MATH 300 – Fall 2025
Mathematics of Data Science

General Information

Please note:

1. The information in this syllabus is subject to change at any point in the semester, as deemed necessary by the instructor.[1] Any changes will be communicated to the students both in class and via email in a timely fashion. For the latest version of this document, please check the course page on Canvas or on class webpage.
2. This course introduces the mathematical theory behind popular machine learning algorithms and the computational methods and tools used to implement these algorithms efficiently. By the end of this course, students should be able to:
   - Select appropriate data types when performing computations.
   - Learn how to visualize data.
   - Evaluate the performance of a machine learning algorithm.
   - Select a suitable machine learning algorithm for a given task.
   - Implement machine learning models efficiently on a computer.
   - Be familiar with popular machine learning packages such as scikit-learn, PyTorch, and JAX.
3. **Important:** the use of large language models (LLMs) is allowed for homework and the course project. However, you are fully responsible for the work you submit. You must be able to explain, justify, and recreate your work without assistance.
4. The prerequisites are CS 170 or MA 170, MATH 221, and MATH 210/211. MA 315 is recommended. Contact the course instructor if you have any questions.

- **Instructor:** Tianshi Xu <tianshi.xu@emory.edu>.
- **Class Schedule:** TTh 4:00 – 5:15 PM, White Hall 110 (all times in Atlanta, GA).
- **Instruction Method:** In person, unless there are special circumstances.
- **Office Hours:** TTh 5:30 – 6:30 PM, MSC N436.

[1] Last Updated: December 29, 2025

Materials and Tools

- **Canvas Page:** Course announcements, Python notebooks, assignments, and submission links will be posted on Canvas: https://canvas.emory.edu. It is your responsibility to visit the website periodically.
- **Textbook:** The Python notebooks will be posted before class on Canvas. The following books are good references for Python programming and machine learning:
  - Python Data Science Handbook
  - Probabilistic Machine Learning: An Introduction
  - Probabilistic Machine Learning: Advanced Topics
- **Lecture Notes:** Python notebooks and other supplemental notes will be posted on Canvas.
- **Tech Requirements:** It is recommended that you have access to the following equipment:
  - A computer with reliable internet access. You should be able to access the Canvas site.
  - A scanner or smartphone for taking photos to upload online.

Grading Information

- **Grade Distribution:**

Homework	25 %
In-class Quiz	25 %
Midterm Exams	30 %
Final Project	20 %
Total	100 %

- **Grading Scale:** Your final grade will be decided based on the following scale:

		B+:	[87,90)	C+:	[77,80)	D+:	[67,70)		
A:	[93,100]	B:	[83,87)	C:	[73,77)	D:	[60,67)	F:	[0,60]
A-:	[90,93)	B-:	[80,83)	C-:	[70,73)				

The class may be curved at the end at the discretion of the instructor. However, your final course grade will be no worse than your actual grade. That is, we will never "curve down". In addition, each exam may be "curved up". As a result, the course grade will not be rounded up. For example, a course grade of 92.99% is strictly 92.99% (and hence an A-).

- **Honor Code:** Students are required to follow the Emory University Honor Code throughout the semester. Details can be found at Emory Honor Code.
- **Attendance:** Attendance is not required but strongly recommended. Please maintain a respectful and professional demeanor if you come to class.
- **Homework:** You will have roughly one homework assignment every two weeks. The assignments will be posted on and submitted through Canvas. You may ask the course instructor and classmates questions about the homework, but **your homework must be your work**. To accommodate late submissions, we have a policy that allows for late assignments with a deduction of 15% per day, for up to two days. Assignments submitted later than two days will receive no credit.
- **In-class Quiz:** You will have roughly one in-class quiz every two weeks. The quiz will be taken in class during the first 10 minutes. No make-up quiz will be provided. The lowest quiz will be dropped.
- **Midterm Exams:** There will be two midterm exams. Midterms must be taken during the lecture. Makeup midterms will be given only in extreme situations. You must notify the instructor at least two weeks before the midterm if you have a conflict, or have a valid excuse verified by the Office of Undergraduate Education (OUE).
- **Final Project:** A final small-group project will be assigned near the end of the semester (groups of 2–3 students). Details will be posted on Canvas.

Student Success Resources

- **Tech Support:** For technical assistance, refer to Emory IT Services.
- **Undergraduate Education Resources:** The Office of Undergraduate Education offers various student support services including academic advice, peer tutoring, and guidelines for missed exams. More information is available at OUE Emory.
- **Accessibility Services:** Students with documented disabilities or who suspect they may have a disability should reach out to the Office of Accessibility Services for accommodation support and resources. Confidentiality regarding any disability-related information is assured. Further details can be found at Office of Accessibility Services Emory.
- **Academic and Religious Observance Calendar:** Please familiarize yourself with the Academic Calendar for crucial academic dates.
- **EPASS:** The course moves quickly. Emory has an excellent peer tutoring program that can be extremely helpful. For information, visit Learning and Peer Assistant Tutoring.
- **Netiquette:** When using online tools for this course, please be courteous to other students and instructors.

