

**Course:** Simulation Modeling and Analysis (IEOR 3404)

**Semester:** Spring 2019

**Lectures:** Tuesdays/Thursdays 2:40-3:55 pm, 451 CS Building

**Recitations:** TBD

**Instructor:** Yi Zhang

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**Office Hour:** 3:45-5:15 pm Fridays

344 Mudd Building

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**Office Hour:** 2:30-4:00 pm Wednesdays

**Office Hour:** 2:30-4:00 pm Mondays

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**Learning Objectives:** Simulation is a broad term related to the generalization, modeling, and analysis of real-world processes or systems with the help of statistics theories and computer programming. Simulation is widely applied both academically and managerially. Decision-makers rely on simulation especially when it is costly (or even impossible) to implement and analyze a real-world system.

This course will delve deep into different simulation techniques with a focus on the application in operation research and financial engineering. We will first introduce simulating random variables from different distributions. We will then discuss how to simulate some important real-world processes (e.g. Poisson process and Geometric Brownian process) and systems (e.g. queueing system, inventory system, repairment system, and stock options). We will wrap up with introducing some important variance reduction and statistical validation techniques to ensure the efficiency and validity of the system simulation.

At the end of this course, you should be able to

1. Use different simulation techniques to generate variables from different distributions.
2. Construct and simulate different systems and analyze the system outputs.
3. Use variance reduction techniques to make the simulation more efficient.
4. Use statistical validation techniques to validate the simulation models.

**Course website:** We will be using CourseWorks to post lecture materials, homework assignments, and grades. Please check the updates on the course website periodically.

**Textbook:** *Simulation* by Sheldon M. Ross (5th edition), Elsevier Academic Press, New York, 2012.

The course will follow the textbook fairly closely, especially during the beginning of the semester. The electronic version of this textbook is free to download from [here](#). You will need your UNI and password to download the textbook. The physical version of the textbook is also available in the bookstores and through online vendors. You are highly advised to supplement the course materials by reading the textbook chapters.

**Software:** We will use Python for this course. The programming environment will be Google Colab.

**Prerequisites:** Understanding of basic probability theory and statistics at the level of IEOR 3658, IEOR 4150, or IEOR 4307. Knowledge of stochastic processes (e.g. IEOR 3106 and/or IEOR 4106) is helpful. Previous knowledge of programming is helpful.

**Tentative Course Schedule:**

- Review of statistics/ Introduction to Python . . . . . Week 1-2
- Random numbers and Monte-Carlo Integral . . . . . Week 3
- Simulation of discrete random variables . . . . . Week 3-4
- Simulation of continuous random variables . . . . .Week 5
- Discrete event simulation (Part 1) . . . . . Week 6 -7
- Mid-term Review and mid-term exam . . . . . Week 8
- **Spring Break** . . . . . Week 9
- Discrete event simulation (Part 2) . . . . . Week 10-11
- Continuous event simulation . . . . . Week 11-12
- Variance reduction technique . . . . . Week 12-14
- Statistical Validation . . . . .Week 14-15
- Final Review . . . . . Week 15

The schedule might be subject to change depending on our course progress and your interest.

**Grading Policy:** Homework (35%), Class Participation (5%), Midterm (25%), Final (35%).

Homework: We will have 8 homework assignments in total. You can collaborate on the homework assignments. However, you **MUST** finish the write-up independently. You can find tentative homework assignment post dates and due dates on CourseWorks.

Class Participation:

Every student is a valued member in this class. To ensure your contribution is rewarded, we assign 5% of the weight to class participation. When assigning class participation grades, we consider:

- Attendance: Regular attendance is important and expected.
- Pop-up quizzes: We will have 6 pop-up quizzes. You are required to answer at least 4 of the quizzes. You will get full credit for each quiz as long as enough effort is shown in answering the questions.
- Class contribution: You are expected to actively contribute to a positive learning process, which includes but not limited to actively participate in class and Piazza discussions and sharing your ideas related to the course.

Exams: We will have two exams. The exams will be computer-based and conducted in the Google Colab environment. It will be open book and open notes. You are required to finish the questions independently.

The letter grade will be assigned based on the curve. When assigning the letter grade, we will consider both your standing among your peers and also the class performance as a whole.

**Late Policy:** The deadlines for all the homework assignments are at midnight. In addition, I will give each person a leeway of 1 hour for each assignment. After the leeway, the submissions will receive a 0. However, the lowest homework grade will be dropped.

**Re-grading Policy:** If there is any question regarding the grading of homework, please contact the instructor within seven days upon receiving your grades and comments. Since I will be posting the solution to each homework assignment, you are expected to compare the solution with your own write-up before sending the request. In your request, you should explain the reasoning for any suspected mistakes in grading.

**Discussion Board:** We highly encourage you to use Piazza to ask and answer questions. The goal is to make Pizza a collaborative space for learning and communicating. We will also periodically answer questions and manage the content there. Please do not post content directly related to the solution of the assignment questions.

We welcome you to drop by the office hours with any questions you have related to the course. We are also happy to schedule separate meetings outside our office hours.

Also, please always feel free to drop us e-mails. For the e-mails, please expect a reply within 24 hours.

If you fail to receive a reply within 48 hours, please send us a reminder.

**Important Dates:**

Midterm . . . . . March 14, 2019 (in class)

Final Exam . . . . . To be scheduled by the university

The final exam schedule will be arranged by the Office of the University Registrar and can be found [here](#). We will also make an announcement when the schedule is published. **Please do not make any travel plans before the announcement of the final exam schedule.** According to the [university policy](#), "Examinations are not rescheduled to accommodate travel plans."

**Laptop Policy:** You are required to bring your laptop to every class. We will be doing some in-class exercise on the laptop. You are also welcome to use the laptop for tasks related to the course materials, such as taking notes and reading the textbook.

**Academic Honesty:** I highly encourage a collaborative environment. You are encouraged to help each other in the learning process. Students are also highly encouraged to come to the instructor/TA for help. However, your homework assignments and quizzes must entirely be your own write-up. Sharing homework solution files and copy other's work is strictly prohibited and will receive different levels of penalty depending on the severity of the case.

For the exams, you need to finish the questions by yourself. No discussion or collaboration is allowed. The derivations, simulation analysis, and descriptions cannot be copied from another person or from any other source. Submissions where these details are identical or nearly identical, either among peers or with another source, will be regarded as cheating. The sanctions may range up to the termination of your enrollment at Columbia University. All suspected incidents will be recorded with SEAS administration at the same time the student is notified.

**Stay Healthy:** Studying at Columbia University can be competitive and stressful. We are here to make sure everyone stays healthy physically and mentally. If you have any help with your work or life, please do not hesitate to approach us. We are always here to help. In addition, please do not hesitate to use Columbia [Counseling and Psychological Services](#) for anonymous consultation.