Lecture 1 CMS 165

Introduction to the course

Logistics

Course Details

- Lectures on Tu/Th at 1pm-2:25pm at ANB 213
- Office Hour: One office hour every week. Please fill out the poll on piazza to help us determine the best time for all of you.
- Recitations: Fri at 1pm-2pm.
- First recitation on Jan 6th at 1pm : Software tools. Location: ANB 213

Logistics

Course Details

- We will be using Piazza for discussion forums and announcements
  - Access code for piazza: xsql9zv0zmh
- We will be using Canvas for managing homeworks and grades
  - CS/CNS/EE/IDS 165 (WI 2022-23) (instructure.com)

- **TAs:**
  - Hongkai Zheng hzzheng@caltech.edu
  - Guanzhi Wang guanzhi@caltech.edu
  - Zongyi Li zongyili@caltech.edu
  - Jiawei Zhao jiawei@caltech.edu

Grading

- Assignments (30%)
- 1 Quiz (20%)
- 1 Project (50%):
  - Proposal Report: 20%
  - Proposal Presentation: 10%
  - Final Report: 50%
  - Final Presentation: 20%

Late Assignment Policy

- Assignments will be due at 4pm on Friday via Canvas. Students are allowed to use up to 48 late hours. Late hours must be used in units of hours. Specify the number of hours used when turning in the assignment. Late hours cannot be used on the projects. There will be no TA support over the weekends.

Collaboration Policy

- **Homeworks**: (taken from CS 1) It is common for students to discuss ideas for the homework assignments. When you are helping another student with their homework, you are acting as an unofficial teaching assistant, and thus must behave like one. Do not just answer the question or dictate the code to others. If you just give them your solution or code, you are violating the Honor Code. As a way of clarifying how you can help and/or discuss ideas with other students (especially when it comes to coding and proofs), we want you to obey the "50 foot rule". This rule states that your own solution should be at least **50 feet away** . If you are helping another students but cannot without consulting your solution, don't help them, and refer them instead to a teaching assistant.
- **Projects**: Students are allowed to collaborate fully within their project teams, but no collaboration is allowed between teams.

Project Guidelines

- Detailed guidelines available on Piazza.
  - Project title and one sentence summary: Jan 20th.
  - Proposal Report Deadline: Due February 6th 1pm
  - Final Presentation : Saturday, March 18nd, 9am-1pm
  - Final Report Deadline: Due March 20th 4pm
- Pick a well-defined problem in ML that can be completed during the course.
- A list of suggested course projects and mentors:

  Project guidelines and ideas
- Check with at least one of the TAs on topic before investing time on it.
- What does NOT count as a project: i) Running a standard benchmark/Kaggle challenge without any detailed ablation and exploratory studies, (ii) Reviewing a paper and just reproducing original experiments.

What is the course about?

- Cannot do both breadth and depth.
- Striking a balance here.
- We will explore some proof ideas in lectures, but not whole proofs.
- In depth reading on your own.
- Main intent: to help you extract useful signal in this environment of large number of AI/ML publications.

Course Outline

Lecture 1: Introduction, Probability
Lecture 2: Sufficient statistics
Lecture 3: Bayesian
Lecture 4: Neyman Pearson
Lecture 5: Sequential detection
Lecture 6: Estimation and UMVU
Lecture 7: Cramer Rao
Lecture 8: Midterm exam
Lecture 9: Spectral Methods: PCA/CCA, HMM
Lecture 10: Spectral Methods: Tensor methods, method of moments
Lecture 11: Optimization: Non-convex
Lecture 12: Optimization in deep learning: Adam, CGD, MAdam
Lecture 13: generalization theory
Lecture 14: generalization theory
Lecture 15: approximation theory
Lecture 16: operator learning
Lecture 17: operator learning
Final presentation: Saturday 9am-1pm, March 18th.

Zoom Alternative

- Link: https://caltech.zoom.us/j/87823247150 (on Canvas)

- Zoom will also be available, (stay in if you are feeling sick and try not to infect others)
- Be on mute and unmute to ask questions.
- Do not share link on any public forums.

Probability and Measure

- Measure theory: generalization of probability.
- Learn about probability spaces and measureability.
- Why is it important to see probability through lens of measure theory?
  - Gives a strong foundation.
  - You will reduce making mistakes about probability events.

References

- **Caution: These are detailed materials. You are not expected to master them to understand future lectures. I gave a high-level understanding of most useful concepts in this lecture. Use them as needed.**
- My notes from previous courses. Available on Piazza.
- Probability and stochastic processes by Bruce Hajek http://www.ifp.illinois.edu/~hajek/Papers/randomprocJuly14.pdf
- Concentration bounds: J. Tropp, https://arxiv.org/abs/1501.01571
- Detection and Estimation: V. Poor https://www.springer.com/us/book/9780387941738
- Machine learning: K. Murphy https://mitpress.mit.edu/books/machine-learning-1