MADS 502: Math Methods for Data Science

Course Overview

There are no prerequisites for this course.

This course will review and introduce some mathematical concepts relevant to applied data science. It will cover important concepts in linear algebra, probability, and statistics.

Week 1 covers some math basics about sets, types of numbers, types of proofs, functions, derivatives, optimization, exponents, logarithms, Euler's number, and natural logarithms. It also covers Part 1 of the unit on Linear Algebra, specifically vector operations with math and with Python and the concepts of span, basis, and linear independence.

Week 2 is Part 2 of the unit on Linear Algebra. It covers matrix operations with math and with Python, the concept of matrices as linear mappings, determinants, traces, and some basics about eigenvalues and eigenvectors.

Week 3 is the unit on Probability. It covers the concepts of random variables, introduces some important discrete and continuous distributions, expectation, variance, conditional probability, independence, Bayes' rule, and Monte Carlo simulations.

Week 4 is the unit on Statistics. It covers the Central Limit Theorem, hypothesis testing, some math and interpretation of OLS regressions and logistic regressions, and a little bit about maximum likelihood.

Instructor and Teaching Staff

Instructor: Alex McLeod (mcleodal@umich.edu)

Assisting Instructors: Lea Wei (zhuoqunw@umich.edu), Ben Merrill (benme@umich.edu)

Course Schedule

- This course starts **Wednesday, January 4th** and ends **Tuesday, January 31**
- Weekly assignments are due on **Tuesdays at 11:59 pm EDT (Eastern Daylight Time)**
- Schedule of Weekly Office Hours via Zoom:
    - **Alex McLeod:** Mondays at 12:00pm EDT
    - **Lea Wei:** Thursdays at 10:00pm EDT
    - **Ben Merrill:** Fridays at 10:00am EDT

Access via Live Events from the course menu. All OH meetings have the passcode **502**

Communication Expectations

- Most questions about the lectures and the assignments should be posted on the Slack channel for the course, so that other students can see the questions, offer their answers and ideas, and see the final answers. Please do not post code related to specific assignment questions (see below).
- If your question is about your specific code for an assignment question, please send a Slack direct message to any of the teaching staff. Make sure to include (a) the assignment number and the question number that your question is about, (b) a clean, minimal version of your attempted code, (c) the output of your code, (d) the error message if any, and (e) a short explanation of what your approach to the problem has been.
- Typically instructors will respond to a Slack post or direct message within 24 hours. If you have not received a response in 48 hours, please resend.

Recommended Textbooks

There is no required textbook for this course, but there are three recommended textbooks:

1. *Linear Algebra and its Applications* by Lay
2. *A First Course in Probability* by Sheldon Ross
3. *Introduction to Econometrics* by Stock and Watson

Learning Objectives

1. Review linear algebra concepts and have familiarity with vectors and matrices in Python

1. Be able to do basic vector operations with math and in Python.
2. Be able to do basic matrix operations with math and in Python.
3. Given a set of vectors, be able to (i) describe their span, (ii) determine whether or not they are a basis of some space, and (iii) determine if they are linear independent.
4. Understand the connection between the inverse of a function and the inverse of a matrix.
5. Review concepts of determinants, eigenvalues, and eigenvectors.

2. Review probability concepts and be introduced to some more advanced concepts

1. Review some important discrete and continuous distributions.
2. Be able to compute the expectation and variance of a simple random variable.
3. Be able to compute a simple conditional probability.
4. Be able to compute a simple probability that involves independent random variables.
5. Be able to implement a simple Monte Carlo simulation.

3. Familiarity with Bayes' Rule

1. Understand when Bayes' rule is useful and what information it provides.
2. Be able to implement a Bayes' rule to solve a standard Bayes' rule problem
3. Be introduced to more complex Bayes' rule problems.

4. Familiarity with Optimization, Hypothesis Testing, OLS Regression, Logistic Regression

1. Understand how first and second derivatives are useful for finding extremum.
2. Understand how hypothesis testing relies on the Central Limit Theorem.
3. Be able to do a step-by-step hypothesis test about a population mean.
4. Understand the optimization problem that an OLS regression solves and how to interpret the results.
5. Understand the optimization problem that a Logistic regression solves and how to interpret the results.
6. Be introduced to the concept of maximum likelihood.

Assignments and Late Policy

This course has four assignments. You have unlimited attempts for each assignment. Any attempt made between 0-24h after the deadline will receive a 15% late penalty. Any attempt made between 24-48h after the deadline will receive a 30% late penalty. Any attempt made between 48-72h after the deadline will receive a 45% late penalty. Any attempt made 72h or more after the deadline will receive a 100% late penalty.

Your grade on the assignment will be your highest grade from all your attempts taking any late penalties into account.

Course Item	Percent of Final Grade	Due Date
Assignment 1	25%	Tuesday, January 10
Assignment 2	25%	Tuesday, January 17
Assignment 3	25%	Tuesday, January 24
Assignment 4	25%	Tuesday, January 31
Total	**100%**	

Letter Grades

Letter Grade	Number Grade Bounds
A	95 – 100%
A-	90 -- 95%
B+	87 -- 90%
B	83 -- 87%

B-	80 -- 83%
C+	77 -- 80%
C	73 -- 77%
C-	70 -- 73%
D+	67 -- 70%
D	63 -- 67%
D-	60 -- 63%
F	0 -- 60%

Refer to the MADS Assignment Submission and Grading Policies section of the UMSI Student Handbook (access to Student Orientation course required).

Academic Integrity

Refer to the Academic and Professional Integrity section of the UMSI Student Handbook. (access to Student Orientation course required).

Accommodations

Refer to the Accommodations for Students with Disabilities section of the UMSI Student Handbook (access to the Student Orientation course required).

Use the Student Application Form in Accommodate to begin the process of working with the University's Office of Services for Students with Disabilities.

Accessibility

Refer to the Screen reader configuration for Jupyter Notebook Content document to learn accessibility tips for Jupyter Notebooks.

Help Desk: How to get Help

For technical or platform problems (Coursera, Slack, etc.), please email umsimadshelp@umich.edu .

Library Access

Refer to the U-M Library's information sheet on accessing library resources from off-campus. For more information regarding library support services, please refer to the U-M Library Resources section of the UMSI Student Handbook (access to the Student Orientation course required).

Student Mental Health

Refer to the University's Resources for Stress and Mental Health website for a listing of resources for students.

Student Services

Refer to the Introduction to UMSI Student Life section of the UMSI Student Handbook (access to the Student Orientation course required).