IE 331: Operations Research: Optimization, Spring 2024

MW (월 수) 10:30-11:45 am, E2-2 (산업경영학동) #1501

Instructor: Dabeen Lee, `dabeenl@kaist.ac.kr`, E2-2 #2109.
Lectures: Mondays and Wednesdays 10:30-11:45 am.
Office hours: Tuesdays 2:00-3:00 pm.
Teaching assistant: To be announced.
Course webpage: `https://dabeenl.github.io/IE331` + KLMS course page
Assignments and lecture notes will be uploaded to the webpage as well as the KLMS page.

Course description Operations Research & Management Science (ORMS) refers to analytical and quantitative techniques that are used in decision-making processes for organizations (including businesses). This course will focus on mathematical optimization and mathematical programming, arguably the most fundamental tool used for quantitative decision-making. We will learn basic yet fundamental frameworks to formulate a decision-making problem as a mathematical optimization model, taking into account data, constraints, and objectives. Topics include, but are not limited to, introduction to linear programming, network flow models, integer programming, scheduling, and stochastic programming.

Key topics

- The components of a mathematical optimization model.
- How to build linear optimization models for common decision-making problems.
- How to model uncertainty and risk in decision-making problems.

This course will focus on linear optimization models and its variants. It will only briefly touch on algorithms and skip over nonlinear models. Those of you interested in nonlinear optimization can take ”IE539: Convex Optimization” offered every fall semester.

Texts There is no required textbook for this course, but students may find the following list of materials useful to follow the topics covered in this course:

- Operations Research: Applications and Algorithms by Wayne L. Winston.
- Applied Mathematical Programming by Stephen P. Bradley, Arnoldo C. Hax and Thomas L. Magnanti.
- Model Building in Mathematical Programming by H. Paul Williams.
- Introduction to Linear Optimization by Dimitris Bertsimas and John N. Tsitsiklis.

- Linear Programming by Robert J. Vanderbei.
- Convex Optimization: Algorithms and Complexity, *Bubeck*, `https://arxiv.org/abs/1405.4980`.

Prerequisites There are no formal prerequisites but you should be comfortable making mathematical arguments, writing proofs, and programming. You should also be comfortable with the background knowledge from previous courses. It is recommended to get equipped with

- basic linear algebra (vectors, matrices, inner products),
- comfort with mathematical reasoning,
- comfort with programming using Python.

Assessment structure There will be assignments (30%), a mid-term exam (30%), and a final exam (40%). **Typesetting in Latex is required for all assignments**.

Course outline What follows is a tentative outline of this course.

- Fundamentals of optimization models
- Building linear programming models
- Linear programming technical details
- Linear programming duality
- Row and column generation for large-scale models
- Network flow models
- Integer programming models
- Production and inventory planning
- Sequencing and scheduling
- Optimization models under uncertainty
- Two-stage optimization models
- Multistage optimization models
- Optimization algorithms for machine learning
- Optimization framework for modern operations research