95.760: Decision Making Under Uncertainty
Fall 2017, Mini 1; 6 units

Instructor

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Teaching Assistants

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Meeting times and locations

Section A1: Mondays, Wednesdays 10:30-11:50am Hamburg Hall 1002
Section B1: Tuesdays 6-8:50pm Hamburg Hall 1204
Recitation (all sections): Fridays 1:30-2:50pm Hamburg Hall A301

Office Hours

Alex Jacquillat: Thursdays, 10:30 am 12 pm, HBH 2118J
Luyao Chen: TBD
Mohammad Khan: TBD
Vinod Krishnappa: TBD
Emily Shawgo: TBD
Vijaya Vijayasarathy: TBD

The recitation time will be used to hold the exams in Weeks 4 and 7. Please make sure not to schedule anything else at that time.

Course Content

This course provides an introduction to modeling and computational methods used by policymakers, managers and analysts to support decision-making. The first half of the course focuses on deterministic optimization, and covers linear programming, network optimization
and integer programming. The second half of this course introduces risk and uncertainty, and includes methods to characterize uncertainty and methods to optimize decisions under uncertainty. Examples are drawn from a variety of domains where these decision-making methods can provide value for business and policy, such as transportation, energy, health care, manufacturing, supply chain management, etc.

The readings, lectures, homework assignments and exams will help you develop modeling skills, computational skills and analytical skills. Modeling skills involve translating a problem into a well-defined mathematical framework, using little more than pen and paper. Computational skills involve solving your model on a computer program. In this course, all applications will be done in Excel. Analytical skills involve critically interpreting a model and translating results into insights for decision-making. All three are important!

**Course objectives**

1. Become familiar with advanced Excel functions. This helps you get a job.
2. Survey optimization and decision science methods. This helps you hire consultants intelligently, should you need to.
3. Learn some analytical methods. This helps you solve smaller problems yourself and develop intuition for more complex problems.
4. Learn how to develop a mathematical model. This helps you think clearly and precisely, and will give you an edge on the marketplace.

The course moves quickly, so it is important that you do your best not to fall behind.

- Attend lectures! Attendance will not be tracked, but it will be extremely hard to catch up if you miss any lecture.
- Assigned readings must be read before class. This will help you develop a thorough understanding of the methods covered and will lead to more interesting discussions in class.
- Start the homework assignments early. Each question will be annotated with the lecture that covers the relevant materials, so that you can attempt the question any time after that lecture.
- Bring your questions to recitation and office hours to address weak spots

**Textbook**

Homework (for both sections of the course)

HW 1: due 6 PM, Tuesday Sep 12
HW 2: due 6 PM, Tuesday Sep 19
HW 3: due 6 PM, Tuesday Sep 26
HW 4: due 6 PM, Tuesday Oct 10

In order to ensure timely feedback, we will often release the HW solution promptly at 6 PM when the homework is due. As a result, no late HW will be accepted. If you have a scheduling conflict, submit the homework early.

Homework assignments should be submitted electronically, via Canvas. Submit a single PDF file. Many of the problems will require you to construct a spreadsheet. In these cases, you should copy a screenshot of the spreadsheet into the PDF that you submit, and also document the formulas that you used (there will be examples you can follow). If you need to draw a picture or write a series of equations by hand, then either scan or take a picture of it, and copy it into the PDF that you submit.

Homework assignments must be submitted individually. You are allowed to work with one (and only one) partner. Partners can help each other to discuss homework problems and build spreadsheet models. If you work with a partner, you are still required to submit your own report, and need to write the name of your partner as part of your submission. No other collaboration is permitted.

Exams (for both sections of the course)

Exam 1: Friday September 22, 1:30-2:50
Exam 2: Friday October 13, 1:30-2:50

There will be no make-up exam. If you miss an exam you can take a 0 or an incomplete in the course and fill in the score from next years exam.

The exams will be closed book and closed computer. It will not be necessary, but you can also bring a simple calculator (no smartphones or tablets).

