Intro and First Day Stuff

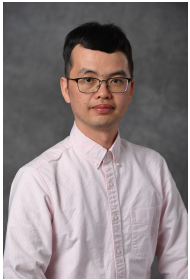
Lecture 1 - CMSE 381

Prof. Lianzhang Bao

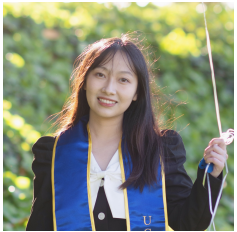
Michigan State University
::
Dept of Computational Mathematics, Science & Engineering

Mon, Jan 13, 2025

People in this lecture



Dr. Bao (he/him)
Dept of CMSE



Christy Lu (she/her)
Graduate Student, CMSE, MSU

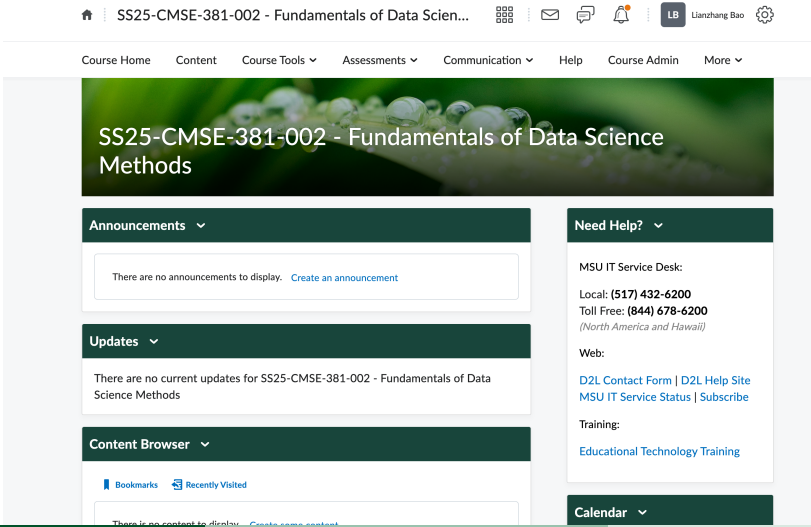
What is this course about?

Topics:

- Fundamental concepts of data science
- Regression
- Classification
- Dimension reduction
- Resampling methods
- Tree-based methods, etc.

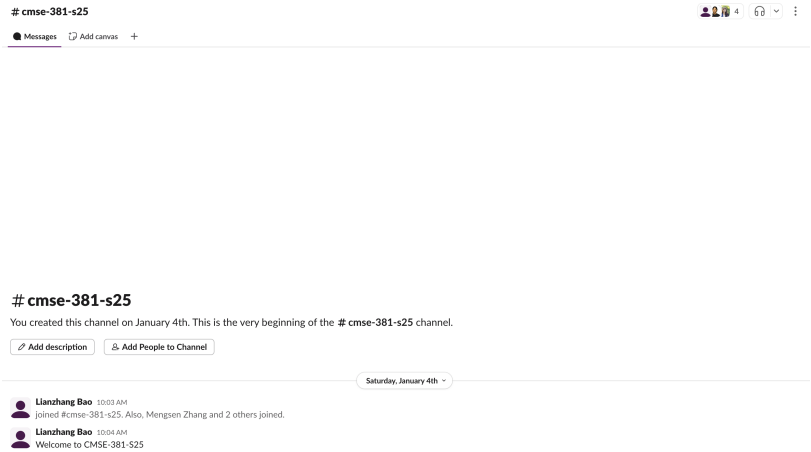
D2L and where to find grades

https://d2l.msu.edu/d2l/home/2066703



Slack and where to find announcements/ask questions

Join `cmse-courses` slack: https://tinyurl.com/cmse-courses-slack-invite



Course Website and where to find slides and jupyter notebooks

https://cmse.msu.edu/CMSE381

–or–

https://msu-cmse-courses.github.io/CMSE381-S25/

CMSE

Search ⌘ + K

CMSE 381 - Spring 2025

- Course Schedule
- Syllabus
- Textbook
- Datasets

Homeworks

- Homework Info
- Internet and Citation Policy

Contents

- Important Course Information
- Instructor Information
- Course schedule

CMSE381 - Fundamentals of Data Science Methods

Important Course Information

- **Where:**
  - Section 001: Wells Hall - A108
  - Section 002: Engineering Building - 2400
- **When:**
  - Section 001: MWF 3:30-4:40 pm
  - Section 002: MWF 12:30-1:40 pm
- **Slack:** cmse-courses.slack.com
  - #cmse381-s25 channel

