Medical Physics 471 / Neuroscience 675
Neuroimaging Research Methods

Must be registered for 3 credits

Fall 2012

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Time: Tuesdays/Thursdays: 8:30 am – 9:45 am
Location: 1022 WIMR (1st Floor Conference Room in Medical Physics Department)
Computer labs will take place in Computer Analysis Bay in the Brain Imaging Lab at the Waisman Center

Office Hours: by request

Class Overview:
The main objectives for this course are to provide a foundation in methods for neuroimaging studies with statistical image analysis. The course will cover many of the most widely used methods for human neuroimaging studies including functional BOLD MRI, structural MRI morphometry, diffusion tensor imaging. Other neuroimaging MRI methods will also be covered. The course will cover methods for statistical image analysis, the physics and methods of image acquisition, discuss steps and tools for image analyses and the interpretation of the results.

The course will be split into graduate and undergraduate groups.

Undergraduate Students: The lecture material will be complimented by in-class journal club discussions.

Graduate Students: The lecture material will be complemented by in-class lab exercises that will expose and train students in the use of image analysis tools.

Textbook and Materials:
Lectures will be supplemented with relevant articles provided by instructor as needed. For the fMRI lectures, we also strongly recommend Functional Magnetic Resonance Imaging by Huettel, Song and McCarthy. Introduction to Functional Magnetic Resonance Imaging: Principles and Techniques by Buxton is also excellent. There are also excellent books on Diffusion Tensor Imaging: Introduction to Diffuison Tensor Imaging by Mori (basic) and Diffusion MRI: Theory, Methods and Applications by DK Jones.

Grades:

Undergraduate Students:

Homework: 25%
Midterm Exam 25%
Journal Discussion: 25%
Semester Project: 25%

Graduate Students:

Homework: 30%
Labs: 30%
Semester Project: 40%

More than 2 class absences must be cleared by instructor.

Late Homework and Lab Reports will be penalized 10% and 20% for each additional week (e.g., 2 weeks late – 50%).

Lab Reports should be 1 page typed summary of the work with additional pages for figures. Each report must have title, objective, introduction, methods, results, discussion.

Semester Projects:

Undergraduate Students:

Write a detailed review paper on a neuroimaging-specific topic not covered directly in the course. You should review, reference and summarize relevant published papers in a specific field. In particular, you should emphasize and discuss the neuroimaging methods used. The review should cover at least six published papers.

Graduate Students:

Write a report on an independent neuroimaging research project. This need not be novel, but should emphasize some aspect of neuroimaging methodology. It may be scanner-related experiments, or computer simulations. MR data sets can be provided by the instructor per request for simulation or image analysis projects. Reports must include appropriate references.

For either option, please **do not simply pursue a project related to previous, ongoing or thesis-related MRI projects** unless approved by instructor.

Neuroimaging Methods – Class Schedule (Dates Tentative)

Lecture	Week	Date	Topic
1	1	3-Sep	Intro/Overview
2		5-Sep	Signal Processing Fundamentals
3	2	10-Sep	Intro to MRI - Precession, Resonance, Relaxation
4		12-Sep	MRI pulse sequences for Neuroimaging research
5	3	17-Sep	MRI Contrast Mechanisms and Measurements
6		19-Sep	Statistical Analysis Methods
7	4	24-Sep	Spatial Registration, Normalization and Morphometry
8		**26-Sep**	**Voxel Based Morphometry Lab (G) / Journal Club (U)**
9	5	1-Oct	fMRI - Mechanisms
10		3-Oct	MRI Scanner Lab
11	6	8-Oct	fMRI – Single-subject analysis
12		10-Oct	fMRI – paradigm design
13	7	15-Oct	fMRI – Group Analysis
14		17-Oct	fMRI - Resting state and Connectivity
15	**8**	**22-Oct**	**fMRI Lab I (G) / Journal Club (U)**
16		**24-Oct**	**fMRI Lab II (G) / Journal Club (U)**
17	9	29-Oct	Diffusion Tensor Imaging
18		31-Oct	Diffusion Tensor Imaging Analyses
19	**10**	**5-Nov**	**Diffusion Imaging Lab I (G) / Journal Club (U)**
20		**7-Nov**	**Diffusion Imaging Lab II (G) / Journal Club (U)**
21	11	12-Nov	Tractography
22		14-Nov	**Tractography Lab / Midterm Exam (U)**
23	**12**	**19-Nov**	Advanced Diffusion Imaging
		21-Nov	Quantitative MRI – Magnetization Transfer, Relaxometry
24	13	26-Nov	Perfusion, MR Spectroscopy
25		28-Nov	Thanksgiving (No Class)
26	**14**	**3-Dec**	**Lab (G) / Presentations (U)**
27		**5-Dec**	**Lab (G) / Presentations (U)**
28	**15**	**10-Dec**	**Lab (G) / Presentations (U)**
29		**12-Dec**	**Lab (G) / Presentations (U)**

Blue = R. Birn
Black = A. Alexander