Course Overview and Prerequisites
This course will introduce and in some cases, review mathematical concepts relevant to future work in applied data science. It will cover important concepts in basic and linear algebra, matrix and vector algebra, eigenvectors and eigenvalues, optimization techniques, Bayes rule, and maximum likelihood.

There are no course prerequisites.

Instructor and Course Assistants
Instructor: Dr. Erin Ware (ebakshis@umich.edu)
Course Assistants: Nai-Yu Shih (nais@umich.edu)
Yumou Wei (yumouwei@umich.edu)

Communication Expectations
- Contacting instructor and course assistant: (email, slack). Please include SIADS502 in the email subject.
- Email/Slack response time: within 24 hours
- Grading response time: 4 days after assignments are due
- Office Hours: See Course Schedule below.

Required Textbook
None.

Technology Requirements (unique to this course)
None.

Learning Outcomes
1. Compute conditional probabilities, correlations, and multiplication of vectors and matrices.
   1a. Revisit basic algebra and notations to be used in this course and through the MADS program
   1b. Apply basic concepts of vectors, perform basic algebra operations using vectors
   1c. Apply basic concepts of matrices, perform basic algebra operations using vectors
   1d. Compute basic and conditional probabilities, and understand probability laws

2. Give examples of eigenvalues, eigenvectors, and matrix decomposition (such as Principal Component Analysis).
   2a. Demonstrate basic linear algebra and computational properties of matrices including identifying linearity
   2b. Recognize how row reduction helps us calculate eigenvalues and eigenvectors
   2c. Discuss the concepts of eigenvalues and eigenvectors
   2d. Practice concepts of matrix decomposition - particularly principal components

3. Interpret Bayes Rule.
   3a. (Re)introduce Bayes Theorem to students and its applications to data science. Give examples of how Bayes
      Theorem integrates with data science broadly

Contents subject to change at instructor discretion.
4. Explain Maximum likelihood estimation in the context of linear regression
   4a. Explain the basics of likelihood and maximum likelihood concepts

5. Explain optimization techniques and their connection to mathematics and data science
   5a. Describe how optimization works in everyday life, mathematics, and data science
   5b. Express the intuition of optimization techniques (gradient descent)
   5c. Identify canonical formulations for linear and logistic regression techniques
   5d. Express the intuition of loss functions and how they relate to optimization

Course Schedule

- **This course begins on Tuesday, October 1, 2019 and ends on Monday, October 28, 2019.**
- **Weekly assignments will be due on Mondays at 11:59 pm** (Ann Arbor, Michigan time-Eastern Daylight Time - EDT, UTC -4).

Schedule of Weekly Office Hours via Zoom (Ann Arbor, Michigan time):

- Mondays 3pm-4pm EDT with Yomou Wei
- Wednesdays 11am-12pm EDT with Dr. Erin Ware
- Thursdays 11am-12pm EDT with Nai-Yu Shih
- Access via Live Events from the course menu

In **Week 1**, you will review math concepts relevant to data science through (a) a review problem set designed to identify areas of strengths and weaknesses of math fundamentals, (b) lectures revisiting important algebraic concepts, introducing fundamental linear algebra ideas, working with vectors and matrices, and (c) a graded problem set applying these concepts using Python and Jupyter Notebook.

In **Week 2**, you will be introduced to matrix decomposition, row reduction methods for matrices, eigenvalues and eigenvectors, and principal components. This week has two assignments. The first will mathematically apply the week’s concepts using Python and Jupyter Notebook in a problem set, while the second will have you read a peer-reviewed article which has incorporated some of the concepts we have covered and write a brief review.

In **Week 3**, you will learn about methods of basic optimization techniques. We will cover the general ideas behind optimization, canonical formulations, loss functions, and gradient descent. This week has two assignments. The first will mathematically apply the week’s concepts using Python and Jupyter Notebook in a problem set, while the second will have you read a peer-reviewed article which has incorporated some of the concepts we have covered and write a brief review. This week, you will also review some of your peer’s written reviews of research articles from week 2.

In **Week 4**, we will revisit probability and statistics and apply theories from the course to maximum likelihood methods for linear and logistic regression. You will have a graded problem set applying these methods using Python and Jupyter Notebook. This week, you will also review some of your peer’s written reviews of research articles from week 3.

Grading

<table>
<thead>
<tr>
<th>Course Item</th>
<th>Percentage of Final Grade</th>
<th>Due</th>
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<tbody>
<tr>
<td>Math Review Assignment</td>
<td>0% (but required for course completion)</td>
<td>Friday, October 4, 2019</td>
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*Contents subject to change at instructor discretion.*
<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
<th>Due Date</th>
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<tbody>
<tr>
<td>Weekly Practice Set 1</td>
<td>20%</td>
<td>Monday, October 7, 2019</td>
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<tr>
<td>Weekly Practice Set 2</td>
<td>20%</td>
<td>Monday, October 14, 2019</td>
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<tr>
<td>Writing Assignment 1 (with peer review)</td>
<td>10%</td>
<td>Monday, October 14, 2019</td>
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<tr>
<td>Weekly Practice Set 3</td>
<td>20%</td>
<td>Monday, October 21, 2019</td>
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<tr>
<td>Writing Assignment 2 (with peer review)</td>
<td>10%</td>
<td>Monday, October 21, 2019</td>
</tr>
<tr>
<td>Weekly Practice Set 4</td>
<td>20%</td>
<td>Monday, October 28, 2019</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
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Note: All assignments are required to earn credit for this course.

Letter Grades, Course Grades, and Late Submission Policy
Refer to the [MADS Assignment Submission and Grading Policies](#) section of the UMSI Student Handbook (access to Student Orientation course required).

Academic Integrity/Code of Conduct
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 Intake Form](#) 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(s): How to get Help

- Degree program questions or general help - umsimadshelp@umich.edu
- Coursera's Technical Support (24/7) - [https://learner.coursera.help/](https://learner.coursera.help/)

*Contents subject to change at instructor discretion.*
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).

Technology Tips
- Recommended Technology
  - This program requires Jupyter Notebook for completion of problem sets and Adobe or other PDF viewer for reading articles.
- Working Offline
  - While the Coursera platform has an integrated Jupyter Notebook system, you can work offline on your own computer by installing Python 3.5+ and the Jupyter software packages. For more details, consult the Jupyter Notebook FAQ.

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