- **Health and Wellness Resources for Students:** Achieving academic success is closely linked to maintaining a healthy lifestyle, both mentally and physically. Emory University offers several no-cost resources to support student well-being:
  - Emory HelpLine: For non-critical mental health needs, students can reach out to the Emory HelpLine at 404-727-4357. This confidential, peer-run phone counseling service operates every evening from 8:30 pm to 1:00 am.
  - For immediate mental health concerns, the Student Counseling Center is available at 404-727-7450.
  - This program supports students dealing with sexual assault, relationship violence, or stalking. Confidential consultations, crisis intervention, and referrals are provided. Contact them at 404-727-1514.
  - Offering a broad range of services including primary care, physical exams, dietary and substance abuse counseling, Emory Student Health is committed to supporting students' physical health.
- **Policy on Harassment:** As per Emory Equal Opportunity and Discriminatory Harassment Policy, Emory University strictly prohibits any form of discriminatory harassment. This includes sexual harassment and harassment based on race, color, religion, ethnic or national origin, gender, genetic information, age, disability, sexual orientation, gender identity, gender expression, veteran status, or any other category protected under applicable law. This policy applies to faculty, staff, administration, students, vendors, contractors, guests, and patrons on campus.

Tentative Topics

Week	Topic
Week 1	Introduction; Python and linear algebra review
Week 2	Python and linear algebra (cont.); stochastic simulation
Week 3	Data preprocessing; introduction to machine learning
Week 4	Gradient descent; linear regression
Week 5	Logistic regression; multiclass classification

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Week	Topic
Week 6	Stochastic gradient descent; K-nearest neighbor
Week 7	Dimension reduction; Gaussian processes
Week 8	Fall Break (Tue); introduction to deep learning (Thu)
Week 9	Deep neural networks; Midterm 1
Week 10	PyTorch/JAX tutorial
Week 11	Convolutional neural networks (CNNs)
Week 12	Graph convolutional networks (GCNs)
Week 13	Reinforcement learning; natural language processing
Week 14	Attention and transformers; Thanksgiving (Thu)
Week 15	Midterm 2; generative models
Week 16	Review; presentations

Tentative Schedule

Red: Quiz, exam, or holiday

Blue: Potential Remote Class

Orange: Homework out

Purple: Homework due

Week	Tuesday	Thursday
Week 1	No Class: 08/26/25 Before classes begin No Class	Lecture 1: 08/28/25 Introduction and course logistics Review Python and linear algebra
Week 2	Lecture 2: 09/02/25 Python and linear algebra (cont.)	Lecture 3: 09/04/25 Stochastic simulation
Week 3	Lecture 4: 09/09/25 Data preprocessing Quiz 1	Lecture 5: 09/11/25 Introduction to machine learning
Week 4	Lecture 6: 09/16/25 Gradient descent	Lecture 7: 09/18/25 Linear regression HW1 due 09/20
Week 5	Lecture 8: 09/23/25 Logistic regression Quiz 2	Lecture 9: 09/25/25 Multiclass classification
Week 6	Lecture 10: 09/30/25 Stochastic gradient descent	Lecture 11: 10/02/25 K-nearest neighbor HW2 due 10/04
Week 7	Lecture 12: 10/07/25 Dimension reduction	Lecture 13: 10/09/25 Gaussian processes Quiz 3
Week 8	No Class: 10/14/25 Fall Break No Class	Lecture 14: 10/16/25 Introduction to deep learning HW3 due 10/18
Week 9	Lecture 15: 10/21/25 Deep neural networks (DNNs)	Lecture 16: 10/23/25 Midterm 1

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Week	Tuesday	Thursday
Week 10	Lecture 17: 10/28/25 PyTorch/JAX tutorial	Lecture 18: 10/30/25 PyTorch/JAX tutorial (cont.) HW4 due 11/01
Week 11	Lecture 19: 11/04/25 Introduction to CNNs	Lecture 20: 11/06/25 More on CNNs Quiz 4
Week 12	Lecture 21: 11/11/25 Introduction to GCNs	Lecture 22: 11/13/25 More on GCNs HW5 due 11/15
Week 13	Lecture 23: 11/18/25 Reinforcement learning	Lecture 24: 11/20/25 Natural language processing Quiz 5
Week 14	Lecture 25: 11/25/25 Attention and transformers	No Class: 11/27/25 Thanksgiving No Class
Week 15	Lecture 26: 12/02/25 Midterm 2	Lecture 27: 12/04/25 Introduction to generative models
Week 16	Lecture 28: 12/09/25 Review; presentations Last Day of Classes	No Class: 12/11/25 Final Exam Period No Class

Final Presentation: Dec 16, 4:00 – 5:15 PM.