EEE 6935 Stochastic Methods for Engineering II

Spring, 2022

Course Outline

1. Review of **SME I** and extensions

   What is a probability space? A random variable?
   σ-algebras: a way to model information
   Conditional distributions and expectation
   Relative entropy and mutual information

2. Convergence Theory

   Various notions of convergence and limit theorems
   Application to stochastic approximation
   stochastic optimization
   reinforcement learning
   Large deviations: from Chernoff's bound to Sanov's Theorem
   Applications: hypothesis testing and statistical communication

3. Random Processes

   Review of stationarity and WSS
   Martingales and "white noise"
   Introduction to the Kalman Filter

4. IV. Markov Chains

   Nonlinear state space models and Markov chains
   Irreducibility
   Stability theory, ergodicity, mixing times, ...

5. Inference for Markov Processes

   Markov Chain Monte Carlo and applications to learning.
   Hidden Markov models / partially observed MDPs, state estimation and Viterbi's algorithm.
   Some statistics: likelihoods and the expectation-maximization (EM) algorithm
   Application to the Baum-Welch algorithm
   Introduction to Gaussian Processes and applications to learning (as time permits)

This course evolved from one taught at UIUC for students interested in control, communications, or signal processing. It remains a required course for every student in any of these areas.

Most of the topics in this course are basic to any machine learning / statistical learning course. While Section 2 mentions applications in stochastic optimization and reinforcement learning, topics such as relative-entropy, mutual information, and hidden Markov models are relevant in every corner of communications, control and signal processing. Wikipedia will list applications ranging from finance to natural language processing.

For more information, contact

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T | Period 8 - 9 (3:00 PM - 4:55 PM)
R | Period 9 (4:05 PM - 4:55 PM) Room: LAR 239