COURSE INFORMATION

Course title:	Managerial Decision Modeling and Analytics		
Course code:	BAMS 523	Credits:	1.5
Session, term, period:	2023W1, Period 6	Class location:	HA 437
Section(s):	001	Class times:	Tu/Th 2pm – 4 pm
Course duration:	Sept 5 - Oct 6, 2023	Pre-requisites:	n/a
Division:	Operations and Logistics	Co-requisites:	n/a
Program:	MBA		

Course websites: https://canvas.ubc.ca

INSTRUCTOR INFORMATION

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

Teaching assistants: Shanshan Luo and Zack Zhu
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COURSE DESCRIPTION

The success of many organizations, across a variety of industries, hinges on the ability to combine available data with advanced analytical techniques to improve decision-making. The term "analytics" is rather broad in its scope and spans three main categories: descriptive, predictive, and prescriptive analytics. This course primarily focuses on the last item: prescriptive analytics, which involves learning how to formulate and solve challenging decision problems, using specialized software. This course does not cover the topics of predictive analytics, such as machine learning, artificial intelligence, and regression. It assumes that any descriptive and predictive modeling has already been completed, and now an organization wants to use these analyses as inputs to prescriptive models, which seek to determine the best set of decisions. The meaning of "best" varies depending on the setting; for example, it could mean trying to maximize profits in traditional business contexts, maximize lives saved in health care applications, or minimize fuel consumption in environmental applications. This course explores examples across a wide range of industries and functional areas of business.

COURSE FORMAT

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

LEARNING OBJECTIVES

- To introduce students to the basic concepts of optimization and decision making under uncertainty.
- To enable students to model and solve decision problems that arise in practice.

- To develop skills in conveying the results of decision models to managerial audiences.

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

- Recognize different problems types and be able to formulate an appropriate decision model for solving them.
- Implement and solve optimization problems using a state-of-the-art optimization software package (Gurobi), called from the Python language, within a Jupyter notebook.
- Implement and analyze Monte Carlo simulation models with Python, for decision making under uncertainty.
- Gain insight into solutions obtained from decision models.
- Understand how changes in different inputs might affect models' outputs ("sensitivity analysis").
- Provide several examples of companies and organizations successfully applying these modeling techniques.

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.
Goal 2: Zero Hunger: 	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.
GOAL 3: Good Health and Well-being 	The course will introduce students to several examples of how optimization and simulation modeling have been used in health care applications. These include clinician scheduling, patient wait time management, and the allocation of scarce health care resources.
Goal 11: Sustainable Cities and Communities 	Many interesting applications of prescriptive analytics relate to community planning. Examples include optimizing school bus routes and creating affordable housing plans.

ASSESSMENTS

Summary

Component	Weight
Optimization Group Assignment	20%
Simulation Group Assignment	20%
Group Project	50%
Class participation/Professionalism	10%
Total	100%

Details of Assessments

Group Assignments:

There will be two 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.

Group Project:

See end of this document for details.

Participation/Professionalism:

The professionalism component includes being to class on time, using laptops for in-class activities only, avoiding distractions (e.g., checking cell phones), and treating others with respect. More aspects of professionalism are covered below in the "Robert H. Lee Graduate School" and "University" policies sections.

There are a number of ways to actively participate in the course. These include: asking and answering questions during lecture as well as outside of class via Canvas, sharing thoughts/ideas/news stories/etc. that promote peer-to-peer learning, participating in office hours, etc.

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, "Check" means "good" and will receive 80%; "CheckPlus" means "very good" and will receive 85%; "CheckMinus" means "below average" and maps to 75%. More specifically, for assignments and the project, "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. The modal mark will generally be a "Check." Also, CheckPlus/Check/CheckMinus marks need not always map exactly to 85%/80%/75%. Some differences

in quality may be accommodated by assigning different numerical marks, but this will be the exception. For example, while most CheckMinus solutions will receive 75%, a really poor submission may receive a lower mark. Also, while most CheckPlus solutions will receive 85%, an especially outstanding solution may receive a higher mark.

