

STAT 721 Spring 2022 Class Schedule

Ray Bai

Point Processes

- 1/10/22: class overview, preliminaries for stochastic processes
- 1/12/22: homogeneous Poisson processes
- 1/14/22: homogeneous Poisson processes, spatial point processes
- 1/17/22: **Martin Luther King Jr. Day (no class)**
- 1/19/22: spatial point processes, nonhomogeneous Poisson processes
- 1/21/22: **campus closed (no class)**
- 1/24/22: nonhomogeneous Poisson processes
- 1/26/22: estimation and prediction with Poisson processes

Mathematical Finance

- 1/28/22: random walks
- 1/31/22: Brownian motion, financial derivatives, options
- 2/2/22: no-arbitrage principle
- 2/4/22: binomial options pricing model
- 2/7/22: Itô integral
- 2/9/22: stochastic differential equations
- 2/11/22: Black-Scholes model for European options
- 2/14/22: Black-Scholes model, Greeks, and volatility

Gaussian Processes

- 2/16/22: Bayesian inference
- 2/17/22: matrix algebra review and multivariate Gaussian distribution (**make-up lecture**)
- 2/18/22: covariance functions and notions of stationarity
- 2/21/22: Gaussian processes (GPs)
- 2/23/22: GP regression
- 2/25/22: empirical Bayes for hyperparameter selection
- 2/28/22: approximation methods for big data with GPs
- 3/2/22: scalable GPs for big data, greedy algorithms
- 3/4/22: GPs for classification

Spring break 3/7/22-3/11/22

Reinforcement Learning

- 3/14/22: Markov decision processes, reinforcement learning
- 3/16/22: Bellman equation, optimal policy
- 3/18/22: dynamic programming, policy evaluation and policy iteration
- 3/21/22: value iteration, Q-learning
- 3/23/22: Q-learning with function approximation, policy gradient methods
- 3/25/22: policy gradient methods
- 3/28/22: actor-critic methods

Markov Chain Monte Carlo (MCMC)

- 3/30/22: Monte Carlo methods, Markov chain Monte Carlo (MCMC)
- 4/1/22: Metropolis-Hastings algorithm
- 4/4/22: Metropolis-Hastings algorithm, Gibbs sampling
- 4/6/22: Metropolis-within-Gibbs, MCMC diagnostics

Dirichlet Processes

- 4/8/22: Dirichlet distribution, Dirichlet process
- 4/11/22: ways of constructing a Dirichlet process (stick-breaking, Chinese restaurant process)
- 4/13/22: Bayesian Gaussian mixture models
- 4/15/22: Dirichlet process mixtures (DPMs), clustering with DPMs
- 4/18/22: density estimation with DPMs, class summary

Group Project Presentations

- 4/20/22: group project presentations
 - hierarchical Dirichlet process for topic modeling
 - building prediction intervals for stochastic stock price movements
 - models for pricing American options
- 4/22/22: group project presentations
 - Runge-Kutta method for solving stochastic differential equations (SDEs)
 - deep reinforcement learning for motion planning in dense traffic
 - Bayesian additive regression trees (BART) for nonparametric regression
 - nearest neighbor Gaussian processes for spatial weather prediction
- 4/25/22: group project presentations
 - jump-diffusion models in option pricing
 - hidden Markov models (HMMs) for biological sequence analysis
 - local approximation methods for scalable Gaussian processes

Optional Lectures (Asynchronous)

- embarrassingly parallel MCMC, consensus Monte Carlo
- Hamiltonian Monte Carlo (HMC)