Signal Extraction in the Presence of Correlated Noise with Application to fMRI Statistic Maps and EEG Spectrograms

Dissertation Prospectus

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Abstract

When testing for the presence and location of a signal in a 2D or 3D image, standard hypothesis testing methods that control the False Discovery Rate (FDR) exhibit decreased power and poor interpretability in the presence of correlated noise. This problem is complicated by the multiple comparisons problem for very large images. This is the setting when testing for activation in fMRI experimental data. One way of alleviating many of the problems related with correlated noise is testing for significance in the wavelet domain. Taking advantage of the wavelet transformation's decorrelating property and sparse representation, several powerful wavelet-based FDR methods have been developed. The power and FDR control of these methods can be further improved by more appropriate resampling methods, new wavelet coefficient shrinkage and significance testing algorithms, and extension to a full 3D wavelet analysis rather than a slice-by-slice 2D wavelet analysis. An extensive fMRI simulation study will be used evaluate all of these methods. The 2D wavelet analysis techniques will also be applied to EEG spectrograms which have similar correlation properties as fMRI statistic maps, but in two dimensions.