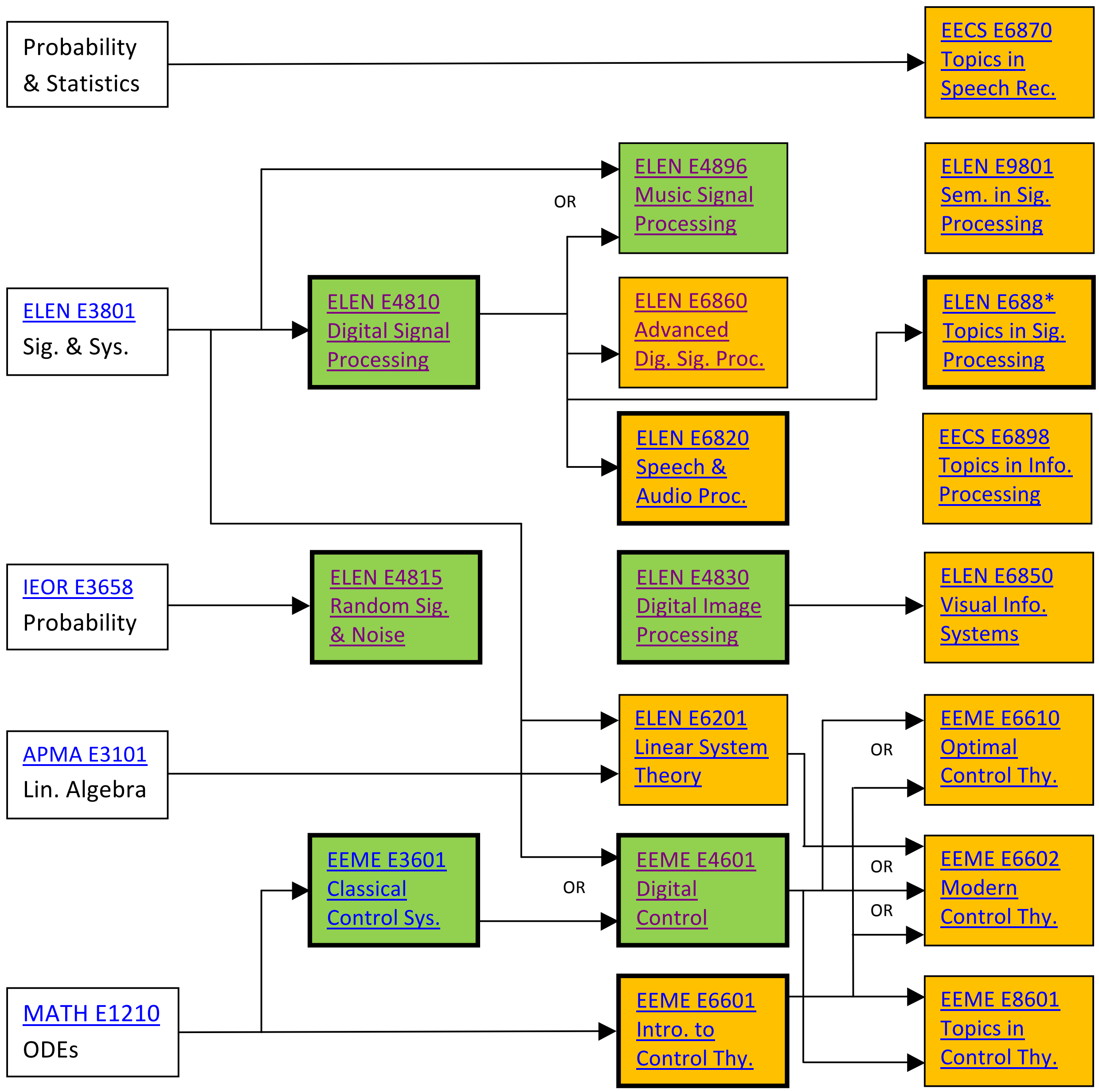
SIGNALS & SYSTEMS & CONTROL

Senior/graduate & Advanced graduate courses in EE



Green = Senior/graduate; Orange = Advanced graduate; Bold border = offered regularly; June 2010

Recent topics for ELEN E688*:

ELEN E6880 Topic: Space-Time Coding / SP for Wireless Communications (*Spring 2008, Spring 2007*)

ELEN E6881 Topic: Video Coding and Communications (*Spring 2009, Spring 2008*)

