Bus 36901 Stochastic Programming
Winter 2013

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Description: This course will provide an overview of the theory, solution algorithms, and applications of models for optimal decision-making under uncertainty. The course will emphasize models and methods that apply to discrete-time, high-dimensional decisions in a variety of domains including energy, finance, logistics, manufacturing, transportation, and services. Continuous-time models will also be presented for comparison. Topics will include characterization of optimality, stability, sensitivity, and robustness, approximation, statistical, and convergence properties, asymptotic and extremal distributions, and computational complexity.

Students will develop skills to represent complex decision problems in a tractable form, to solve large-scale problems, and to describe resulting solution properties. Students will be prepared to read, understand, and interpret recent literature in the field.

Prerequisites: Fundamental knowledge of linear programming, probability, and stochastic processes; some familiarity with nonlinear optimization and convex analysis.

Text: Birge and Louveaux, *Introduction to Stochastic Programming*, Second edition, Springer-Verlag, 2011; additional papers to accompany specific topics.

Assignments: Weekly problems, project, midterm, and final examination. Grading (class participation (5%), homework (20%), midterm (20%), project (20%), and final (35%)).

Outline:

Week 1: Basic stochastic programming models in discrete-time; Review of optimization principles and probability background; Characteristic examples in portfolio planning (Chapter 1, 2.11)

Week 2: Alternative representations of stochastic optimization problems and risk characterization: recourse model, probabilistic constraints, robust optimization, statistical decision theory, stochastic control, robust optimization, coherent risk measures, dynamic programming (Chapter 2)

Week 3: Properties of the stochastic program: existence, convexity, duality, optimality conditions; Probabilistic constraint representations; Continuous time representations and relation to Bellman-Hamilton-Jacobi equations. (Chapter 3)

Week 4: Value of information, value of the stochastic solution, portfolio examples discrete-time version of fundamental theorem of asset pricing. (Chapter 4)

Week 5: Decomposition algorithms, Lagrangian methods, and multistage extensions. (Chapter 5)

Week 6: Midterm/ Multistage extensions. (Chapter 6)

Week 7: Stochastic integer programs and computational complexity results. (Chapter 7)

Week 8: Approximating expectations, moment problem solutions, and chance-constrained bounds for reliability and Value-at-Risk. (Chapter 8)

Week 9: Monte Carlo methods, convergence theory for sample average approximations, basic stochastic methods: stochastic approximation and decomposition. (Chapter 9)

Week 10: Multistage approximations, approximate dynamic programming, and extensions (Chapter 10).

Homework #1: due Week 2.

1. Text, p. 17, #1.
2. Text, p. 17, #2.
3. Text, p. 18, #6.
4. Text, p. 27, #2.
5. Text, p. 27, #3.
6. Text, p. 27, #4.