Homework 4
Functional Magnetic Resonance Imaging
Due Monday, February 3

In this homework problem you will use the results from the last homework to map neural activity in the brain using fMRI. In fMRI, a series of MRI brain images are collected over time. Because oxgenated and deoxygenated hemoglobin have slightly different magnetic characteristics, variations in the MRI intensity indicate areas of the brain with increased blood flow and hence neural activity.

The central problems in fMRI is reliably detecting neural activity at different spatial locations (pixels) in the brain. The data are noisy and the variation in intensity due to activation is very subtle. Consequently, statistical signal detection methods are routinely used to derive an "activation" map; a 2-d binary image of active and non-active brain regions.

The objective of this homework problem is to develop an FFT-based procedure for producing an "activation" map. To get you started, I have written a very crude program that inputs the images `fmri.m`, which is available at the website. The data file `fmri.mat` which contains the fMRI images is also available at the website. The basic idea is the compute the FFT of each pixel's time-series, and then check/detect the presence of a peak at the frequency corresponding to the period of the activation signal. In this case, the person was periodically tapping their finger, as in Homework 3, and a representative response from an activated pixel is given in `fmri_sig.mat`.

In developing your brain-mapping scheme, I would like you to address/consider the following issues.

1. Determine an appropriate "threshold" for deciding whether or not a pixel is active. Discuss how and why you selected a particular threshold.

2. Discuss other variations in the pixel signals (DC offset, slowly varying drifts, noise) and their impact on your mapping procedure.

3. Produce a map of activated pixels by superimposing (in color) the activated pixel locations on an image of the brain.