USC Marshall
School of Business

BUAD 313: Advanced Operations Management and Analytics (Spring 2024, 4 Units)

Syllabus (Version 1/8/2024)

Contact Information

Instructor	TA
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Office Hours: In-person (BRI 400F) and on Zoom Tuesday 11am – 3pm and by appointment	Office Hours (Zoom Only): Tue 3pm – 7pm and Wed 10am -12noon

The Zoom links for the office hours are on Blackboard. I want to accommodate as many students as possible, so I would be happy to hold additional office hours based on the students' requests

Class Schedule: Section 14926: Monday and Wednesday 12 – 1:50 pm (JFF 331)
Section 14927: Monday and Wednesday 4 – 5:50 pm (HOH 2)

Course Description: The course will teach advanced techniques in operations management and analytics, focusing on optimization and simulation modeling. You will learn how to make better business decisions under uncertainty through the use of optimization and simulation, and you will see the enormous and impactful applications of optimization and simulation across multiple industries, including aviation, hospitality, retail, supply chain, manufacturing, banking, services, and call centers. This course will teach you the tools and techniques to formulate an optimization model, incorporate uncertainty through simulation, solve the optimization and simulation models, and interpret the resulting solutions. You will gain a unique analytics edge in an increasingly competitive global business environment.

Learning Objectives: You will learn advanced operations analytics, enhance your managerial insights and intuition, and improve your business decisions. The focus of the course is on the Marshall Undergraduate Learning Goals (see the end of the syllabus for a complete description) of "understanding key business areas" and "developing critical thinking skills", while also supporting the goal of "being effective communicators." Upon successful completion of the course, students will master the following learning objectives.

1. Identify and describe business problems and applications where optimization and simulation models are applicable.
2. Translate a complex business problem into an optimization model by identifying appropriate decision variables, writing out the objective function in terms of the decision variables, and developing constraints that capture the underlying business requirements.
3. Describe the optimization model using precise and appropriate mathematical notation.
4. Structure, implement, and solve the optimization model in an Excel spreadsheet, and, possibly with the help of generative AI tools, employ advanced scientific computing packages to expand optimization analysis beyond the standard scope of Excel.

5. Incorporate uncertainty into optimization models through simulations by translating sources of randomness and system dynamics into probabilistic simulation models, leading to precise methods to measure, evaluate, and determine key operational decisions.
6. Translate the uncertainties and dynamics of business processes into simulation models, and use @Risk and other simulation techniques to develop, implement, and evaluate these simulation models.
7. Understand and interpret the solutions of the optimization and simulation models.
8. Extract business insights from the models and provide recommendations for better decisions.

Prerequisites: The class is designed for exceptionally motivated students who want to learn advanced techniques in operations management and analytics. There will be multiple homework assignments, which can be long, complex, and challenging. Students must have completed BUAD 312 or BUAD 310 (with a grade of B+ or better recommended); alternatively, students may have instead completed EE 364 or MATH 407. Students are expected to have access to a laptop and be able to use regularly, efficiently, and effectively a word processor, e-mail, a web browser, and the Excel software. We will frequently use laptops during class, and laptops are required to complete homework and case assignments, possibly along with the midterms and final exam.

This is a course that requires computation: If a student's laptop cannot work with large datasets, please contact the professor immediately to make arrangements. In particular, please see the following options for borrowing laptops from USC:

From USC Libraries: https://itservices.usc.edu/spaces/laptoploaner/
• Mac or PC
• Rent on Hourly Basis for free (4-hour max, can renew in person for more hours.)
• Can come any time the library is open.
• If requested from Professor, Libraries may allow advance reservation, Professor would email ITS Learning environments at spaces@usc.edu for this special request.

IMPORTANT NOTE**:** This class duplicates the credit in BUAD 311. You cannot get credits for this class and BUAD 311. If you already took BUAD 311, you **cannot** take this class. **This course will satisfy the core operations management requirement for Marshall undergraduates.**

Required Materials: You will need access to Excel, and you will need to install the Solver add-on. This is free of charge, and instructions will be provided. We will analyze various external cases, which may require extra purchases. If cost is ever a barrier to you participating in the course, please contact the professor and support will be provided, no questions asked.

You are also required to install the VS Code, Python, and GitHub Copilot on your laptop. These software are free of charge and instructions will be provided. We will use these software extensively in the course.

There is no official course textbook. You are expected to refer to the class lecture slides and other posted material on Blackboard.

