Syllabus

CS732 Advanced Machine Learning (Fall 2024)

General Information

Course Number: CS732 CRN 15989
Lecture Hours: 1:00 – 3:50 pm, Friday
Lecture Location: GITC 4402

Instructor

Shuai Zhang, Assistant Professor
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Office Room: GITC 2117
Phone Number: 973-596-2743
Office Hour: 1:00 pm -2:00 pm Tuesday & Thursday

Course Overview

This course aims to enhance your theoretical understanding of the statistical properties of learning algorithms. For instance, it will delve into questions like when and why machine learning algorithms are effective, how to formalize the process of algorithmic learning from data, and how mathematical thinking can be employed to craft improved machine learning techniques. The topics covered generalization bounds through uniform convergence, classical machine learning theory, and recent advancements in deep learning theory.

Prerequisites

Students are expected to have the following background:

- Calculus
- Linear algebra
- Probability
- Machine learning
- Recommended but not required: functional/real analysis, Convex optimization, Matrix analysis

Schedule

DATE	CLASS	LIST OF LECTURE TOPICS	Lecture #
09/06	1	Introduction	L1
09/13	2	Mathematical Preliminary Asymptotic analysis	L2
09/20	3	Uniform Convergence	L3
09/27	4	Concentration Inequalities, Sub-Gaussian Distribution	L4
10/04	5	Rademacher Complexity, and generalization bound for linear model	L5
10/11	6	Challenges in deep learning, generalization bound for shallow neural networks, Overparameterized model	L6
10/18	7	Non-convex Optimization in DL	L7
10/25	8	Neural Tangent Kernel	L8
11/01	9	Implicit regularization effect of initialization	L9
11/08	10	Implicit regularization effect of noise, Stochastic gradient descent	L10
11/15	11	Unsupervised learning, Spectral Clustering, Introduction to Non-convex Optimization	L11
11/22	12	Paper Review / Project Presentation	
11/27	**13**	Paper Review / Project Presentation	
12/03	14	Paper Review / Project Presentation	

Textbooks

There will be no required textbooks for the class. Some of the class material, however, will be based on content from the following scribe notes:

- Tengyu Ma, Lecture notes for machine learning theory

  (Link: https://github.com/tengyuma/cs229m_notes/blob/main/master.pdf)

Assignments

There will be **4 assigments/quizs** throughout the semester. Each assignment consists of several small problems needs to be solved or proved. Each assignment has its own detailed instructions. Each assignment needs to be completed in two weeks days and submitted via Canvas.

Paper Review and Project

- The paper review and project can be carried out by a group of at most 3 students. Each group is required to write a review of one paper and conduct one mini-project.
- You can choose any paper/project for your topics as long as they are related to machine learning.
- Each group is required to give a presentation for one paper and submit a final report for your project.
- Additional details regarding the paper review and project will be announced in a separate document.

Grading Policies

- Lecture attendance (20%)
- Assignments/Quiz (30%)
- Project (25%)
- Paper presentation (25%)

Grading Scale

- **A**: 90-100,
- **B+**: 80-89,
- **B**: 75-80
- **F**: 0-74.

You will receive an **F** if you miss three lectures without valid reasons, fail to submit any homework on time, do not submit the project, or do not complete the paper review. In addition, you will only be able to receive **B or below grade** if you are copying directly from things that you do not understand (e.g., AI tools).

Grade Corrections

Check the grades in course work and report errors promptly. Please try and resolve any issue **within one week of the grade notification**.

Course Policies

Collaboration and External Resources for Assignments

Some homework problems will be challenging. You are advised to first try and solve all the problems on your own. **You are also allowed to collaborate with your classmates and search for solutions online. But you should use such solutions only if you understand them completely** (admitting that you do not understand something is way better than copying things you do not understand). **Also, make sure to give the appropriate credit and citation.**

Late Policy

- There will be a **10% penalty** of total regular points for every day an assignment is late.
- **Max. late submission is 3 days late.**

Academic Support System

NJIT Academic Calendar:

https://www5.njit.edu/registrar/calendars/ This contains drop/add and other important dates.

Generative AI:

Student use of artificial intelligence (AI) in this course is permitted only for grammar checking and language improvement. Additionally, if and when students refer to any AI generated contents, the AI must be cited as is shown within the NJIT Library AI citation page for AI. If you have any questions or concerns about AI technology use in this class, please reach out to your instructor prior to submitting any assignments.

Academic Integrity:

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http:www5.njit.edu*policies*sites*policies*files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university**. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Academic Support and Student Affairs:

"From questions about becoming a student at NJIT – to student engagement – to searching for information on career development, the Division of Academic Support and Student Affairs Staff is here to help."

Bookstore: NJIT has a bookstore. Please check its web page how COVID is affecting operations.

Canvas Help Page: Canvas support for students.

Center for Counseling and Psychological Services

"The NJIT Center for Counseling and Psychological Services (C-CAPS) is committed to assisting students in the achievement of their academic goals as well as benefiting from their personal experience on campus. College life can be personally challenging and stressful at times. We believe that the educational process is an important component of the development of the individual as a whole person. Our goal is to optimize the college experience and improve the quality of the lives of our students by promoting their mental health and facilitating students' personal, academic and professional growth."

The Learning Center

"Our mission is to assist students both in the classroom and beyond by providing tutorial services, academic coaching, academic and personal enrichment workshops and staff and peer support so students can meet the demands of their coursework and are prepared for life after graduation."

Robert W. Van Houten Library

"The Van Houten Library offers electronic and print resources essential to the mission of New Jersey's science and technology university, including a core collection of academic books, databases, and journals, as well as research and consultation services."

Student Disability Services

"The Disability Support Services office works in partnership with administrators, faculty and staff to provide reasonable accommodations and support services for students with disabilities that have provided our office with documentation to receive services."

Student Financial Aid Services

"Student Financial Aid Services (SFAS) at NJIT is committed to providing you with every opportunity to obtain funding to support your undergraduate educational costs at NJIT."

Acknowledgement

This course includes materials adapted from Course CS229M by Prof. Tengyu Ma at Stanford University.