



QST BA 885: Advanced Analytics II

Instructor: Nachiketa Sahoo
Office Phone: 617-353-6145
e-mail: nachi@bu.edu
Class Meeting: Tue, Thu 12:45pm to 3:30pm HAR414
Office Hours: Tue, Thu 11:30am – 12:30pm
HAR639A or Zoom.

COURSE DESCRIPTION & LEARNING GOALS

BA885 covers analytics topics in applied optimization (or prescriptive analytics). In contrast to the unsupervised and supervised machine learning studied in BA820 and BA810 (and BA865) where the focus was to discover patterns and predict uncertain events, this course focuses on determining the best course of action given an objective and a set of constraints. In other words, taking (operational and strategic) decisions using a rigorous and principled approach.

The methods learnt in this course have broad application including in logistics, marketing, healthcare, finance and more. Examples problems include determining which products to advertise to which customer to maximize sales, identifying best location of warehouses to best serve geographically dispersed stores or customers, and allocating medical resources to health care facilities to minimize the fallout during an active pandemic.

Topics include linear programming, integer programming, network models, and related methods. Students will learn how to setup such optimization problems and solve them using spreadsheets and Python.

Upon completion of this course, you will be able to:

- Structure decision problems to formal models (optimization problems) to analyze.
- Identify which model is appropriate for the problem you have.
- Implement those models in spreadsheet and Python and make recommendations.

PREREQUISITES

- MSBA required courses.

COURSE STRUCTURE & PEDAGOGY

The general structure of each class will be as follows:

- Lecture and discussion (first half of class) – every lecture will start with a recap of the previous lecture; if you have questions from the prior lecture (or any other prior material), this is a great time to bring them up.
- Short break
- Lab, coding session, discussion, Q&A (second half of class)

The lab part of each class will be devoted to applying discussed concepts to analyze real-world cases. You must bring your laptop to each class: they are necessary to do the lab exercises.

COURSE MATERIALS

Textbook

Most chapters to read are assigned from the following book:

- **(BHM)** Stephen P. Bradley, Arnaldo C. Hax, Thomas L. Magnanti - Applied Mathematical Programming (1977) – freely available online at <http://web.mit.edu/15.053/www/AMP.htm>

The following two books provide excellent alternative treatment of the material.

- **(HL)** Frederick Hillier, Gerald Lieberman - Introduction to Operations Research-McGraw Hill (2020) – only Chapters 1–12
- **(W)** Wayne L. Winston - Operations Research: Applications and Algorithms (2003) – only Chapters 1–10, 19

Both also show how to solve optimization problems using Excel and Solver plugin.

The following book primarily focuses on application scenarios and model formulation—an important skill—not algorithms to solve them. Many of the Gurobi notebooks ([on Github](#)) are based on these examples.

- H. Paul Williams - Model Building in Mathematical Programming-Wiley (2013)

Software

- Excel/Solver
- Gurobi and related libraries in Python (on Colab)

Distribution

I'll share slides, data, model and other instructor resources through a [Google drive folder](#). You need to be logged into BU Google account to access.

COURSE DELIVERABLES AND GRADING

You will be graded according to the following criterion:

Class participation:	10%
In-class quizzes:	5%
Individual assignments: $2 \times 15\% =$	30%
Team project: 5% (proposal) + 20% (final) =	25%
Final Exam:	30%
Total:	100%

The deliverables will be collected through the course Blackboard.

Class Participation

Satisfactory class contributions require attending every session, preparing for every session; and active, quality participation in class discussions. Simply attending class, however, does not constitute a positive contribution to class and will not yield high class contribution scores. I may call upon any student to answer questions during class.

There are three classes where we'll discuss cases. It is particularly important that you attempt to formulate the optimization models and be prepared to discuss them in class. You may collaborate with others to prepare, but you'll be individually responsible to answer when called upon.

Please bring your name tent card to class so that I can accurately assign participation points.

In-class Quizzes

In some classes we will take short online quizzes on recently discussed topics. These will be available *only during the class*. We will drop the lowest among these to allow one bad day.

Individual Assignment

The homework assignments need to be completed individually and submitted through blackboard by 11pm on the day they are due. It is OK to ask your classmates for help, but you must disclose them (no penalty). It is not OK to copy someone else's code into submission. All code and answers that you submit must be produced by you.