Optional Textbooks: For those wanting additional reading, the following textbook will allow you to go deeper into the course's methodology:

DMD -- Data, Models, and Decisions: The Fundamentals of Management Science by D. Bertsimas and R. M. Freund, 2nd Edition, published by Dynamic Ideas in 2004 (ISBN-13: 978-0975914601 and ISBN-10: 097591460X). The textbook is available at bookstore, or online at Dynamic Ideas through https://www.dynamic-ideas.com/books/ecbcnthsfb6hnzfdezpw0aldtvl9yr
DES -- Discrete-Event System Simulation by Banks, Carson, Nelson, and Nicol (publisher: Prentice Hall)

These are great references, but we will not be following them precisely. They should eb thought of as possibly augmenting your learning, rather than guiding the course.

Instructional Methods: The class will be taught through the following three instructional methods.

Lectures: During the lecture, I will cover key concepts and methodologies, along with simple illustrative examples. The lecture note will be posted on Blackboard.

Problem Solving: There will be around a dozen class sessions where we focus on solving real-world business problems using optimization and simulation models. The problems that we cover in these sessions are often based on *large-scale, challenging, and real-world applications*. These sessions are designed to give student hands-on experience in using optimization and simulation tools to solve complex business problems. In many of sessions, we will also work together in-class to write code.

In-class Activities: These in-class activities will provide students with firsthand experience of the versatility of the models and techniques used in optimization and simulation. The experiential learning will be done through games, role plays, sports, and illustrations.

Grading Policies: The course grade will be curved and based on class participation, preparation and effort during problem solving sessions, homework and case assignments, midterms, and a cumulative final exam, according to the following weights:

Class Participation	10%
Problem Solving Sessions	5%
Assignments	35%
Exams (Midterm and Final)	50%

Class Participation: It is very important for each student to actively participate in the class discussion. Read the assigned material before the class and make sure you are familiar with the main issues to be discussed in class. You will be cold-called. Your participation is evaluated mainly on the quality of your contribution and insights. I will make every effort to call on as many students who wish to speak up as possible.

Problem Solving Sessions: There are a number of problem-solving sessions during the semester. These sessions are important in consolidating your understanding of optimization models, sharpening your ability to apply optimization and simulation techniques to business applications, and improving your overall problem solving skill set. Each student is expected to attend all problem-solving sessions; attendance will be taken through the form of wrap-up questions at the end of each session. Each student will be given a handout with a detailed description of the business problem in advance (on Blackboard), and before coming to the class, each student is expected to have read the problem description and attempted to formulate an optimization or simulation problem. Each student is expected to fully participate in these activities.

Assignments: During the course, you will be given 6 assignments. The assignment with the lowest score will be dropped. Students must complete the assigned readings, homework assignments, and case studies prior to coming to class. Assignments are due on the indicated due date before the start of the class and no late work will be accepted. You can work on the cases and assignments individually or in a team. Each team will consist **of at most 2 students**. Teams will be self-selected. Assignments #2 will involve case questions, and on this assignment, I will ask students to present their results to the class.

Exams: We have two exams in the course: a midterm and a final exam. We will give more weight to the exam with the higher score. The overall score for the exam will be computed based on the following formula:

60% x (maximum score between the two exams) + 40% x (minimum score between the two exams)

Makeup Exams: Makeup exams are allowed for "documented medical emergencies". The students need to provide proper documentations by the time of the exam, including (a) a signed doctor's note, with the name and phone number of the medical professional verifying the medical emergency and (b) an email from the student's Marshall advisor.

Course Disclaimer: This syllabus is an invitation to students to engage in an exciting and interactive study of optimization and simulation. The intention of the instructor is to provide you with information, offer practice with skill sets, and enhance your capacity to use fundamental concepts to build your repertoire of optimization and simulation tools and make sound decisions. The learning environment will be collaborative and supportive; we will learn from one another both in and out of the classroom. To that end, modifications to this syllabus may be warranted as determined by the instructor as we assess the learning needs of this particular class of students. In addition, grades for class participation and problem-solving sessions are under the sole discretion of the instructor.

Responsibility and ownership of work: While teamwork is allowed on assignments and group study is encouraged (and shown to be a significant boost to your learning!), each student is individually responsible for the accuracy and legitimacy of their work. Sound reasoning should be given for each problem solution, and students may be asked to explain further. This applies to solutions developed with classmates but also to the use of advanced toolkits, such as those based on generative AI (ChatGPT, GitHub CoPilot, etc). ***Depth of understanding is a prerequisite to any submission, and all aids must be properly acknowledged.*** In summary, students are fully responsible for all submitted work.

