Intro and First Day Stuff

Lecture 1 - CMSE 381

Prof. Elizabeth Munch

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

Weds, Aug 31, 2022

People in this lecture

Dr. Munch (she/her)
Depts of CMSE and Math

Emily Bolger (she/her)
Graduate Student, CMSE, MSU

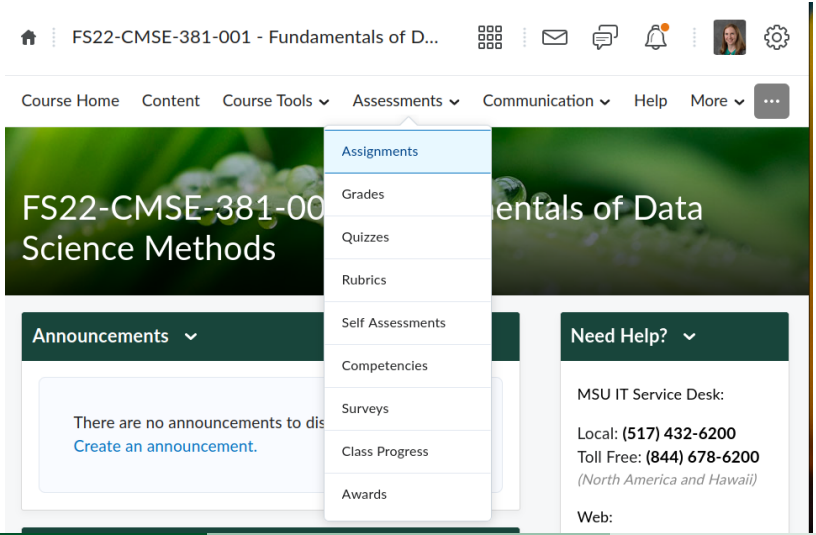
What is this course about?

Topics:

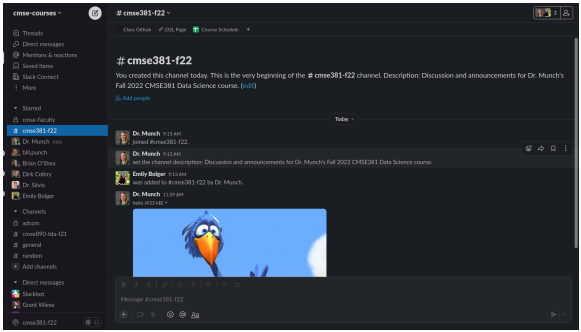
- Fundamental concepts of data science
- Regression
- Classification
- Dimension reduction
- Resampling methods
- Tree-based methods, etc.

D2L and where to find grades

https://d2l.msu.edu/d2l/home/1579786

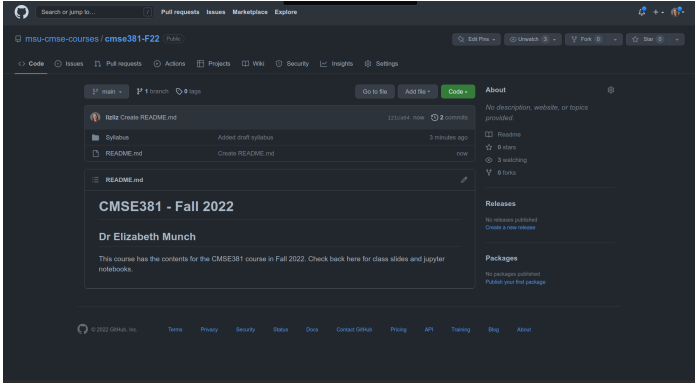


Slack and where to find announcements/ask questions



Github and where to find slides and jupyter notebooks

https://github.com/msu-cmse-courses/cmse381-F22/



Office hours

Zoom link: https://bit.ly/3FTuRqG

Dr. Munch

Time TBD

Zoom & EGR 1511

Emily Bolger

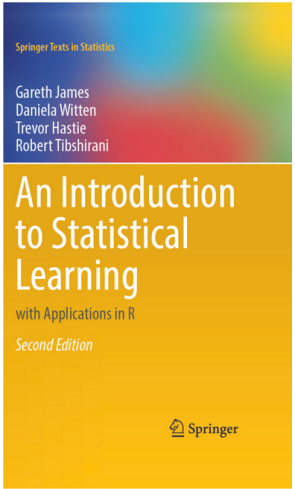
Wed 10:30-noon
Fri 1-2:30

Zoom & EGR (Room TBD)