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, *after* class.

Suggested Reading Materials:

While you can certainly do well in the course without purchasing a book, there are several good textbooks on decision modeling for further reference. These include:

- *Managerial Decision Modeling with Spreadsheets*, second Canadian edition, by Render, Stair, Balakrishnan, Smith
  - This is available for temporary loan through course reserves; you can ask for it at the front desk of the David Lam library.
- *Management Science: The Art of Modeling with Spreadsheets*, by Powell and Baker.
  - Note: this book is also available online, via the UBC library: https://courses.library.ubc.ca/instructorhome/id/213339/open/114596

Technology Requirements:

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

COURSE-SPECIFIC POLICIES AND RESOURCES

Prerequisites

This is a quantitative course. Students should have a basic familiarity with statistics and probability. This course also requires some comfort with coding in Python. Most of you (except for perhaps any exchange students) have taken BA 515 with Professor Gene Lee, which introduces MBA students to Python. If you have not taken this, then I recommend that you go through "Introduction to Data Science in Python" course on DataCamp prior to beginning this course (and for those who did take Prof. Lee's course, I recommend that you review the basics of Python there).

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. 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 (see more in section below on the "use of AI")

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.

If a student suspects possible COVID-19 infection, they should use the BC Ministry of Health's self-assessment tool, to help determine whether further assessment or testing for COVID-19 is recommended.

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, 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.

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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, and traditions from one generation to the next on this site.

COURSE SCHEDULE

Class#	CLASS TOPICS	ASSIGNMENTS / DELIVERABLES
Week 1	• Introduction to Optimization and Linear Programming • Sept 7: Burrito Optimization Game	Register for Gurobi to be ready to play "The Burrito Optimization Game" in class 2 (the make-up class on Friday) Sept 7: HW1 assigned
Week 2	• Linear programming Sensitivity Analysis • Network optimization • Introduction to Integer Programming	Sept 15: Project Proposal due
Week 3	• Integer Programming examples • Introduction to Decision Making under Uncertainty and the "Flaw of Averages"	Sept 21: HW 1 due Sept 22: HW2 assigned
Week 4	• Introduction to Monte Carlo Simulation • Monte Carlo (MC) Simulation in Python	Oct 6: HW2 due
Week 5	• Examples of Monte Carlo simulation across several industries • Simulation optimization	HW 2 due
Week 6	Final Project	TBD

Project Details

Overview

The purpose of the course project is to gain optimization or simulation modeling, analysis, and "Storytelling with Analytics" experience. Groups of 3-4 students should propose an optimization or simulation project that interests them and that I approve after reviewing the proposal. 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 it may be based on a case study that requires optimization or simulation 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://gw2jh3xr2c.search.serialssolutions.com/?sid=sersol&SS_jc=TRANONED&title=Transactions%20on%20education

Examples of past projects include:

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

Deliverables and Deadlines

Project component	Due
Proposal	Sept 15 (11:59 PM)
Final Deliverables	TBD (during exam week)

Proposal

In 1-2 paragraphs, briefly describe your project proposal. If you plan to pursue your own project idea, describe the problem and the questions you plan to investigate. If you are planning to work on a published case study, provide the link or pdf to the case and the questions you plan to answer around it. I will give you feedback on your proposal within 24 hours of your submitting it (you can submit it prior to Sept 15).

Final Deliverables

If your project uses the optimization tools we learned about, then you may either submit your Project by: a) creating a self-contained Jupyter notebook, with all the discussion, models, and "storytelling with analytics" embedded in the notebook, or b) creating an "Excel to Gurobi" input Excel file (to be explained in class) 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.

If your project uses the Monte Carlo simulation tools we learned about, then submit a self-contained Jupyter notebook, with all the discussion, models, and "storytelling with analytics" embedded in the notebook.

Include the following sections in your report:

1. An Executive Summary
2. Introduction
3. Model formulations
4. Model results
5. Discussions/Recommendations/Conclusion