Academic Conduct, Learning Environment, and Support Systems

Academic Conduct: Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on Research and Scholarship Misconduct.

Open Expression and Respect for All: An important goal of the educational experience at USC Marshall is to be exposed to and discuss diverse, thought-provoking, and sometimes controversial ideas that challenge one's beliefs. In this course we will support the values articulated in the USC Marshall "Open Expression Statement."

Students with Accommodations: USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
sites.google.com/usc.edu/counseling-mental-health
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline - 988 for both calls and text messages – 24/7 on call
988lifeline.org
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to

remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL) – 24/7 on call
sites.google.com/usc.edu/rsvpclientservices/home
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
eeotix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
osas.usc.edu
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention - (213) 740-0411
campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
ombuds.usc.edu
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice - (323) 442-2850 or otfp@med.usc.edu
chan.usc.edu/patient-care/faculty-practice
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.

COURSE OUTLINE

The pictures next to each session describe the instructional methods used in the session, where  denotes lectures,  denotes problem solving sessions, and  denotes in-class activities. The relevant learning objectives (#1 - #8) are listed on the first page of the syllabus. Selected key operations management topics are highlighted for each new material session; some topics can and will appear across multiple sessions, even if not listed.

Session 1 – 1/8/24 (Monday)  : Introduction to operations management. Understanding process analysis, capacity, utilization, and process analysis.
Question: What is operations management (OM)? Why do we study OM? You will discover that OM defines business competitiveness and that the study of OM prepares you to become business leaders and entrepreneurs by qualitatively and quantitatively assessing trade-offs. You will learn how the flow of customers or products into and out of a system determines process measures and profit.
Learning outcomes: By the end of the session, you will be able to

- Define and identify Operations Management problems in real-world situations
- Construct and interpret business processes using process flow diagrams
- Calculate key performance measures of a process, including capacity, flow rate, and utilization rate
- Define flow time and work-in-process
- Identify the bottleneck that governs the capacity of a process

Relevant learning objectives: **#1**, **#2**

Session 2 – 1/10/24 (Wednesday)  : Kristen's Cookie Company and intro to linear optimization
Question: What is the makeup of a small cookie business? How do we determine the capacity of a process? Through this case, you will gain a better understanding of the business profitability through business process analysis; you will evaluate key performance measures under different sales mixes, and recognize the impact of the bottleneck on price and profit. You will discover linear programming (LP), which is one of the most common tools used in operations analytics. We will also introduce a simple application of LP in online advertising.
Learning outcomes: Through this case, students should be able to

- Conduct business process analysis to assess business profitability
- Evaluate key performance measures under different sales mixes
- Quantify the impact of the bottleneck on price and profit
- Formulate a linear program (LP) and solve small LP problems using Excel Solver.
- Understand the components of a linear program

Relevant learning objectives: **#1**, **#2**
Reading: The Kristen's Cookie Company case on Blackboard

Session 3 – 1/15/24 (Monday): **NO CLASS --- Martin Luther King's Birthday**

Session 4 – 1/17/24 (Wednesday)  : The Chocolate Game and intro to refinery optimization
Question: How can firms make effective decisions over time? How can linear program be used in in oil refinery optimization? Through the Chocolate Game simulation, you will experience firsthand the challenge of making effective decisions over time. Introduce the concept of a policy. We will introduce how linear program can be used to optimize the refinery operations.
Learning outcomes: By the end of the session, you will be able to

- Understand the challenge of making decisions over time
- Recognize how linear programs can be used to help oil refineries optimize their operations

Relevant learning objectives: **#1**, **#2**
Reading: Handout on the LP Refinery problem on Blackboard

Session 5 – 1/22/24 (Monday)  : Wrap-up refinery optimization

Question: How can linear program be used in in oil refinery optimization? You will complete the linear program for refinery optimization and learn how to implement LP in Python and solve it using Gurobi package. We will show how to solve the model in Excel. You will acquire hands-on experience in formulating a complex LP to maximize profitability, using actual data from a business operation.

