Applied Machine Learning – CPE/EE/AAI 695WS/WS1

Schaefer School of Engineering & Science
Fall 2022

Meeting Times: **6:30pm – 9:00pm**, Wednesday
Classroom Location: Live stream over Zoom at https://stevens.zoom.us/j/96964224910

Instructor: Shucheng Yu (Associate Professor, ECE Department, Office: B211)
Contact Info: shucheng.yu@stevens.edu (Message on Canvas is preferred)

Office Hours: **1:00pm – 4:00pm Tuesdays**
Zoom link: https://stevens.zoom.us/j/99678884042

Course Web Address: https://sit.instructure.com/courses/61342

Prerequisite(s): Basic probability and statistics; familiarity with Python language.
Corequisite(s): None
Cross-listed with: N/A

COURSE DESCRIPTION

An introductory course for machine learning theory, algorithms, and applications. The content aims to provide students with the knowledge to understand key elements of how to design algorithms/systems that automatically learn, improve, and accumulate knowledge with experience. Topics covered in this course include decision tree learning, neural networks, Bayesian learning, reinforcement learning, ensembling multiple learning algorithms, and various application problems. Students will be provided opportunities to simulate their algorithms in a programming language and apply them to solve real-world problems.

LEARNING OBJECTIVES

After successful completion of this course, students will be able to…

- **Demonstrate** basic principles and algorithms of representative machine learning systems including supervised learning, unsupervised learning, batch learning, online learning, model-based learning, and instance-based learning.
- **Determine** appropriate machine learning algorithms for real-world tasks.
- **Evaluate** the performance of a machine learning system with appropriate performance measurement metrics.
- **Apply** appropriate training, evaluation, and parameter tuning techniques to improve machine learning algorithms.
- **Develop** a machine learning system with programming languages such as Python.
- **Create** interactive documentation with program codes and rich texts.

- **Write** a comprehensive report to communicate the main ideas, techniques, and findings of a machine learning project.

FORMAT AND STRUCTURE

- This course is offered in person. To access the course materials online, please visit stevens.edu/canvas (Links to an external site.) . For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

COURSE MATERIALS

Textbook(s):

- Mitchell, T. (2017). *Machine learning*. New York: McGraw Hill. ISBN-13: 978-1-25-909695-2
- Géron, A. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow : concepts, tools, and techniques to build intelligent systems*. Sebastopol, CA: O'Reilly Media, Inc. ISBN-10: 1492032646

Other Readings:

- Bishop, Christopher M. *Pattern recognition and machine learning*. New York: Springer, 2006. Print. Available online here.
- Marsland, S. (2015), *Machine Learning An Algorithmic Perspective*, 2nd Edition. CRC Press.
- Goodfellow, I., Bengio, Y. & Courville, A. (2016). *Deep learning*. Cambridge, Massachusetts: The MIT Press.

Materials: All other materials and slides will be uploaded to course website (Canvas).

COURSE REQUIREMENTS

This course is designed to train you with both theoretical/algorithmic knowledge and hands-on skills. As you move through the topics in each module, rather than simply viewing lecture content, you will be asked to read, interact with a variety of media, and practice with programming examples and tasks and regularly prompted to actively evaluate your knowledge as you're building it.

The components in each module are designed to be completed sequentially. In addition to videos, readings, and interactives, please bring your attention to a few types of learning activities you'll encounter.

- **Homework:** There are five homework assignments throughout the course. Each homework presents you with a problem-based scenario to solve. Homework addresses the basic concepts as well as programming.
- **Quizzes:** At the end of each module, you will complete a graded quiz covering concepts introduced in the module. These quizzes are designed to assess your learning at regular intervals, identify gaps in knowledge, and help you prepare for the course exams.
- **Midterm Exam:** The midterm exam covers content from Modules 1–8.
- **Final Project:** You will work in teams of three to complete the Final Project. There are three milestones for the final project: proposal, mid-stage report, and a final report with a recorded presentation.

- **Class Participation:** You are expected to actively participate in class discussions and interact with your project team after class (teamwork & communication).
- **Office Hours:** Use this time to ask your instructor about any concepts you are struggling with, difficulties with assignments, or simply share something relevant to the class you encountered this week.
- **Late Policy:** All assignments (homework, quizzes, final project submissions) have a deadline. For homework and final project submissions, 25% penalty will be applied if submitted within 7 days after the deadline. No submission is accepted beyond 7 days after the deadline. The deadlines for the quizzes are hard and no late submission will be accepted. Midterm exam will be taken at the scheduled date and time. No make-up exam will be offered. In case of exceptional situations (e.g., medical emergency) and accommodation is needed, official proof (e.g., doctor's note or approval from Disability Office) shall be provided and the instructor shall be contacted in advance if possible.

