

COURSE INFORMATION

Course title:	Optimal Decision Making II	Credits:	1.5
Course code:	BAMS 508	Class location:	Henry Angus 435 (BA1) David Lam 125 (BA2)
Session, term, period:	2023W1, Period 2	Class times:	BA1: Tues/Thurs 8am-10am BA2: Tues/Thurs 10am-12pm
Section(s):	BA1 and BA2	Pre-requisites:	BAMS 506
Course duration:	Oct 30 – Dec 1, 2023	Co-requisites:	N/A
Division:	Operations and Logistics		
Program:	MBAN		
Course website:	https://canvas.ubc.ca		

INSTRUCTOR INFORMATION

Instructor:	Steven Shechter	Office location:	HA 477
Phone:	604-822-8340	Office hours:	By appointment
Email:	steven.shechter@sauder.ubc.ca		

Teaching assistants:	Shanshan Luo and Zack Zhu
Office hours:	TBD
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COURSE DESCRIPTION

Optimization problems arise whenever one seeks to use activities in the best possible way, to maximize profits, to minimize costs, or more generally to find a "best" solution to a complex problem. Discrete Optimization models are those optimization models that involve a discrete structure, such as when activity levels are restricted to integer values, when modeling logical relationships using binary logic, or when optimizing over a graph or network. Discrete optimization applies to many functional fields of management, such as production and operations, supply chain, transportation and logistics, project planning, health care, marketing, as well as capital budgeting and investment planning. It also applies to several disciplines in science, such as computer science, mathematics, physics and biology, and to many fields in engineering.

The course will present fundamental models and methods in discrete optimization. The emphasis will be placed on useful modeling methodologies, their applications, and the managerial insights that result from optimization-based solutions.

COURSE FORMAT

The course will consist of live lectures, discussions, games, and other in-class exercises.

The lectures will be self-contained and no textbook is required for this course. Copies of the slides used in class will be available on the course website after the lecture. You should supplement the slides with your own notes taken during the lectures.

LEARNING OBJECTIVES




- To introduce students to the basic concepts and models of discrete optimization and integer programming.
- To enable students to develop and use discrete optimization models arising in a variety of industries.

By the end of this course, students will be able to:

- Formulate a discrete optimization model for a decision problem, solve it using appropriate tools, interpret the results, and derive managerial insights relevant for the intended application.
- Solve these problems using a state-of-the-art optimization software package (Gurobi), called from the Python language, within a Jupyter notebook
- Understand the main solution approaches used in practice, and appreciate their strengths and weaknesses in view of their practical applications.

SUSTAINABLE DEVELOPMENT GOALS (SDGS)

- At UBC Sauder, we are committed to responsible business practices that can have transformative impacts on society. One of the ways we are reinforcing our commitment to responsible business is by showcasing relevant content in our courses via the lens of the [United Nations Sustainable Development Goals](#). In this course, we will touch on topics that include (but are not limited to) the following goals:

Sustainable Development Goal	Description of how and when the goal is covered in the course.
<p>Goal 2: Zero Hunger</p> 	<p>We will discuss a famous optimization problem, known as “The Diet Problem”, which helps in identifying food plans that meet nutritional targets at low costs. This idea of using optimization for developing sustainable diets has been explored in many studies.</p>
<p>GOAL 3: Good Health and Well-being</p> 	<p>The course will introduce students to several examples of how optimization modeling has been used in health care applications. These include physician scheduling, facility location models, and kidney donation.</p>
<p>Goal 11: Sustainable Cities and Communities</p> 	<p>Many interesting applications of prescriptive analytics relate to community planning. Examples include optimizing school bus routes and creating affordable housing plans.</p>

ASSESSMENTS

Summary

<u>Component</u>	<u>Weight</u>
Two group assignments	40% (20% each)
Final group project	35%
Three individual, in-class quizzes	15% (5% each)
Participation/Professionalism	<u>10%</u>
Total	<u>100%</u>

Details of Assessments

Group Assignments:

There will be 2 group assignments during this course, performed by teams consisting of 3-4 students each. You will be *randomly assigned* to groups for each homework set. I realize that random matchings of students for assignments may create some discomfort for some people. However, there is important real-world experience gained with this approach. Most of us do not end up with professional colleagues of our choosing, and so this is meant to simulate the need to successfully complete various jobs with random co-workers. That being said, you will get to choose your own group for the course project; after all, maybe you will create a start-up with classmates you know well.