Learning outcomes: By the end of the session, you will be able to

- Recognize how linear programs can be use to help oil refineries optimize their operations
- Implement LP and solve it in Python and Excel Solver

Relevant learning objectives: **#1**, **#2, #3, and #4**

Reading: Handout on the LP Refinery problem on Blackboard

**** 1/24/24: Assignment #1 is due. ****

Session 6 – 1/24/24 (Wednesday)  : Xtreme Sands Inc. Introduction to sensitivity analysis

Question: How does the objective value of a linear program change with the problem parameters?

Outline: What are the typical business problems where LP techniques can be applied?

Learning outcomes: By the end of the session, you will be able to

- You will practice more advanced LP formulation and learn how to use the sensitivity report, which shows how the solutions change if the conditions vary.
- Explain the impact of changes in the problem's parameters
- Understand the concept of shadow prices
- Interpret the sensitivity report generated by Excel Solver

Relevant learning objectives: **#7, #8**

Session 7 – 1/29/24 (Monday)  : Geometry of LP, shadow prices, and sensitivity analysis

Question: What is the geometry of LP? What are shadow prices? How can we interpret the sensitivity report from Excel Solver?

Learning outcomes: By the end of the session, you will be able to

- You will learn the geometry of linear program, understand the concept of shadow prices.
- Learn how to interpret the sensitivity report generated by Excel Solver.
- Extract shadow prices and sensitivity report from Gurobipy package

Relevant learning objectives: **#7, #8**

Session 8 – 1/31/24 (Wednesday)  : Multi-period Production Planning: Solving Large LPs

Question: How can we use LP to develop an optimal production schedule that involves thousands of variables? How to formulate the problem using linear objective function and linear constraints?

Learning outcomes: By the end of the session, you will be able to

- Formulate the multi-period LP for production scheduling
- Structure the multi-period LP in Excel

Relevant learning objectives: **#3**, **#4, #8**

Reading: Handout on the Factory Planning problem on Blackboard

Session 9 – 2/5/24 (Monday)  : Wrap-up Multi-period Production Planning

Question: We will wrap up our discussion on solving large scale LP using Python. We will also introduce students to OpenSolver, which is a powerful open-source optimizer that extends the capability of the Excel Solver.

Learning outcomes: By the end of the session, you will be able to

- Understand the limits of Excel Solver and identify when it is (or is not) the appropriate solution technique
- Use Github CoPilot (and/or other generative AI tools) to model large scale LPs.
- Use OpenSolver to address large-scale optimization problems with many variables

Relevant learning objectives: **#4, #7, #8**

**** 2/7/24: Assignment #2 (Filatoi Riuniti Case) is due. ****

Session 10 – 2/7/24 (Wednesday): Filatoi Riuniti Case presentation by students

Question: How can Filatoi Riuniti use LP's to optimize yarn productions and make strategic business decisions? We will discuss your solution approaches to the Filatoi Riuniti case, identify key business insights from the optimization models, and explore additional business questions that can be answered through optimization.

Learning outcomes: By the end of the session, you will

- Learn how to formulate linear program to help companies optimize their production operations.
- Learn about outputs of LP and sensitivity report can be used to help in setting prices, determining capacity expansion, and evaluating strategic acquisition opportunities.
- Formulate an LP for a production planning problem
- Use sensitivity report to analyze business opportunities

Relevant learning objectives: **#3, #4, #7, #8**

Session 11 – 2/12/24 (Monday)  : Introduction to discrete optimization

Question: Can we apply optimization tools when the decision variables are not divisible?

Learning outcomes: Optimization is more than linear and nonlinear programming. The firms cannot hire half of a person or fly a quarter of an airplane. You will be able to formulate an integer program (IP) and solve small IP problems using Excel Solver.

- Understand the components of an integer program
- Formulate an integer program and solve it using Excel solver
- Understand how to use binary decision variables to model constraints in integer programming

Relevant learning objectives: **#1**, **#2, #3**

Session 12 – 2/14/24 (Wednesday)  : Strategic relocation problem

Question: How to identify problems that can be solved using IP? How to use IP to solve the strategic relocation problem?

Learning outcomes: You will learn about additional applications of IP, including locating shelters, matching, and scheduling.

