Extracting the haemodynamic response function in fMRI using Fourier-wavelet regularised deconvolution

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We present a method to extract the haemodynamic response function (HRF) from a functional magnetic resonance imaging (fMRI) time series. The method is based on Fourier-wavelet regularised deconvolution (ForWaRD). The extraction algorithm is very general: it relies only on the assumptions of the general linear model (GLM) and the fact that signal and noise can be distinguished in the frequency and wavelet domain, respectively.
Before extracting the HRF, low-frequency trends are removed from the time signals by a standard wavelet-based method. The combined routine of detrending and extraction is tested extensively, using noise from an fMRI data set and simulated event-related activation. The output of the extraction program is a time series of image volumes, containing the HRF at each voxel location. Such a time series may be used in many fMRI-related problems, like defining region-specific HRFs (by combining the HRFs found in a specific region), finding a set of basis functions to efficiently describe the HRF (by decomposing the extracted HRF into a more general set of functions), or comparing subject-specific HRFs. A new HRF model is introduced, and it is used in combination with the extraction method to describe fMRI responses. The use of these modeled responses is demonstrated in the analysis of an event-related fMRI experiment. Test results show that using subject-specific, regional HRFs substantially improves the detection of active regions in fMRI.

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