COURSE INFORMATION

Course title:	Simulation Modeling		
Course code:	BAMS 503	Credits:	1.5
Session, term, period:	2022 W2, Period 5	Class location:	HA 133
Section(s):	BA1, BA2	Class times:	BA1 cohort: M-F, 10 am – 12 pm BA2 cohort: M-F, 2-4 pm Except: Tues, April 18 and Mon, April 24 will be joint cohorts from 2-4 PM.
Course duration:	Apr 17 – Apr 28, 2023	Pre-requisites:	N/A
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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COURSE DESCRIPTION

Simulation is a widely used methodology in both industry and academia because it is a vital tool for decision making under uncertainty. A computer simulation model allows a decision maker to test a variety of "what-if" scenarios and evaluate a multitude of outcomes before considering implementing any changes to a complex process. Areas of application include health care, supply chain management, manufacturing, financial planning, marketing, and human resource management.

This course introduces students to Monte Carlo and Discrete-Event Simulation (MCS and DES, respectively). MCS is typically used by individuals or organizations who want to make informed decisions under uncertainty. Examples include:

- an individual who wants to understand how different retirement investment portfolios may evolve over time.
- a retailer who wants to forecast monthly revenues and costs under different inventory policies.
- a project manager who wants to estimate how long it will take to complete a project.

DES is typically used to model processes involving queues, with a goal of identifying cost-effective ways to manage wait times. Examples include:

- an emergency room manager who wants to estimate patient wait times as a function of the number of beds, nurses and doctors.
- an airport security manager who wants to estimate wait times as a function of the number of agents and scanners.

- an amusement park that wants to estimate wait times for rides under different membership plans.

This course covers best practices in simulation modeling, from 1) converting raw data into appropriate simulation input parameters, to 2) model development using appropriate software (e.g., Excel, R, Python, and DES-specific software such as Arena or Simio), to 3) performing statistical analyses of simulation outputs, to 4) communicating simulation results to managerial audiences.

Regarding model development, the course will mostly focus on MC simulations, as the queueing simulations of DES typically require much more coding and/or company-specific (i.e., not open-source) software.

COURSE FORMAT

The course will consist of lectures, in-class discussions, in-class hands-on work, and out-of-class discussions in Canvas.

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 learn the benefits of MC and DES modeling through several examples
- To learn how to develop MC simulations in Excel, Python, and/or R
- To learn the foundations of DES and the basics of DES-specific software
- To learn how to analyze and process available data for use in a simulation model
- To develop critical thinking skills when making decisions under uncertainty
- To develop the ability to translating technical content into managerial insights

ASSESSMENTS

Summary

Component	Weight
1 Group assignment:	50%
2 In-class Canvas quizzes (7.5% each)	15%
Various in-class exercises	25%
Participation/Professionalism	10%
Total	100%

Details of Assessments

Group Assignment:

There will be one group assignment, due the second Friday (April 28), by midnight. The assignment will be released by end of day, Monday, April 17.

This assignment will be marked on a “CheckPlus/Check/CheckMinus” scale. These will then be converted into a number. Usually, a “Check” means an “average” solution and will receive approximately 80%. CheckPlus will receive more than this (typically 85%) and CheckMinus will receive less (typically 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 percentage marks. For example, while most CheckMinus solutions may receive 75%, a really poor job may receive a lower mark. Also, while most CheckPlus solutions may receive 85%, an especially outstanding solution may receive a higher mark.

In general, a "CheckPlus" means that the report was thorough and thoughtful, the model development was entirely (or nearly entirely) correct, and that recommendations were clearly justified. "Check" means that the solution was satisfactory but with room for improvement, due to modeling or analysis mistakes and/or due to recommendations that were not as compelling as they could be. Finally, "CheckMinus" means that the solution 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:
There will be two 20-minute, in-class Canvas quizzes, one on each Friday of class, at the start of class. Quizzes will be multiple choice and based on material covered in class through the Thursday before the quiz. You may access course material (e.g., slides, examples) from Canvas during these quizzes, but other uses of the internet are not permitted.

Quizzes will be marked based on the % of questions answered correctly.

In-Class Exercises:
There will be various in-class exercises, which may involve coding small models, extending the code of existing models, short summaries of model results, short responses to a question, etc. These will involve a mix of group and individual submissions. As noted below in the section on the "Use of ChatGPT", you may use tools like that for generating code snippets, but not for writing natural language responses to questions.

The mark for these will be based on the cumulative performance over the course, with the check+/check/check- grading scheme.

