**fMRI physics and practical data analysis**

**Time and location: 2:00 – 4:25 PM, C3-2011**

**Office hour: 4:25-5:25, C2-913**

**Format of the class:**

* Prior reading / homework for each week of approx 30 minutes;
* Class is 2.5 hours:
  + 15 minutes debrief from previous class
  + 125 minutes talk introduction + questions;
  + 10 minutes break;

As we cover the material, we will also pause at times to cover how to do:

* version control;
* code collaboration.

**Course Director:**

Prof. Peiwu Qin,

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We plan to visit a local hospital to get some hands-on experience on how to use MRI machine to collect some data.

**Course information：**

This course is intended to provide a comprehensive and rigorous introduction to the technique of functional magnetic resonance imaging (fMRI). Students will learn the basic physics underlying MRI, the biological principles of fMRI, the principles of experimental design, the processing steps associated with data analysis, the use of available software packages, and the writing of analysis script in python. Each week’s session will be composed of a lectures or laboratory. Where possible, the laboratory topics will be flexible so that students with more experience can explore the issues covered in more detail. As this is a graduate course, grades will reflect a certification of training, rather than a competition between students. Grades will be based on participation in course sessions (10%), completion of laboratory exercises and homework (35%), one take-home test at the middle of the semester (15%, around 12th week), and a final research project (40%). Auditors are welcome (and encouraged) to take the course, but regular attendance and participation is required. It is strongly recommended that auditors attend both the lecture and laboratory sessions, if possible, as they will be designed to complement each other.

**Course Outline**

1. Course introduction

1.1 Brief introduction to linear algebra

1.2 brief introduction to statistics concepts

2. python programing and Github.

2.1 Installation of python and Github

2.2 Collaboration with Github

2.3 version control and diagnostics

2.3 Python module：numpy, pandas and nibabel

3 Statistical method for data analysis

3.1 convolution and correlation

3.2 regression and general linear model

3.3 diagnostics using principle component analysis

3.41D interpolation and slice timing

3.5 optimization, 2D interpolation and registration

3.6coordiate systems and cross modality registration

3.7 registration between subjects

3.8 smoothing and modeling

3.9 random effects, choosing models

3.10 statistical inference

4. Introduction to fMRI

4.1 Quantum mechanics basics: operator, Hamiltonia, angular momentum, particle in 3D box

4.2 Fourier transformation, 1D and 2D NMR, coherence, chemical shift.

4.3 Free induction decay, proton relaxation, analysis of basic pulse sequence with angular momentum

5: Pulse Sequences and image Contrast.

5.1 Creating a MR Image

5.2 BOLD fMRI Imaging

5.3 Functional Localization of Activation using BOLD fMRI: Limits on Resolution, Understanding refractory effects

5.4 Spatial and Temporal Properties of BOLD fMRI, Effects of sampling upon functional images