The course focuses on the role of computing in modeling and analyzing complex stochastic systems. The topics chosen are motivated by applications in the Computer, Cognitive and Neural Sciences. In each topic area, students will perform experiments in Matlab that highlight and confirm the analytical foundations developed in class.

Prerequisites for the course are: (i) basic knowledge of probability and statistics (at the level of AM165), and (ii) linear algebra (minimally at the level of AM34).

I. Probability recap: probability, random variables, probability distribution functions, densities, etc.

II. Generating "random" numbers on the computer

III. Limit laws: applications of the law of large numbers and the central limit theorem. Basic techniques of Monte Carlo simulation

   A. Monte Carlo integration and the law of large numbers

   B. Central limit theorem

IV. Random walks and exit times

V. Dependency graphs and computing

   A. Markov chains and Markov random fields

   B. Hidden Markov models (HMM)

   C. Bayes nets and expert systems

   D. Gibbs sampling

Realistically, this is probably about as much material as we can cover in 12 or 13 weeks. As time permits, however, possible additional topics include—

VI. Computer-based methods of nonparametric testing

VII. Multivariate data analysis

   A. Multivariate Gaussian distributions

   B. Principle and independent component analysis

   C. Poisson processes