IE8930 Optimization under Uncertainty Tuesdays/Thursdays 9:30am - 10:45am
Hybrid Online + In Person

Instructor: Dr. Yongjia Song, **Email: yongjis@clemson.edu**

- Office Hours: By appointment on Zoom.

Course modality: Online: synchronous Zoom conferences

- Lecture slides will be provided before each session, lecture recordings will be provided after each session.
- Links to Zoom lectures and office hours will be provided on Canvas from tab "Zoom". Login information will be provided via course announcements.
- In person arrangement: TBD.

Online learning resources:

1. For general guideline, refer to: `https://ccit.clemson.edu/working-remotely`
2. Zoom virtual lecture instructions:
   - To ensure the smoothness of the Zoom conference, **please make sure that your video is turned off and you are muted.**
   - Please use the **chat window for questions** at any time.
   - If you have a question that you would like to ask in words rather than putting into the chat window, do not interrupt the lecture by speaking directly. **Use the "raise hand"** option on Zoom before asking a question. I will unmute you and then you may ask the question in words.
   - I will stay on Zoom for 5 mins after each lecture (and will stop recording), in case you have any immediate questions.
   - The online lecture recordings and the chat history will be shared with everyone on Canvas after each online lecture.
   - In case of any technical difficulty that would prevent the Zoom lecture to continue smoothly, I will cancel the online Zoom lecture immediately and provide pre-recorded lecture materials on Canvas instead.

Reference books:

- Introduction to Stochastic Programming, 2nd edition, by J. Birge and F. Louveaux (Nice and easy)
- Stochastic Programming, 2nd edition, by P. Kall and S. Wallace. Available online at: `http://www.csee.wvu.edu/~xinl/library/books/stochastic_programming.pdf` (Pretty decent)
- Reinforcement Learning and Stochastic Optimization `https://castlelab.princeton.edu/wp-content/uploads/2020/01/Powell-RLSO-Jan202020.pdf` (Very broad range of topics)

- Lectures on Stochastic Programming: Modeling and Theory, Second Edition, by A. Shapiro, D. Dentcheva and A. Ruszczynski. (Very theoretical, requires very advanced math background).
- Robust optimization, by A. BenTal et. al., can be found at `http://www2.isye.gatech.edu/~nemirovs/FullBookDec11.pdf`. (Will use this one occasionally)

Main software: Python + Gurobi

- Python (highly recommended with extra credits): a modern, versatile, and powerful programming language. We will use an interactive coding environment made possible by **Anaconda**.
- We will use a powerful optimization solver called **Gurobi**.
- Instructions on how to install Anaconda and Gurobi are provided on Canvas.

Prerequisite: Consent of the instructor.

Catalog description: Selected topics in industrial engineering emphasizing new developments in systems science, systems analysis and operations research.

Course objectives: This course will address basic models and algorithms for stochastic programming (optimization). Stochastic programming is a popular optimization tool that integrates statistics and operations research. Students are expected to have certain math background: basic calculus, basic linear algebra, and some mathematical analysis ability. Basic knowledge in optimization: linear programming, mathematical modeling. Basic knowledge in statistics: basic probability, statistical tests. Basic knowledge in a general purpose programming language is preferred, but not required. After the course, students are expected to understand and apply stochastic optimization tools:

- How to create a stochastic programming model using the given information (data, probability distribution, decision makers' risk tolerance, etc)
- How to solve the stochastic programming model using optimization solvers (e.g., through Python)
- How to perform statistical analysis on solutions of stochastic programs

Course Topics:

- Part 1: Modeling uncertainty in optimization: stochastic programs and robust optimization
- Part 2: Solution methods for:
  - Robust optimization
  - Two-stage stochastic programs with recourse
  - Two-stage robust optimization
  - Multi-stage stochastic programs
  - Risk averse and chance-constrained programs
- Part 3: An approximate dynamic programming perspective on stochastic programming
- Part 4: Data-driven distributionally robust stochastic programs

Grading Policy The grade is distributed into the following sections:

- Homework: 30%
- Mid-term: 30%
- Final Project: 30% (Topic of your own choice, or assigned by the instructor)
- Participation: 10%

Homework assignments:

- All assignments are due when class begins on the assigned due date.
- You have **FIVE FREE late days** for delayed assignment submission for the entire semester (allocate them in an optimal way!) After that, 20% of the grade will be taken off for each day delayed.
- No assignments will be accepted if more than FIVE days overdue, regardless if you apply free days or not.
- All coding assignments will be submitted through Canvas.

Grading scale:

- A: $\geq$90
- A-: 86.7-89.9
- B+: 83.4-86.6
- B: 80-83.3
- B-: 76.7-79.9
- C+: 73.4-76.6
- C: 70-73.3
- F: $<$70

Other policies:

1. Waiting: Students must wait 10 minutes before leaving the Zoom room or classroom if I am late.
2. Attendance: I will not take attendance. However, if you miss a class you are responsible to make sure that you are aware of what was discussed in class.
3. Disability: Students with disabilities needing accommodations should contact the Office of Student Disability Services in Suite 239, Academic Success Center building 864-656-6848, to discuss specific needs within the first month of classes.

4. Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The policy is located at `http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html`. Alesia Smith serves as Clemson's Title IX Coordinator and may be reached at alesias@clemson.edu or (864) 656-3181.

5. Integrity: "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity." (`http://gradspace.editme.com/AcademicGrievancePolicyandProcedures#integritypolicy`)

This syllabus is subject to change at any time at the discretion of the instructor.