RUTGERS UNIVERSITY
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Seminar

Speaker: Abhyuday Mandal, University of Georgia

Title: Multi-objective Optimal Experimental Designs in Event-Related fMRI Studies

Date: Tuesday March 3, 2009

Time: 12:00 PM

Place: 552 Hill Center

Abstract

Functional magnetic resonance imaging (fMRI) is considered one of the leading technologies for studying human brain activity in response to mental stimuli. With sophisticated allocations of stimuli, researchers can gather valuable fMRI time series and acquire precise information about human brain activity. However, due to the nature of fMRI experiments, the underlying design space is very large and irregular. This makes it difficult to find an optimal design that simultaneously accomplishes various goals of a study and fulfills the scientific restrictions. Here we propose an efficient approach to find optimal experimental designs for event-related functional magnetic resonance imaging (ER-fMRI). We consider multiple objectives, including estimating the hemodynamic response function (HRF), detecting activation, circumventing psychological confounds and fulfilling customized requirements. Taking into account these goals, we formulate a family of multi-objective design criteria and develop a genetic-algorithm-based technique to search for optimal designs. Our proposed technique incorporates existing knowledge about the performance of fMRI designs, and its usefulness is shown through simulations. We also find designs yielding higher estimation efficiencies than m-sequences. When the underlying model is with white noise and a constant nuisance parameter, the stimulus frequencies of the designs we obtained are in good agreement with the optimal stimulus frequencies derived by Liu and Frank, 2004, NeuroImage 21: 387-400. In terms of CPU time and achieved design efficiency, we demonstrate that our approach outperforms the methodologies known hitherto.

(Joint research with Ming-Hung (Jason) Kao, John Stufken and Nicole Lazar)