Final Grades

The HW and exam scores will be combined with the following weights:

HW: 50%
Exam 1: 25%
Exam 2: 25%
Participation: An important tie-breaker!
Grades will be curved to conform to Heinz college standards. Typically, the curve usually results in most of the grades being roughly evenly divided between A, A-, B+, and B, with a few exceptions (both high and low).

Special needs

Please feel free to let me know if you need any accommodation based on the impact of a disability. I am happy to discuss your specific needs privately.

Communication

Please bring your questions to the weekly office hours. This is the time where the teaching staff is the most available. You are also welcome to send your questions by email. You should cc all TAs on any email, especially for questions regarding HW grading.

Use the Canvas system for communications that might be of interest to others.

Academic Integrity

The rules and the academic integrity standards outlined in your student handbook will be strictly enforced. Violations of these rules or standards are considered a fundamental breach of trust and will result in failure of the course.

Collaboration on homework (except with your partner, if you choose work with one) is not permitted in this class. Cheating will be treated very seriously.

The following are acceptable:

- Discussing the requirements of a homework problem as long as no specific solution is discussed
- Discussing general approaches to solving a problem as long as no specific solution is discussed
- Using Excel samples from the textbook and class handouts.

The following are considered cheating:

- Discussing specific math or Excel formulations
- Showing anyone your Excel spreadsheet
- Looking at anyone else’s Excel spreadsheet
- Having anyone else produce an Excel spreadsheet for you
– Having anyone else correct your Excel spreadsheet for you
– Copying any Excel spreadsheet you find online
– Using solutions from past courses or the solutions manual

You are not permitted to be in possession of any assignments, exams or exercises from another student either from the current semester or from past semesters whether they are electronic or paper. Possession of or sharing such files constitutes an infraction of the academic integrity policies of this course.

There are unscrupulous booksellers on the Internet who will sell you a copy of the Solutions Manual for our textbook. This is illegal, and our book publisher actively seeks out, and sues, such vendors and sometimes those who buy these illegal books. Moreover, using such a book usually results in great homework scores and really bad exam scores. Since the exam scores are much more heavily weighted, your best plan is to work all of the homework problems yourself. Also, there are often errors in the solutions manual, some of them placed there on purpose by the author, designed to let us discover who is cheating in this way.

Course Schedule

Week 1
Lecture 1: Introduction to Operations Research; Linear Programming
Lecture 2: Linear Programming
Friday: Recitation
Reading: Chapter 2, Chapter 3, 3.0-3.5, 3.7-3.14
Optional reading: OR – A Catalyst for Engineering Grand Challenges
HW1 out on Tuesday, August 29 — Linear Programming

Week 2
Lecture 1: Sensitivity Analysis
Friday: Recitation
Reading: Chapter 4, 4.0 4.6 [Rest of Chapter 4 is optional]

Week 3
Lecture 1: Network Flows
Lecture 2: Network Flows
Friday: Recitation
Reading: Chapter 5, 5.0 5.7
HW1 due on Tuesday, September 12
HW2 out on Tuesday, September 12 — Network Flows

Week 4
Lecture 1: Integer Programming
Lecture 2: Integer Programming
Friday: **Exam 1**

*Reading:* Chapter 6

**HW2** due on Tuesday, September 19

**HW3** out on Tuesday, September 19 — Integer Programming

**Week 5**

Lecture 1: Probability Modeling
Lecture 2: Random Variables and Sampling
Friday: Recitation

*Reading:* Bertsimas, D. and Freund, R. *Data Models and Decisions*, Chapters 2 & 3, selected pages posted on Canvas

**HW3** due on Tuesday, September 26

**HW4** out on Tuesday, September 26 — Stochastic Simulation and Optimization

**Week 6**

Lecture 1: Monte Carlo simulation
Lecture 2: Stochastic Programming
Friday: Recitation

*Reading:* Chapter 12

**Week 7**

Lecture 1: Decision Analysis
Lecture 2: Review
Friday: **Exam 2**

*Reading:* Chapter 14

**HW4** due on Thursday, October 10