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 the Canvas discussion board, participating in office hours, contributing to practice problems (e.g., by solving them and/or proposing new ones), and others.

The professionalism component includes attending all classes, being on time to class, avoiding distractions (e.g., cell phone usage, use of computer for non-course activities), and treating others with respect. More aspects of professionalism are covered below in the "Robert H. Lee Graduate School" and "University" policies sections.

LEARNING MATERIALS

Technology requirements:

- In-class examples will primarily be shown in Python. However, for many models discussed, I will post both Python and R versions.
- The Group Assignment and in-class exercises may be done in either Python or R.

Suggested Reading Materials:

An excellent simulation textbook used for graduate courses at many universities is: "Simulation Modeling and Analysis" by Law and Kelton (there are several updated editions of this, with more recent editions just have the single author "Law"). The book is by no means required for the course; it's just a good textbook to have on your bookshelf if you see yourself doing simulation modeling in the future.

COURSE-SPECIFIC POLICIES AND RESOURCES

Prerequisites

Simulation modeling requires a solid understanding of other analytics methodologies; namely statistics and probability. It also requires comfort with coding (the coding you did already in the program with Python and R will be enough coding background for this course).

Missed or late quizzes

Late submissions will not be accepted and will receive a grade of zero.

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 (see more in next section on the use of ChatGPT)

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. Sudents who are in any doubt as to what constitutes plagiarism should consult their instructor before handing in any assignments.

Use of ChatGPT and other similar generative-AI tools

You may use ChatGPT to generate initial drafts of code for the assignment and in-class exercises. 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 unauthorized and "cheating" (See 3.b(iv) of the Vancouver Academic Calendar). Be aware of the limitations of ChatGPT. One limitation is that it gets things wrong. Often. If it represents anything as fact, assume it is wrong. You are responsible for any errors.

ChatGPT (and similar tools) may not be used to draft responses to questions and other write-ups. In other words, for this class, they may only be used to help generate code. All natural language writing should originate from and be generated by you.

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.

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 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.

Academic Freedom and Students Studying from Outside Canada

During this pandemic, the shift to online learning has greatly altered teaching and studying at UBC, including changes to health and safety considerations. Keep in mind that some UBC courses might cover topics that are censored or considered illegal by non-Canadian governments. This may include, but is notlimited to, human rights, representative government, defamation, obscenity, gender or sexuality, and historical or current geopolitical controversies. If you are a student living abroad, you will be subject to the laws of your local jurisdiction, and

your local authorities might limit your access to course material or take punitive action against you. UBC is strongly committed to academic freedom, but has no control over foreign authorities (please visit http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,33,86,0 for an articulation of the values of the University conveyed in the Senate Statement on Academic Freedom). Thus, we recognize that students will have legitimate reason to exercise caution in studying certain subjects. If you have concerns regarding your personal situation, consider postponing taking a course with manifest risks, until you are back on campus or reach out to your academic advisor to find substitute courses. For further information and support, please visit: http://academic.ubc.ca/support- resources/freedom-expression

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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 xwməθkwəy̓əm (Musqueam) people, who for millennia have passed on their culture, history, andtraditions from one generation to the next on this site.

ONLINE TEACHING TOOL & REQUIREMENTS

The default for office hours will be to hold them via Zoom. If you don't have a Zoom account yet, please set one up. Links to office hours will be provided once the class begins.

COURSE SCHEDULE

(Subject to change with class consultation)

Date/DOW	Topic	Assessments due
April 17/Mon	• Introduction to simulation • The "Flaw of Averages" • Our first simulations	
April 18/Tues	• Common probability distributions in simulation • Example: Airline revenue management—part I	Note: Joint class, from 2-4 pm
April 19/Weds	• Input modeling • Distribution fitting • Example: Production planning	
April 20/Thurs	• Random number and random variable generation • Example: Surgical scheduling	
April 21/Fri	• Output Analysis • Comparing multiple decisions • Example: Airline revenue management—part II	Quiz 1: First 20 minutes of class.
April 24/Mon	• Continue with revenue management problem. • In-class time to work on Assignment	Note: Joint class, from 2-4 pm
April 25/Tues	• Financial examples of Monte Carlo simulation	
April 26/Weds	• Introduction to Discrete-Event Simulation	
April 27/Thurs	• Intro to DES with Arena	Group assignment, due at midnight
April 28/Fri	• Further topics in simulation • Debrief of group assignment and course	Quiz 2: First 20 minutes of class.