ISyE 4602 Foundations of Modern Data Science

Spring, 2027

Day and Time

Mondays and Wednesdays 9:30 – 10:45 AM

Instructor and email

Ashwin Pananjady (ashwinpm@gatech.edu)

Prerequisite

(ISYE 3030 OR ISYE 3070) AND ISYE 3133 AND CS1301

Course Description

This course for advanced undergraduates develops the (mathematical) foundations of data science, developing the pillars of modern machine learning and AI. It will introduce students to the life-cycle of data-driven decision-making based on principles of probabilistic modeling, optimization-based model-fitting, and statistical inference. Topics include: frequentist and Bayesian paradigms of data science, low-dimensional parameter estimation and confidence intervals, inference and uncertainty quantification in (linear and nonlinear) regression, high-dimensional models and fundamental limits of inference, high dimensional stochastic optimization problems, and (multiple) hypothesis testing. Time permitting, we will also cover some basic causal inference and robust data analysis algorithms. Our focus will be on looking under the hood of modern data science methodology: while there will be some exposure to implementing these methods on real data, our primary focus will be on understanding these methods and developing judgement for them.

Course Learning Outcomes

At the end of this course, the students will have learned:

1. How to recognize and justify a reasonable data generating process for a problem at hand,
2. Design principles for data analysis based on formulating and solving optimization problems,

3. How to think carefully and critically about modeling assumptions under which parametric and nonparametric methods are expected to work, and to understand the downstream goals of prediction and decision-making,
4. To have a qualitative and quantitative understanding of which method is more suitable given the various constraints (data/computation/flexibility) at hand.

Required Course Materials

None other than materials that will be posted on Canvas.

Grading Policy

Homeworks: 40%

In-class midterms: 30%

Final project: 25%

Participation: 5%

Grade cutoffs: A: 90+; B: 80-89; C: 70-79; D: 60-69

Description of Graded Components

There will be 5 homeworks in total. There is an additional (and optional) Homework 0 that counts as 3 bonus points towards the HW portion of the grade.

There are 2 in-class midterms in total.

In lieu of a final exam, we will have a project in which students study in depth a topic of their choosing related to the course. Students can form groups of upto 2, or work alone on this project. There will be several deliverables for the project over the course of the semester. The main deliverable is a report that is due on the date on which the final exam for this course would typically have been scheduled.

USG required Course Policies

Attendance and/or Participation

You are strongly encouraged to attend lectures and participate in discussion. Participation in discussion is worth 5% of the overall grade.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Please review Georgia Tech's Honor Code, the student Code of Conduct.

Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Core IMPACTS

Not applicable

Additional Georgia Tech Required Policies

Accommodation for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Collaborations, Group Work

You are allowed to work in groups on assignments, but any submission must be written on your own. The assignments are for learning so that you can demonstrate your understanding on the test without any assistance. Class tests and exams will be closed book and notes, with a short cheat sheet allowed.

Use of Generative AI

Limited Generative AI Use Permitted: Use of Generative AI (such as ChatGPT, Gemini, Claude, Microsoft Copilot, etc) for homework/course project is permitted in this course,

but strictly within instructor-approved boundaries. For this course, you can use Generative AI to assist with English writing in your solutions (e.g. grammar refinement) and coding assistance (e.g. checking correctness of already written code, or improving documentation of existing code). You *cannot* use generative AI to generate math solutions, or code from scratch, in this course.

Any use of Generative AI must be transparent and documented in a required AI Usage Statement with each submission. The statement must include:

- Tool used and date of access
- The input (prompt) you provided
- A copy of the output
- A description of how you used or edited the AI-generated content

Failure to follow these guidelines – including using Generative AI when it is not permitted or failing to disclose its use – may be considered a violation of Georgia Tech's academic integrity policies. When in doubt, always consult the instructor before using Generative AI.