COURSE NUMBER: DNSC 6307

COURSE TITLE: Optimization I

COURSE DESCRIPTION:
This course focuses on optimization problems in business context, such as resource allocation, work shift planning, or selecting portfolio of investments. The emphasis is on the (i) problem formulation and (ii) interpretation of the results in an intuitive and practical manner. The core concepts behind the solution approaches are covered to the extent that are required to understand and interpret the results and their sensitivities to the model parameters. The optimization problems are formulated and solved using Excel and Python programming language with Gurobi optimization engine. The covered models include linear, multiobjective, and network optimization models.

PREREQUISITES:
Some exposure to matrix algebra is recommended. MSBA candidacy or instructor approval.

PROFESSOR: Janne Kettunen

Department of Decision Sciences
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TEACHING ASSISTANT: Gaoyu Xie, e-mail: gaoyux@gwmail.gwu.edu. Virtual office hours: Fridays 3 pm-4 pm. Please reserve your appointment by e-mail beforehand.

IT SUPPORT: General information technology questions: 202 994 4948
Blackboard related questions: 202 994 0485

LECTURES: Thursdays 4:30pm – 7:00pm at Duques Hall 258. All lectures are recorded and recordings are posted on Blackboard.

LEARNING OBJECTIVES:

1. To competently formulate practical business problems as optimization models (linear, multiobjective, and network).
2. To acquire skills to program the optimization models using Excel and Python.
3. To be able to efficiently represent, analyze, and interpret the optimization model results.
4. To obtain fundamental understanding how the different optimization algorithms work.

WORK REQUIREMENTS:

The amount of work required to achieve the objectives is about 2hrs 30mins per week via attending the lectures. Completing workshops, reading assigned materials, preparing for the exam, and other out-of-class work is estimated at around 5hrs and 30 mins per week and includes 2hrs final exam.

COURSE BOOK:

I have listed below three reference books. Reading one of them is recommended for deeper understanding of the covered material. Under the course schedule section, I have listed chapters related to the concerning lecture from the book of Ragsdale. However, you can read the same material from the books of Winston and Albright and Rardin.

"Rardin, R. L., Optimization in Operations Research, 2nd Edition, Pearson Publishing, 2017". Holistic overview of optimization, most comprehensive and rigorous. Includes content that is beyond this course.

"Ragsdale, C. T., Spreadsheet Modeling and Decision Analysis, 8th Edition, Cengage, 2018". Good coverage of course topics. Easy to understand. Not as rigorous or comprehensive as Rardin's book.

"Winston *W*. L. and Albright S. C., Practical Management Science, Cengage, 2019". Good coverage of course topics. Easiest but also least rigorous.

Each student is responsible for understanding all assigned materials as listed in course schedule. A recommended reading is supplemental and provides further information about a specific topic area for those who want to develop their understanding in that area further. If reading generates questions that are not discussed, the student has the responsibility of addressing the instructor privately.

SOFTWARE:

The following software will be used for developing and solving optimization models:

1. Excel with Solver: Solver is a standard add-in that comes with Excel, and is readily accessible for modeling, solving, and interpreting the outputs from optimization models. The free version that comes with Excel has problem size limitations and is restricted to using a specific solver of limited capability, thus rendering it only useful for relatively smaller and easier-to-solve models. We will use Excel with solver in the 1st workshop assignment and in a few examples.

2. Python with Gurobi: Python with Gurobi allows modeling and solving complex industrial size optimization problems. It can handle major problem types, including linear programming, mixed-integer linear programming, quadratic programming convex and non-convex, quadratically-constrained programming, and network problems. We will use it in several examples, and you will need to use it in the homework assignment.

GRADING:

The course grade depends on the performance in several team and individual assignments. These assignments are as follows:

Assignment	Points	Effort	Due
Participation (best 2 classes)	2x50	Individual	Every lecture
List of team members	Required	Team	Start of 2nd lecture
Team charter	Required	Team	Start of 3rd lecture
LP workshop report	400	Team	Start of 5th lecture
Homework	150	Individual	Start of 7th lecture
Final exam	350	Individual	As scheduled by registrar's office
EXTRA CREDIT			
Feedback survey	15 (if > 70% of students respond)	Individual	End of feedback period

The grades will be assigned based on the total sum of points at the end of the semester. The average grade will be B+. I will apply a curve, with the following approximate proportions of grades:

A:	5-10% of students
A-:	10-25% of students
B+:	25-50% of students
B:	10-25% of students
B- or lower:	0-10% of students

There is no provision for any extra-credit work beyond the extra-credit obtained from feedback survey. Please do not request other extra-credit work to make up poor performance during the semester, instead prepare well for each assignment beforehand.