ELEN E6882 Topic: Stat. Methods for Video Index & Analysis (*Fall 2007*)

ELEN E6883 Topic: Detection & Estimation (*Fall 2010, Fall 2009, Fall 2008, Fall 2006*)

ELEN E6884 Topic: Speech Recognition (*Fall 2005*)

ELEN E6885 Topic: Network Science (*Fall 2010*)

ELEN E6886 Topic: Multimedia Security Systems (*Spring 2006*)

ELEN E6887 Topic: Statistical Learning Theory (*Spring 2010, Spring 2009*)

ELEN E6888 Topic: Intro. to LTE & WiMax Systems (*Spring 2010*)

ELEN E6889 Topic: Distributed Stream Processing and Analysis (*Spring 2010*)

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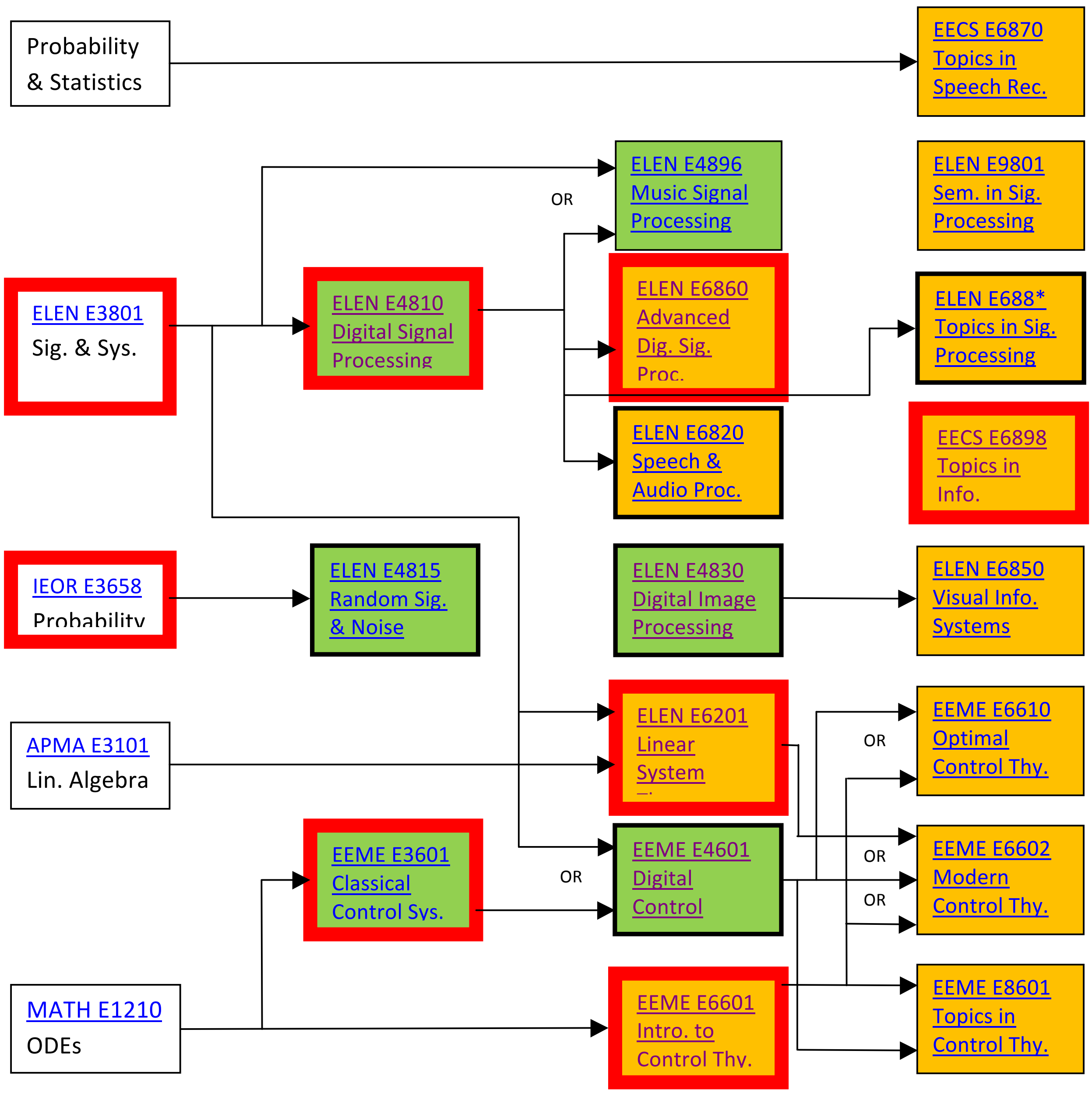

