NATIONAL UNIVERSITY OF SINGAPORE
NUS Business School
Department of Analytics & Operations

DBA3701: Introduction to Optimization

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Office hour: By Appointment, BIZ1 8-76

TA: TBA

Session: Semester II, 2024/2025;

Objectives

The objective of this course is to introduce students to the theory and applications of modern optimization techniques. Formulation and modeling of real life optimization problems via sophisticated software tools will be emphasized to strengthen students' understanding of various fields in optimization. Throughout the course, references will be made wherever appropriate, to business applications, such as pricing, logistics problems and others. Students who are interested in computer and quantitative approaches in business will learn many useful techniques in large business system management from this course.

After this course, students should be able to achieve 2 major objectives:

(1) Polish their thinking and mathematical skills in optimization and
(2) Formulate problems arising in different business context and solve optimization problems using state-of-the-art commercial solver.

Prerequisite

Linear algebra and basic probability, or equivalent course.

Assessment

Individual Assignment	20%
Class Participation	5%
Team Term Paper Proposal Presentation	5%
Team Term Paper	30%
Final Exam	40%

Textbooks for Reference

Materials will be mainly based on lecture notes but the following three books are relevant in further study of the subject.

- Introduction to Operations Research, by Frederick S. Hillier, Gerald J. Lieberman
- Introduction to Linear Optimization, by Dimitris Bertsimas, John N. Tsitsiklis
- Applied Mathematical Programming, by Bradley, Stephen P., Hax, Arnoldo C., Magnanti, Thomas L.

Individual Assignment

Individual assignment is expected to be completed alone. Assignment will generally be due in-class. Everyone should turn in individual hard copy, including printout of code.

Term Paper

Each project team is required to prepare a term paper on certain application or research topic relevant to the subjects covered in this class. Any paper used for fulfilling requirements of other courses MUST NOT be recycled in this class.

The purpose of the term paper is to demonstrate that you can apply the analytical techniques learned in this class to an analytics problem of your choosing. The paper must include a statement of the problem, data or process(es) analyzed, and the principles learned. There is no page limitation, but a good term paper may need 5 to 8 pages of narratives to provide in-depth analysis of a selected topic.

Term Paper Presentation (for Proposal)

Each project team is required to give a 10-15 minutes presentation on their proposal for term project in the class.

The presentation should give a particular emphasis on: 1) business environment and motivation of the problem; 2) the operations research tool to be used in the project; 3) preliminary results (if any).

Software

For very simple examples, Excel will be used for quick demonstrations. But for the most part of the course, we will use Python (https://docs.python.org/3/tutorial/) and Gurobi (http://www.gurobi.com/) to solve more complicated optimization problems.

Tentative Course Outline

Week One

- Operations Research in Practice

Read

- Note on Installation of Anaconda (for Python) and Gurobi

Week Two

- Linear Programming and its Applications

Read

- Hillier and Liberman. Chapter 3: Introduction to Linear Programming
- Hillier and Liberman. Appendix 4: Matrices and Matrix Operations

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Week Three

- Geometry of Linear Programming and Simplex Method

Read

- Hillier and Liberman. Chapter 5: The Theory of the Simplex Method
- Bertsimas and Tsitsiklis. Chapters 2 and 3

Week Four

- Duality Theory and Sensitivity Analysis

Read

- Hillier and Liberman. Chapter 6: Duality Theory
- Bertsimas and Tsitsiklis. Chapters 4 and 5

Week Five

- Case Discussions

Read

- Lecture Notes

Week Six

- Network Optimization I

Read

- Hillier and Liberman. Chapter 10: Network Optimization Models
- AMP Chapter 8: Network Flow

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Week Seven

- Network Optimization II

Read

- Hillier and Liberman. Chapter 10: Network Optimization Models
- AMP Chapter 8: Network Flow

Week Eight

- Integer Programming I

Read

- Hillier and Liberman. Chapter 12: Integer Programming
- AMP Chapter 9: Integer Program

Week Nine

- Integer Programming II

Read

- Hillier and Liberman. Chapter 12: Integer Programming
- AMP Chapter 9: Integer Program

Week Ten

- No Class due to INFORMS Annual Meeting

Week Eleven

- Dynamic Programming I

Read

- Hillier and Liberman. Chapter 11: Dynamic Programming
- AMP Chapter 11: Dynamic Program

Week Twelve

- Dynamic Programming II

Read

- Hillier and Liberman. Chapter 11: Dynamic Programming
- AMP Chapter 11: Dynamic Program

Week Thirteen

- Project Proposal Presentation