ENAS 913: **Probability and Estimation for Bio-medical Image Analysis**

Instructor:

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Time:

T-Th, 1p.m.-2.15 p.m.

Location:

N305, 3rd Floor, The Anlyan Center.

Description:

The aim of this course is to study advanced topics in imaging. The course will concentrate on probability theory and statistical inference as applied to medical imaging.

Textbook:

Essentials of Statistical Inference, G. A. Young and R. L. Smith, Cambridge University Press, 2005. (Price at the Barnes and Noble Yale Bookstore: $39.00).

Reference:

Pattern Theory, Ulf Grenander and Michael Miller, Oxford University Press, 2007.
Probability, Random Variables and Stochastic Processes, Athanasios Papoulis, McGraw Hill, 1991.
Fundamentals of Statistical Signal Processing: Estimation Theory, Steven M. Kay, Prentice Hall, 1993.

Topics:

Review of probability and random variables. Probability models for conditionals and priors. Bayesian Analysis. Decision and Inference Principles. Sufficiency. Likelihood Theory. Linear Inference. Inference in Markov Random Fields. The EM algorithm. Applications to Ill-posed Linear Systems, Tomographic Reconstruction, Mixture models, and Segmentation.

Grading:

Homework:	30%
Midterm:	30%
Project:	30%
Class Participation:	10%

Schedule:

1/15:	Introduction and course logistics
1/17:	Math. Background
1/22:	Math. Background.
1/24:	Examples of estimation problems in imaging. Projects.
1/29:	Estimation Theory fundamentals. Estimation Geometry.
1/31:	Admissibility, Bayesian estimation
2/5:	Bayesian Methods.
2/7:	The Normal Problem – I
2/12:	The Normal Problem - II
2/14:	The Normal Problem- III
2/19:	Conjugate Priors
2/21:	Improper/Non-informative Priors
2/26:	
2/28:	Maximum-likelihood/MAP
3/5 :	Maximum-likelihood/MAP
3/7:	Segmentation

SPRING BREAK

3/26:	The EM Algorithm
3/28:	The EM Algorithm
4/2:	**Mid Term**
4/4:	James-Stein Estimators
4/9:	(General Linear Model)
4/11:	Markov Random Fields
4/16:	Markov Random Fields
4/18:	(MCMC methods)
4/23:	Project Presentations
4/25:	Project Presentations

Project: You are expected to do a semester-long project. The goal is for you to understand the different steps involved from taking a word description of the project, to an estimation theoretic formulation, to finding an estimator and characterizing it.

You may choose something related to your SI as a project – but it has to be a new problem. It cannot be exactly what you are doing/or have done in the past for SI.

Extra credit if the project is "real-world" (theory is real-world) and if you have real data for the project. The project need not be image or biomedical in nature.

Course website: http://noodle.med.yale.edu/hdtag/enas913.html

Instructions for downloading videos:

1. Copy and paste http://noodle.med.yale.edu/hdtag/enas913a/ in your browser URL address box.
2. You should see a list of mp4 and pdf files. The mp4 files are the videos.
3. Download the video(s) you are interested in by a right click->save as (on Windows).
4. Double click on the downloaded file to watch. Don't watch the video on a hand held device (such as a smartphone). It may not have sufficient resolution.