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), Saurabh Budholiya (srbh@umich.edu)

Course Schedule

- This course starts **Tuesday, January 9th** and ends **Monday, February 5th**
- Weekly assignments are due on **Mondays at 11:59 pm ET (Eastern Time)**
- Schedule of Weekly Office Hours via Zoom:
    - **Alex McLeod: Mondays at 8:00am ET**
    - **Lea Wei: Thursdays at 10:00pm ET**
    - **Saurabh Budholiya: Fridays at 12:00pm (i.e. noon) ET**

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 suggestions, and see where the discussion goes . **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 please send one Slack direct message to all of the teaching staff at once. 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 12 hours. If you have not received a response in 24 hours, please resend.

Recommended Textbooks

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

1. *Essential Math for Data Science* by Nield
2. *Linear Algebra and its Applications* by Lay
3. *A First Course in Probability* by Ross
4. *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. For any attempt made between 0-24h after the deadline, a 15% late penalty will be applied to the entire attempt. For any attempt made between 24-48h after the deadline, a 30% late penalty will be applied to the entire attempt. For any attempt made between 48-72h after the deadline, a 45% late penalty will be applied to the entire attempt. For any attempt made 72h or more after the deadline, a 100% late penalty will be applied to the entire attempt.

Your official grade on the assignment will be the maximum of the grades on your attempts of the assignment. For example, if you attempt an assignment four times and receive the grades 50, 75, 80, 85 (100 with a 15% late penalty), then your official grade on the assignment would be 85. For another example, if you attempt an assignment five times and receive the grades 20, 50,

87, 76.5 (90 with a 15% late penalty), and 70 (100 with a 30%) late penalty, then your official grade on the assignment would be 87

Each student starts the course with one "free pass," which allows them to choose one week of the course (Week 1, Week 2, Week 3, or Week 4) and extend the deadlines for that week's assignment by three days (72 hours). In order to use your free pass, simply DM everyone on the instructional team (in one DM) and say that you would like to use your free pass for a certain week's assessments. Please be clear about which week you are applying it to.

Course Item	Percent of Final Grade	Due Date
Assignment 1	25%	January 15th
Assignment 2	25%	January 22th
Assignment 3	25%	January 29th
Assignment 4	25%	February 5th
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%
E	0 -- 60%

Refer to the [MADS Assignment Submission and Grading Policies Opens in a new tab](#) section of the UMSI Student Handbook (access to Student Orientation course required).

Academic Integrity

Refer to the [Academic and Professional Integrity Opens in a new tab](#) section of the UMSI Student Handbook. (access to Student Orientation course required).

Accommodations

Refer to the [Accommodations for Students with Disabilities Opens in a new tab](#) section of the UMSI Student Handbook (access to the Student Orientation course required).

Use the Student Application Form in [Accommodate Opens in a new tab](#) 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 Opens in a new tab](#) 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 Opens in a new tab .

Library Access

Refer to the [U-M Library's information sheet Opens in a new tab](#) on accessing library resources from off-campus. For more information regarding library support services, please refer to the [U-M Library Resources Opens in a new tab](#) 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 Opens in a new tab](#) for a listing of resources for students.

Student Services

Refer to the [Introduction to UMSI Student Life Opens in a new tab](#) section of the UMSI Student Handbook (access to the Student Orientation course required).