GRADING PROCEDURES

Grades will be based on:

Homework	(32 %)	320 points
Module Quizzes	(16 %)	160 points
Mid-term Exam	(12 %)	120 points
Team Project	(30%)	300 points
Class Participation	(10 %)	100 points
Total	100%	1000 points

ACADEMIC INTEGRITY

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.

EXAM ROOM CONDITIONS

The following procedures apply to quizzes and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Room Conditions on the quiz or exam.

1. Students may use the following devices during quizzes and exams. Any electronic devices that are not mentioned in the list below are not permitted.

Device	**Permitted?**	
	Yes	No

Laptops	X	
Cell Phones		X
Tablets		X
Smart Watches		X
Google Glass		X
Other (non-programmable calculator)	X	

2. Students may use the following materials during quizzes and exams. Any materials that are not mentioned in the list below are <u>not</u> permitted.

Material	**Permitted ?**	
	Yes	No
Handwritten Notes *Conditions*: one A4 sheet	X	
Typed Notes *Conditions*: one A4 sheet	X	
Textbooks Conditions: textbooks as defined in "Course Materials"	X	
Readings Conditions: other readings as defined in "Course Materials" and printouts of lecture interactive modules	X	

3. Students <u>are not</u> allowed to work with or talk to other students during quizzes and/or exams.

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.

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.

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.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and in-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.

TENTATIVE COURSE SCHEDULE

The following is a tentative course schedule. Any changes to this schedule will be communicated to you 1) via class lecture and/or 2) via email. The Canvas shell for this course will always be kept up to date so you can always reference the "Assignments" tab for accurate due dates.

Modules	Topic(s)	Readings	Assignment

#1: Sept. 7	Introduction & Tools	Mitchell, Chapter 1 Géron, Chapters 1 and 2	**Module 1 Quiz** Begin Homework 1
#2: Sept. 14	Linear Regression	Géron, Chapter 4	**Module 2 Quiz** Continue Homework 1
#3: Sept.21	Logistic Regression	Géron, Chapters 3 and 4 Jurafsky and Martin (3rd Ed.), Chapter 5	**Module 3 Quiz** **Submit Homework 1** Begin Homework 2 **Form a team**
#4: Sept. 28	Decision Tree Learning	Mitchell, Chapter 3 Géron, Chapter 6	**Module 4 Quiz** Continue Homework 2 **Submit Team Contract**
#5: Oct. 5	Bias-Variance Tradeoff; Ensemble Learning; Random Forest	Géron, Chapter 7	**Module 5 Quiz** **Submit Homework 2** Begin Homework 3
#6: Oct. 12	Support Vector Machine	Géron, Chapter 5	**Module 6 Quiz** Continue Homework 3 **Submit Team Project Proposal**
#7: Oct. 19	Bayesian Learning	Mitchell, Chapter 6	**Module 7 Quiz** **Submit Homework 3** Begin Homework 4
#8: Oct. 26	Artificial Neural Networks; mid-term review	Mitchell, Chapter 4 Géron, Chapter 10	**Module 8 Quiz** Continue Homework 4
#9: Nov. 2	**Midterm Exam**		
#9: Nov. 9	Evaluating Hypothesis	Mitchell, Chapter 5 Géron, Chapter 15	**Module 9 Quiz** Continue Homework 4 **Submit Team Project Mid-Stage Report**
#10: Nov. 16	Unsupervised Learning; Dimensionality Reduction	Marsland, Sections 7.1 and 14.1 Géron, Chapters 8 and 9	**Module 10 Quiz** Submit Homework 4 Begin Homework 5
#11. Nov. 23	Thanksgiving Holiday. No Class		
#11: Nov. 30	Genetic Algorithms	Mitchell, Chapter 9 Marsland, Chapters 10	**Module 11 Quiz** Continue Homework 5
#12: Dec. 7	Introduction to Deep Learning (1)	Géron, Chapters 11 and 14	**Module 12 Quiz** Submit Homework 5
#13: Dec. 14	Introduction to Deep Learning (2)	Géron, Chapter 15 and 16	**Module 13 Quiz**
#15. Dec. 21	**Submit 1) Final Report and 2) Presentation Video**		