Team Project

You will work on projects in teams of three students. You will select teams during the first class. I will assign anyone unassigned at the end of first class to a team.

The purpose of this exercise is for you to identify a real world decision problem of interest to you and cast it as an optimization exercise. There are two key steps. First, present submit your project proposal (a written document up to two pages) describing the context, decision/planning problems, objective, and constraints. I'll review to approve and provide feedback. On the last day of class (prior to the final exam), you will present your project in class. This will consist of a 15-minute presentation where you will present your key findings, and 3-4 minutes Q&A.

Please look for the "BA885 Project Instructions" document on the course folder for important details.

Exam

The final exam will be an offline closed-books and notes in class exam. It'll consist of small modelling/problem formulation, coding, and short answer questions. You are allowed to bring one sheet of notes (both sided).

Grade Distribution

Keeping with the grade distribution guidelines for MSBA elective courses:

- Up to 50% of grades in the class will be in the A or A- range
- Grades below A- will be assigned as earned

If you have any questions about grades that you receive on assignments, raise them within one week of receiving your grade on that assignment. Unless we have made computational errors, we will be

unable to alter grades after final grades have been determined. If you have grade-related considerations that you think are important, please raise these with me as early as possible so that I can help you approach the course in a way that will maximize your performance.

DIVERSITY AND INCLUSIONS STATEMENT

In developing this course, I have aimed to be thoughtful about how identity and culture impact the course content. I invite you to share your personal experiences and perspective related to the course content. If there are topics or conversations that you feel would benefit from incorporation of social context, a differing perspective, or Questrom's Office of Diversity & Inclusion, please inform me and I will explore resources and opportunities for us to engage a wide variety of perspectives in our classroom.

COURSE POLICIES

Attendance

Attendance is mandatory except as permitted by the [Boston University rules](#). Unexcused absences will hurt your participation grade.

Accommodations for Students with Special Needs

In keeping with university policy, any student with a disability who needs or thinks they need academic accommodations must call the Office of Disability Services at 353-3658 or stop by 19 Deerfield Street to arrange a confidential appointment with a Disability Services staff member. Accommodation letters must be delivered to me in a timely fashion (within two weeks of the date on the letter and not later than two weeks before any major examination). Please note that accommodations will not be made absent an official letter of accommodation.

Mental Health and Wellness

Life at college can get complicated and it is easy to feel overwhelmed, lost, anxious, or depressed. If you find yourself struggling with your mental or physical health this semester, please feel free to approach me. I will try to be flexible and accommodating, within reason. But I am not a professional therapist and there is no shame in getting help. Help for managing stress and your mental wellbeing can be found at Student Health Services. There you can find short term therapy, groups and workshops, 24/7 on-call service (617-353-3569), referrals, and more resources. If you are feeling stressed and having trouble making choices around alcohol consumption the Collegiate Recovery Program may offer help.

Financial Insecurity

We learn as whole people. It can be challenging to do your best in school when you are worried about meeting basic needs like safe shelter, sleep, and nutrition. If financial insecurity is an obstacle to learning for you I urge you to contact Terrier Meal Share, Boston University Financial Assistance, or the Dean of Students Office.

Academic Integrity

My goal is to create a community in BA810 where you will feel invested and included. The importance of honesty and integrity in this learning community cannot be overemphasized. Every member of the Boston University Questrom School of Business is responsible for creating an ethical environment; I will do my best every day to create that in our class, but it can't happen without your

commitment too. I expect you to abide by the Academic Conduct Code. It is easy to do: follow all assignment and exam rules. If you have a question about the rules of an assignment, (can I collaborate on this assignment? Can I use my phone to check the time during an exam?) ask me.

Any student caught cheating or submitting work that is not their own will receive a failing grade for the assignment and/or the course and be referred to the Academic Committee for investigation which may result in removal from the program. They most likely will be ashamed of themselves and embarrassed for their lapse in judgment for years to come.

Please see [BU's Academic Conduct Code](#) for more information. And always remember: if you have questions or concerns about an assignment, deadline, reading, exam, or anything related, just ask me.