Variations in grade distribution will always be considered by the instructor where called for by the performance in each individual class. A student does not have any 'right' to a certain grade, but is responsible for earning grades. The instructor has unfettered discretion to evaluate student performance and assign all grades.

To avoid any possible problems with academic integrity (for more information read the section academic integrity) make sure that the work is done by your group. Everyone in a group is responsible for submitted group work.

In a situation where you believe there is a mistake in grading, you need to contact the grader within one week of receiving the grade. Requests beyond this one-week period will not be considered.

ASSIGNMENTS:

Participation (2 x 50 points)
One of the objectives of this course is to develop an ability to analyze business opportunities and their risks. Passive listening is not effective in developing analytical thinking skills, and therefore, class participation (preparation, curiosity and relevance) is critical. You need to learn to communicate your thoughts effectively, and the classroom is a benign place to participate and practice this. Particularly important, is the participation during the cases that are solved in-class. The following rubric is applied for the participation:

- 50 points: student is engaged for the entire class and offers good insights (or one excellent insight), asks helpful questions, builds on other students' or the instructor's comments, e.g., by elaborating or offering counterpoints, or gives good examples.
- 25 points: student is engaged during the class but does not participate verbally beyond simple questions.
- 0 points: student is absent.

If you come to the class but do not participate, the maximum grade obtainable, but not automatically assigned, is 25 points, so come well prepared. The overall participation score is calculated accounting for only the best four lecture participation scores. For example, if your participation points in the end are from the 7 classes: 0, 25, 25, 50, 25, 25, 50 you would receive full 100=50+50 points from participation, since only the best two participation scores matter.

List of team members (Required)
You should organize yourselves in teams of 3 to 4 students for the workshops.

The names of the team members need to be submitted via blackboard link (under Assignment submission). Select one person from the group who does this.

Team charter (Required)
Once you have formed the group for the workshop, you need to develop together roughly one-page long team charter. The purpose of the team charter is to set rules for communication and working as a team. It should encourage good behavior and discourage poor behavior. It should be specific enough to allow solve possible problems that may arise in the teamwork.

Completed team charters need to be submitted via blackboard link (under Assignment submission). Select one person from the group who does this.

Workshop report (400 points)

You will have the opportunity to apply the frameworks and tools introduced during the asynchronous learning material. In the workshop, you will be presented with a practical business problem. You will be provided a workshop guide to help you to conduct the analysis. Based on the workshop results, you need to prepare a report and interpret and present the results answering to the questions included in the workshop guide. You are expected to work in teams of 3 to 4 that you organized yourselves in the beginning of the course.

A short workshop report (of about 3 pages plus appendices of any length) that highlights your results is to be turned in via blackboard's assignment section. The cut-off time on due dates follows the beginning of the next synchronous session. Late submission will result in a 20% penalty of any given grade and an additional penalty of 10% per integer day including weekend and holidays. To ease the grading of the report, you should include first the number of the question and then the answer for that question. Regarding the format, 1.5 line spacing and font size 12 is preferred.

Workshop report needs to be submitted via blackboard link (under Assignment submission). Select one person from the group who does this.

Homework (150 points)
You will complete the homework individually. The homework requires formulating an optimization problem, coding the formulation using Python and Gurobi, and reporting the optimal solution.

The completed homework needs to be submitted via blackboard link (under Assignment submission).

Final Exam (350 points)
You will complete individually final exam that is administered in-class at the scheduled time. You can bring to the exam a one A4 size notes page. The exam includes materials covered during the entire seven weeks. The exam consists of multiple-choice questions, short answer questions, and calculation questions. To best prepare for the exam, make sure you understand all aspects of the covered material.

The final exam can be deferred only in case of a medical emergency or due to attending a funeral of your parent, spouse, sibling, or child. If one of these cases apply, please contact the professor as soon as possible and provide appropriate documentation.