- Identify problems that can be formulated as an IP
- Convert business problems into an IP using appropriate variables
- Create a model for the strategic relocation problem using IP

Relevant learning objectives: **#1**, **#2, #3**

Session 13 – 2/19/24 (Monday): **NO CLASS --- President's Day**

**** 2/21/24: Assignment #3 is due. ****

Session 14 – 2/21/24 (Wednesday)  : Discrete optimization for corporate restructuring
Question: How can we use discrete optimization to develop a plan to either invest in, maintain, or sell the various divisions within our enterprise? Discrete optimization can be used to develop a plan to focus resources on the best collection of divisions.
Learning outcomes: By the end of the session, you will

- Formulate an integer program (IP) to determine the schedule for workers
- Express scheduling and business constraints using linear functions

Relevant learning objectives: **#1, #2, #3, #4**
Reading: The International Industries, Inc. Case on Blackboard

NOTE: I will have extra office hours on Monday (2/26), Tuesday (2/27) and Wednesday (2/28) to help with the midterm preparation.

Session 15 – 2/26/24 (Monday): Review for Midterm
Session 16 – 2/28/24 (Wednesday): Midterm

Session 17 – 3/4/24 (Thursday)  : Discrete optimization in finding the best volume discounts
Question: How can we use discrete optimization to identify the best volume discounts? The market for mobile phones has reached saturation. To reduce cost, mobile phone operators must decide how to allocate phone calls to carriers in most cost-efficient fashion. You will have an opportunity to apply integer programming to identify the best strategy for obtaining volume discounts, which is based on an actual business problem.
Learning outcomes: By the end of the session, you will

- Learn how to formulate a discrete optimization problem to identify the optimal volume discount

Relevant learning objectives: **#1**, **#2, #3, #4, #7, #8**
Reading: "Selecting Telecommunication Carriers" case on Blackboard.

Session 18 – 3/6/24 (Thursday)  : Wrap-up application in finding the best volume discounts
Question: You will learn how to write Python code to find the best volume discounts and how to set up Excel spreadsheet to solve this problem.
Learning outcomes: By the end of the session, you will

- Write Python code and construct Excel spreadsheet for finding the optimal volume discounts

Relevant learning objectives: **#1**, **#2, #3, #4, #7, #8**
Reading: "Selecting Telecommunication Carriers" case on Blackboard.

Spring Break: 3/11/24 – 3/15/24

Session 19 – 3/18/24 (Monday)  : Applications of discrete optimization in logistics
Question: How can we use IP in logistics problems?
Learning outcomes: You will have an opportunity to formulate a large-scaled IP for a logistic problem based on an actual business operation of a firm.

- Learn about the traveling salesman problem (TSP)
- Understand how to formulate the TSP and its variants

Relevant learning objectives: **#1**, **#2, #3, #4, #7, #8**
Optional Reading: Handout on the Logistics problem on Blackboard

Session 20 – 3/20/24 (Wednesday)  : Wrap-up discrete optimization in logistics
Question: How can we use subtour elimination in the traveling salesman problem?
Learning outcomes: You understand how to add valid inequalities to rule out infeasible solutions and implement the large-scaled IP for a logistic problem using Excel
Relevant learning objectives: **#1**, **#2, #3, #4, #7, #8**
Optional Reading: Handout on the Logistics problem on Blackboard

Session 21 – 3/25/24 (Monday)  : Decision making under uncertainty through decision trees
Question: How do we optimize our decisions in the face of uncertainty? What is a decision tree? The decision tree is a schematic model to manage uncertainty by clearly identifying alternative choices. You will learn how to construct a decision tree — its nodes and branches — and solve for the optimal decision.
Learning outcomes: By the end of this section, you will be able to

- Use decision trees to express alternative choices and to manage uncertainty
- Described differences between the three types of nodes in the decision trees
- Solve decision tree problems

Relevant learning objectives: **#5**

**** 3/27/24: Assignment #4 is due before the class starts.**

Session 22 – 3/27/24 (Wednesday)  : Introduction to dynamic optimization
Question: What is a dynamic optimization? What are the important features of such problems? Many business problems require a multi-period optimization framework. How to recognize such problems? What are the important features of these problems?
Learning outcomes: By the end of this section, you will be able to

- Recognize a dynamic optimization problem
- Understand the principle for solving such problems.
- Understand the concept of value function and the dynamic programming formulation

Relevant learning objectives: **#5, #7**

Session 23 – 4/1/24 (Monday)  : Solving the Chocolate Game problem
Question: How can we implement dynamic programming and solve the dynamic optimization problem in Excel? You will learn about the value function and how it can be used to solve the dynamic programming equation.
Learning outcomes: By the end of this section, you will be able to

- Implement dynamic programming on Python and Excel
- Understand the concept of value functions
- Solve for the value function in Excel for the Chocolate Game from Session #1.

