Syllabus

Math 295: Math for Machine Learning
MWF 12:30-1:45 in ZEI 201

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Office hours: MWF 10:50 - ? and 1:50 - ?

Course description

Machine learning is a fun topic that is currently of tremendous importance and widespread use. Writing software to implement machine learning involves not just sophisticated programming techniques but, also, a high level of mathematical knowledge. Even the *use* of machine learning libraries in your programming requires a mathematical understanding of the algorithms in the background.

Thus, in this course, we will

- Learn some important algorithms used in machine learning today, such as

  - Linear and logistic regression,
  - K-nearest neighbor classification
  - K-means clustering, and
  - Neural networks.

- Learn the basics of the mathematics behind these algorithms, such as

  - Single variable calculus,
  - Linear algebra,
  - The geometry of \n\-dimensional space,
  - Multivariable calculus
  - Probability theory and statistics.

- Use these tools within Python programs.

Materials

There are a few things you'll need to succeed in this course.

Computer and internet connectivity

I will mostly coordinate the course through our class webpage:
https://marksmath.org/classes/Spring2025MML/

The course schedule, presentations, handouts, and assignments will all be posted there. There will also be some online HW and computer labs that you'll need a computer for.

- Homework will be done via MyOpenMath:
  https://myopenmath.com/
- We'll use Google Colab for computer labs:
  https://colab.research.google.com/

Textbooks

You are not required to purchase any textbook for this class. There are several references that I'll use and refer to regularly, though. All references are copyrighted and published but also freely available via downloadable PDF.

The selection of topics and overall presentation is largely influenced by *Math for Machine Learning* by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong and published by Cambridge University Press.
Download: https://mml-book.github.io/

When discussing neural networks, we'll borrow heavily from the following texts:

The Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani, Jerome Friedman.
Download: https://hastie.su.domains/ElemStatLearn/

An Introduction to Statistical Learning with Python by Gareth James, Daniela Whitman, Trevor Hastie, and Robert Tibshirani.
Download: https://www.statlearning.com/

Course schedule

There is a detailed course schedule in both outline and calendar form:

- Outline:

  - HTML: https://marksmath.org/classes/Spring2025MML/schedule/outline.html
  - PDF: https://marksmath.org/classes/Spring2025MML/schedule/outline.pdf

- Calendar: https://marksmath.org/classes/Spring2025MML/schedule/calendar.html

As detailed as that is, it is certainly subject to change. As this is a new and developing class, I might even refer to this whole endeavor as "aspirational".

Note that there are currently 5 exams and 7 labs on the schedule.

Grades

Components contributing to your grade

Your grades will be based on the following components:

- **Exams**: There are 5 exams scheduled each worth about 50 points. I'm pretty sure that calculators and/or computers will not be allowed on exams.
- **Labs**: There are 7 computer labs scheduled worth 20-30 points apiece. You should be able to complete most labs during class time. Lab 4 on regression and Lab 6 on neural networks might take a bit more.
- **HW**: Most of the purely mathematical material will have homework assigned via MyOpenMath. You will receive login instructions in class.
- **Participation**: You'll accumulate 50 points throughout the semester just by coming to class and participating in class activities regularly.

How grades are determined

Your grade will be determined by a scale not harder than 90-80-70-60. That is,

- 90% will guarantee an A-,
- 80% will guarantee an B-,
- 70% will guarantee an C-,
- 60% will guarantee an passing grade.

I will also take a look at the overall class distribution and determine if I feel the need to adjust the scale down. I'll go through that process after each exam and notify you of your status after each exam.

Course policies

Attendance

I don't take daily attendance. Missing class with any regularity, however, will affect your course grade directly through the class participation grade and indirectly through its impact on your performance.

Academic integrity

You are expressly permitted to discuss questions and problems arising from homework or lab assignments with your classmates.

Exams are expected to be your work and yours alone. In addition, the expectation is that there will be no computational assistance, unless expressly permitted in limited situations. Please don't cheat; I simply refer such cases to the administration.

Further information

You can find more information on dealing with special challenges here:
https://marksmath.org/OfficialPolicies/