You may either submit your assignments (and project) as: a) self-contained Jupyter notebooks, with all the discussion and “storytelling with analytics” embedded in the notebook, or b) if you plan to use the “Excel to Gurobi” notebook, you can submit your input.xls file along with a Word document containing your discussions and storytelling (with screenshots of Gurobi results as needed). If you are taking option a), then be sure your notebooks are well-documented (e.g., clear labeling of variables, markdown text and comments clarifying steps of the code), so that someone who has not developed the model can easily understand it and replicate your results and findings. If you are taking option b), make sure your input file is clearly labeled, so that it’s clear what the objective, decision variables, and constraints of your model are.

Final Project:

See end of this document for details.

Quizzes:

There will be 3 in-class, 15-minute Canvas quizzes during the course. They are each cumulative and may cover material up until the previous class’s lecture. These will take place at the start of class on Thursdays Nov 9, 16, 23.

Participation/Professionalism:

There are a number of ways to actively participate in the course. These include: asking and answering questions during lecture, sharing thoughts/ideas/news stories/etc. that promote peer-to-peer learning in class and/or via the Piazza discussion forum, participating in office hours, contributing to practice problems (e.g., by solving them and/or proposing new ones), and others.

The professionalism component includes being on time to class, avoiding distractions (e.g., cell phone usage), and treating others with respect. More aspects of professionalism are

covered below in the “Robert H. Lee Graduate School” and “University” policies sections.

Marking Policy

All assessments, except for the quizzes, (assignments, project, participation/professionalism) will be marked on a “CheckPlus/Check/CheckMinus” scale. These will then be converted into a number. By default, a “Check” means “good” and will receive 80%. CheckPlus means “very good” and will receive 85%, and “CheckMinus” means “below average” and maps to 75%. The category assigned will depend on the quality of the solutions, where quality involves a combination of good modeling and derivation of results, as well as good presentation and discussion of the solution. The modal mark will generally be a “Check.” CheckPlus/Check/CheckMinus marks need not always map exactly to 85%/80%/75% marks. Some differences in quality may be accommodated by assigning different numerical marks, but this will be the exception. For example, while most CheckMinus solutions may receive 75%, a really poor job submission may receive a lower mark. Also, while most CheckPlus solutions will receive 85%, an especially outstanding solution may receive a higher mark.

For assignments and the project, a “CheckPlus” means that the work was thorough and thoughtful, the model development was entirely (or nearly entirely) correct, and that recommendations were clearly justified. “Check” means that the work was reasonable but with some room for improvement, due to modeling or analysis mistakes and/or due to recommendations that were not as compelling as they could be. “CheckMinus” means that the work was unsatisfactory with significant room for improvement. For example, model development contained several errors and/or recommendations and explanations were unclear or unsupported by the evidence.

Quizzes will be marked based on the percentage scores obtained.

LEARNING MATERIALS

Requirements:

- The lectures will be self-contained and no textbook is required for this course. Copies of the slides used in class will be available on the course website. You should supplement them with your own notes taken during the lectures.

Technology requirements:

- Jupyter, Python, and Gurobi software, either installed locally on your computer, or run on the cloud via Google Colab (see “Gurobi Setup” notes on the course website).

Suggested Reading Materials:

- Hillier, Frederick S. and Lieberman, Gerald J. (2014). Introduction to Operations Research, 10th Edition. McGraw Hill.
 - Relevant sections in the 10th edition are indicated in the Course Schedule below (marked with “HL” in the readings column).

This text is an excellent resource, but not required for the course.

