COURSE INFORMATION

Course title:	Optimal Decision Making II		
Course code:	BAMS 508	Credits:	1.5
Session, term, period:	2022W1, Period 2	Class location:	HA 133
Section(s):	BA1 and BA2	Class times:	BA1: Tues/Thurs 2pm-4pm BA2: Tues/Thurs 4pm-6pm
Course duration:	Oct 31 – Dec 2, 2022	Pre-requisites:	BAMS 506
Division:	Operations and Logistics	Co-requisites:	N/A
Program:	MBAN		
Course website:	https://canvas.ubc.ca		

INSTRUCTOR INFORMATION

Instructor:	Steven Shechter		
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Teaching assistant:	Shanshan Luo
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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 complex 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 involving discrete activities. 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 and their applications. The course will present guidelines for choosing among alternate formulations, as well as among alternate solution approaches.

COURSE FORMAT

The course will consist of lectures, exposing the relevant material, in-class discussions, in-class hands-on work, out-of-class discussions on Piazza, and out-of-class practice problems.

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.
- 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 (see #2), 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.

ASSESSMENTS

Summary

Component	Weight
Two group assignments	40% (20% each)
Final group project	50%
Participation/Professionalism	10%
Total	100%

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.

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 learningin 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 in the course (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.

Expectations of group work:

It is expected that everyone in a group contributes substantially to the deliverables. The default will be to give everyone in a group the same mark, but if I hear concerns about this (e.g., "free-riding"), then I may need to consult with the members of the group. Also, while different groups may discuss assignments and projects with each other at a high level, groups should not share their work with each other (e.g., detailed formulations, results, etc.).

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 withyour 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).
- It is highly recommended that students review the "Introduction to Data Science in Python" course on DataCamp prior to beginning this course.

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. If an academic concession is granted during the course, the student will be provided options by RHL, or by the instructor in consultation withRHL, per UBC's policy on Academic Concession.

Code Plagiarism

Code plagiarism falls under the UBC policy for Academic Misconduct. Students must correctly cite anycode 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 inany 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 havingreceived 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 laterthan 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 berequired 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 survivorsof 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 othersand 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 allstudents 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 cheatingmay 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.

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ACKNOWLEDGEMENT

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

COURSE SCHEDULE

(Subject to change with class consultation)

Week	Topic	Optional Readings	Assessments due
1	• Introduction to Discrete Optimization • Introduction to Computational Complexity • Network optimization: Transportation and Assignment problems	HL 9.1, 9.3	Nov 3: HW 1 assigned
2	• Network optimization: Trees and Paths Min Cost Network Flows	HL 10.1-10.6, 10.8	Nov 11: Project Proposal due
3	• Integer programming (IP) formulations • IP "tricks" • Covering, Packing, and Partitioning	HL 12.1-12.5	Nov 16: HW 1 due, 11:59 pm Nov 17: HW 2 assigned
4	• Case study: Pediatrician Scheduling at BC Women's Hospital	Required reading: BCWH Case Study	
5	• IP solution methods ○ Branch-and-Bound ○ Cutting planes ○ Heuristics	HL 12.5-12.8 Ch. 14	Dec 2: 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. 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

Note: Most projects require more decision variables and constraints than Excel Solver can handle. In such cases, you may use the free Excel add-in OpenSolver (available at opensolver.org), or call an optimization package from within Python or R (e.g. Gurobi, CPLEX, PULP, etc.).

Deliverables and Deadlines

Project component	Due
Proposal	Nov 11 (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 11).

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.