Math 391: Mathematics of Machine Learning

Basic Information

Instructor Dr. Levi Heath (he/him)
Email lheath2@unl.edu
Office Hours By appointment–if you have a question about an assignment or would like to meet for any other reason, please send me an email and we can set something up!

Class Meeting Time and Location 9 AM–12 PM MTWRF on Zoom–link on Canvas homepage.
Required Materials You will need a computer to attend class and complete programming assignments. The library offers laptops, which you can check out for free: https://libraries.unl.edu/laptops.
Course Website All information will be on Canvas.
Textbook Michael Nielsen's *Neural Networks and Deep Learning*, which is freely available online:
http://neuralnetworksanddeeplearning.com/
We will not follow this book directly, but it is a nice resource if you like referencing textbooks.
Prerequisites A grade of P, C, or better in Math 107 or Math 107H.

Course Description An introduction to the mathematical underpinnings of machine learning. Topics include matrix algebra, gradient descent, multidimensional arrays, artificial neural networks, and implementation with MATLAB or Python. Additional topics vary but can include support vector machines, decision trees, and large language models.

Grades and Assessments

Grade Breakdown There will be five components to your grade for this term, weighted as shown below.

Participation	Homework	Projects
20%	50%	30%

Letter Grades Letter grades will be given no stricter than:

A	A-	B+	B	B-	C+	C	C-	D+	D	F
90-100%	87-89%	84-86%	80-83%	77-79%	74-76%	70-73%	67-69%	64-66%	60-63%	0-60%

Participation In class, we will often work in groups to complete activities or worksheets. Your participation during class will determine part of your grade.

Homework There will be regular homework assignments to allow you to practice concepts learned in class. Each assignment will be accessible through our Canvas course page. Many current and past instructors spent a significant amount of time curating these problems for you, so please take advantage of this resource which is a significant percentage of your grade.

Projects To assess your ability to apply the mathematics we learn, there will be three projects. Two of the projects will involve building machine learning models using Python and TensorFlow (an industry-standard open-source programming package for machine learning). Please note that you are not expected to have any prior programming experience. One of the projects will involve giving an in-class presentation. You will work in groups of two for all of the projects.

Make-up Work Make-up exams and homework will be given at the instructor's discretion. If you will miss an assignment for some reason, please let your instructor know so they can do their best to figure something out. Our only goal for the course is for you to learn linear algebra and completing every assignment is crucial to reaching that goal!

Policies

Instructional Continuity Plans for when Classes are Canceled If in-person classes are canceled, you will be notified of the instructional continuity plan by an announcement or email in Canvas.

Departmental Grading Appeals The Department of Mathematics does not tolerate discrimination or harassment on the basis of race, gender, religion, or sexual orientation. If you believe you have been subject to such discrimination or harassment, in this or any other math course, please contact the department. If, for this or any other reason, you believe your grade was assigned incorrectly or capriciously, then appeals may be made to (in order) the instructor, the vice chair, the department grading appeals committee, the college grading appeals committee, and the university grading appeals committee.

University Policies Students are responsible for knowing the university policies and resources found on this page (http://go.unl.edu/coursepolicies):

- University-wide Attendance Policy
- Academic Honesty Policy
- Services for Students with Disabilities
- Mental Health and Well-Being Resources
- Final Exam Schedule
- Fifteenth Week Policy
- Emergency Procedures
- Diversity & Inclusiveness
- Title IX Policy
- Other Relevant University-Wide Policies

Tentative Schedule

Week 1
Thursday, Jan. 2 Multivariable Functions and Gradient Descent
Friday, Jan. 3 Matrix Algebra and Transformations

Week 2
Monday, Jan. 6 Feedforward Neural Networks and Intro to Python Programming
Tuesday, Jan. 7 Project 1: How to Train Your Model
Wednesday, Jan. 8 Finish Project 1
Thursday, Jan. 9 Backpropagation
Friday, Jan. 10 Training from Scratch

Week 3
Monday, Jan. 13 Project 2: Getting to know Machine Learning
Tuesday, Jan. 14 Finish and present Project 2
Wednesday, Jan. 15 Model Testing
Thursday, Jan. 16 Project 3: Dataset Benchmarking
Friday, Jan. 17 Finish Project 3