Linear Algebra for Data Science

Fall 2021 | Syllabus | Math 505

Class Information

Professor
Lauren Williams, PhD

Meeting Times
MW 5:30 - 6:45 pm

Meeting Location
LIB 126

Office Hours

Monday 12 - 12:50 pm
Monday 4 - 5 pm
Tuesday 9 - 10 am
Tuesday 1 - 1:50 pm
Wednesday 12 - 12:50 pm
Friday 8 - 8:50 am

Contact

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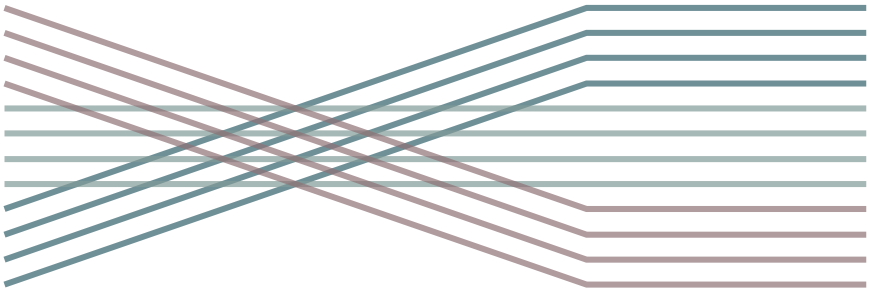

Course Description

This course will provide students pursuing a graduate degree in data science with essential tools of linear algebra. The course will focus on applications of linear algebra to machine learning. Topics will include systems of linear equations, matrix and vector operations, norms, inverses, determinants, matrix decomposition, tensors and tensor operations, eigenvalues and eigenvectors, and principle component analysis. Additional topics may be included.

Course Objectives

On successful completion of the course, students will be able to:

- appreciate how linear algebra can be applied to machine learning and other topics of interest to data science.
- define objects from linear algebra such as a vector, matrix, and tensor, and perform various operations on them.
- describe the general ideas behind matrix factorization and identify which method is appropriate for a given matrix.
- utilize the Python programming language and libraries to solve a variety of linear algebra based problems.
- calculate and interpret solutions of statistical problems using linear algebra.

Required Materials

No books are required for this course. Lecture material and code samples will be available on Blackboard throughout the semester.

You are welcome to install Python on your personal machine, or use the in-browser notebooks as in class. However, you are not required to purchase any hardware or software for this course.

Exams

We will have three midterm exams. Each should be considered cumulative, meaning all material covered in class to that date may appear. Exams will be taken in class on these dates:

- Wednesday, September 29
- Wednesday, November 3
- Monday, December 13 (during scheduled final exam period)

Further information about the exams will be provided in class.

Grading

Your final grade for the course will be the average of your three midterm exam grades, each weighted the same.

Your final (rounded) grade will be converted to a letter on your transcript using the Mathematics Department grading scale:

F	D	C	C+	B	B+	A
0-59	60-69	70-78	79-82	83-89	90-92	93-100

Covid

Masks

University policy requires all individuals to wear face coverings while indoors on campus. Masks are not required while sitting alone at your office desk or while eating.

Food and Drink in the Classroom

In light of the COVID-19 situation, eating is not permitted in classrooms, labs, or other academic spaces. A water bottle or cup with a lid (and preferably a straw) is permitted to be used in classrooms and labs to help prevent a student from becoming dehydrated. Masks should be pulled only slightly away from the bottom of the face to take a quick drink and immediately replaced to cover the mouth and nose.

Academic Honesty

Collaboration is important, particularly in mathematics and computer science. However, your grade in this class is meant to reflect your own personal growth and understanding of the material. Therefore, it is of upmost importance that the work you submit as your own is indeed your own. You will *not* be permitted to work together or consult outside sources on any class exams. A specific list of materials that may be used during the exams will be provided - any deviation from this list will be considered academic dishonesty and result in a grade of 0 on that exam.

