

Recent Applications of Probability and Statistics

This is a topics course, covering a selection of modern applications of probability and statistics in the computational, cognitive, engineering, and neural sciences. The course will be rigorous, but the emphasis will be on application. Topics will likely include: Markov chains and their applications to MCMC computing and hidden Markov models; Dependency graphs and Bayesian networks; parameter estimation and the EM algorithm; Kalman and particle filtering; Nonparametric statistics (“learning theory”), including consistency, bias/variance tradeoff, and regularization; the Bayesian approach to nonparametrics, including the Dirichlet and other conjugate priors; principle and independent component analysis; Gibbs distributions, maximum entropy, and their connections to large deviations. Each topic will be introduced with several lectures on the mathematical underpinnings, and concluded with a computer project, carried out by each student individually, demonstrating the mathematics and the utility of the approach. There will be no exams.