

STANFORD UNIVERSITY
DEPARTMENT OF STATISTICS
DEPARTMENT SEMINAR

4:15 p.m., Tuesday, May 21, 2002
Sequoia Hall Room 200
(Cookies at 3:45 in 1st Floor Lounge)

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A Using the False Discovery Rate for fMRI

Functional Magnetic Resonance Imaging, or fMRI, experiments collect information sequentially about bloodflow throughout the brain during a psychological experiment. One approach to analyzing such data, referred to as a “whole brain analysis”, in contrast to a “region of interest analysis” (ROI) which focuses on a small region of the brain, is to correlate the observed time series at each time point with an “ideal” sequence representing the temporal aspect of the experimental task. After this, the 3-dimensional image of correlations is searched for “interesting regions”, that is, regions where the observed signal is highly correlated with the experimental task.

Due to the huge number of spatial locations, usually of the order of 100-200,000 there is a serious multiple comparison problem to be addressed in assessing the significance of the observed correlations. A typical solution is to threshold the image of correlations at a level chosen to try to control the Family Wise Error Rate (FWER) at some pre-determined level α . Another, more powerful approach is to use p -value dependent thresholds which seek to control the False Discovery Rate (FDR) at some pre-determined level α .

Both procedures can be thought of as exploratory set estimation procedures which seek to identify regions that are worthy of further study, with control of the FWER being more conservative than control of the FDR. Both procedures also restrict the regions of interest to be excursions of the observed image of correlations or the equivalent t -statistics, i.e. if X_t is the image of t -statistics, then both procedures use sets of the form

$$X^{-1}[u, +\infty) = \{t \in \text{brain} : X_t \geq u\}.$$

In this talk, which is a report of work in progress, we review some of the basic issues described above for the analysis of fMRI data, and argue that, in some cases, this restriction

to the “excursion sets” should be relaxed and better results can be obtained, for instance, by “smoothing” the binary “excursion sets”. One way, though not the only way, to perform this smoothing is to use some basic tools from mathematical morphology. Some simulation results will be presented, as well as some preliminary analyses of two fMRI examples: one, a simple “finger-tapping” block design experiment and the second, a more complicated reward anticipation design.

This is joint work with Brian Knutson in the Psychology department.