

# ORI 397-18835 – Optimization Under Uncertainty

## General Information

**Instructor:** Grani A. Hanasusanto

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**Prerequisites:** Graduate-level knowledge of linear programming, integer programming, nonlinear programming, probability, and statistics. Knowledge of convex optimization and analysis is beneficial. Students are expected to be comfortable with advanced mathematical formality and reasoning.

**Texts (optional):**

1. A. Shapiro and D. Dentcheva, *Lectures on Stochastic Programming: Modeling and Theory*, SIAM, 2014.
2. A. Ben-Tal, L. El Ghaoui, and A. Nemirovski, *Robust Optimization*, Princeton University Press, 2009.

**Software:**

- MATLAB.
- YALMIP. Can be downloaded from <http://users.isy.liu.se/johanl/yalmip/>.  
J. Löfberg, *YALMIP: A toolbox for modeling and optimization in MATLAB*, IEEE International Symposium on Computer Aided Control Systems Designs, 2004.
- MOSEK. Free academic license is available at <https://license.mosek.com/academic/>.

**Course Description:** A wide variety of decision making problems in engineering, science, and economics involve uncertain parameters whose values are unknown to the decision maker when the decisions are made. The underlying uncertainty of these problems may arise from incomplete data, measurement errors or the inherent stochastic nature of the respective problems. Ignoring this uncertainty can lead to inferior solutions that perform poorly in practice.

The goal of this course is to introduce optimization models and methodologies that address uncertainty-affected decision problems. The course will introduce fundamental techniques from stochastic programming, robust optimization, and distributionally robust optimization. The theory will be motivated through concrete examples from production planning, supply chain management, project management, portfolio selection, machine learning, etc.

**Didactic Approach:** The course will be taught in the classical formal teaching fashion. The material will be presented at a modern research level and the main results will be proved rigorously.

**Learning Outcomes:** By the end of the course, the student must be able to:

- Formulate uncertainty-affected decision problems as formal mathematical optimization models
- Solve the resulting models using standard off-the-shelf optimization solvers and to interpret the results
- Appreciate the benefits and the shortcomings of different paradigms for optimization under uncertainty

**Topics Covered:**

- **Introduction:** Convex optimization, duality theory, probability theory, YALMIP
- **Stochastic Programming:** Risk measures, stochastic programming with recourse, L-shaped method, Benders decomposition, chance constrained programming, Monte-Carlo sampling methods, multi-stage problems, stochastic dual dynamic programming, decision rules approximation, expected value of perfect information, value of the stochastic solution
- **Robust Optimization:** robust counterparts of LP, choice of uncertainty sets, multi-stage problems, Benders decomposition, distributionally robust optimization, distributionally robust chance constraints, data-driven models

**Grading Policy:** In this course, there will be several homework assignments, one project and one final exam. The weightings are as follows:

Homework Assignments	35%
Project (groups of 2 or 3)	30%
Final Exam	35%

Homework assignments are due at the beginning of class on designated days. On these assignments, you are allowed and in fact encouraged to discuss the problems with your classmates. However, you *must* write your own solution. Late assignments will not be accepted.

**Exam Policy:** You are required to take the exam at the scheduled time. Make-up exams will not be given without a valid medical excuse.

**Email Communication:** For this class, email will be used as an official form of communication for notifying you of new homework assignments and other class updates. The University of Texas email policy can be found at: <http://www.utexas.edu/cio/policies/university-electronic-mail-student-notification-policy>.

## Additional Information

- **Students with Disabilities:** The University of Texas at Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TTY.
- **Course Evaluation:** Near the end of the course you will have an opportunity to anonymously evaluate the course and instructor using the standard College of Engineering evaluation form.
- **Class Web Site and Privacy:** For this class, web-based, password-protected class sites will be available via the *Canvas* system. The syllabus, handouts, assignments and other resources are types of information that may be available within this site. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, a class e-mail roster will be a component of the site. Students who do not want their names included in this electronic class roster must restrict their directory information in the Office of the Registrar, Main Building, Room 1. For information on restricting directory information see: <http://registrar.utexas.edu/students/records/restrictmyinfo>.
- **Honor Code:** The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.
- **Plagiarism:** Plagiarism is a serious offense and is cause for dismissal from the University. Please see [http://deanofstudents.utexas.edu/sjs/scholdis\\_plagiarism.php](http://deanofstudents.utexas.edu/sjs/scholdis_plagiarism.php) and <http://www.lib.utexas.edu/services/instruction/learningmodules/plagiarism/index.html>
- **Behavior Concerns Advice Line (BCAL):** If you are worried about someone who is acting differently, you may use the Behavior Concerns Advice Line to discuss by phone your concerns about another individual's behavior. This service is provided through a partnership among the Office of the Dean of Students, the Counseling and Mental Health Center (CMHC), the Employee Assistance Program (EAP), and The University of Texas Police Department (UTPD). Call 512-232-5050 or visit <http://www.utexas.edu/safety/bcal>.
- **Religious Holy Days:** By UT Austin policy, you must notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.