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[Department of Electrical Engineering](#) - [Columbia University](#)

ELEN E4810 - Fall 2010

DIGITAL SIGNAL PROCESSING

Home page

[Course outline](#)

[Matlab scripts](#)

[Problem sets](#)

[Projects](#)

[Exams](#)

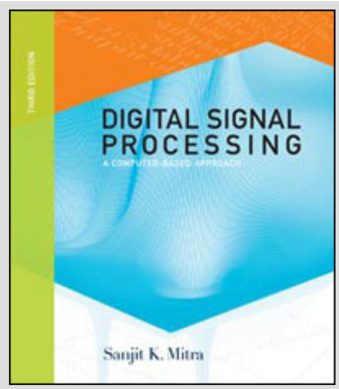
[Columbia Courseworks (Discussion Board)](#)

Announcements

2010-08-30: Fall 2010 session

Welcome to the web site for Digital Signal Processing. Below is some introductory material about the class. This web site will act as the main conduit for lecture notes, problems sets, etc. throughout the semester. Best wishes for the course!

General Information

Instructor:	[Dan Ellis](#) <dpwe@ee.columbia.edu> Schapiro CEPSR Room 718
Instructor office hours:	Thursdays, 14:00-16:00
Teaching assistant:	**TBA**
TA office hours:	**TBA**
Required text:	[Digital Signal Processing: A computer-based approach](#) (3rd ed.) Sanjit K. Mitra, McGraw-Hill, 2005 (ISBN 0-07-304837-2, international edition ISBN 007-124467-0) (available for instance from [Barnes and Noble](#); Here are the [Publisher's Errata](#) for the 3rd edition. 
Other	Discrete-Time Signal Processing (3rd ed.)

- **ELEN E6860y Advanced digital signal processing** *3 pts. Lect: 2.* Prerequisites: ELEN E4810. This course is designed as an extension to ELEN E4810, with emphasis on emerging techniques in the area of digital signal processing. Topics include multirate signal processing, multidimensional signal processing, short-time Fourier transform, signal expansion in discrete and continuous time, filter banks, multiresolution analysis, wavelets, and their applications to image compression and understanding. Other topics may be included to reflect developments in the field.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Autumn 2010 :: ELEN E6860					
ELEN 6860	76797 001	F 11:00a - 12:50p 825 Seeley W. Mudd Building	T. Nguyen	3	more info

- **ELEN E6201x Linear system theory** *3 pts. Lect: 3.* Prerequisites: ELEN E3801 and APMA E3101, or equivalents. Abstract objects, the concepts of state. Definition and properties of linear systems. Characterization of linear continuous-time and discrete-time, fixed, and time-varying systems. State-space description; fundamental matrix, calculation by computer and matrix methods. Modes in linear systems. Adjoint systems. Controllability and observability. Canonical forms and decompositions. State estimators. Lyapunov's method and stability.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Autumn 2010 :: ELEN E6201					
ELEN 6201	58401 001	Th 6:50p - 8:40p 415 Schapiro Cepser	E. Fishler	1	more info

- **EEME E6601x Introduction to control theory** *3 pts. Lect: 3.* Prerequisites: MATH E1210. A graduate-level introduction to classical and modern feedback control that does not presume an undergraduate background in control. Scalar and matrix differential equation models, and solutions in terms of state transition matrices. Transfer functions and transfer function matrices, block diagram manipulations, closed-loop response. Proportional, rate, and integral controllers, and compensators. Design by root locus and frequency response. Controllability, observability. Luenberger observers, pole placement, and linear-quadratic cost controllers.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Autumn 2010 :: EEME E6601					
EEME 6601	76783 001	W 6:50p - 9:20p 227 Seeley W. Mudd Building	R. Longman	11	more info

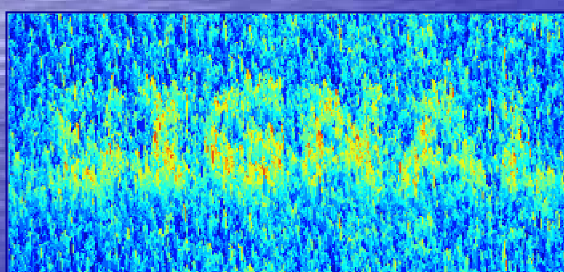
Learn to uncover hidden messages buried in noise.
Prepare for an exciting career in information technology.

