Syllabus for CS3400 Machine Learning

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What You'll Learn This Quarter

Welcome to CS3400 Machine Learning! This quarter, we are going to explore the conceptual basis of machine learning. We've prepared some exciting lectures and labs for you. We'll spend time playing with linear geometry and studying how machine learning models classify objects. For the second half of the class, we'll dive into analytic geometry and discuss how machine learning algorithms are trained. At the end of the quarter, you'll be able to implement several machine learning algorithms from scratch and be well prepared to study data science (applications of machine learning) and deep learning.

Outcomes

On successful completion of this course, the student will:

- Understand the basic process of machine learning
- Understand the concepts of learning theory, i.e., what is learnable, bias, variance, overfitting
- Understand the concepts and application of supervised and unsupervised learning
- Analyze and implement basic machine learning algorithms
- Understand the role of optimization in machine learning
- Assess the quality of predictions and inferences
- Apply methods to real world data sets

About Your Instructor

I was born in Ft. Lauderdale, FL. In 2010, I moved to South Bend, IN for graduate school. I met my wife during that time, and we moved to Milwaukee in January 2015 for my wife to pursue an amazing career opportunity. At the time, I was working remotely as a software engineer in industry.

This Fall will be the start of my third year of teaching at MSOE. My specialties include data science, machine learning, and algorithms / data structures. I really enjoy teaching these classes along with the introductory programming sequence.

I maintain an active research program in genomics. I combine traditional bioinformatics techniques with machine learning to answer questions about structural variations and functional properties of insect genomes. I collaborate with faculty at the Medical College of Wisconsin,

University of Tennessee—Knoxville, and other large research institutions. MSOE students regularly work with me on these projects. Please come talk with me if you are interested in learning more about participating in research during your time at MSOE.

Since moving to Milwaukee, I've became an avid cyclist. During the summers, you'll often find me on the Oak Leaf Trail. My wife and I have two dogs. I enjoy taking them to the dog park. We were previously foster parents to two siblings but are no longer actively fostering. In my free time, I build LEGO kits and read books on history, philosophy, sociology, and social work.

How This Class Will Be Delivered

For everyone's safety, I decided to run our class completely online. I intend to use a "flipped" classroom style in which video lectures are posted online for viewing on your own time. Your primary activities for this class will involve viewing the lecture videos, taking notes from those videos, programming-intensive labs, large problem sets for practicing concepts, and participating in weekly small groups and reviews of lab and problem set solutions.

We will use our scheduled class times for synchronous activities on MS teams. I will invite you to Outlook calendar events for our classes. The events will have links to Microsoft Teams meetings that you can use to join the class.

Despite being online, my goal is to be available to you and ensure that all of us will have opportunities to engage and interact just as if class was held in person. I am aiming for everyone to be successful this quarter. Please feel free to reach out with questions, concerns, or feedback about class topics, how the class is running, how to be successful with learning online, or topics outside of class. During my four years of industry work, I was entirely remote. I've learned a number of strategies to help make online and remote work more successful, and I am always happy to brainstorm with you on ways to help with time management, studying, or counteracting the psychological impacts of working online. I also am happy to help with accommodations or offer flexibility as needed to help you be successful as long as you provide notice in advance (24 hours or more).

Class time will be structured as follows: We will use four of our scheduled hours for mandatory synchronous activities. One hour each week will be devoted to reviewing lab and problem set solutions. Four of the scheduled synchronous hours will be used for labs. During the lab times, I may pull small groups of students out of class to discuss that week's material. My intention is for you to use the lab times like study halls to work on videos, labs, and problem sets and ask me questions. One of the four lab hours is optional. (My hope is that lab hours scheduled during the normal class times will serve some of the purpose of office hours and will be easier for everyone to attend.) Attendance will be mandatory for review session and labs but not the optional office hour.

Tip: Set up study groups and arrange times to meet on MS Teams outside of class. Work individually or collaboratively during that time to watch videos. This will help you hold yourself accountable and make the experience more fun.

Class Schedule

New material will be released on Monday mornings. You will have three things to submit every week (lab, problem set, and notes). Materials will be due before midnight on Fridays.

Day of the Week	Scheduled Time	Topic	Mandatory Attendance?
Monday	9:00 – 9:50 am	(optional) Lab	No
Tuesday	9:00 – 10:50 am	Lab / small groups	Yes
Wednesday	9:00 – 9:50 am	Review problem set and lab solutions	Yes
Friday	9:00 – 9:50 am	Lab	Yes

Learning Activities and Materials

Canvas

MSOE is phasing out Blackboard in favor of Canvas. You access the MSOE Canvas instance here:

https://msoe.instructure.com/

All assignments will need to be submitted as PDFs (notes, problem sets) and zip files of source code (labs) through Canvas. For your notes and problem set solutions, I highly recommend using the Microsoft Lens app to scan your document using your phone's camera and generate a PDF.

Textbook

The Data Science Design Manual by Skiena, Springer, 2017. ISBN: 978-3319554433

Video Lectures

> Tip: How to learn effectively from videos
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> When watching video lectures, you need to employ active listening techniques. You cannot watch videos passively like a movie or TV show for entertainment. Instead, you need to focus on what you are watching and provide your full attention. To aid with this, you should take notes while watching the lectures. Pause the lectures when you need to take a note or need a break. Rewind the lectures and listen again when something isn't clear. Since videos will be available throughout the course, you can re-watch videos when preparing for exams or you need to remind yourself of something.

