

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

DBA3701/DSC3214: Introduction to Optimization

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Office hour: By Appointment, BIZ1 8-76

Session: Semester II, 2023/2024;

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.

Textbooks for Reference

Materials will be mainly based on lecture notes but the following book is relevant in further study of the subject.

- Introduction to Linear Optimization, by Dimitris Bertsimas, John N. Tsitsiklis – DB&JT

Midterm

Midterm will be conducted in class in the middle of the semester after the reading week.

Individual Assignment

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

Group Assignment

Group assignment is expected to be completed in a group. Every group should turn in individual soft copy, including code files.

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, Introduction to Linear Programming, Basics of Linear Algebra

Read

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

Week Two

- Python Programming – basics and solving optimization problems in Python

Read

- Basics of Python, some examples

Individual Assignment 1 Due on Week Three

Week Three

- Introduction to Linear Optimization – Formulations and solving in Python

Read

- **Chapter 1 of DB & JT**

Week Four

- Theory of Optimization – Geometry of Linear Optimization and Simplex; More Gurobi

Read

- **Chapter 2&3 of DB & JT**

Week Five

- Theory of Optimization – Duality theory and Sensitivity Analysis

Read

- **Chapter 4&5 of DB & JT**

Week Six

- Network Optimization

Read

- **Chapter 7 of DB & JT**

Recess Week

Week Seven

- Midterm

Syllabus:

- Lectures until Network Optimization
-

Week Eight

- Integer Programming

Read

- Chapter 10 of DB&JT
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Week Nine

- Nonlinear Optimization

Read

- Notes will be provided
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Week Ten

- Advanced Topics 1 – Optimization under Uncertainty – Stochastic and Robust Optimization

Read

- Notes will be provided
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Week Eleven

- Advanced Topics 2 – Optimization and Machine Learning

Read

- Notes will be provided
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Week Twelve

- Advanced Topics 3 – Distributed and Federated Optimization; Modern Optimization; Summary of the course

Read

- Notes will be provided
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Week Thirteen

- Project Proposal Presentation