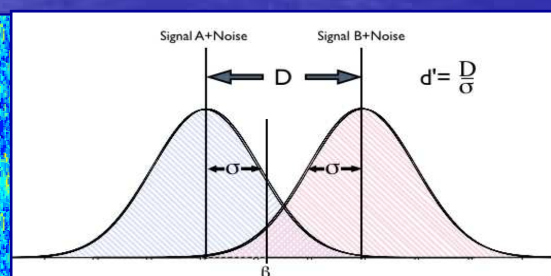
ELEN E6883 Topics in Signal Processing: Detection and Estimation Theory

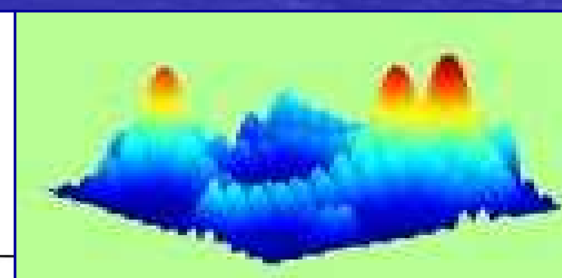
Prof. Ta-Hsin Li

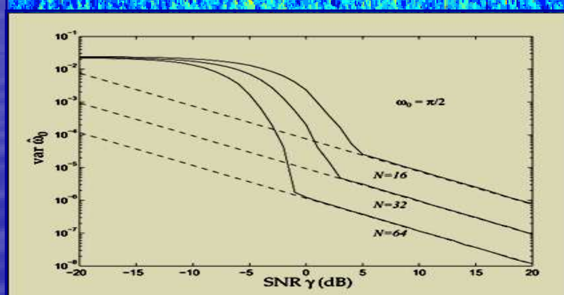
Tuesday 6:50 – 9:20 pm

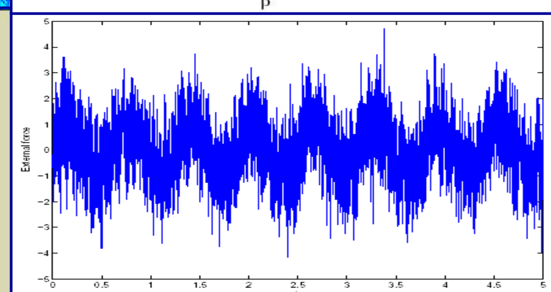
327 Seeley W. Mudd Building

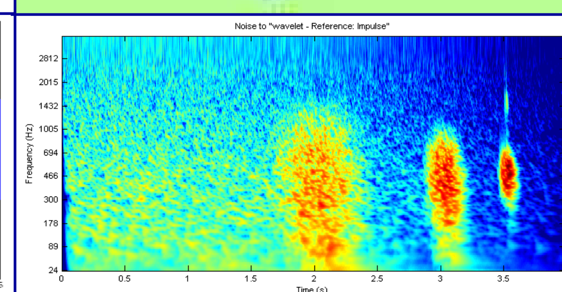












Topics

- Review of Basic Concepts: Random experiments, events, probability measure, conditional probability, independence, random variables, Gaussian distributions, modes of convergence of random sequences
- Parameter Estimation: Exponential family of distributions, sufficient and complete statistics, minimum-variance unbiased estimation, Cramér-Rao lower bound, method of moments, maximum likelihood estimation, EM algorithm, Bayesian method, Markov Chain Monte Carlo (MCMC) algorithm
- Signal Estimation: Linear estimation and prediction, State-space models and Kalman filter, Wiener filter
- Hypothesis Testing: Neyman-Pearson lemma, Bayes and minimax tests, multiple hypothesis testing, composite hypothesis testing
- Signal Detection: Deterministic signal in Gaussian noise, Gaussian random signals in Gaussian noise, detection in Non-Gaussian noise

- Textbook: H. V. Poor, An Introduction to Signal Detection and Estimation, 2nd Edition, Springer
- Computing: Software such as MATLAB, R, S-plus

New "Network Science" course in the EE Dept., Columbia Univ.