Extra credit: feedback survey (15 extra points)
Around the last week of the course, you will have a chance to provide course feedback. You will receive a separate e-mail with a link to the feedback webpage. I value and use these responses to develop the course further. Even if you do not have specific comments due to being satisfied about the course, I appreciate to hear that, too. To give you an additional incentive to provide feedback, I will grant everybody 15 additional points if at least 70% of students taking the course have provided feedback.

Resource Usage in Workshop Report and Homework
The use of following resources are prohibited or permitted as indicated. Where indicated, you may use the resource, and doing so requires proper citation. If you have questions about other resources, please

don't hesitate to contact me. If the resource is not listed under "permitted" or "permitted with citation," you should assume it's prohibited unless you receive notice otherwise from me. If I detect you used prohibited resources or failed to cite appropriately, I will address that matter as described in our University's Code of Academic Integrity. Questions about that process should be directed to Student Rights & Responsibilities.

Resource	Permitted	Permitted with Citation	Prohibited
Chegg, Course Hero, Quizlet, and similar sites focused on academic assessments.			X
Classmates in your assigned group. **ONLY IN WORKSHOP REPORT. NOT IN INDIVIDUAL HOMEHORK!**	X		
Classmates, including via GroupMe or other shared conversations.			X
Classmates in other groups, not your own.			X
Course materials on Blackboard.	X		
Course materials not on Blackboard.		X	
Gelman Library Research Services.		X	
Google translate, other translation services and tools, or other tools of "artificial intelligence".		X	
GW Writing Center	X		
Material from outside of this course (e.g., library books, notes from other courses, online material, Wikipedia, YouTube).		X	
Material from students formerly enrolled in the course (academic integrity violation for all students involved).			X
Notes taken in course meetings (including office hours).	X		
Other people (not classmates as noted above).			X
Recorded lectures (from this class, if recording was done or permitted by instructor).	X		
Recorded lectures, talks, podcasts, videos (from a source other than this class).	X		
A tutor from GW's Academic Commons or elsewhere at GW.		X	

A tutor not affiliated with a GW service.			X
All other resources not specified, unless you receive direction otherwise from the course instructors.			X
Copying (including and pasting) text or answers from a resource without citation or if that resource is prohibited.			X

COURSE SCHEDULE

The weekly schedule is provided in the table below.

Session 1: Introduction and Linear Programming I

Frameworks & concepts covered

- Introduction to optimization
- Introduction to Linear Programming (LP)
- Solving LP problems graphically

Recommended before-class reading

- Chapters 1-2 from Ragsdale's book

Session 2: Linear Programming II

Frameworks & concepts covered

- Solving LPs systematically using simplex algorithm
- LP problem manipulations
- Solving LP problems using Excel's linear programming tools and interpreting results
- Duality and sensitivity analysis

Recommended before-class reading

- Chapters 3-4 from Ragsdale's book

Session 3: Linear Programming III

Frameworks & concepts covered

- Case: "Red Brand Canners"
- Analyzing trade-offs among resource allocation alternatives

Preparation before-class

- Read Red Brand Canners case carefully and try to solve it

Session 4: Linear Programming IV

Frameworks & concepts covered

- Linear programming workshop using Microsoft Excel's linear programming tools

After-class work

- Complete any remaining workshop assignments and write and submit the workshop report

Session 5: Linear Programming V

Frameworks & concepts covered

- Review of workshop solution
- Linear programming using Python and Gurobi

Before-class reading

- "Installation of Python and Gurobi"
- "Sensitivity analysis with Gurobi and Python"

Preparation before-class

- Install Python and Gurobi
- Complete and turn in workshop report

Session 6: Multiobjective Optimization

Frameworks & concepts covered

- Trade-offs, efficient frontier
- Preemptive optimization
- Goal programming
- Weighted-sum of objectives approach

Recommended before-class reading

- Chapter 7 from Ragsdale's book

Preparation before-class

- Try to solve the assignment on blackboard using Python and Gurobi

Session 7: Optimization in Network

Frameworks & concepts covered

- General network flow problems
- Transportation and assignment models
- Shortest path and travelling salesman problems

Recommended before-class reading

- Chapter 5 from Ragsdale's book

Preparation before-class

- Try to solve the assignment on blackboard
- Complete and turn in homework

GENERAL REGULATIONS AND POLICIES

Changes for Syllabus

This syllabus represents the best possible plan at this time. The instructor reserves the right to make revisions to any item on this syllabus, including, but not limited to, any class policy, the course outline and schedule, examination schedule, grading policy, required assessments, etc.