COURSE-SPECIFIC POLICIES AND RESOURCES

Prerequisites

This course builds on the foundation established in BAMS 506, so a good understanding of that material is necessary for doing well in BAMS 508.

Missed or late assignments/projects

Late submissions will not be accepted and will receive a grade of zero (this is standard for RHL courses).

Academic Concessions

If extenuating circumstances arise, please contact the RHL Graduate School program office as early as reasonably possible, and submit an [Academic Concession Request & Declaration Form](https://webforms.sauder.ubc.ca/academic-concession-rhlee) <https://webforms.sauder.ubc.ca/academic-concession-rhlee>. If an academic concession is granted during the course, the student will be provided options by RHL, or by the instructor in consultation with RHL, per [UBC's policy on Academic Concession](#).

Code Plagiarism

Code plagiarism falls under the UBC policy for [Academic Misconduct](#). Students must correctly cite any code that has been authored by someone else or by the student themselves for other assignments.

Cases of "reuse" may include, but are not limited to:

- the reproduction (copying and pasting) of code with none or minimal reformatting (e.g., changing the name of the variables)
- the translation of an algorithm or a script from a language to another
- the generation of code by automatic code-generations software

An "adequate acknowledgement" requires a detailed identification of the (parts of the) code reused and a full citation of the original source code that has been reused.

Students are responsible for ensuring that any work submitted does not constitute plagiarism. Students who are in any doubt as to what constitutes plagiarism should consult their instructor before handing in any assignments.

POLICIES APPLICABLE TO COURSES IN THE ROBERT H. LEE GRADUATE SCHOOL

Attendance

Excepting extenuating circumstances, students are expected to attend 100% of their scheduled class hours. Absent students limit their own academic potential, and that of their classmates, and cause unnecessary disruption to the learning environment. Students missing more than 20% of the total scheduled class hours for a course (including classes held during the add/drop period) without having received an academic concession will be withdrawn from that course. Withdrawals, depending on timing, could result in a "W" or an "F" standing on the transcript.

COVID-19 Policies for Attendance & Academic Concessions:

If a student feels unwell, they should stay home and send a courtesy email to each impacted instructor and cc their program manager. The student should also submit an [Academic Concession Request & Declaration Form](#).

Punctuality

Students are expected to arrive for classes and activities on time and fully prepared to engage. Late arrivals may be refused entry at the discretion of the instructor or activity lead. Students arriving later than halfway through a scheduled class will be treated as absent for that class.

Electronic Devices

Devices such as laptops, tablets, and cell phones are not permitted to be used in class unless directed by the instructor for in-class activities. Students who do not follow the School's policy in this regard may be required to leave the room for the remainder of the class, so that they do not distract others. Research shows that students' use of laptops in class has negative implications for the learning environment, including reducing their own grades and the grades of those sitting around them.

Citation Style

Please use the American Psychological Association (APA) reference style to cite your sources.

Details of the above policies and other RHL Policies are available at:

<http://www.calendar.ubc.ca/vancouver/index.cfm?tree=12,199,506,1625>

UNIVERSITY POLICIES AND RESOURCES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the UBC Senate website at <https://senate.ubc.ca/policies-resources-support-student-success>.

Respect for Equity, Diversity, and Inclusion

The UBC Sauder School of Business strives to promote an intellectual community that is enhanced by diversity along various dimensions including status as a First Nation, Metis, Inuit, or Indigenous person, race, ethnicity, gender identity, sexual orientation, religion, political beliefs, social class, and/or disability. It is critical that students from diverse backgrounds and perspectives be valued in and well-served by their courses. Furthermore, the diversity that students bring to the classroom should be viewed as a resource, benefit, and source of strength for your learning experience. It is expected that all students and members of our community conduct themselves with empathy and respect for others.

