Functional Magnetic Resonance Imaging Data Processing

Motivation

Functional Magnetic Resonance Imaging (fMRI) is an imaging technique that produces output that reveals functional activity rather than just anatomy of the body. For example, fMRI of the brain allows visualization of the neuronal activations in different regions of the brain as a function of time. This allows better understanding of the inner working of the brain (which is yet to be fully understood) and how processing of different sensory, motor, or higher order processing of such complex activities such as emotions and reasoning. In this particular application, fMRI relies on repetitive acquisition of magnetic resonance images of the same location to acquire a stack of images of the same slice as a function of time. At the same time during the acquisition, the subject is asked alternate between performing certain tasks (e.g., allowed to see a light stimulus or asked to move fingers, etc.) and rest. Then, the trace of each image pixel as a function of time, which is conventionally termed "time course", is processed to find out which locations have time course signals that correlate with the stimulus (tasks) given to the subject. Based on the degree of such correlation, a map is created with color codes that reflect the strength of involvement of each point and whether such involvement was directly or inversely proportional to the stimulus. In this project, we experiment with a real fMRI data set and explore the processing techniques involved in this area.

Research Tasks Involved

A. fMRI data set handling and manipulation.
B. fMRI preprocessing and noise filtering.
C. Estimation of functional activations.
D. Display of activations on high-resolution anatomical images.

Design Input

- Real fMRI data set used by the instructor in [1] and a simple Matlab reader code.

Design Output

- A lab notebook (preferably in Microsoft OneNote® format) with all the experiments done to address each of research tasks listed above including documented Matlab code for each.

References

[1] Y.M. Kadah, "Adaptive denoising of event-related functional magnetic resonance imaging data using spectrum subtraction," *IEEE Trans Biomed Eng*, vol. 51, pp. 1944-1953, 2004.

[2] R. Buxton, *Introduction to Functional Magnetic Resonance Imaging Principles and Techniques*, Cambridge University Press, Cambridge, 2009.