Mathematical Foundations of Machine Learning

Course Information

- **Instructor:** Sara Fridovich-Keil (sfk@gatech.edu)
- **Course Prefix and Number:** ECE/ISYE/CS/CSE 7750
- **Term:** Fall 2026

Course Description

The purpose of this course is to provide first year PhD students in engineering and computing with a solid mathematical background for two of the pillars of modern machine learning, data science, and artificial intelligence: linear algebra and applied probability. *This is a foundational mathematical introduction to machine learning* and does not engage with applications of deep learning/large language models.

Course Learning Outcomes

Upon successful completion of the course, you will have learned:

1. The linear algebraic principles behind modeling function classes, with exposure to both finite and infinite dimensional modeling techniques.
2. The probabilistic principles based on which we can perform statistical estimation with our models given data.
3. Some basic principles that govern the design and analysis of optimization algorithms used to fit models to data.

The most important takeaway for some of you might be to recognize that these ideas can help in designing new, principled machine learning methodology, or conversely, to recognize the immense opportunity that exists to place several modern machine learning techniques on a rigorous footing.

Prerequisites

There are no formal prerequisites. However, I expect students to have exposure to basic linear algebra and probability, and have basic programming skills. Mathematical and proof-based arguments will be extensively used throughout the course. Having taken a rigorous, proof-based undergraduate course will prove very helpful. We will try our best to bring you up to speed with some of the prerequisites by using some auxiliary handouts, reviews during lecture, and optional Homework 0.

Required Course Materials

There is no required text. Extensive course notes will be provided. From time to time, I will point you to books, videos, and notes by others that are good resources for the material we are talking about.

Grading Policy

This course is graded on a letter grade basis (A>90; B>80; C>70; D>60). Grades will be calculated according to:
50% Homework
25% Midterm
25% Final

Attendance Policy

Active participation in the class discussions is expected. Lectures will *not* be recorded, so **I strongly recommend that you attend lecture in person to keep up with the class.** However, you will not be penalized for any excused absences (e.g., due to illnesses, religious observances, career fairs, job interviews, etc.). Extensive course notes will be provided. These can help you catch up on an occasional missed lecture; if you have further questions about a missed lecture, please come to office hours.

You have up to 5 late days for all homeworks throughout the semester. If you exhaust these late days, late submissions thereafter cannot be graded. **Exams will be completed during specified time frames. If you expect to miss an exam, please contact me as soon as you realize this so we can make alternative arrangements.**

Academic and Research Honesty/Integrity Statement

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. For information on Georgia Tech's Academic Honor Code, please visit www.catalog.gatech.edu/policies/honor-code. Any student suspected of cheating or plagiarizing 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. **Redistributing materials from this course and/or using external sites for assistance (e.g., contributing to test banks, CourseHero, Chegg, or similar sites) is prohibited.**

Collaboration and group work
Students are *strongly* encouraged to discuss homework problems with one another. However, **each student must write up and turn in their own solutions written in their own words**. **Cases where solutions appear to be identical or nearly identical will be immediately referred to the Office of Student Integrity.**

AI Use Policy: Limited Generative AI Use Permitted
Use of Generative AI (such as Microsoft Copilot) for homework 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.**

Core IMPACTS

Not applicable.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services 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. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, we encourage you to remain committed to the ideals of Georgia Tech while in this class. See www.catalog.gatech.edu/rules/22 for an articulation of some basic expectation that you can have of us and that we have of you.