Course Title: ***(ELEN E6885) Topics in Signal Processing: Network Science***

Instructor: ***Prof. Ching-Yung Lin***

Time: Mondays ***4:10pm – 6:40pm, Fall 2010***

Location: ***Please check www.ee.columbia.edu***

Outline:

Lecture 1: Overview – Social, Information, and Cognitive Network Analysis *(first class 09/13/2010)*

Lecture 2: Network Representations and Characteristics

Lecture 3: Network Partitioning and Clustering

Lecture 4: Network Visualization

Lecture 5: Network Sampling and Estimation

Lecture 6: Network Models

Lecture 7: Network Topology Inference

Lecture 8: Dynamic Networks

Lecture 9: Social Influence and Info Diffusion in Networks

Lecture 10: Information and Knowledge Networks

Lecture 11: Privacy, Security, and Economy Issues in Networks

Lecture 12: Behavior Understanding and Cognitive Networks

Lecture 13: Large-Scale Network Processing System

Lecture 14: Final Project Presentation

Description:

Network as a new scientific discipline is emerging. Entities -- people, information, societies, nations, devices -- connect to each other and form all kinds of intertwined networks. Social-informatic networks are becoming part of our daily life. How do we analyze these "Big Network Data"?

Researchers from multiple disciplines -- electrical engineering, computer science, sociology, public health, economy, management, politics, laws, arts, physics, math, etc – are interacting with each other to build up common grounds of network science. Network theory for describing the dynamics, behaviors, and structures or a systematic mathematical formalism that enables predictions of network behavior and network interactions is emerging. A trans-disciplinary approach is required to lay the foundations of this science and to develop the requisite tools.

Network data analysis will become essential for graduate or senior students pursuing advanced understanding in Signal Processing. For its interdisciplinary nature, it is also suitable for students in other disciplines conducting researches in various forms of networks.

Students shall learn fundamental network analysis concept, math, and tools, and gain hand-on experiences. Students will need to choose final project topic of their interest and conduct comprehensive study or preliminary research.

Prerequisites:
Basic courses in probability & statistics such as E3658 (Probability) and signal processing such as E3801 (Signals and Systems). Students need to know at least one programming language or statistical tool (Matlab, C, Java, C++, Perl, Python, SPSS, R) for finishing homeworks. Students outside the Engineering School (e.g., GSAS, Business School, Law School, etc.) are also welcome.

Grading: Homeworks 50%, Final Project 50%

Textbook: E. Kolaczyk, "Statistical Analysis of Network Data," Springer, 2009

Reference Book: M. Newman, "Networks – An Introduction," Oxford, 2010

Ching-Yung Lin is the IBM Lead of the Social and Cognitive Network Science Research Center. He joined IBM Watson Research Center in 2000. He is also an Adjunct Associate/Full Professor at Columbia University since 2005, and an Affiliate Assistant/Associate Professor at the University of Washington 2003-9. His research interest focuses on multimodality signal processing and understanding, data and network mining, and security. Dr. Lin is a keynote speaker of Web 2.0 Expo, New York, 2009. His research work on the "Value of Social Networks" was selected as "Top Story of the Week" of *BusinessWeek* Magazine, April, 2009. Dr. Lin is the Chair of IEEE CAS Society Multimedia Technical Committee, 2010-2011, the General Chair of IEEE Intl. Conf. on Multimedia and Expo (ICME), 2009, and the Steering Committee Chair of ACM SIGHINF Health Informatics (IHI), 2010-2012.

Large-Scale Machine Learning

EECS 6898, Fall 2010

Sanjiv Kumar

Home | Lectures | Homework | Projects

Class lectures: Tuesdays 12:35-2:25pm in TBA

Instructor: Sanjiv Kumar (Office Hours: Tuesdays 2:25pm - 3:25pm)
TA: Jun Wang / Junfeng He (Office Hours: TBA)

Driven by rapid advances in many fields such as Biology, Finance and Web Services, applications involving millions or even billions of data items such as documents, user records, reviews, images or videos are not that uncommon. Can we develop methods that can learn efficiently from these massive amounts of potentially noisy data? There is an urgent need to revisit the traditional machine learning methods and tools to bridge the wide gap between large scale practical requirements and traditional learning approaches.

The goal of this course is to introduce fundamental concepts of large-scale machine learning. Both theoretical and practical aspects will be discussed. The primary focus of the course will be on analyzing basic tools of large-scale learning including the relevant theory and algorithms rather than focusing on specific machine learning techniques. It will also provide running examples from real-world settings from various fields including Vision and Information Retrieval. The course will prepare students to evolve a new dimension while developing models and optimization techniques to solve a practical problem - scalability.

