ISQS 7339: Optimization and Simulation (Prescriptive Analytics) Syllabus - Online Section

Instructor

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Description and Background of Course

Many business problems involve too many choices or alternatives for human decision-makers to consider effectively. This course uses optimization and simulation methods to identify the best alternative solutions to meet business objectives. This course has several use cases for managers, such as determining the best pricing and advertising strategy to maximize revenue, the optimal inventory at fulfillment centers, or the best mix of investments in a retirement portfolio to manage risk and rewards.

Prerequisite

Basic programming knowledge in R and Python, as well as basic knowledge in Algebra, Probability, and Statistics.

Learning Outcomes

After taking this course, students will be able to:

1. Develop optimization decision models for business problems
    - Assessed by Homework 1-2 and Quiz 1
2. Develop Monte-Carlo simulation for risk analysis
    - Assessed by Homework 3-4 and Quiz 2
3. Develop discrete-event simulation models for queuing systems
    - Assessed by Homework 5 and Quiz 3

Textbook

There is no required textbook for this course. All assigned readings will be available online. For students who wish to do further reading, the following offer relevant materials to this course:

- Hillier, F. S. Lieberman G. J. Introduction to Operations Research (10th ed.). Mc Graw Hill Education (ISBN: 978-0-07-352345-3)
- Evans, J. Business Analytics (2nd ed.) (Chapter 12-16), Pearson (ISBN: 978-0321997821)

Course Structure

Module 1- Decision Making by Linear Programming

Linear optimization is an area of analytics that determines optimal values or solutions formulated with linear equations and inequalities. This process involves finding the

minimal or maximal values given some conditions or constraints. In this module, we cover the following contents:

- Introduction to linear programming (LP)
- Solving LP by Simplex method
- Sensitivity analysis in LP

Module 2- Decision Making by Integer Programming

Integer programming is a type of linear programming where the variables are restricted to be integers. Integer programming is widely used in various real-world applications, such as scheduling, resource allocation, and logistics, where the variables represent discrete decisions, such as assigning tasks to employees or selecting products to manufacture.

- Introduction to integer programming (IP): The branch and bound method
- Solving binary integer programming (BIP) and mixed-integer programming (MIP) applications

Module 3- Introduction to Monte Carlo Simulation

Monte Carlo simulation is the process of generating random values for uncertain inputs in a model, computing the output variables of interest, and repeating this process for many trials to understand the distribution of the output results. This module covers the following contents:

- Introduction to Monte-Carlo simulation
- Random number generation
- The business application of the Monte-Carlo simulation

Module 4- Data-Driven Monte Carlo Simulation

Data-driven Monte Carlo simulation is a technique that uses historical data to model and analyzes a system's behavior. Data-driven Monte Carlo simulation focuses on the input analysis, specifically determining the proper fit distribution for the historical data and using it as the input to the simulation.

- Input analysis
- Resampling methods (bootstrapping)
- Applications

Module 5: Markov Chain Monte-Carlo (Only for Ph.D. students)

Markov Chain Monte Carlo (MCMC) is a family of algorithms for sampling from a probability distribution. It is a powerful method for approximating complex and high-dimensional distributions, and it is widely used in various fields such as Bayesian statistics.

- Introduction to Markov Chain

- Markov Chain Monte-Carlo (MSCM) sampling algorithms
- Using MCMC for Bayesian Inference

Module 6- Discrete Event Simulation

Discrete event simulation (DES) is a method of simulating the behavior and performance of a real-life process, facility, or system, including servers and queues. This module covers the following contents:

- Introduction to discrete event simulation
- Introduction to simulation in R Simmer
- Modeling service operations
- Analyzing simulation outputs

Assessment and Grading

Assignment	Percentage
Homework (5)	40%
Quiz (3)	45%
Group Application	15%

Grades are calculated based on the following. [97%, 100%] A+, [93%, 97%) A, [90%, 93%) A-, [87%, 90%) B+, [83%, 87%) B, [80%, 83%) B-, [70%, 80%) C, [60%, 70%) D, and [00%, 60%) F. Please do NOT count on rounding to move you from a lower grade category to a higher one!

Homework

There will be five homework assignments throughout the semester. Homeworks allow students to practice the skills and techniques covered in lectures and demonstrate their grasp of related concepts and terminology. **Late submissions will be penalized 15% daily** (1 hour late also counts as a day). Students are not allowed to share their write-ups with other students. Any evidence of academic misconduct will be reported to the Office of Student Conduct, and if a student is determined to be guilty of cheating or plagiarism, the final letter grade for that student might be reduced to F.

Quiz

There will be three quizzes throughout the semester. These quizzes contain short-answer or multiple-choice questions and focus mainly on the concepts, definitions, coding notations, and the interpretation of outputs. **Late submission is not allowed** unless under emergency circumstances, and the student has communicated with the instructor in advance to discuss alternative arrangements. Students are not allowed to share questions and answers with other students. Any evidence of academic misconduct will

be reported to the Office of Student Conduct, and if a student is determined to be guilty of cheating or plagiarism, the final letter grade for that student might be reduced to F.

Group Application

Students have an opportunity to work on a set of problems as a group. The students' attempts will be graded based on their participation in the discussion and the quality and correctness of the final submission. **Late submission is not allowed** unless under emergency circumstances, and the student has communicated with the instructor in advance to discuss alternative arrangements. Groups are not allowed to share their solution with other groups. Any evidence of academic misconduct will be reported to the Office of Student Conduct, and if a student (or group) is determined to be guilty of cheating or plagiarism, the final letter grade for the student or group might be reduced to F.

