CPSC8420-001: Advanced Machine Learning, fall 2020

Duration: August 19 to December 11, 2020

Instructor: Kai Liu

Instructor email: kail@clemson.edu

Instructor phone: (720) 476-2638 (Note that email is my preferred form of communication)

Meeting time: TTh 11:00AM - 12:15PM (Please allow up to 15 minutes if I am late in starting a class meeting. Links to the Zoom sessions will be available from the Canvas course home page.)

Office hours: TTh 8:00 - 9:00 AM through Zoom, or by appointment through email

Class type: fully online, synchronous

Online Zoom: https://clemson.zoom.us/j/91000754537 (for classes and office hours)

Slides & recordings: on canvas 2-6 hours subsequently (to allow for Zoom post-processing)

Course Description

This course provides a broad introduction to machine learning with theoretical analysis. We will especially be interested in using mathematical models to explain why and when certain methods/models work, particularly we will pay attention to certain algorithms with convergence rate analysis.

Tentative topics covered in this course may include, but are not limited to:
- Linear Models for Regression
- Linear Models for Classification
- Gradient Descent with its Variations
- Support Vector Machine
- Principal Component Analysis & Independent Component Analysis
- Variable/Feature Selection & Sparsity
- Clustering & Projection & Matrix Factorization
- Manifold Learning
- Expectation Maximation & Alternating Minimization
- Adversarial Learning
- Reinforcement Learning
- Online/Stochastic Learning

Learning Objectives

Upon competition of this course, students will be able to:

- Master the principles of various machine learning algorithms
- Be familiar with modelling machine learning problems mathematically and optimizing the solutions
- Understand technical details of model assessment and selection
- Identify and use proper programming models to solve machine learning problems
- Be able to do machine learning research in certain direction

Recommended Materials

A textbook and some reference books are provided:

- Textbook: Trevor Hastie, Robert Tibshirani & Jerome Friedman. The elements of statistical learning (2nd edition), Springer, 2009.
- Reference: Shai Shalev-Shwartz, Shai Ben-David. Understanding Machine Learning (From Theory to Algorithms), Cambridge, 2014.
- Reference: Mehryar Mohri, Afshin Rostamizadeh & Ameet Talwalkar. Foundations of Machine Learning (2nd edition), MIT Press, 2018.
- Reference: Trevor Hastie, Robert Tibshirani & Martin Wainwright. Statistical Learning with Sparsity, CRC Press, 2015.

Technical Requirements

Ideally, students should have taken courses in Linear Algebra, Statistics, Optimization and Machine learning. Students should be comfortable with programming in MATLAB or Python.

Assessment Activities and Grading

The tentative grading scheme is as follows:

- Homework: 40% (5 problem sets)
- Final project: 25% (1-2 student team, proposal, progress report, presentation, report)
- Exam: 35% (take-home)

A standard 10-point scale will be guaranteed (i.e., A is 90-100, B is 80-89). Fractional semester averages will be rounded normally. There will be no curves for the exams, etc. However, based on the distribution of the final semester averages, I reserve the right to widen one or more grade bands to account for the clustering of semester averages

Grading Policies

Late Work

The homework assignments are graded out of 100 points, late submissions will be penalized at a rate 2 penalty points per hour. The final exam will take place 2 weeks prior to the final exam week, while the final project presentation will be done at the week before the final exam week. Because of the unusual nature of health-related circumstances that many of you and your families are experiencing this semester, out the 5 homework sets, only the best 4 will be taken into account for your final grade.

Computer or Network crashes are NOT an acceptable excuse for late submission. To avoid problems with such crashes and last-minute problems, students are encouraged to submit early.

Plagiarism will cause VERY serious issue, if it is confirmed, then students should be responsible for any possible results caused by that.

Course Feedback
You are welcome to ask questions or raise concerns about the course in class or to send me email anytime to give me feedback on the course.

Course and University Policies
Attendance
Daily attendance is not graded. However, Clemson students receiving Veteran Administration Educational benefits should interact at least weekly so that the University can certify weekly contact for an online course. Paper summary and evaluations should be completed before class discussion and will be graded. You can drop two lowest grades for paper summary and evaluation with no need to explain any absences. If you have medical issues or conflicts because of approved university activities, we will make arrangements for you to make up the missed work.

