

# DECISION ANALYTICS FOR BUSINESS AND POLICY

Fall 2020

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<b>Instructor:</b>	Peter Zhang	<b>Time:</b>	MW 15:20 – 16:40 Eastern Time
<b>Email:</b>	<a href="mailto:pyzhang@cmu.edu">pyzhang@cmu.edu</a>	<b>Place:</b>	HBH 1202 or Zoom.

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*Last Updated: November 11, 2020*

## Course Pages:

1. Canvas: [Link](#)
2. Zoom Lecture: [Link](#)

## Teaching Assistants:

- TBA

## Office Hours:

- TBA

**Main References:** Most reading materials will be provided during the course. You may find the following optional textbooks useful.

- Hillier and Lieberman, *Introduction to Operations Research*, McGraw-Hill, 2015.
- Cohon, *Multiobjective Programming and Planning*, Dover Publications, 2003.

**Summary:** This course introduces modeling frameworks and computational tools to address complex, ill-defined, and large-scale decision-making problems that arise in policy and business. Through lectures and case studies, it covers advanced methods of decision-making under uncertainty: (large-scale) deterministic optimization, stochastic/robust optimization, sequential decision-making, and simulation. It will focus on modeling (how to formulate models to address policy or business problems), computation (how to solve large-scale problems), and applications in policy and business (how to integrate viewpoints of different stakeholders, how to select the scope of the model, etc.). Applications are drawn from a variety of real-world settings in transportation, energy, information systems, health care, supply chain management, etc. Participants are expected to take “active learning” roles in the computational application of the materials presented in class using the python programming language and the Gurobi optimization solver. A term project simulates realistic and challenging issues where new solutions need to be developed, implemented and communicated.

**Prerequisites:** The prerequisite is an introductory course in Operations Research, such as Management Science I and II or Decision-Making under Uncertainty, as well as maturity in programming and mathematics.

**Grading Policy:** Homework (40% = 5% × 8), Reading (30% = 3% × 10), Project (30%).

We will replace two of your lowest grades homework assignments with two of your highest grades. In particular, this implies that you can submit 6 out of 8 assignments without incurring any penalty. Otherwise, for any late submissions to be considered for grading, they need to be accompanied by an official written petition with proper supporting documents.

### Tentative Outline:

Week 1 .....	Introduction, Math Boot Camp
Weeks 2-5 .....	Deterministic Optimization
Weeks 6-8 .....	Optimization Under Uncertainty
Weeks 9-10 .....	Simulation
Weeks 11-13 .....	Advanced Topics
Weeks 14 .....	Project Presentations

**Learning Objectives:** By the end of this course, you should be able to design end-to-end decision analytics pipelines, by ...

1. identifying components of decision problems that are (not) susceptible to analytical modeling, and selecting the appropriate tools (e.g., simulation, optimization),
2. translating decision problems to logical, mathematical formulations, and clearly identifying the objectives, decision variables, constraints, input/output,
3. translating these mathematical formulations into code (Python), and
4. applying findings back to the decision problem context in business and policy through written and verbal communication.

**Format of Instructions:** We do not require in-person attendance in this course. We do expect you to make every effort to attend the Zoom sessions. **Please send an email to the TAs about your initial decision to attend the class remotely vs in person, by the end of the first week.** You can switch later, but this helps us plan accordingly in the beginning. We may sometimes flip the class by asking you to study via pre-recorded videos before coming to class, and participate in (virtual) group discussions during lecture time.

**Zoom Etiquette:** Please make sure that your internet connection and equipment are set up to use Zoom and able to share audio and video during class meetings. (See [this page](#) from Computing Resources for information on the technology you are likely to need.) Let me know if there is a gap in your technology set-up ([pyzhang@cmu.edu](mailto:pyzhang@cmu.edu)) as soon as possible, and we can see about finding solutions.