Classroom Conduct

- **Professionalism:** Students are expected to follow the [Boston University's Student Codes of Conduct](#). They are expected to conduct with a sense of respect and professionalism and can expect the same treatment. A part of the training is learning what is expected in a workplace, and we try to enforce those standards throughout the program.
- **Punctuality:** Students are expected to arrive at the classes and scheduled meetings on time.
- **Name Tents:** Students are expected to keep the name tents in front of them during the class. This helps peers and faculty know them faster.
- **Participation:** Students are expected and strongly encouraged to ask questions and get involved in class discussions. This helps everyone get more out of the class.
- **Cell Phone:** Students cannot use their cell phone during class or exams unless specifically instructed. If you need to take an urgent call, simply leave the classroom, and return as soon as possible.
- **Activities Unrelated to Class:** Activities that are unrelated to the class are not allowed during the class. These include, but are not limited to, using social media, news sites, online video sites, gaming, checking/writing emails, unless asked by the instructor for the purpose of the class.
- **Absence Policy** - If you need to miss a class, notify your instructor before the class.

Sexual Misconduct/Title IX Policy

The Questrom School of Business is committed to fostering a safe learning environment for all members of the its community and preventing sexual misconduct. All forms of sexual misconduct, including rape, acquaintance rape, sexual assault, domestic and dating violence, stalking, and sexual harassment are violations of Boston University's policies, whether they happen on campus or off campus. Title IX of the Education Amendments of 1972 is a federal civil rights law that prohibits sex-based discrimination in federally funded education programs and activities. This law makes it clear that violence and harassment based on sex and gender is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources at <http://www.bu.edu/safety/sexual-misconduct/>.

As an instructor, one of my responsibilities is to help create a safe learning environment on our campus. I also have a mandatory reporting responsibility in my role as a faculty member. It is my goal that you feel able to share information related to your life experiences in this class. I will seek to keep the information you share private to the greatest extent possible. However, I am required to

share information regarding sexual misconduct with the University. Students may speak to someone confidentially by contacting the Sexual Assault Response & Prevention Center.

Class Recording Policy

All class sessions will be recorded for the benefit of registered students. Recorded sessions will be made available to registered students ONLY via their password-protected course accounts. Students may not share such sessions with anyone not registered in the course and may certainly not repost them in a public platform. Students have the right to opt-out of being part of the class recording. Please contact me to discuss options for attending the course in such cases.

COURSE SCHEDULE

#	Date	Topics	Notes
1	Jul 11, 23	Course introduction; linear programming Prep: Gurobi lecture on Mathematical optimization and ML ; BHM Ch 1	Team composition due
2	Jul 13, 23	Sensitivity analysis and examples/types of LP problems Prep: BHM Ch 2.1; skim 2.2, 2.3; Ch 3.1, 3.2	
3	Jul 18, 23	Duality, economic interpretation, game theory Prep: BHM Ch 4.1–4.5, Ch 4.8, 4.9	
4	Jul 20, 23	Case analysis using LP; homework 1 introduction Prep: BHM Ch 7	
5	Jul 25, 23	Network models Prep: BHM Ch 8.1, 8.2, 8.3	
6	Jul 27, 23	Classes and examples of network problems	HW1 due
7	Aug 1, 23	Case analysis using network models; homework 2 introduction Prep: HL Case 10.1 (money in motion)	Case selection for the final project due
8	Aug 3, 23	Integer programming (IP); techniques Prep: BHM 9.1, 9.2, 9.3	
9	Aug 8, 23	IP solution procedures; applications Optional: BHM 9.4–9.8	HW2 due
10	Aug 10, 23	Case analysis using IP Prep: W Case 6 (selecting corporate training programs)	
11	Aug 15, 23	Dynamic programming (DP) Prep: 11.1, 11.3, 11.4	
12	Aug 17, 23	Further applications and miscellaneous topics Optional: 11.5, 11.6, 11.7	
13	Aug 22, 23	Project presentations; recap	
14	Aug 24, 23	Exam	

Disclaimer: the schedule could change as the course progresses.

Additional Resources

1. [Decision Making 101](#) (Very good short videos on optimization using excel and some GurobiPy). See Sections “Introduction to Linear Optimization with Excel”, “Optimization – Basic”, “Optimization – Advanced”.
2. Videos 8.* from [The Analytics Edge](#) from MIT OCW. (Videos 8.* for Lec 1–3, 9.* for Lec 8–10)
 - a. [Excel solver tutorial](#).
3. [Gurobi Linear Programming Tutorial](#) (for Lec 1–3, 8–10)