CORNELL TECH | HOME OF THE JACOBS TECHNION-CORNELL INSTITUTE

CS 5785/ORIE 5750/ECE 5414: Applied Machine Learning

Fall, 2024

Instructor: Prof. Kyra Gan

Meeting Time(s) and Location(s): Tuesday/Thursday 11:40 a.m. - 12:55 p.m., Bloomberg Auditorium (Bloomberg Center, Room 131)

Credits and Grading: 3, Letter Grade-Only

Course Description:

While most computer programs require a rigid specification of the precise behavior of the program through exact rules, machine learning offers an alternative path to automation: learning from experience. With machine learning, we can extract patterns from data, devising flexible programs with adaptable behavior. Machine learning addresses a diverse set of problem formulations, draws upon tools from diverse fields (e.g. statistics, computer science, information theory, optimization, optics, and cognitive science), and provides value in diverse application domains. Despite this breathtaking breadth, there's a common thread: machine learning is concerned with developing algorithms that improve (at some task and with respect to some evaluation metric) as they acquire more experience.

Course Objectives/Learning Outcomes:

By the end of this class, you will be able to:

- Articulate the fundamental problems addressed by machine learning and their exemplar applications, and be conversant with established tools of the trade.
- Describe and derive linear models and neural networks for arbitrary applications.
- Construct rigorous experiments from data collection to (cross-)validation to test set evaluation to robustness checks and ablation tests.
- Identify new opportunities to apply machine learning, executing an R&D project from beginning to end.

Course Frequency: Offered every Fall

Textbook(s) and/or Other Required Materials:

- Course slides and notes
- Dive into Deep Learning [free]: https://d2l.ai/
- Optional: Machine Learning by Tom Mitchell; Machine Learning—A Probabilistic Perspective by Kevin Murphy; Pattern Recognition and Machine Learning by Christopher Bishop.

Prerequisites: Cs 2800 or the equivalent plus basic familiarity with Python, or permission of the instructor.

Corequisites: Linear Algebra, Introduction to Probability

Course Staff/Teaching Assistants: TBD

Office Hours: TBD

Assignments, Exams and Projects:

- Class Participation 10%
- 5 Homeworks + Homework 0 40%
- Midterm Kaggle Competition 25%
- Group Final Project 25%

Typical Topics Covered:

- Supervised learning (non deep learning): linear regression, logistic regression, random forest, and regression trees
- Unsupervised learning: naive Bayes, gaussian mixture models, density estimation, clustering, and principal component analysis
- Deep learning: multilayer perceptrons, convolutional neural networks
- Advanced topics: recurrent neural networks, reinforcement learning, ethics in AI, causality

Method of Assessing Student Achievement:
Please provide a rubric of how grades are assessed for each activity:

Class Participation Rubric:

Component	Grade Percentage
Attendance and class survey partipation	60%
Contribution to class discussion	40%

Homework Rubric: see detailed instructions in each homework assignment
(each homework set will contain 1) questions on course lecturing material, 2) programming questions, and 3) written/math questions.

Midterm Kaggle Competition Rubric:

Component	Grade Percentage
Relative performance of the proposed method to different baseline methods and relative performance in Kaggle competition	70%
Midterm report quality (clarity, novelty of the proposed methods)	30%

Final Project Rubric:

Component	Grade Percentage
Final project one paragraph description (Due 10/23, Wed)	2%
Revised one-pager project description	3%
Final report writing quality (clarity, structure)	20%
Final report problem novelty: Is the problem well-defined? What are the difficulties in addressing the problem? Is the problem feasible to solve given existing ML methods?	25%
Final report proposed method: Is the proposed method suitable? Is the proposed method novel compared to current practices?	25%
Final report numerical evaluation: Is the data appropriate for the defined task? Are the evaluation metrics clear and suitable? Are the numerical results convincing?	25%

Grading:

The University Grading scale can be found here

Grade	**GPA**
A+	**4.3**
A	**4.0**

A-	**3.7**
B+	**3.3**
B	**3.0**
B-	**2.7**
C+	**2.3**
C	**2.0**
C-	**1.7**
D+	**1.3**
D	**1.0**
D-	**0.7**
F	**0.0**

Academic Integrity

All students should abide by the Cornell University Code of Academic Integrity, and all writing submitted should be one's own writing. While discussing course concepts with other students is highly encouraged, plagiarism (including the misuse of ChatGPT) will result in zero credit and/or a referral to the Office of Student & Academic Affairs. Please reach out if additional questions arise on what is or is not permitted.

Academic Misconduct

A faculty member may impose a grade penalty for any misconduct in the classroom or examination room. Examples of academic misconduct include but are not limited to, talking during an exam, bringing unauthorized materials into the exam room, and disruptive behavior in the classroom.

Students with Disabilities

Your access in this course is important to us. Please give us your Student Disability Services (SDS) accommodation letter early in the semester so that we have adequate time to arrange your approved academic accommodations. If you need immediate accommodations for equal access, please speak with us after class or send an email message to us and/or SDS at sds_cu@cornell.edu. If the need arises for additional accommodations during the semester,

please contact SDS. You may also feel free to speak with the Student & Academic Affairs team at Cornell Tech who will connect you with the university SDS office. If you have, or think you may have a disability, please contact Student Disability Services for a confidential discussion: sds_cu@cornell.edu, 607-254-4545, sds.cornell.edu. **You must request your SDS accommodation letter no later than 3 weeks prior to needing it.**

- Students currently registered with SDS: Once you request your accommodation letter and it is approved by SDS, it will be emailed to both you and your instructors. Processing time can be up to 48 hours.
- Students not registered with SDS: The registration process for new accommodations can take up to three weeks. Once you are approved by SDS for accommodations, you will be able to request your accommodation letter for this course.
- If you are approved for accommodations later in the semester: you must request your accommodation letter as soon as possible.

Mental Health & Well-being

Your health and well-being are important to us, and you should always feel free to reach out to us for support. There are services and resources at Cornell designed specifically to bolster student mental health and well-being. Remember, your mental health and emotional well-being are just as important as your physical health. If you or a friend are struggling emotionally or feeling stressed, fatigued, or burned out, there are many campus resources available to you:

Cornell Tech students: This link provides a list of resources for Cornell Tech students: https://mentalhealth.cornell.edu/get-support/tech. You can additionally also contact studentwellness@tech.cornell.edu with concerns.

Religious Observances

Cornell University is committed to supporting students who wish to practice their religious beliefs. Students are advised to discuss religious absences with their instructors well in advance of the religious holiday so that arrangements for making up work can be resolved before the absence. Students are encouraged to anticipate their religious/spiritual needs early in the semester, and at least two weeks before the observance, leaving plenty of time for the professor and student to reach a reasonable accommodation.