

Decision Sciences

(Friday 09:10 – 12:00, Fall 2024)

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Course Web Site: <https://wm5.nccu.edu.tw/mooc/index.php>

Prerequisites: Management science (管理科學)

Description: This is a required course for graduate students in the department of Management Information Systems. We focus on *decision-making under uncertain parameters and outcomes*. Students will be exposed to discrete/continuous probability distributions and simulation models that are crucial for evaluating decisions in a stochastic (non-deterministic) environment. We will analyze numerous operational decision problems that can be solved by simulation analysis. Methods for financial planning and algorithmic marketing will be discussed as well.

The primary goal of this course is to sharpen students' quantitative modeling capabilities for better business decisions. After taking this course, students are expected to have a good understanding of predictive and prescriptive data analytics. Also, *Python* programming will be part of this learning process. Note that this is NOT a programming language course so I will not teach you *Python* from scratch. Instead, sample codes for lecture problems will be clearly explained and provided. To make our life easier, we will use Colaboratory developed by Google. The only way to maximize learning efficacy is to get your hands dirty and write the program.

Finally, I highly encourage students to ask me questions in- and off-class whenever you don't understand my lectures. I urge students NOT to ask for solutions to homework problems. Be open-minded to LISTEN to each other, be proactive to share, and think out-of-the-box.

Grading

This is a tentative plan and I reserve the right to adjust score allocation rules.

Homework: 40% I expect to distribute 4-5 assignments during the semester.

Midterm: 35% I will explain the exam logistics in detail.

Final Project: 25% I will explain the deliverables in detail.

Don't be a free rider. Form your team wisely.

Textbook

Lecture notes and assigned readings will be provided. So NO textbooks are required. Below is a list my key references in developing this course.

Bertsimas & Freund 2004 *Data, models, and decisions: The fundamentals of management science*.

Myerson & Zambrano 2019 *Probability models for economic decisions* (2nd Edition).

Kroese et al 2022 *Data science and machine learning: Mathematical and statistical methods*.

Powell 2022 *Reinforcement Learning and Stochastic Optimization*.

Outline of the course

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| Class 1 (Sep 13) | Course introduction Monte-Carlo simulation using <i>Python & Google Colab</i> |
| Class 2 (Sep 20) | Decision analysis Bertsimas & Freund 2004 (Chapter 1) |
| Class 3 (Sep 27) | Fundamentals of discrete probability with simulation (I) Bertsimas & Freund 2004 (Chapter 2) |
| Class 4 (Oct 04) | Fundamentals of discrete probability with simulation (II) Some important discrete distributions |
| Class 5 (Oct 11) | Fundamentals of continuous probability with simulation Bertsimas & Freund 2004 (Chapters 3 & 5) |
| Class 6 (Oct 18) | Stochastic dependencies Multivariate Gaussian |
| Classes 7-8 (Oct 25 & Nov 01) | More probability distributions Random time-to-event & non-negativity |
| Class 9 (Nov 08) | Optimization of decision variables Newsvendor model & revenue management Derivative-free search algorithms |
| Class 10 (Nov 15) | Dynamic simulation Multi-period planning Multi-agent bidding |
| Class 11 (Nov 22) | Midterm exam Logistics to be determined & announced |
| Class 12 (Nov 29) | Monte-Carlo methods for optimization Simulated annealing, particle swarm, & differential evolution |
| Class 13 (Dec 06) | Practice papers & special topics |
| Class 14 (Dec 13) | Systems thinking |
| Class 15 (Dec 20) | NO class meeting Final project preparation |
| Class 16 (Dec 27) | Meetings with groups Final project development |
| Class 17 (Jan 03) | Meetings with groups Final project development |
| <u>Final report due at 23:59 on Jan 11, 2025</u> Upload your code & report onto WM5 | |