We will analyze tools for large-scale learning that can be applied to a variety of commonly used machine learning techniques for classification, regression, ranking, clustering, density estimation and semi-supervised learning. Example applications of these tools to specific learning methods will also be provided. A tentative list of tools we plan to discuss is given below:

1. Randomized Algorithms
2. Matrix Approximations I (low-rank approximation, decomposition)
3. Matrix Approximations II (sparse matrices, matrix completion)
4. Approximate Nearest Neighbor Search I (trees)
5. Approximate Nearest Neighbor Search II (hashes)
6. Fast Optimization (first-order methods)
7. Kernel Methods I (fast training)
8. Kernel Methods II (fast testing)
9. Dimensionality Reduction (linear and nonlinear methods)
10. Sparse Methods/Streaming (sparse coding...)

Announcements

Please check this section frequently for new announcements.

- First (Intro) lecture will be on Sept 7.
- Course website is up (August 20).

Course Prerequisites

- Basic Linear Algebra
- Basic Probability and Statistics
- Basic Optimization
- Basic intro to Machine Learning is preferred but not necessary.

Grading

- **No Exams!**
- Homeworks (3 assignments 60%)
- Final project (40%)

COMS W4705x Natural language processing *3 pts. Lect: 3.* Prerequisites: COMS W3133, or W3134, or W3137, or W3139, or the instructor's permission. Computational approaches to natural language generation and understanding. Recommended preparation: some previous or concurrent exposure to AI or Machine Learning. Topics include information extraction, summarization, machine translation, dialogue systems, and emotional speech. Particular attention is given to robust techniques that can handle understanding and generation for the large amounts of text on the Web or in other large corpora. Programming exercises in several of these areas.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Autumn 2010 :: COMS W4705					
COMS 4705	48197 001	TuTh 2:40p - 3:55p 535 Seeley W. Mudd Building	J. Hirschberg	27	more info

COMS W4737x or y Biometrics *3 pts. Lect: 3.* Prerequisites: A background at the sophomore level in computer science, engineering, or like discipline. Corequisites: None In this course we will explore the latest advances in biometrics as well as the machine learning techniques behind them. Students will learn how these technologies work and how they are sometimes defeated. Grading will be based on homework assignments and a final project. There will be no midterm or final exam. This course shares lectures with COMS E6737. Students taking COMS E6737 are required to complete additional homework problems and undertake a more rigorous final project. Students will only be allowed to earn credit for COMS W4737 or COMS E6737 and not both.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Autumn 2010 :: COMS W4737					
COMS 4737	62198 001	TuTh 1:10p - 2:25p 327 Seeley W. Mudd Building	P. Belhumeur	9	more info

COMS W4772x Advanced machine learning *3 pts. Lect: 3.* Prerequisites: COMS W4771 or permission of instructor; knowledge of linear algebra & introductory probability or statistics is required. An exploration of advanced machine learning tools for perception and behavior learning. How can machines perceive, learn from, and classify human activity computationally? Topics include Appearance-Based Models, Principal and Independent Components Analysis, Dimensionality Reduction, Kernel Methods, Manifold Learning, Latent Models, Regression, Classification, Bayesian Methods, Maximum Entropy Methods, Real-Time Tracking, Extended Kalman Filters, Time Series Prediction, Hidden Markov Models, Factorial HMMS, Input-Output HMMs, Markov Random Fields, Variational Methods, Dynamic Bayesian Networks, and Gaussian/Dirichlet Processes. Links to cognitive science.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Autumn 2010 :: COMS W4772					
COMS 4772	72849 001	Tu 4:10p - 6:00p 535 Seeley W. Mudd Building	T. Jebara	12	more info

- **BMEN E4420y Biomedical signal processing and signal modeling** *3 pts. Lect: 3.* Prerequisites: APMA E3101 and ELEN E3202 or instructor's permission Fundamental concepts of signal processing in linear systems and stochastic processes. Estimation, detection and filtering methods applied to biomedical signals. Harmonic analysis, auto-regressive model, Wiener and Matched filters, linear discriminants, and independent components. Methods are developed to answer concrete questions on specific data sets in modalities such as ECG, EEG, MEG, Ultrasound. Lectures accompanied by data analysis assignments using MATLAB.

Course Number	Call Number/ Section	Days & Times/ Location	Instructor	Enrollment	
Spring 2011 :: BMEN E4420					
BMEN 4420	18297 001	W 1:10p - 3:55p TBA	P. Sajda	0	more info