Relevant learning objectives: **#5, #7, #8**

Session 24 – 4/3/24 (Wednesday) : Simulating the optimal policy

Question: Now that we compute the optimal policy of the Chocolate Game, how do we determine the distribution of revenue obtained under the optimal policy? You will learn how to write a simulation code in Python to simulate the revenue obtained under the optimal policy, and assess the variability of the revenue.

Learning outcomes: By the end of this section, you will be able to

- Write a simulation code in Python that evaluate the revenue on each sample path
- Understand the sequence of events under the optimal policy
- Determine the distribution of revenue under the optimal policy

Relevant learning objectives: **#5, #7, #8**

Session 25 – 4/8/24 (Monday) : Newsvendor Problem

Question: How can we leverage the structure of Monte Carlo simulations using Python to solve the newsvendor problem with correlated demand? We will show how to perform Monte Carlo simulation with correlated random variables using Python.

Learning outcomes: By the end of this section, you will

- Learn the basic loop structure of simulation experiments and connect this to Python
- Generate summary statistics and histograms of outputs

Relevant learning objectives: **#5, #7**

**** 4/10/24: Assignment #5 is due before the class starts.**

Session 26 – 4/10/24 (Wednesday) : Introduction to Queueing Models, Little's Law, and the M/M/s Queue

Question: How does waiting impact business operations, and what is a queueing model? We will discuss key queueing characteristics (arrival patterns, service discipline, service distributions), and the exponential distribution. We will also introduce important queueing relationship including Little's Law. We will also discuss basic performance measures for M/M/s queue.

Learning outcomes: By the end of this section, you will

- Understand the elements of queueing model
- Understand the memoryless property of the exponential distribution
- Link various performance measure using Little's Law
- Understand properties of M/M/s queue

Relevant learning objectives: **#6, #7, #8**

Session 27 – 4/15/24 (Monday) : Simulating and staffing queueing models under general distributions

Question: How do we determine queueing performance measures when the interarrival and service times are not exponentially distributed? How can we use the queueing simulation models we have developed to determine optimal staffing levels for service systems with time-varying demand? We will discuss how to build a queueing simulation model that allows for general interarrival and service time distributions. Our simulation model will track the events within the queue and allow us to assess performance. We will use our queueing model knowledge and simulation skills to implement an iterative staffing algorithm. Through an application to real world data, we will calculate the requisite staffing levels needed to achieve target levels of service quality while managing demand flows that vary across time.

Learning outcomes: By the end of this section, you will

- Understand the logic for building a general queueing simulation model
- Identify the operational challenges created by time-varying arrival rates

Relevant learning objectives: **#6, #7, #8**

Session 28 – 4/17/24 (Wednesday)  : Kristen's Cookie Simulation
Question: What would happen to the waiting time, utilization, and revenue if there are uncertainty in the arrival and processing times in Kristen's Cookie operations. We will develop simulation model for the Kirsten's Cookie to account for variability in arrivals and processing times.
Learning outcomes: By the end of this section, you will

- Write Python code to conduct discrete event simulation
- Identify key business insights from the simulation and optimization model

Relevant learning objectives: **#6, #7, #8**

Session 29 – 4/22/24 (Monday)  : Wrap-up Kristen's Cookie Simulation
Question: We will wrap-up our simulation model for the Kirsten's Cookie when there is uncertainty in the arrival and processing time.
Learning outcomes: By the end of this section, you will

- Write Python code to conduct discrete event simulation
- Identify key business insights from the simulation and optimization model

Relevant learning objectives: **#6, #7, #8**

**** 4/24/24: Assignment #6 is due. ****

Session 30 – 4/24/24 (Wednesday): Review for the Final Exam

Following the university schedule,

the final exam is on Thursday, May 2, from 11am – 1pm.

Note that the exam time follows the BUAD 311/313 "Exception" schedule,

not the time-of-class schedule.

No early finals are allowed by University policy.

A summary of the class schedule and due dates are given on the next two pages.