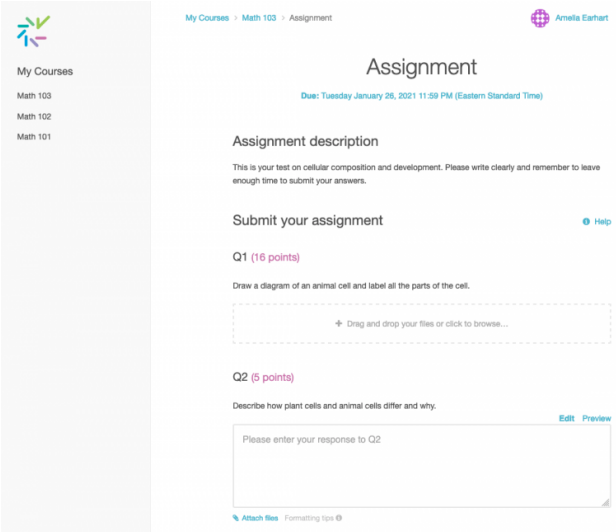
Instructor Information

Mengsen Zhang (Section 001)
mengsen@msu.edu
Assistant Professor
Dept of Computational Mathematics, Science & Engineering
Dept of Medicine

Lianzhang Bao (Section 002)

Crowdmark and where to submit homework

No URL: You will get an automated email from the system (I think.....?)



Office hours

Dr. Bao

Tu-W 9am - 10am

Zoom & EGR 2507L

Christy Lu

Time TBD

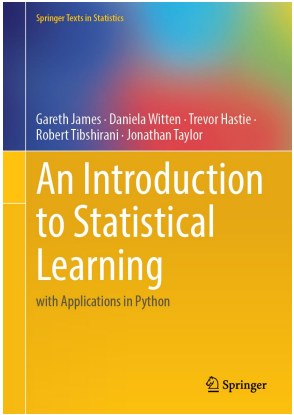
Zoom & EGR (Room TBD)

Details on the calendar posted on the course webpage
https://msu-cmse-courses.github.io/CMSE381-S25/

Textbook

Free download

https://www.statlearning.com/



Class Structure

- Class is a combination of lecture time, and group work/coding time.
  - Bring computer every day
  - Jupyter notebooks
  - Python
- Once a week, there will be a short check-in quiz. This will be basic content realted to lectures since the last class. Possible questions include checking on definitions, or basic understanding of major ideas.
  - 10 points per quiz
  - Drop two lowest grades

Class Structure Pt 2

- Homeworks due once a week, midnight of the day marked in the schedule (mostly Sundays).
  - 20 points per homework
  - Drop two lowest grades
  - Sliding scale:
    - 24 hours late: 5% penalty.
    - 48 hours late: 15% penalty.
    - >48 hours: No late work accepted.
- Three Midterms
  - See schedule for dates
  - 100 points each
  - Not cumulative
- One Project
  - Analyze dataset using tools in class, submit written report
  - 100 points
  - Due at the end of the semester

Approximate schedule

Lec #	Date		Topic	Reading	HW	Pop Quizzes	Notes
1	M	1/13	Intro / Python Review	1			
2	W	1/15	What is statistical learning	2.1		Q1	
3	F	1/17	Assessing Model Accuracy	2.2.1, 2.2.2			
	M	1/20	MLK - No Class				
4	W	1/22	Linear Regression	3.1		Q2	
5	F	1/24	More Linear Regression	3.1	HW #1 Due Sun 1/26		
6	M	1/27	Multi-linear Regression	3.2			
7	W	1/29	Probably More Linear Regression	3.3		Q3	
8	F	1/31	Last of the Linear Regression		HW #2 Due Sun 2/1		
9	M	2/3	Intro to classification, Bayes classifier, KNN classifier	2.2.3			
10	W	2/5	Logistic Regression	4.1, 4.2, 4.3.1-3		Q4	
11	F	2/7	Multiple Logistic Regression / Multinomial Logistic Regression	4.3.4-5	HW #3 Due Sun 2/9		
	M	2/10	***Project Day & Review***				
	W	2/12	**Midterm #1**				
12	F	2/14	Leave one out CV	5.1.1, 5.1.2			
13	M	2/17	k-fold CV	5.1.3			
14	W	2/19	More k-fold CV	5.1.4-5		Q5	
15	F	2/21	k-fold CV for classification	5.1.5	HW #4 Due Sun 2/23		
16	M	2/24	Subset selection	6.1			
17	W	2/26	Shrinkage: Ridge	6.2.1			
18	F	2/28	Shrinkage: Lasso	6.2.2			
	M	3/3	Spring Break				
	W	3/5	Spring Break				
	F	3/7	Spring Break				
19	M	3/10	PCA	6.3			
20	W	3/12	PCR	6.3		Q6	
	F	3/14	***Review***		HW #5 Due Sun 3/16		
	M	3/17	**Midterm #2**				
21	W	3/19	Polynomial & Step Functions	7.1-7.2			
22	F	3/21	Step Functions; Basis functions; Start Splines	7.2-7.4	HW #6 Due Sun 3/23		
23	M	3/24	Regression Splines	7.4			
24	W	3/26	Decision Trees	8.1			Q7
25	F	3/28	Random Forests	8.2.1, 8.2.2	HW #7 Due Sun 3/30		
26	M	3/31	Maximal Margin Classifier	9.1			Q8
27	W	4/2	SVC	9.2			
28	F	4/4	SVM	9.3, 9.4	HW #8 Due Sun 4/6		
29	M	4/7	Single Layer NN	10.1			
30	W	4/9	Multi Layer NN	10.2			Q9
31	F	4/11	CNN	10.3			
32	M	4/14	Unsupervised learning / clustering	12.1, 12.4	HW #9 Due Sun 4/13		
33	W	4/16	Virtual: Project Office Hours				Q10
	F	4/18	***Review***				
	M	4/21	**Midterm #3**				
	W	4/23					
	F	4/25				**Project Due**	
			No final exam				

