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Machine Learning Techniques to Analyze Dynamic Functional Neuroimaging Patterns Underlying Inhibitory Control Mechanisms

(NIDA R01-DA020949 FY 05)

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We propose novel computational techniques to analyze brain-behavior relationships underlying mechanisms of inhibitory control, focusing on performing classification of hard-to-categorize groups of subjects based on brain activation response patterns to behavioral challenges of inhibitory control using fMRI. These classification methods are applied on two distinct datasets: substance dependent individuals and individuals with a particular genotype (MAOA) conferring vulnerability to aggression. We hypothesize that unique patterns of variability in brain function can assist in identification of brain mechanisms rooted in compromised inhibitory control. Machine Learning techniques have been shown to be successful in discovering optimal features and patterns in complex high dimensional datasets. The diversity of the underlying questions and the subtlety of the effects that can be used for classification, motivate us to propose an integrated machine learning framework for the *joint* exploration of *spatial*, *temporal* and *functional* information for the analysis of fMRI signals: 1) A differential spatial brain pattern indicates a diagnosis of drug addiction and a membership in one or another level of MAOA genotype. Spatial information from static 3D contrast maps is input to PCA-based and Voxel-based methods, and Adaboosting with Side information 2) A temporally accounted intrasubject pattern of response to the inhibitory control challenge conditions in the fMRI paradigms reveals group membership in both data sets. 3) A connectivity map corresponding to brain circuits functionally subserving inhibitory control is revealed with indications of directionality of influence between brain regions by analyzing functional information with Dynamic Bayesian Networks.

Project (or PI) Website

http://www.cs.sunysb.edu/~ial/brain.html

Publications

1. Modeling Neuronal Interactivity using Dynamic Bayesian Networks, Lei Zhang, Dimitris Samaras, Nelly Alia-Klein, Nora Volkow, Rita Goldstein, In *NIPS 2005* (to appear).

2. Machine Learning for Clinical Diagnosis from Functional Magnetic Resonance Imaging, Lei Zhang, Dimitris Samaras, Dardo Tomasi, Nora Volkow, Rita Goldstein, In *IEEE Proc. of CVPR*, pp. I:1211-1217, 2005.

3. Exploiting Temporal Information in Functional Magnetic Resonance Imaging Brain Data, Lei Zhang, Dimitris Samaras, Nelly Klein, Dardo Tomasi, Lisa Cottone, Andreana Leskovjan, Nora Volkow, Rita Goldstein, In *MICCAI 2005* pp. 679-687