CS 559-B Machine Learning: Fundamentals and Applications

2022 Spring

Time: Wednesday, 6:30PM-9:00PM, 2022 Spring
Location: McLean 218B or via Zoom https://stevens.zoom.us/j/99613721574 Passcode: cs559b22s
Instructor: Ping Wang
Email: ping.wang@stevens.edu
Office Hours: Thursday, 1:00PM-2:00PM via Zoom https://stevens.zoom.us/j/98697323146

Teaching Assistant:
Yifan Wang (ywang291@stevens.edu)
Course Email: mlfa.stevens@gmail.com
Office Hours: Wednesday, 3:30PM-5:30PM via Zoom
Zoom Link: https://stevens.zoom.us/j/4423606697 Passcode: 558648

Course Description:
This course introduces fundamental concepts, theories and algorithms for machine learning. The following topics will be covered: Bayesian decision theory, maximum likelihood estimation, latent variable model, EM algorithm, component analysis, clustering, support vector machine, boosting and deep learning with neural networks.

Prerequisites:
It is important that you have a solid background of mathematics and probability. You should have taken Math 222: Probability Theory or CS 556: Mathematical Foundations of Machine Learning (or equivalent).

Course Materials:
- C. Bishop, Pattern Recognition and Machine Learning, Springer, 2006 http://users.isr.ist.utl.pt/~wurmd/Livros/school/Bishop%20-%20Pattern%20Recognition%20And%20Machine%20Learning%20-%20Springer%20%202006.pdf
- Goodfellow et al., Deep Learning, MIT, 2016 https://www.deeplearningbook.org/
- Hastie, Trevor and Tibshirani, Robert and Friedman, Jerome, 2008. The Elements of Statistical Learning https://web.stanford.edu/~hastie/ElemStatLearn/printings/ESLII_print12_toc.pdf

Objectives and Learning Outcomes:

- Decision Theory - Explain Bayesian decision theory, the likelihood ratio, and minimum risk classification.
- Maximum Likelihood Estimation - Implement Maximum Likelihood Estimation for Logistic Regression.
- Dimensionality Reduction - Apply dimensionality reduction using Principal Component Analysis.
- Linear Discriminant Functions - Implement classifiers using linear discriminant functions and Fisher Linear Discriminant Analysis.
- Non-parametric Learning - Implement k-nearest neighbors, and perform non-parametric classification.
- Clustering – Implement k-means clustering, and perform EM for Gaussian mixtures.
- Support Vector Machines - Explain the advantages of Support Vector Machines and margin maximization.
- Boosting - Explain boosting and decision tree models.
- Neural Networks – Implement backpropagation for basic neural networks.

Tentative Schedule:

Week	Date	Topic	HW
1	Jan 19	Introduction and Overview	
2	Jan 26	Linear Regression	HW1 Out
3	Feb 2	Linear Classification	
4	Feb 9	Logistic Regression, PCA	HW2 Out; HW1 Due
5	Feb 16	Support Vector Machines	
6	Feb 23	Decision Trees and Boosting	
7	Mar 2	Non-parametric Learning	HW2 Due; HW3 Out
8	Mar 9	Midterm Exam	
9	Mar 16	Spring Recess: No class	
10	Mar 23	Clustering, K-means	
11	Mar 30	Gaussian Mixture Model, EM	HW3 Due
12	Apr 6	Graphical models	HW4 Out
13	Apr 13	Neural Networks	HW5 Out (Optional)
14	Apr 20	Deep learning	
15	Apr 27	Final Review	HW4 Due
16	May 4	Friday Class Schedule: No class	HW5 Due
17	May 11	Final Exam	

Important Dates:

- **Mar 9: Midterm exam**
- **May 11: Final exam**

Grading Policy: The course will use the following grading scale: A (90-100), A- (85-90), B+ (80-85), B (75-80), B- (70-75), C+ (65-70), C (60-65), F (<60).

- **Homework (35%):** There will be five homework assignments with both written and programming problems. HW5 will be optional. Only four homework with the highest score will be considered

in the final grading. The assignments are designed to help you deepen your understanding of the theoretical concepts.

- **Midterm Exam (30%):** The midterm exam will be an in-class written exam to evaluate your understanding of the course so far.
- **Final Exam (30%):** The final exam will be an in-class written exam to evaluate your understanding of the whole course.
- **Participation (5%):** Attending classes, participating in classes. You are also encouraged to initiate or participate in discussions on Canvas, which will also be considered as class participation.

Submission and Late Policy:

- All the homework assignments must be **submitted on Canvas before 6:30 PM** on the due date.
  - Any late submission within 24 hours will be penalized 10%.
  - Any late submission within 24-48 hours will be penalized 20%.
  - Any late submission within 48-72 hours will be penalized 40%.
  - The 72 hours after the deadline will be the hard deadline for each assignment. Assignments submitted after this hard deadline will not be graded and get no points for the assignment.
- You are encouraged to work and discuss in a group, but you have to write down and **submit your OWN answers and codes.**

Undergraduate Honor System

Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at http://web.stevens.edu/honor/

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Reporting Honor System Violations

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor.

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the

process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.

Learning Accomodations

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/office-disability-services. If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at pgehman@stevens.edu or by phone 201-216-3748.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

Inclusivity

Name and Pronoun Usage

As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

Inclusion Statement

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester.

Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

Mental Health Resources

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments are can be made by phone (201-216-5177).

Emergency Information

In the event of an urgent or emergent concern about the safety of yourself or someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text "Home" to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu. A member of the CARE Team will respond to your concern as soon as possible.