A Bayesian Time-Course Model for Functional Magnetic Resonance Imaging Data

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Functional Magnetic Resonance Imaging (fMRI) is a new technique for studying the workings of the active human brain. During an fMRI experiment, a sequence of Magnetic Resonance images is acquired while a subject performs specific behavioral tasks. Changes in the measured signal can be used to identify and characterize the brain activity resulting from task performance. The data obtained from an fMRI experiment are a realization of a complex spatio-temporal process with many sources of variation, both biological and technological. This paper describes a nonlinear, Bayesian, hierarchical model for fMRI data and presents inferential methods that enable investigators to directly target their scientific questions of interest, many of which are inaccessible to current methods. The paper describes optimization and posterior sampling techniques to fit the model, both of which must be applied many thousands of times for a single data set. The model is used to analyze data from a psychological experiment and test a specific prediction of a cognitive theory.

KEY WORDS: Bayesian Inference; Hierarchical Models; Magnetic Resonance; Functional Neuroimaging.

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