IM2010 – Operations Research, Spring 2015

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Operations Research (OR) is a field in which people use mathematical and engineering methods to support decision making. While the main application of OR is to solve business problems, people in the fields of Economics, Computer Science, Civil Engineering, Electrical Engineering, etc., also benefit from OR methods. People use those models, algorithms, and solution processes in OR to optimize all kinds of decisions. This is why people refer to OR as a decision making tool. In this course, we will study how to facilitate decision making for either a single decision maker or multiple decision makers. Most examples will be adopted from the business world while some will be from various engineering fields. Basic knowledge on Calculus, Linear Algebra, Discrete Mathematics, and Probability is assumed for students taking this course.

This is a required course for the sophomores in the Department of Information Management in National Taiwan University. In most cases, all students who want to enroll in or audit this course are welcome. This course is taught in English.

Note. *For this course, I plan to adopt the "flipped classroom" principle, which may be new to you. Please pay attention to the syllabus to get an idea about the design of this course.*

Basic information

Instructor	• Ling-Chieh Kung (孔令傑). E-mail: lckung(AT)ntu.edu.tw. • Office: Room 413, Management Building II. Tel: 02-3366-1176. • Office hour: 2:00-3:00pm, Thursday or by appointment. • http://www.im.ntu.edu.tw/~lckung/
Teaching Assistants	• Kiwi Liu (劉騏瑋). E-mail: r03725034(AT)ntu.edu.tw • Amy Liu (劉盈秀). E-mail: r03725033(AT)ntu.edu.tw
Lectures	• 9:10-12:10pm, Thursday. • Room 103, Management Building I.
Prerequisites	• Calculus: "Calculus I" and "Calculus II" in the IM department, or equivalent. • Linear Algebra: "Management Mathematics" in the IM department, or equivalent. • Probability: "Statistics I" in the IM department, or equivalent. • Discrete Mathematics: "Discrete Mathematics" in the IM department, or equivalent.
Textbook	• *Introduction to Operations Research* by F. S. Hillier and G. J. Lieberman, Ninth edition, McGraw Hill. 臺灣代理: 東華書局/新月圖書, (02) 2311-4027.
References	• *Management Science Modeling* by S. C. Albright and W. L. Winston. • *Operations Research: Applications and Algorithms* by W. L. Winston. • *Game Theory for Applied Economists* by R. Gibbons. • 「管理科學：作業研究與電腦應用」，陳文賢、陳靜枝。
On-line Resources	• To check grades: CEIBA. • To download or link to materials: http://www.im.ntu.edu.tw/~lckung/courses/OR15/. • To discuss: the bulletin board "NTUIM-lckung" on PTT.

Overview of topics

In this course, we introduce the modeling approach for facilitating decision making. The focus is on deterministic optimization techniques. This course is divided into three modules:

1. Linear optimization: basics (four weeks): The first module introduces basic ideas about Linear Programming, the most fundamental optimization technique. We study the definition of linear programs, an applicable algorithm for solving linear programs, and a lot of examples of applying Linear Programming in decision making.
2. Linear optimization: advances (four weeks): The second module discusses some theoretical properties of linear

programs and their implications. Moreover, we introduce how to incorporate integer variables into linear programs to solve more complicated decision problems.

3. Nonlinear optimization (three weeks): The last module contains an introduction to Nonlinear Programming, the tool needed for problems that cannot be solved by linear optimization techniques. We discuss basic convex analysis, analytical and numerical ways to solve nonlinear programs, and applications.

This course emphasizes on both theories and applications. We will give you mathematical models, properties, algorithms, and examples. The applicability of those models will be demonstrated with examples in manufacturing, logistics, marketing, finance, supply chain management, human resource management, and information management. Though we focus on business decision making, students may eventually see these ideas and techniques also used in Economics and Computer Science.

Grading

Breakdown

- Quiz: 0%.
- Pre-lecture problems: 5%. Lecture problems: 15%. Class participation: 5%.
- Four homework: 10%. Two case studies: 15%.
- Project: 25%. Final exam: 25%.
- (Bonus!) PDAO contest or a bonus problem: 5%.

