Machine Learning Principles
Computer Science 461
4 credits
Spring 2023

Instructor: Qiong Zhang
Meeting location: SEC 205
Prerequisites: M 250 (Introductory Linear Algebra), CS 112 (Data Structures), CS 206 (Introduction to Discrete Structures II) OR M 477 (Mathematical Theory of Probability) OR S 379 (Basic Probability Theory)
Meeting Times: M/H 10:20am-11:40am
Email: CS461_instructors@email.rutgers.edu

Course Description
This course is a systematic introduction to machine learning, covering theoretical as well as practical aspects of the use of statistical methods. Topics include linear models for classification and regression, support vector machines, regularization and model selection, and introduction to deep learning. Machine learning is a vast, fast-changing field. The course is designed to provide a solid starting point by focusing on technical foundations. Students will learn fundamental concepts in the field such as generalization and model selection. Students will also learn how to implement key techniques in the field from scratch including gradient descent, kernel trick, boosting, and expectation maximization. The course content will be delivered by a combination of written assignments that require rigorous proofs and self-contained Python Juypter Notebooks that require completing missing portions and empirically investigating the behavior of models on datasets. The course will reinforce learning with a series of short quizzes throughout the semester.The course content is designed to be accessible to all SAS students regardless of their majors who have an adequate background in linear algebra, calculus, probability, and programming.

Learning Objectives
The course objectives are: (1) understanding the goals, capabilities, and principles of machine learning, (2) acquiring mathematical tools to formalize machine learning problems, and (3) acquiring implementation skills to build practical machine learning systems. At the end of the course, students will have the knowledge of core machine learning techniques, so that they can use them to solve real-world prediction problems using basic Python and a small set of libraries. The knowledge they acquire in this course will directly transfer to any future courses they may take that go deeper into specific application areas of machine learning.

Text/Resources
There is no required text. Lecture slides are self-contained. To augment lectures, there will be optional reading from publicly available online textbooks such as:

Machine Learning, (Tom Mitchell, 1997)
Machine Learning: A Probabilistic Perspective (Murphy, 2012)

There will also be suggested reading from other publicly available technical notes written by various instructors/researchers.

Coursework Requirements

To assess that students have acquired basic literacy in all the concepts, tools, and techniques they are taught, they will be given 3 quizzes (each 15%) periodically through the semester.

There will be five assignments (each 10%). The assignments are designed to be challenging but rewarding. Collaboration is allowed and encouraged as long as students (1) write their own solutions entirely on their own, and (2) specify names of student(s) they collaborated with in their writeups. The students will need to digest and reformulate the lecture content in order to successfully complete the assignments. Discussion about assignment problems on Canvas is encouraged.

Students are expected to attend all classes and take notes on the most basic and important concepts discussed in each class. There will be ten in-class surveys distributed randomly across the semester (each 0.5%). They consist of short true and false questions which serve as attendance and attention check for that class.

Grade Evaluation

Quizzes	45%
Assignments	50%
Attendance survey	5%

Week 1
    General Introduction (01/19)

Week 2
    Decision Tree Learning (01/23, 01/26)

Week 3
    Estimating Probabilities (01/30, 02/02)

Week 4
    Naïve Bayes (02/06, 02/09)

Week 5
    Logistic Regression (02/13, 02/16)

Week 6
    Generalization I. (02/20)
    Quiz 1 (02/23)

Week 7
    Generalization II. (02/27)
    Model Selection I. (03/02)

Week 8
    Model Selection II. (03/06)
    Clustering I. (03/09)

Spring break 03/11-03/19

Week 9
    Clustering II. (03/20)
    SVM and Kernel I. (03/23)

Week 10
    SVM and Kernel II. (03/27)
    Linear Regression I. (03/30)

Week 11
    Quiz 2 (04/03)
    Linear Regression II. (04/06)

Week 12
    Neural Network Basics (04/10, 04/13)

Week 13
    Deep Neural Networks (04/17)
    Reinforcement Learning I (04/20)

Week 14
    Reinforcement Learning II (04/24)
    Advanced topics, Review (04/27)

Week 15
    Quiz 3 (05/01)

Academic Integrity Policies

Rutgers University regards acts of dishonesty (e.g. plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty. These policies are detailed here:

https://nbprovost.rutgers.edu/academic-integrity-students

In addition, the Computer Science departments has established policies for academic integrity that pertain specifically to programming assignments:

https://www.cs.rutgers.edu/academics/undergraduate/academic-integrity-policy/programming-assignments

Late Assignment Policies

You receive 8 total grace days for use on any homework assignment. We will keep track of them. No assignment will be accepted more than 3 days after the deadline or once the grace days run out.

In general, we do not grant extensions on assignments. There are several exceptions:

Medical Emergencies: For minor illnesses, we expect grace days or our late penalties to provide sufficient accommodation. For medical emergencies (e.g. prolonged hospitalization), students may request an extension afterwards and should include a doctor's note.
Family/Personal Emergencies: If you have a family emergency (e.g. death in the family) or a personal emergency (e.g. mental health crisis), please contact your academic adviser or Counseling Services. In addition to offering support, they will reach out to the instructors for all your courses on your behalf to request an extension.

The email should be sent as soon as you are aware of the conflict and at least 5 days prior to the deadline. In the case of an emergency, no notice is needed.

Student-Wellness Services

Just In Case Web App
http://codu.co/cee05e
Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS)
(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901/ www.rhscaps.rutgers.edu/
CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA)
(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 / www.vpva.rutgers.edu/
The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Disability Services
 (848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / https://ods.rutgers.edu/
Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.