*Sharing video:* In this course, being able to see one another helps to facilitate a better learning environment and promote more engaging discussions. Therefore, our default will be to expect students to have their cameras on during lectures and discussions. However, I also completely understand there may be reasons students would not want to have their cameras on. If you have any concerns about sharing your video, please email me as soon as possible ([pyzhang@cmu.edu](mailto:pyzhang@cmu.edu)) and we can discuss possible adjustments. Note: You may use a background image in your video if you wish; just check in advance that this works with your device(s) and internet bandwidth.

- During our class meetings, please keep your mic muted unless you are sharing with the class or your breakout group.
- If you have a question or want to answer a question, please use the chat or the “raise hand” feature (available when the participant list is pulled up). I or a TA will be monitoring these channels in order to call on students to contribute.

Table 1: Detailed Course Schedule (Subject to Change)

	Lecture	Homework	Reading	Project
1	Introduction to Operations Research			
2	Math Boot Camp		R1 due	
3	Analytical Approaches	HW1 due		
4	Linear Programming		R2 due	
5	Linear Programming			
6	Integer Programming		R3 due	
7	Integer Programming	HW2 due		
8	Duality		R4 due	
9	Duality	HW3 due		
10	Multiobjective Programming		R5 due	
11	Guest Lecture: Shared Transportation	HW4 due		
12	Optimization Under Uncertainty		R6 due	
13	Optimization Under Uncertainty	HW5 due		
14	Case Study: Supply Chain Risk		R7 due	
15	Case Study: School Bus Transportation	HW6 due		
16	Discussion: Project		R8 due	Project release
17	Case Study: Supply & Demand during Pandemic			
18	Simulation: Epidemic Models			Team selection
19	Simulation: Epidemic Models			
20	Queueing		R9 due	
21	Queueing	HW7 due		
22	Dynamic Decision Making		R10 due	Proposal due
23	Dynamic Decision Making			
24	Dynamic Decision Making	HW8 due		
25	Dynamic Decision Making			
26	Project Wrapup			
27	Project Wrapup			
28	Project Wrapup			Final report due

- Our synchronous meetings will involve breakout room discussions, and those will work better if everyone in your small group has their camera turned on.

**In-Person Class Policy:** If you decide to attend classes in person (again this is not required), I expect that you will abide by all behaviors indicated in “[A Tartan’s Responsibility](#)”, including any timely updates based on the current conditions. In terms of specific expectations for in-person students, this includes:

- entering the classroom via the designated ingress route with appropriate physical distancing,
- wearing a facial covering throughout class,
- sitting in the seats with appropriate spacing (and not moving furniture),
- using the sanitizing wipes available in the classroom to wipe surfaces (e.g., your desk, tablet arm) upon entry and exit,
- exit the classroom at my direction, proceeding in a row-by-row fashion, following the designated egress route and maintaining proper distancing.

*Facial coverings:* If you do not wear a facial covering to class, I will ask you to put one on (and if you don’t have one with you, I will direct you to a distribution location on campus). If you do not comply, please remember that you will be subject to student conduct proceedings, up to and including removal from CMU. Accordingly, I will be obliged to take other measures for the safety of the whole class.

**Remote Instruction Policy:** If the class needs to go fully remote, you will receive an email from me and an announcement will be published on our course website on [Canvas](#). During the semester, we will use the same Zoom room, here is a copy of the [link](#).

**Special Needs:** If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will be happy to discuss your specific needs privately and to work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

**Academic Honesty:** Honesty and transparency are important features of good scholarship. The rules and the academic integrity standards outlined in your student handbook will be strictly enforced. Violations are considered a fundamental breach of trust and will result in failure of the course. Homework computations and reports must be prepared individually, or with a partner following the guidelines detailed above. Demonstrated evidence of copying (same presentation, same pieces of code, same wording of sentences, etc.) will result in zeros for each paper with this evidence.

**Your Well-Being:** This semester is like no others, and this makes it especially important for you to take care of yourself during the semester. Always pay close attention to and keep an open mind about your physical and mental well-being.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at <http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:

CaPS: 412-268-2922

Re:solve Crisis Network: 888-796-8226

If the situation is life threatening, call the police

On campus: CMU Police 412-268-2323

Off campus: 911

We hope you have a productive and safe semester!