G80.3042.002 – Fall 2007
Statistical Analysis and Modeling of Neural Data

Course Description

Instructors:	Bijan Pesaran & Eero Simoncelli
Prerequisites:	Mathematical Tools for Neural Science (G80.2221), or equivalent (basic calculus, linear algebra, linear systems theory, basic probability and statistics). See `http://www.cns.nyu.edu/~eero/math-tools/` for further information.
Brief description:	A graduate course covering advanced tools for analysis and modeling of neural systems and data. The goal of the course is to provide fundamental mathematical, statistical and computational tools necessary to solve data analysis and modeling problems, the transformations of raw data into a form in which these tools may be utilized, and the interpretation of such analyses. Lectures on each topic will include mathematical background, derivation of basic results, and examples relavent to neural science.
Format/grading:	The course consists of two 2-hour lectures per week. There will be a sequence of 3-4 homework assignments, primarily in the form of computer exercises in MATLAB , to examine the lecture topics in terms of concrete and realistic problems. Grades are based on homework.
Course materials:	There is no textbook for this course. Supplementary reading materials will be handed out in class. Where possible, we'll also make materials available as Acrobat (pdf) files from the course web site: `http://www.cns.nyu.edu/doctoral/courses/2007-2008/fall/statAnMod/`
Tentative topics:	**Fitting models to neural data.** Tools: general linear models, point processes, estimation theory, bias-variance tradeoff, overfitting, bootstrapping, cross-validation, basics of optimization. **Analyzing neural responses.** Tools: Time series and point process analyses, temporal and frequency representations, correlation and coherence, linear models, state space models, multivariate decompositions, conditional independence. **Linking neural responses with perception.** Tools: signal detection and ideal observer theory, estimation/decision theory, bias-variance tradeoff, cramer-rao bound, population coding, linear discriminant analysis, **Models of neural networks.** Tools: unsupervised learning, Principal components analysis, Independent components analysis, sparse optimization, local linear embedding, unsupervised clustering methods, Gaussian mixtures and the EM algorithm, graph cuts methods, attractors and phase plane analysis. **Spike sorting.** Tools: matched filters, unsupervised clustering methods, quadratic programming,