Specific COVID-19 related information for in-person classes
While on campus, face coverings are required in all buildings and classrooms. Face coverings are also required in outdoor spaces where physical distance cannot be guaranteed. Please be familiar with the additional information on the Healthy Clemsonwebsite, such as the use of disinfectant wipes for in-person classes. If an instructor does not have a face covering or refuses to wear an approved face covering without valid documented accommodation, students should notify the department chair. If a student does not have a face covering or refuses to wear an approved face covering without valid documented accommodation, the instructor will ask the student to leave the academic space and may report the student's actions to the Office of Community & Ethical Standards as a violation of the Student Code of Conduct. If the student's actions disrupt the class to the extent that an immediate response is needed, the instructor may call the Clemson University Police Department at 656-2222.

Academic Continuity Plan for this course
Clemson has developed an Academic Continuity Plan for academic operations. Should university administration officially determine that the physical classroom facility is not available to conduct classes in, class will be conducted in a virtual (online) format. The University issues official disruption notifications through email and social media. When notified, use one of the following links to navigate to Clemson Canvas where you will find important information about how we will conduct class:
- Primary access link: www.clemson.edu/canvas
- Secondary access link, if needed: https://clemson.instructure.com/
- You can also use the Canvas Student App.

Student Accessibility Services
Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to a class should let the professor know, and make an

appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848 or by emailing studentaccess@lists.clemson.edu. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: http://www.clemson.edu/campus-life/campus-services/sds/.

Email Policy / Response Time
You can expect a response to your email inquiries within 36 hours, excluding weekends and university holidays.

Copyright
All materials found in this course are strictly for the use of students enrolled in this course and for purposes associated with this course; they may not be retained or further disseminated. Clemson students, faculty, and staff are expected to comply fully with institutional copyright policy as well as all other copyright laws.

Academic Integrity
As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning." Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form.

A simple definition of plagiarism is when someone presents another person's words, visuals, or ideas as his or her own. The instructor will deal with plagiarism on a case-by-case basis. I will use, at my discretion, the Plagiarism Resolution Form. All infractions of academic dishonesty will be reported to Undergraduate Studies for resolution through that office.

See http://catalog.clemson.edu/content.php?catoid=28&navoid=879#undergraduate-academic-integrity for additional information about academic integrity at Clemson.

Title IX Policy
Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

The University is committed to combatting sexual harassment and sexual violence. As a result, you should know that University faculty and staff members who work directly with students are required to report any instances of sexual harassment and sexual violence, to the University's

Title IX Coordinator. What this means is that as your professor, I am required to report any incidents of sexual harassment, sexual violence or misconduct, stalking, domestic and/or relationship violence that are directly reported to me, or of which I am somehow made aware.

There are two important exceptions to this requirement about which you should be aware:
- Confidential Resources and facilitators of sexual awareness programs such as "Take Back the Night and Aspire to be Well" when acting in those capacities, are not required to report incidents of sexual discrimination.

- Another important exception to the reporting requirement exists for academic work. Disclosures about sexual harassment, sexual violence, stalking, domestic and/or relationship violence that are shared as part of an academic project, a research project, classroom discussion, or course assignment, are not required to be disclosed to the University's Title IX Coordinator.

This policy is located at http://www.clemson.edu/campus-life/campus-services/access/title-ix/. Ms. Alesia Smith is the Executive Director for Equity Compliance and the Title IX Coordinator. Her office is located at 223 Holtzendorff Hall, phone number is 864.656.3181, and email address is alesias@clemson.edu.

Student Support Services

Academic Success Center
The Academic Success Center provides free services, including tutoring, academic coaching, and academic skills workshops, for all Clemson students. Visit https://www.clemson.edu/asc/ for more information on their services and workshops.

Writing Center
Clemson University's Writing Center offers free one-on-one tutoring for all Clemson students. Visit https://www.clemson.edu/centers-institutes/writing/ for more information about their services or to make an appointment.

Cooper Library
Reference librarians are available in person and via text, phone, email, and chat to answer your research questions. Visit https://libraries.clemson.edu/ask-a-librarian/ for more information or to get in touch with a librarian.

Technical Support
If you are having hardware or software problems, CCIT's Service Desk may be able to help you. Contact them at ITHELP@clemson.edu with a detailed description of your problem.

Registrar
https://www.clemson.edu/registrar/ provides information about important deadlines, degree and program requirements, and other key information, including use of iROAR to add, drop, or withdraw from courses.