Cell phones and electronic equipment

As a courtesy please turn off all cell phones, etc. You may quietly use electronic devices (e.g. laptops, etc.) for taking notes as long as it does not provide a distraction from the class lecture or discussion.

Incomplete Grades

At the option of the instructor, an Incomplete may be given for a course if a student, for reasons beyond the student's control, is unable to complete the work of the course, and if the instructor is informed of, and approves, such reasons before the date when grades must be reported. An Incomplete can only be granted if the student's prior performance and class attendance in the course have been satisfactory. Any

failure to complete the work of a course that is not satisfactorily explained to the instructor before the date when grades must be turned in will be graded F, Failure.

If acceptable reasons are later presented to the instructor, the instructor may initiate a grade change to the symbol I, Incomplete. The work must be completed within the designated time period agreed upon by the instructor, student, and school, but no more than one calendar year from the end of the semester in which the course was taken. To record the exact expectations, conditions, and deadlines of the Incomplete please use the Elliott School's Incomplete Grade Contract:

http://go.gwu.edu/incompletecontractgraduate

The completed and signed contract is to be submitted to the Academic Affairs and Student Services Office. All students who receive an Incomplete must maintain active student status during the subsequent semester(s) in which the work of the course is being completed. If not registered in other classes during this period, the student must register for continuous enrollment status. For more information regarding Incompletes please review the relevant sections in the University Bulletin:

http://bulletin.gwu.edu/universityregulations/#Incompletes

Instructor Response Time
I will do my best to respond to emails within 24 hours on weekdays and on the next business day over weekends and holidays. Similarly, you should expect to receive your grade from an assignment within one week of its due date.

Differences in time Zone
All the times in this Blackboard course correspond to the U.S. Eastern Time zone (e.g., Washington, DC). It is your responsibility to convert these times to the time zone of your location so that you can meet this course's deadlines.

Inclement Weather
Please note that online courses at the George Washington University will continue to be held even when the University is closed for inclement weather.

GW Acceptable Use for Computing Systems and Services
All members of the George Washington University must read and comply with the Acceptable Use Policy when accessing and using computing systems and services, including email and Blackboard. Please read the Acceptable Use Policy to familiarize yourself with how GW information systems are to be used ethically.

Netiquette
Please observe the following rules of netiquette for communicating online:

- Remain professional, respectful, and courteous at all times.
- Remember that a real human being wrote each post and will read what you write in response. It is easy to misinterpret discussion posts. Let's give the benefit of the doubt.

- If you have a strong opinion on a topic, it is acceptable to express it as long as it is not phrased as an attack. Please be gracious with differing opinions.
- When upset, wait a day or two prior to posting. Messages posted (or emailed) in anger are often regretted later.
- Proofread and use the spell check tool when you type a post. It makes the post easier to read and helps your readers understand what you are saying.

I reserve the right to delete any post that is deemed inappropriate for the discussion forum, blog, or wiki without prior notification to the student. This includes any post containing language that is offensive, rude, profane, racist, or hateful. Posts that are seriously off-topic or serve no purpose other than to vent frustration will also be removed.

Academic Integrity
Academic dishonesty is defined as cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and the fabrication of information.

Please review GW's policy on academic integrity, located at https://studentconduct.gwu.edu/code-academic-integrity. All graded work must be completed in accordance with the George Washington University Code of Academic Integrity. For more information see Academic Dishonesty Prevention.

Sharing of Course Content
Unauthorized downloading, distributing, or sharing of any part of a recorded lecture or course materials, as well as using provided information for purposes other than the student's own learning may be deemed a violation of GW's Student Conduct Code.

Use of Student Work (FERPA)
The professor will use academic work that you complete during this semester for educational purposes in this course during this semester. Your registration and continued enrollment constitute your consent.