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work

done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

Use of Artificial Intelligence

You may use ChatGPT or other similar generative AI tools only to generate initial drafts of code or model formulations, should you find that helpful. Like any other outside source (e.g., Stack Overflow, "googling" around for snippets of code), you need to reference it and acknowledge its use. This includes submitting your ChatGPT (or similar AI tool) logs, including all prompts and responses. Your instructor or TA may request to see the log. Failure to fully declare the use of this tool will be considered academic misconduct. Also, be aware of the limitations of these tools. One limitation is that it gets things wrong. Often. So while they may help get some initial code in place as a foundation, you are responsible for checking it (super) carefully.

ChatGPT (and similar tools) may not be used to generate natural writing (e.g., explanations, storytelling with analytics, etc.) in your assignments and projects. In other words, all prose should originate from and be generated by you.

COPYRIGHT

All materials of this course (course handouts, lecture slides, assessments, course readings, etc.) are the intellectual property of the instructor or licensed to be used in this course by the copyright owner.

Redistribution of these materials by any means without permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline and could be subject to legal action. Any lecture recordings are for the sole use of the instructor and students enrolled in the class. In no case may the lecture recording or part of the recording be used by students for any other purpose, either personal or commercial. Further, audio or video recording of classes are not permitted without the prior consent of the instructor.

ACKNOWLEDGEMENT

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəyəm (Musqueam) people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

COURSE SCHEDULE

(Subject to change with class consultation)

Week	Topic	Optional Readings	Assessments due
1	<ul style="list-style-type: none"> • Introduction to Discrete Optimization • Introduction to Computational Complexity • Network optimization: Transportation and Assignment problems 	HL 9.1, 9.3	Nov 2: HW 1 assigned
2	<ul style="list-style-type: none"> • Network optimization: Trees and Paths • Min Cost Network Flows 	HL 10.1-10.6, 10.8	Nov 9: Quiz 1 Nov 10: Project Proposal due
3	<ul style="list-style-type: none"> • Integer programming (IP) formulations • IP "tricks" • Covering, Packing, and Partitioning 	HL 12.1-12.5	Nov 16: Quiz 2 Nov 18: HW 1 due Nov 18: HW 2 assigned
4	<ul style="list-style-type: none"> • Case study: Pediatrician Scheduling at BC Women's Hospital 	Required reading: BCWH Case Study	Nov 23: Quiz 3
5	<ul style="list-style-type: none"> • IP solution methods <ul style="list-style-type: none"> ○ Branch-and-Bound ○ Cutting planes ○ Heuristics 	HL 12.5-12.8 Ch. 14	Dec 1: HW 2 due
6	Final Project deliverables		Due date/time: TBD

PROJECT DETAILS

Overview

The purpose of the course project is to gain optimization modeling, analysis, and report-writing experience. Your optimization models should be solved using Python/Gurobi. Groups of 3-5 students should propose an optimization project that interests them and that I approve after reviewing the proposal. This may include extending your project from BAMS 506 to use methods from BAMS 508. You may form your own groups, or let me know if you need help finding a group.

The project may be something that groups come up with on their own, or based on a case study that requires optimization modeling, and which does not have a publicly available solution. One source of such case studies is the journal: INFORMS Transactions on Education. You can access this via the UBC Library here: <https://pubsonline-informs-org.ezproxy.library.ubc.ca/journal/ited>

Examples of past projects include:

- Staffing optimization at a clothing store
- Beer production optimization
- Assigning pharmaceutical sales representatives to different regions
- Airline revenue management

Deliverables and Deadlines

Project component	Due
Proposal	Nov 10 (11:59 PM)
Final deliverables	TBD (during exam week)

Proposal

In one page, provide a brief background of your project topic and the questions you plan to investigate. I will give you feedback on your proposal within 48 hours of your submitting it (you can submit it prior to Nov 10).

Final report

Your report should include the following sections:

1. Executive Summary
2. Introduction
3. Model formulations
4. Model results
5. Discussion/Conclusion

See page 2, under “Group Assignments” section, for the two options for how to submit your report. When writing up your reports, consider two perspectives: 1) a student showing me you know the technical details of what is going on, and 2) a consultant explaining to management what is going on. With regard to the latter, be sure you don’t just provide numerical results, but explain things clearly and concisely. Provide insight and justify your recommendations.