MAT 180 Special Topics Fall 2022

Title: The Mathematics of Machine Learning
Instructor: Alex Chandler (aachandler at ucdavis dot edu)
Teaching Assistant: Gregory DePaul (gdepaul at ucdavis dot edu)
Lectures: 2:10 PM - 3:00 PM MWF Giedt 1007
Office Hours: TBD

Topic: Machine learning is a rapidly expanding area of study combining tools from linear algebra, probability, statistics, and optimization. It aims to develop algorithms to make predictions based on input data. The goal of this course is to provide a mathematically rigorous introduction to the theory of machine learning algorithms while gaining intuition and experience through completing concrete assignments and a group project.

Prerequisites: MAT 22A and familiarity with a programming language (ideally Python).

Textbooks: We will primarily be following

1. The Deep Learning Book. `https://www.deeplearningbook.org/` by Goodfellow, Bengio, Courville.

   but may supplement with readings from

2. Strang, Gilbert. Linear Algebra and Learning from Data.

3. James, Witten, Hastie, Tibshirani. An Introduction to Statistical Learning with Applications in R.

Plan: We will mostly follow The Deep Learning Book, using the other two for reference and exercises. At the very least, we will cover the following topics. If there is extra time, we may proceed with topics according to class interest.

1. Background in Linear Algebra, Statistics, and Optimization
2. Linear and Logistic Regression
3. Multilayer Perceptron (Deep Feedforward Neural Networks)
4. Regularization
5. Convolutional Neural Networks
6. Recurrent and Recursive Neural Networks (Sequence Modeling)
7. Applications

Course Grade: Based on

- homework (60%)
- a group project (30%)
- scribing lecture notes (10%)

Homework: Homework will be assigned weekly through Gradescope which you can access through the course Canvas page. The homework will be a hybrid of theoretical problems solved by hand (submit written by hand or using LaTeX) and programming problems which will be given in the form of Jupyter notebooks which you must complete. To submit these, convert your notebook into a .pdf (using the print function of your browser) and submit both the .ipynb file and the .pdf file in Gradescope.

Project: The project takes the place of what would have been the last three homework assignments for the course. You can work in groups of two or three. *You must submit a proposal for a project before Wednesday November 9 and the project is due before the last day of class December 2.* More information will be provided in a separate document.

Scribing: You will be responsible to typeset a portion of the lecture notes for the course in LaTeX. We will all work on Overleaf (a website for collaboritive typesetting) with the goal of producing a textbook for the content of the course. You will work in groups of two or three (the same groups as for the project). Each group will be responsible for a single lecture, expanding the notes if necessary with any missing details, and adding a section of exercises at the end. A more complete set of instructions will be issued in a separate document.

Message from Student Disabilites Center: Any student with a documented disability (e.g. physical, learning, psychiatric, vision, hearing, etc.) who needs to arrange reasonable accommodations must contact the Student Disability Center (SDC). Faculty are authorized to provide only the accommodations requested by the SDC. If you have any questions, please contact the SDC at 530-752-3184 or `sdc@ucdavis.edu`.