Summary of the Schedule of Classes

Week	Session	Date	Topics and Instructional Methods	Activities to Complete before Coming to Class and Assignments Due
1	01	M 01/08	Process analysis: Capacity and utilization. Introduction to Chocolate Game 	Please submit your bid for the chocolate game by Wednesday (1/10) at 8pm. The link is available on Blackboard.
	02	W 01/10	Application of process analysis: Kristen's Cookie Introduction to LP: NBT Problem 	Study the Kristen's Cookie case before coming to class
2	03	M 01/15	**NO CLASS --- Martin Luther King's Birthday**	
	04	W 01/17	Play the Chocolate Game. Intro to refinery optimization 	Study the refinery problem before coming to class
3	05	M 01/22	Refinery optimization wrap-up	
	06	W 01/24	Xtreme Sands Inc. Introduction to sensitivity analysis. 	**Assignment #1 is due**
4	07	M 01/29	Geometry of LP and shadow prices analysis 	
	08	W 01/31	Multi-period Production Planning: Solving Large LPs in Python & Open Solver 	Study the factory planning problem before coming to class
5	09	M 02/05	Wrap-up Multi-period Production Planning	
	10	W 02/07	Case presentation by students (Filatoi Riuniti) 	**Assignment #2 (Filatoi Riuniti) is due**
6	11	M 02/12	Introduction to Discrete Optimization (DO) 	
	12	W 02/14	Strategic Relocation Problem 	
7	13	M 02/19	**NO CLASS --- President's Day**	
	14	W 02/21	DO application: Corporate Restructuring 	Study the International Industries problem before coming to class **Assignment #3 is due**
8	15	M 02/26	Review for Midterm	
	16	W 02/28	**Midterm Exam**	
9	17	M 03/04	DO application: Optimal Volume Discounts 	Study the "Selecting Communication Carriers" case before coming to class
	18	W 03/06	Wrap-up Optimal Volume Discounts	

Spring Break 03/11 – 03/15				
10	19	M 03/18	DO Application in Logistics 	Study the logistic problem before class
	20	W 03/20	Wrap-up DO Application in Logistics	
11	21	M 03/25	Modeling uncertainty: Decision making under uncertainty through decision trees 	
	22	W 03/27	Introduction to dynamic optimization (Nim) 	**Assignment #4 is due**
12	23	M 04/01	Solving the Chocolate Game in Python and Excel 	
	24	W 04/03	Simulating the Optimal Policy 	
13	25	M 04/08	Newsvendor Problem 	
	26	W 04/10	Introduction to queueing models, Little's Law, and the M/M/s queue 	**Assignment #5 is due**
14	27	M 04/15	Staffing and simulating queues under general interarrival and service time 	
	28	W 04/17	Simulating Kristen's Cookies operations under random arrivals and service times 	
15	29	M 04/22	Wrap-up Kristen's Cookies under Uncertainty	
	30	W 04/24	Review for final exam	**Assignment #6 is due**
Final Exam: Thursday, May 2, 11am – 1pm				

Contribution of BUAD313: Advanced Operations Management and Analytics to Student Achievement of Marshall's Six Undergraduate Program Learning Goals			
#	**Marshall Program Learning Goal Description**	**Degree of Emphasis**	**BUAD313 Course Objectives that Support Marshall Undergraduate Goals**
1	**Our graduates will understand types of markets and key business areas and their interaction *to effectively manage different types of enterprises.* Specifically, students will:**	**High**	**BUAD313 Course Objectives 1-8 support Goal #1**
1.1	Demonstrate foundational knowledge of core business disciplines, including business analytics and business economics.		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making 5. Incorporate uncertainties in operational decisions 8. Understand the broad range of applications of optimization and simulation
1.2	Understand the interrelationships between functional areas of business so as to develop a general perspective on business management.		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making 5. Incorporate uncertainties in operational decisions 7. Articulate the business implications of optimization and simulation models 8. Understand the broad range of applications of optimization and simulation
1.3	Apply theories, models, and frameworks to analyze relevant markets (e.g. product, capital, commodity, and factor and labor markets).		2. Analyze trade-offs in decision-making 3. Describe optimization models rigorously 5. Incorporate uncertainties in operational decisions 7. Articulate the business implications of optimization and simulation models 8. Understand the broad range of applications of optimization and simulation
1.4	Show the ability to utilize technologies (e.g., spreadsheets, databases, software) relevant to contemporary business practices.		4. Implement optimization models via Solver or code 5. Incorporate uncertainties in operational decisions 6. Write code to develop simulation models
2	**Our graduates will develop a global business perspective. They will understand how local, regional, and international markets, and economic, social and cultural issues impact business decisions *so as to anticipate new opportunities in any marketplace***	**Low**	**BUAD313 Course Objectives 1, 2, 5, 7, and 8 support Goal #2**
2.1	Understand how local, regional and global markets interact and are impacted by economic, social and cultural factors.		1. Recognize how optimization and simulation models interface with other functional areas 8. Understand the broad range of applications of optimization and simulation
2.2	Understand that stakeholders, stakeholder interests, business environments (legal, regulatory, competitor) and business practices vary across regions of the world.		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making 5. Incorporate uncertainties in operational decisions 7. Articulate the business implications of optimization and simulation models 8. Understand the broad range of applications of optimization and simulation
3	**Our graduates will demonstrate critical thinking skills *so as to become future-oriented decision makers, problem solvers and innovators.* Specifically, students will:**	**High**	**BUAD313 Course Objectives 1-8 support Goal #3**
3.1	Understand the concepts of critical thinking, entrepreneurial thinking and creative thinking as drivers of innovative ideas.		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making 3. Describe optimization models rigorously 4. Implement optimization models via Solver or code 5. Incorporate uncertainties in operational decisions 6. Write code to develop simulation models 7. Articulate the business implications of optimization and simulation models
3.2	Critically analyze concepts, theories and processes by stating them in their own words, understanding key		1. Recognize how optimization and simulation models interface with other functional areas