Conversion rule

- The final letter grades will be given according to the following conversion rule:

Letter	Range	Letter	Range	Letter	Range	Letter	Range	Letter	Range
F	[0, 60)	C−	[60, 63)	C	[63, 67)	C+	[67, 70)	B−	[70, 73)
B	[73, 77)	B+	[77, 80)	A−	[80, 85)	A	[85, 90)	A+	[90, 100]

Tentative schedule

Week	Date	Lecture	Textbook	Note
1	2/26	Overview and ***quiz***[1]	Chs. 1 and 2	
		Module 1: Linear Optimization: Basics		
2	3/5	Linear Programming basics	Ch. 3	Homework 0 due on 3/2 (Mon)
3	3/12	The simplex method (1)	Ch. 4	
4	3/19	The simplex method (2)	Ch. 4	
5	3/26	Applications of Linear Programming	Ch. 3/handouts	Homework 1 due on 3/23 (Mon)
6	4/2	***Holiday: spring recess***		
		Module 2: Linear Optimization: Advances		
7	4/9	Linear Programming duality	Ch. 6	Case Study 1 due on 4/7 (Tue)
8	4/16	Network flow models	Chs. 8 and 9	
9	4/23	Integer Programming	Ch. 11	
10	4/30	Applications of Integer Programming	Ch. 11/handouts	Homework 2 due on 4/27 (Mon)
11	5/7	***No class: The instructor goes to a conference***		Case Study 2 due on 5/11 (Mon)
		Module 3: Nonlinear Optimization		
12	5/14	Single-variate Nonlinear Programming	Ch. 12	***PDAO Contest*** on 5/16 (Sat)
13	5/21	Inventory Theory	Ch. 18	Bonus problem due on 5/18 (Mon)
14	5/28	Multi-variate Nonlinear Programming	Ch. 12/handouts	Homework 3 due on 5/25 (Mon)
15	6/4	***Project presentations***		Project report due on 6/5 (Fri)
16	6/11	***Final exam***[2]		

[1] The quiz is only for you to check whether your technical background is appropriate for this course. It counts nothing in calculating the semester grades.
[2] Thanks to "flipped classroom" and your efforts, the class ends at week 16. No class for weeks 17 and 18!

Policies

"Flipped Classroom"

- The main idea of flipped classroom is "lectures in videos, then discussions in classes". To learn more about the principle, please search "flipped classroom" or "翻轉教室" online.[3]
- Before each Thursday lecture (except the first one), the instructor will upload videos containing the materials to be discussed on that Thursday. The video will be around one and a half hour. Students must watch the video before the lecture. One pre-lecture problem will be assigned to students for them to submit at the beginning of the lecture.
- During the lecture, students may ask questions regarding anything covered in the video. However, the instructor will not redo the whole lecture. Then students will form teams to work on lecture problems assigned by the instructor. Some will present their answers to the class. The instructor may make comments and lead the discussions for extended topics when appropriate.
- Students must form teams to do lecture problems. Each team must have exactly three students unless a special approval is obtained. Students may change teammates at any time. Of course, one student cannot be in two teams. Students in a team will be required to sit together in the classroom.

Attendance and Class Participation

- We do not require one to attend all the lectures. If you have something to do, feel free to drop a class. Nevertheless, as lecture problems count for grades, missing a lecture makes it harder for your team to get this part of grades.
- During lecture time, students are more than welcome to ask or answer questions and provide comments. The one who presents for her/his team is obviously considered as an active participator. You are also welcome to use the course bulletin board on PTT or send the instructors or TAs e-mails at any time. These will not only give one good participation grades but also help one's learning.

Office Hour

- You are welcome to my office hour to ask me any question. You may ask me to clarify some concepts, give hints for homework problems, or discuss the final project. In fact, discussions not related to course materials are also welcome. If you do not want to come in the designated time, feel free to send me an e-mail to schedule a meeting.

Homework and Case Assignments

- Four homework will be assigned throughout this semester for students to understand the theories taught in class. Students must do homework individually.
- Two case assignments will be assigned for students to apply their knowledge to solve "real" business decision problems. Students form teams, each with at most three students, to do case studies.
- The TAs will grade these assignments and regrade them upon request. If you have a regrading request, please contact the TAs directly. For all assignments, discussions are strongly encouraged. However, each individual or team should create her/his/their own work. Copying will result in severe penalties for everyone involved.

PDAO Contest

- The PDAO (Programming Design and Optimization) contest is an ACM-style contest held by IM students. If students form teams to participate in this contest, they will get bonus points according to their performance. In particular, a team member gets $\min\{5, 0.5x\}$ points, where x is the number of problems (including testing problems) solved by the team. For those who plan to join but cannot make it, they may work on a special bonus problem for comparable credits.

Final Project

- Students must form teams to do a final project by applying the techniques learned in this course to a self-selected problem. The number of students in each team will be determined after the class size is finalized (according to the past experiences, around five to eight). Each team will make an oral presentation and submit a report. All team members must be in class for the team to present.

Final Exam

- The final exam will be in-class and open book. However, except calculators, all other electronic devices are disallowed. Cheating will result in severe penalty for everyone involved. The exam is comprehensive and may cover everything taught in this semester.

[3] On my blog, there are several articles (in Chinese) regarding flipped classrooms. You may find it at http://lckung.wordpress.com.