Copyright Policy Statement
Materials used in connection with this course may be subject to copyright protection under Title 17 of the United States Code. Under certain Fair Use circumstances specified by law, copies may be made for private study, scholarship, or research. Electronic copies should not be shared with unauthorized users. If a user fails to comply with Fair Use restrictions, he/she may be liable for copyright infringement. For more information, including Fair Use guidelines, see Libraries and Academic Innovations Copyright page.

Disability Support Services & Accessibility
If you may need disability accommodations based on the potential impact of a disability, please register with Disability Support Services (DSS) at disabilitysupport.gwu.edu/registration. If you have questions about disability accommodations, contact DSS at 202-994-8250 or dss@gwu.edu or visit them in person in Rome Hall, Suite 102. For additional information see: disabilitysupport.gwu.edu

For information about how the course technology is accessible to all learners, see the following resources:

Blackboard accessibility

Kaltura (video platform) accessibility

Religious Observances
In accordance with University policy, students should notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. For details and policy, see: registrar.gwu.edu/university-policies#holidays

Mental Health Services
The University's Mental Health Services offers 24/7 assistance and referral to address students' personal, social, career, and study skills problems. Services for students include: crisis and emergency mental health consultations confidential assessment, counseling services (individual and small group), and referrals. For additional information call 202-994-5300 or see: counselingcenter.gwu.edu/

Emergency Preparedness and Response Procedures
The University has asked all faculty to inform students of these procedures, prepared by the GW Office of Public Safety and Emergency Management in collaboration with the Office of the Executive Vice President for Academic Affairs.

To Report an Emergency or Suspicious Activity
Call the University Police Department at 202-994-6111 (Foggy Bottom) or 202-242-6111 (Mount Vernon).

Shelter in Place – General Guidance
Although it is unlikely that we will ever need to shelter in place, it is helpful to know what to do just in case. No matter where you are, the basic steps of shelter in place will generally remain the same.

- If you are inside, stay where you are unless the building you are in is affected. If it is affected, you should evacuate. If you are outdoors, proceed into the closest building or follow instructions from emergency personnel on the scene.
- Locate an interior room to shelter inside. If possible, it should be above ground level and have the fewest number of windows. If sheltering in a room with windows, move away from the windows. If there is a large group of people inside a particular building, several rooms may be necessary.
- Shut and lock all windows (for a tighter seal) and close exterior doors.
- Turn off air conditioners, heaters, and fans. Close vents to ventilation systems as you are able. (University staff will turn off ventilation systems as quickly as possible).
- Make a list of the people with you and ask someone to call the list in to UPD so they know where you are sheltering and who is with you. If only students are present, one of the students should call in the list.
- Await further instructions. If possible, visit GW Campus Advisories for incident updates or call the GW Information Line 202-994-5050.
- Make yourself comfortable and look after one other. You will get word as soon as it is safe to come out.

Evacuation

An evacuation will be considered if the building we are in is affected or we must move to a location of greater safety. We will always evacuate if the fire alarm sounds. In the event of an evacuation, please gather your personal belongings quickly (purse, keys, GWorld card, etc.) and proceed to the nearest exit. Every classroom has a map at the door designating both the shortest egress and an alternate egress. Anyone who is physically unable to walk down the stairs should wait in the stairwell, behind the closed doors. Firemen will check the stairwells upon entering the building.

Once you have evacuated the building, proceed to our primary rendezvous location: the court yard area between the GW Hospital and Ross Hall. In the event that this location is unavailable, we will meet on the ground level of the Visitors Parking Garage (I Street entrance, at 22nd Street). From our rendezvous location, we will await instructions to re-enter the School.

Alert DC
Alert DC provides free notification by e-mail or text message during an emergency. Visit GW Campus Advisories for a link and instructions on how to sign up for alerts pertaining to GW. If you receive an Alert DC notification during class, you are encouraged to share the information immediately.

GW Alert
GW Alert provides popup notification to desktop and laptop computers during an emergency. In the event that we receive an alert to the computer in our classroom, we will follow the instructions given. You are also encouraged to download this application to your personal computer. Visit GW Campus Advisories to learn how.

Additional Information
Additional information about emergency preparedness and response at GW or the University's operating status can be found on GW Campus Advisories or by calling the GW Information Line at 202-994-5050.