STATISTICS

IEMS 401: Applied Mathematical Statistics

- Linear model theory
- Multivariate normal and related distributions
- Multiple regression and correlation
- Analysis of variance for single and multifactor experiments
- Maximum likelihood estimation and likelihood ratio tests

IEMS 490: Statistical Learning

- Fundamental theory of statistics and optimization
- Principled design of learning algorithms
- Turning data into decisions
- Programming in R or Python, with a focus on statistics, optimization, and learning

SIMULATION

IEMS 435: Stochastic Simulation

- Modeling: Discrete-event and process representations, High-level and low-level languages
- Input Modeling: fitting distributions to data, selecting distributions without data, nonstationary arrival processes, multivariate input models
- Output Analysis: point and interval estimation for means, probabilities and quantiles
- Experiment Design: terminating vs. steady-state simulation, determining number of reps/batches for fixed precision, initial bias mitigation, use of common random numbers and antithetic variates
- Variate Generation: pseudorandom number generators, inverse cdf transformation, nonstationary arrival processes, multivariate input models
- Using Simulation in Research: experiment within an experiment approach

OPTIMIZATION

IEMS 450-1: Mathematical Optimization I

- Optimization Models: Linear programming, integer programming, network models, nonlinear programming, deterministic dynamic programming, modeling languages
- Optimization Theory: Duality, sensitivity analysis, convexity, integrality property
- Optimization Algorithms, Implementation and Complexity Analysis: Simplex method, branch-and-bound, some network algorithms, Newton's method, interior-point method

IEMS 450-2: Mathematical Optimization II

- Computational Complexity: Algorithm complexity, NP-completeness, Cook's theorem, problem reductions
- Nonlinear Optimization: Convex analysis, optimality conditions and solution methods for constrained and unconstrained problems
- Polyhedral Theory: Farkas' lemma, Minkowski and Weil theorems, equivalence of separation and optimization

- Approaches to hard discrete optimization problems: Lagrangian relaxation, cutting planes, heuristics; performance analysis of these approaches

APPLIED PROBABILITY

IEMS 460-1: Stochastic Processes I

- Discrete and continuous time Markov chains: transient and steady state analysis
- Steady state analysis of Markovian and M/G/1 queues

IEMS 460-2: Stochastic Processes II

- Renewal Theory; stopping times, Wald's lemma
- Regenerative reward processes
- Networks of Markovian queues (open and closed)
- Approximations for non-Markovian queues
- Stochastic ordering, modes of convergence, sample path coupling
- Numerical solution of large-scale Markov chains

DECISION ANALYSIS

IEMS 488: Economics and Decision Analysis

- Making decisions under uncertainty and risks, including decision trees and value of information, and behavioral decision making
- Modeling risks and market demand using utility functions
- Stochastic dynamic programming and Markov decision process
- Multi-objective decision making
- Game theory (static and dynamic games with complete and incomplete information)
- Mechanism design and principle-agent models