Grade distribution

	Estimated Points
Homeworks	(10 homeworks - 2 lowest grades) $\times$ 20 points $=$ 160
Quizzes	(12 Quizzes - 2 lowest grades) $\times$ 10 points $=$ 100
Midterm	(3 Midterms) $\times$ 100 $=$ 300
Final Project	100
TOTAL:	660 (Subject to change!)

Section 1

Intro to class

What is Statistical Learning?

Statistical Learning

- Subfield of statistics
- Emphasizes models and their interpretability, precision, and uncertainty

Machine Learning

- Machine learning has a greater emphasis on large scale applications and prediction accuracy.

Very blurred distinction at this point....

Why should you care?

Data is cheap (or even free), learning how to analyze data is critical.

- Web data, e-commerce (Amazon, JD, Alibaba)
- Car sales (Tesla, Ford, and GM)
- Sports team (MSU, Lions, etc)
- Politics and government

Learning Tools as Black Boxes

- Need to know what tool to use
- Need to know how to interpret output of the tool
- Don't need to rebuild the entire box from scratch

Example: Email spam

	`george`	`you`	`your`	`hp`	`free`	`hpl`	`!`	`our`	`re`	`edu`	`remove`
`spam`	0.00	2.26	1.38	0.02	0.52	0.01	0.51	0.51	0.13	0.01	0.28
`email`	1.27	1.27	0.44	0.90	0.07	0.43	0.11	0.18	0.42	0.29	0.01

if $(\texttt{\%george} < 0.6)$ & $(\texttt{\%you} > 1.5)$ then `spam` else `email`.

if $(0.2 \cdot \texttt{\%you} - 0.3 \cdot \texttt{\%george}) > 0$ then `spam` else `email`.

Supervised learning

- Outcome measurement Y (also called dependent variable, response, target, label).
- Vector of p predictor measurements X (also called inputs, regressors, covariates, features, independent variables).
- In the regression problem, Y is quantitative (e.g price, blood pressure).
- In the classification problem, Y takes values in a finite, unordered set (survived/died, digit 0-9, cancer class of tissue sample).

Unsupervised learning

- No outcome variable, just a set of predictors (features) measured on a set of samples.
- Objective is fuzzier: find groups of samples that behave similarly, find features that behave similarly, find linear combinations of features with the most variation.
- Difficult to know how well you are are doing.
- Different from supervised learning but can be useful as a pre-processing step for supervised learning.

Generative AI discussion

Definition via Wikipedia:

> *Generative artificial intelligence (AI) is artificial intelligence capable of generating text, images, or other media, using generative models. Generative AI models learn the patterns and structure of their input training data and then generate new data that has similar characteristics.*

Examples:

- ChatGPT
- Bard
- DALL-E

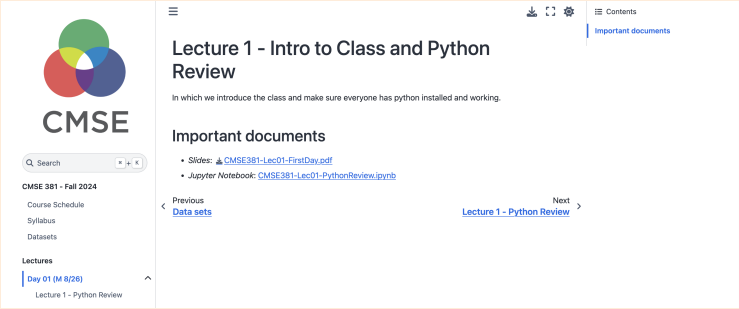
- Get in a group of about 4.
- Open this google doc (MSU Login required): tinyurl.com/CMSE381-genAI
- In your group, brainstorm cases where someone might use generative AI in the context of our class.
- Once you have added a few, start adding arguments for or against whether we should allow the use of that context in class.

Section 2

Python Review Lab: Pt 1

Plan for the lab

- Find a group of 4 or so.
- Find the class website (cmse.msu.edu/CMSE381) and download the jupyter notebook for the Python Review Lab.
- Get started!



Next time

- Weds: What is statistical learning?
- First HW Due Sunday, 1/26
- Quiz sometime **this** week
- Office hours:
  - Maintained on the website
  - Dr. Bao: Tuesday and Wednesday 9-10 (Starting next week)
  - Christy Lu: Times TBD

Lec #	Date		Topic	Reading	HW	Pop Quizzes	Notes
1	M	1/13	Intro / Python Review	1			
2	W	1/15	What is statistical learning	2.1		Q1	
3	F	1/17	Assessing Model Accuracy	2.2.1, 2.2.2			
	M	1/20	MLK - No Class				