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.
  - 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

Approximate schedule

Up to date version: https://bit.ly/3SE0Phl

Lec #	Date	Topic	Reading	Homeworks
1	W Aug 31	Intro / First day stuff / Python Review Pt 1	1	
2	F Sep 2	What is statistical learning? / Python Review Pt 2	2.1	
	M Sep 5	No class - Labor day		
3	W Sep 7	Assessing Model Accuracy	2.2	HW #1 Due
4	F Sep 9	Linear Regression	3.1	
5	M Sep 12	More Linear Regression	3.2	
6	W Sep 14	Even more linear regression	3.3	HW #2 Due
7	F Sep 16	Probably more linear regression		
8	M Sep 19	Intro to classification, Logisitic Regression	4.1, 4.2, 4.3	
9	W Sep 21	More logistic regression		HW #3 Due
10	F Sep 23	Review		
11	M Sep 26	***Midterm #1***		
12	W Sep 28	[No class, Dr Munch out of town]		
13	F Sep 30	[No class, Dr Munch out of town]		
14	M Oct 3	Leave one out CV	5.1.1, 5.1.2	
15	W Oct 5	k-fold CV	5.1.3	
16	F Oct 7	More k-fold CV	5.1.4	
17	M Oct 10	CV for classification	5.1.5	HW #4 Due
18	W Oct 12	Resampling methods: Bootstrap	5.2	
19	F Oct 14	Subset selection	6.1	
20	M Oct 17	Shrinkage: Ridge	6.2.1	HW #5 Due
21	W Oct 19	Shrinkage: Lasso	6.2.2	
22	F Oct 21	Dimension Reduction	6.3	

Lec #	Date	Topic	Reading	Homeworks
	M Oct 24	No class - Fall break		
21	W Oct 26	More dimension reduction; High dimensions	6.4	
22	F Oct 28	Polynomial & Step Functions.	7.1,7.2	HW #6 Due
23	M Oct 31	Review		
24	W Nov 2	***Midterm #2***		
25	F Nov 4	Basis functions, Regression Splines	7.3,7.4	
26	M Nov 7	Smoothing Splines; Local regression; GAMs	7.5-7.7	
27	W Nov 9	Decision Trees	8.1	
28	F Nov 11	Ensemble methods	8.2	HW #7 Due
29	M Nov 14	Maximal Margin Classifier	9.1	
30	W Nov 16	SVC	9.2	
31	F Nov 18	SVM	9.3, 9.4, 9.5	HW #8 Due
32	M Nov 21	More SVM		
33	W Nov 23	Single layer NN	10.1	
	F Nov 25	No class - Thanksgiving		
35	M Nov 28	Multi Layer NN	10.2	HW #9 Due
36	W Nov 30	CNN	10.3	
37	F Dec 2	Unsupervised Learning & Clustering	12.1, 12.4	
38	M Dec 5	More Clustering	12.4	HW #10 Due
39	W Dec 7	Review		
40	F Dec 9	Midterm #3		

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
TOTAL:	560

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 (%george < 0.6) & (%you > 1.5) then spam else email.

if $(0.2 \cdot$ %you $- \ 0.3 \cdot$ %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.

Section 2

Python Review Lab: Pt 1

Plan for the lab

- Find a group of 4 or so.
- Download the jupyter notebook and the csv file from github.
- Get started!

Next time

- Friday: What is statistical learning?
- No homework or quiz until next week

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