Lecture Notes

You will be required to take notes for the video lectures. Scan your notes with an app like Microsoft Lens and submit a PDF through Canvas. Notes will be treated as a participation grade and will be graded pass / fail. I may check notes to verify that you watched the videos but you are free to use any note-taking style or approach that works best for you.

> Tip: Advice for Taking Notes
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> Round 1: Take notes while watching videos. Use a spiral notebook or other scratch paper. Use one color (e.g., black) to write down content from the videos and a second color (e.g., blue) to write down any of your own ideas, thoughts, or reflections that come to mind as you are watching.
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> Round 2: At a later point, rewrite your notes. (This counts as studying!) It helps me to pretend that I am preparing my notes to be read by someone (e.g., such as a blog post or slides); by doing so, I am motivated to include more details. Restate the notes in your words; doing this will help you retain ideas and gives you a chance to review the material and refresh yourself. Lastly, take time to organize your notes so that you can easily find topics.
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> Round 3: Review your notes regularly. Often times, you'll run across a new idea that is connected to an old idea in your notes. Record these ideas and connections by writing comments in the margins. Use a third color (e.g., red) to differentiate later comments from initial notes and ideas.

Labs

Unless stated explicitly, all laboratory assignments will be completed individually. You are expected to read the ENTIRE assignment BEFORE asking questions. No make ups will be allowed. Arriving late to lab may disqualify you from the ability to participate in the lab at the discretion of the instructor. Detailed submission expectations will be included with each lab. Only one lab submission will be allowed.

All labs will be handed in through Canvas. Within the Canvas section of the class, you should select the "Content" tab, and the labs will be posted as assignments. Lab submissions should be done by zipping up the lab project files and attaching them to the "assignment submission" portion of the Lab Assignment. You are encouraged to add comments (in Canvas) when submitting the project, but they aren't required. Do not forget to click "Submit." If you are unsure whether your assignment was submitted correctly, you can check your submissions before asking the instructor.

We will review solutions together in class, and I'll answer any questions that might come up. Solutions will not be posted, and the associated lecture will not be recorded; you will need to attend class to see the solutions.

Problem Sets

Weekly problem sets will be assigned. These will generally be large assignments that will take about the same amount of time to complete as the labs. The goals of the problem sets are to (1) practice concepts from the lectures, especially conceptual or mathematical concepts that do not fit naturally into a lab, (2) help you assess your own understanding of the lectures, and (3) give practice with concepts that didn't fit into the labs. Problem sets will be graded pass/fail. We will review solutions together in class, and I'll answer any questions that might come up. Solutions will not be posted, and the associated lecture will not be recorded; you will need to attend class to see the solutions.

> Tip: Use Problem Sets to Study for Exams
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> Problem sets will be similar to what you will see on the exams. To study for exams, redo the problem sets from scratch in "testing conditions" (time yourself and make sure you aren't using your notes or watching the lectures). Focus on trying to finish the assignment in the time allotted. If you run into problems you can't solve, skip the question. When you are done, compare your answers to your previous solutions. Spend more time studying anything you missed or were unable to answer. Repeat this until you feel comfortable answering every question correctly under "testing conditions."

Exams

There will be two exams (a midterm and a final). Exam formats will be decided at a later time.

Grades

Item	Percentage
Lecture Notes	5%
Problem Sets	15%
Labs	25%
Final Project	15%
Mid-term Exam	20%
Final Exam	20%

Grading Scale

Letter Grade	Percentage Needed
A	>=93%
AB	>=89%
B	>=85%
BC	>=81%
C	>=77%
CD	>=74%
D	>=70%
F	<70%

Make Ups

Make up quizzes, labs, and exams are not available unless extenuating circumstances exist. Ask the professor if you believe you qualify. It is always favorable for your case if you ask before a due date. Near the end of the quarter make up and extension requests are rarely granted.

Professionalism

All work submitted by you is expected to be your own writing unless explicitly allowed in the assignment (it will be clearly written). **Copying and pasting code from other students, the internet or any other sources other than the professor or textbook is considered plagiarism and is not allowed. If copying and pasting is discovered, it will cause the both the person who submitted copied code and the person they obtained the code from to earn a 0 on the lab/assignment, and depending on the circumstances, it may cause the submitter to earn a 0 in the course.** IF YOU ARE UNSURE if "borrowing" code is allowed, please ask. It is better to ask for permission than forgiveness in this instance.

Phones, "smart" watches, music players, and other digital devices are not allowed on quizzes or exams. Bathroom breaks during exams or quizzes are also not allowed. If you suspect another student of cheating on anything in the class, you are expected to report the activity to the professor within 24 hours of your realization. The professor will keep reports of cheating confidential. Failure to report cheating activities of other students implicates you as complicit in the activity. All cases of suspected plagiarism or cheating will be submitted to the Vice President of Academics and may become part of your permanent academic record as per campus policy.

Special Accommodations

If you require special accommodations, please notify the instructor within the first three (3) weeks of the quarter to ensure adequate time to provide appropriate accommodations.

Tentative Schedule

This is subject to change.

Week	Topic
1	Introduction to ML, Structuring the Data, Review of Geometry and Linear Algebra
2	Decision Boundaries, Model Evaluation
3	KNN Regression and Classification, Logistic Regression, Overview of Scikit-Learn
4	Decision Trees, SVMs, Review
5	**Exam 1,** Modeling, Review of Analytic Geometry and Calculus
6	Optimization 1 (cost functions), Optimization 2 (fitting / training models)
7	Numerical Differentiation, catch up
8	Optimization 3 (numerical optimization), Optimization 4 (applications)
9	Simple Neural Networks / Backpropagation
10	Project presentations
11	**Final Exam**