion-deficit analysis and MR datasets, performing classification of realistic brain lesion distributions generated using a lesion-deficit simulator [1]. The spatial statistical model of lesion distributions conformed to the Frontal Lobe Injury in Childhood (FLIC) study [2]. The subjects were classified into two classes according to the subsequent development of attention-deficit hyperactivity disorder (ADHD) after closed head injury. Given a new subject with a set of lesioned voxels, the goal was to determine the more plausible class.

In experiments, we varied both the size of datasets for the classes and the number of lesioned voxels belonging to a new subject. For each combination of these parameters, we performed the experiments and monitored the classification performance, measuring accuracy rate as the ratio of the number of hits and the total number of rounds.

Results:

Experiments showed that the proposed method based on Mahalonobis distance could provide a reliable and accurate classification between the subjects who did and did not develop ADHD confirming earlier observation of disparity between these two distributions [3]. Prediction accuracy of 90% or better can be achieved with sufficiently high number of lesioned voxels for examined subject. The method based on Kullback-Leibler distance was inferior to the "Mahalanobis" approach, due to difficulties in estimation of a new subject lesion distribution.

Conclusions:

The proposed method has been shown capable of providing accurate classification of the subjects regarding the development of ADHD. In addition to lesion-deficit analysis, the proposed approach can be potentially applied to task-activation analysis and classification of 3D-probabilistic activation maps.

References:

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