How to Succeed in this Course

If you want to be a successful student:

- Be self-motivated and self-disciplined.
- Be willing to "ASK QUESTIONS" if problems arise. The discussion board will be a great platform to ask your questions like you are sitting in the class. I will actively check the discussion board and respond to your concerns.
- Be willing to commit to this course for 8 to 24 hours per week.
- Take notes while watching videos.
- Be curious to understand all coding syntaxes. The best place to ask questions is the discussion board.
- Be able to write codes and apply analysis after watching demonstration videos or reading independently.
- Be able to communicate through writing.
- Start early.

In contrast, some common behaviors lead to failing the course.

- Don't watch videos before starting to work on assignments.
- Wait until the last day to begin assignments.
- Forget about deadlines.
- Ignore the instructor and/or peers' blackboard announcement emails regarding course activities.
- Ignore discussion board posts.
- Don't get familiar with the grade book and syllabus.

Netiquette

Your instructor and fellow students wish to foster a safe online learning environment. All opinions and experiences, no matter how different or controversial they may be perceived, must be respected in the tolerant spirit of academic discourse. You are encouraged to comment, question, or critique an idea, but you should not attack an individual. Our differences, outlined in the university's nondiscrimination

statement below, will add richness to this learning experience. Please consider that sarcasm and humor can be misconstrued in online interactions and generate unintended disruptions. Working as a community of learners, we can build a pleasant and respectful course ambiance. Please read the Netiquette rules for this course:

- Do not dominate any discussion. Allow other students to join in the discussion.
- Do not use offensive language.
- Present ideas appropriately.
- Be cautious in using the Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language. This could lead to misinterpretation.
- Keep an "open mind" and be willing to express even your minority opinion.
- Think and edit before you push the "Send" button.

Academic Misconduct in ISQS-7339

Academic misconduct is defined pervasively as including, but not limited to, cheating on examinations or assignments; plagiarizing, which means misleading as your work any part of work performed by another person; working with another student on an assignment in which that assignment is designated as an individual assignment; interfering with another student's work, and any other misrepresentation of your work.

Plagiarism, cheating, etc., include any misrepresentation of your work. You are expected to provide your own responses from your own brain for all class assignments. If you copy material from the internet and misrepresent it as your own, that is plagiarism. If you copy answers to homework or exams from the internet or another student or an article or a textbook, that is cheating. All answers from all students on written work are submitted to iThenticate. iThenticate identifies about 99% of plagiarized and copied material. Please do your own work.

Please note that academic misconduct is a serious offense and will be handled by the appropriate authorities in the department, the college, and the university. If a student is determined to be guilty of cheating or plagiarism, the final letter grade for that student might be reduced to F.

Grade and Course Communication: Blackboard

Course announcements, syllabus, handouts, supplemental readings, handouts, and grades are made available through Blackboard and via TTU email. All students are required to regularly check the class Blackboard space for announcements. Blackboard is also used to submit classwork.

Academic Integrity / Dishonesty (Operating Procedure 34. 12)

Operating Procedure 34.12 states: Academic integrity is taking responsibility for one's own class and/or course work, being individually accountable, and demonstrating intellectual honesty and ethical behavior. Academic integrity is a personal choice to abide by the standards of intellectual honesty and responsibility. Because education is a shared effort to achieve learning

through the exchange of ideas, students, faculty, and staff have the collective responsibility to build mutual trust and respect. Ethical behavior and independent thought are essential for the highest level of academic achievement, which then must be measured. Academic achievement includes scholarship, teaching, and learning, all of which are shared endeavors. Grades are a device used to quantify the successful accumulation of knowledge through learning. Adhering to the standards of academic integrity ensures grades are earned honestly. Academic integrity is the foundation upon which students, faculty, and staff build their educational and professional careers. Please also see *Student Handbook and the Code of Student Conduct*. [Texas Tech University ("University") Quality Enhancement Plan, Academic Integrity Task Force, 2010].

The Master of Science in Data Science Program (MS-DS) at Texas Tech is committed to educating critical thinkers that are free of academic or professional dishonesty. All MS-DS students are upheld to the standard of having integrity in the work they produce. The standard rule is for all MSDS students to be responsible in an ethical and honest manner. Any instance of academic integrity violations as listed in the *MS-DS Program Academic Integrity Policy,* including, but not limited to, cheating on examinations or assignments, plagiarism, collusion, and misrepresenting facts will be taken seriously. All acts of academic misconduct will be reported and adjudicated as prescribed by the *MS-DS Program Academic Integrity Policy*.

Students with Disabilities Policy (Operating Procedure 34.22)

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor's office hours. Please note: instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, please contact Student Disability Services in West Hall or call 806-742-2405.

Student Absence for Observance of Religious Holy Day Policy (Operating Procedure 34.19)

"Religious holy day" means a holy day observed by a religion whose places of worship are exempt from property taxation under Texas Tax Code §11.20.2. A student who intends to observe a religious holy day 4 should make that intention known in writing to the instructor prior to the absence. A student who is unable to submit assignments or complete scheduled quizzes due to the observance of a religious holy day shall be allowed to complete those within a reasonable time after the absence.

Disclaimer

This syllabus is subject to change.