	components, identifying assumptions, indicating how they are similar to and different from others and translating them to the real world.		2. Analyze trade-offs in decision-making 3. Describe optimization models rigorously 5. Incorporate uncertainties in operational decisions 7. Articulate the business implications of optimization and simulation models
3.3	Be effective at gathering, storing, and using qualitative and quantitative data and at using analytical tools and frameworks to understand and solve business problems.		1. Recognize how optimization and simulation models interface with other functional areas 4. Implement optimization models via Solver or code 5. Incorporate uncertainties in operational decisions 6. Use @Risk and code to develop simulation models 8. Understand the broad range of applications of optimization and simulation
3.4	Demonstrate the ability to anticipate, identify and solve business problems. They will be able to identify and assess central problems, identify and evaluate potential solutions, and translate a chosen solution to an implementation plan that considers future contingencies		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making 3. Describe optimization models rigorously 5. Incorporate uncertainties in operational decisions 7. Articulate the business implications of optimization and simulation models 8. Understand the broad range of applications of optimization and simulation
4	**Our graduates will develop people and leadership skills to promote their effectiveness as *business managers and leaders.* Specifically, students will:**	**Moderate**	**BUAD313 Course Objectives 1, 2, 5, 7, and 8 support Goal #4**
4.1	Recognize, understand, and analyze the motivations and behaviors of stakeholders inside and outside organizations (e.g., teams, departments, consumers, investors, auditors).		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making
4.2	Recognize, understand and analyze the roles, responsibilities and behaviors of effective managers and leaders in diverse business contexts e.g., marketing, finance, accounting.		1. Recognize how optimization and simulation models interface with other functional areas 7. Articulate the business implications of optimization and simulation models 8. Understand the broad range of applications of optimization and simulation
4.3	Understand factors that contribute to effective teamwork.		2. Analyze trade-offs in decision-making 5. Incorporate uncertainties in operational decisions
5	**Our graduates will demonstrate ethical reasoning skills, understand social, civic, and professional responsibilities *and aspire to add value to society.* Specifically, students will:**	**Low**	**BUAD313 Course Objectives 1, 2, and 8 support Goal #5**
5.1	Understand professional codes of conduct.		1. Recognize how optimization and simulation models interface with other functional areas 8. Understand the broad range of applications of optimization and simulation
5.2	Recognize ethical challenges in business situations and assess appropriate courses of action.		1. Recognize how optimization and simulation models interface with other functional areas 2. Analyze trade-offs in decision-making 8. Understand the broad range of applications of optimization and simulation
6	**Our graduates will be effective communicators *to facilitate information flow in organizational, social, and intercultural contexts.* Specifically, students will:**	**Moderate**	**BUAD313 Course Objectives 1, 7, and 8 support Goal #6**
6.1	Identify and assess diverse personal and organizational communication goals and audience information needs		1. Recognize how optimization and simulation models interface with other functional areas 8. Understand the broad range of applications of optimization and simulation
6.2	Understand individual and group communications patterns and dynamics in organizations and other professional contexts		1. Recognize how optimization and simulation models interface with other functional areas 7. Articulate the business implications of optimization and simulation models
6.3	Demonstrate an ability to gather and disseminate information and communicate it clearly, logically, and persuasively in professional contexts.		1. Recognize how optimization and simulation models interface with other functional areas 7. Articulate the business implications of optimization and simulation models 8. Understand the broad range of applications of optimization and simulation