ADA and Learning Differences

Mercyhurst University is committed to making reasonable accommodations for qualified students, and employees with disabilities as required by law. Please refer to the HUB

`https://lakersmercyhurst.sharepoint.com/sites/StudentsHub`

and select the Services tab, then ADA Accommodations from the dropdown for instructions to request an accommodation. You may also contact Susan Reddinger, ADA Coordinator, ADA@mercyhurst.edu, 814-824-2362, Egan Hall 200. For students with questions about Academic Support, please refer to the HUB

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and select the Academic Resources tab, then Academic Support for more information.

Title IX Information

Mercyhurst is committed to providing an environment free from sex discrimination, including sexual harassment and sexual violence. Please refer to the HUB:

`https://lakersmercyhurst.sharepoint.com/sites/StudentsHub`

and select the Resources tab, then Title IX – Sexual Respect from the dropdown for more information. If you would like to file a sexual misconduct complaint, please contact Ann Miller, Title IX Coordinator and Compliance Officer, titleix@mercyhurst.edu, 814-824-2363. Please be aware that in compliance with Title IX, educators must report incidents of sexual assault/harassment, stalking, and domestic/dating violence. If you disclose any of these situations in class, in papers, or to me personally, I am required to report it to the Title IX Coordinator (or any of the Deputy Title IX Coordinators).

Course Evaluations

Near the end of the semester, you will be asked to complete an online course evaluation. The evaluation will be completed in class during the last two weeks of the semester using any laptop, tablet, or mobile device. The response tool allows you to note aspects of the course that helped you learn, as well as aspects that might be modified to help future students learn more effectively. You will receive an email letting you know when the evaluation window for our class is open. Please note that these course evaluations are anonymous and instructors do not see the results until after the grades for the course are submitted.

Math 505 Linear Algebra for Data Science - Fall 2021 Semester Schedule

Week	Topic
1 Aug 25	**Course Introduction** Course expectations and structure, and an overview of linear algebra.
2 Aug 30, Sept 1	**Matrices, Vectors, and Operations** An introduction to the objects we'll be working with throughout the semester: vectors and matrices, which you might know as "arrays". We'll also see how to combine these objects through operations like addition, matrix multiplication, and the dot product.
3 Sept 6, 8	**Systems of Equations** Linear algebra exists because of the need to find common solutions to a series of equations. We'll define these systems and see a few approaches to solving them.
4 Sept 13, 15	**Linear Algebra in Python** Very little linear algebra is done "by hand". We'll look at some useful Python libraries and get started with programming.
5 Sept 20, 22	**Determinants and Inverses** An important property of every square matrix, finding the inverse of a matrix, and what it means when there is no inverse.
6 Sept 27, 29	**Inner Products** Midterm I Wednesday Measuring similarity between vectors and our first midterm exam.
7 Oct 4, 6	**Norms and Support Vector Machines** The many ways to measure distances and length, and an overview of a very useful technique for solving complicated problems.
8 Oct 11	**Eigenvalues and Eigenvectors** No Class Wednesday The definition of "eigenstuffs" and an introduction to finding them.
9 Oct 18, 20	**Eigenvalues and Eigenvectors** Some useful applications of eigenvalues and eigenvectors, and reconstructing a matrix.
10 Oct 25, 27	**Special Matrices** A few important classifications of matrices and special techniques required when working with them, including orthogonal, sparse, and symmetric matrices.
11 Nov 1, 3	**Matrix Factorization** Midterm II Wednesday A few methods for decomposing a matrix, including LU factorization, QR factorization, and Cholesky decomposition.
12 Nov 8, 10	**Singular Value Decomposition** A more general approach to matrix decomposition that is extremely valuable in data science, and our second midterm exam.
13 Nov 15, 17	**Tensors and Tensor Operations** An introduction to tensors, the multidimensional generalizations of matrices and the Python tools for working with them.
14 Nov 22	**Multivariate Statistics** No Class Wednesday Some tools and techniques from linear algebra applied to statistics.
15 Nov 29, Dec 1	**Principal Component Analysis** Principal component analysis uses matrix operations to reduce dimensionality, making a large complicated problem into one that's far more manageable.
16 Dec 6, 8	**Regression** Solving linear regression problems with least squares optimization.
** Dec 13	**Final Exam Week** Midterm III Monday The third and final midterm exam will be taken during the time scheduled for the final exam, Monday December 13 from 6-8 pm.