Applied Machine Learning – CPE/EE/AAI 695A
Schaefer School of Engineering & Science
Fall 2023

Instructor: Prof. Shucheng Yu
Canvas Course Address： https://sit.instructure.com/courses/67763
Course Schedule: Wednesday - Tuesday
Contact Info: shucheng.yu@stevens.edu (Burchard 211)
Virtual Office Hours: **1:00pm – 4:00pm, Wednesday**
    Zoom link: https://stevens.zoom.us/j/99678884042

Teaching Assistant: Mr. Ruiran Wang (email: rwang43@stevens.edu)
    Office hours: **2:00pm – 4:00pm, Friday**
    Zoom link: https://stevens.zoom.us/j/92491482533 (or Burchard 213)

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

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.

STUDENT LEARNING OUTCOMES
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.

COURSE FORMAT AND STRUCTURE

This course is on-campus. To access the course, please visit stevens.edu/canvas . For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

Instructor's Online Hours

I prefer **Canvas Messenger** for online communications instead of emails (but emails are also welcome for urgent questions). I will be available via Canvas Messenger and respond as soon as I am available (generally within 24-48). I will check my messages at least three times per week. Furthermore, there is a Discussion forum on Canvas that you can use to ensure that you have my attention – to ask questions or to call my attention to a particular discussion you are engaged in that you would like me to take a look at. Keep in mind that it is not possible for me to respond to every single posting every week (nor is it pedagogically appropriate), but I will be sure to respond to various postings and students each week and attempt to assure equality in terms of responses to students. If you feel you are being neglected in any way, please contact me. When messaging me, please place in the subject line the course number/section and the topic of the email (i.e., CPE 695 – Homework 2 Question). This will help me tremendously in understanding what you are looking for.

Virtual Office Hours
Virtual Office Hours are a synchronous session through Zoom to discuss questions related to weekly readings and/or assignments. Office hours will be held Wednesday afternoons from 1:00-4:00 pm EST. To connect to the weekly session, go to https://stevens.zoom.us/j/99678884042.

Online Etiquette Guidelines

Your instructor and fellow students wish to foster a safe online learning environment. No matter how different or controversial they may be perceived, all opinions and experiences must be respected in the tolerant spirit of academic discourse. You are encouraged to comment, question, or critique an idea, but you cannot attack an individual. Our differences, some of which are outlined in the University's inclusion statement below, will add richness to this learning experience. Please consider that sarcasm and humor can be misconstrued in online interactions and generate unintended disruptions. Working as a community of learners, we can build a polite and respectful course ambiance. Please read the Netiquette rules for this course:
- Do not dominate any discussion. Allow other students to join in the discussion.
- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.

- Avoid using vernacular and/or slang language as it could lead to misinterpretation.
- Keep an "open-mind" and be willing to express even your minority opinion.
- Think and edit before you push the "Send" button.
- Do not hesitate to ask for feedback.

TENTATIVE COURSE SCHEDULE

The following is a <u>tentative</u> 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. 6	Course Logistics. Introduction to ML. Polynomial fitting. Programming & tools.	Mitchell, Chapter 1 Géron, Chapters 1 and 2	**Module 1 Quiz** Begin Homework 1
#2: Sept. 13	Programming & tools. Linear Regression	Géron, Chapter 4	**Module 2 Quiz**
#3: Sept. 20	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. 27	Decision Tree Learning	Mitchell, Chapter 3 Géron, Chapter 6	**Module 4 Quiz** **Submit Team Contract**
#5: Oct. 4	Bias-Variance Tradeoff; Ensemble Learning; Random Forest	Géron, Chapter 7	**Module 5 Quiz** **Submit Homework 2** **Begin Homework 3**
#6: Oct. 11	Support Vector Machine	Géron, Chapter 5	**Module 6 Quiz** **Submit Team Project Proposal**
#7: Oct. 18	Bayesian Learning	Mitchell, Chapter 6	**Module 7 Quiz** **Submit Homework 3** **Begin Homework 4**
#8: Oct. 25	Artificial Neural Networks;	Mitchell, Chapter 4 Géron, Chapter 10	**Module 8 Quiz**
#9: Nov. 1	Evaluating Hypothesis (Zoom recording; no in-person meeting) **Midterm Exam**	Mitchell, Chapter 5 Géron, Chapter 15	**Module 9 Quiz**
#10: Nov. 8	Instance-based learning. Unsupervised Learning.	Marsland, Sections 7.1 and 14.1 Géron, Chapters 8 and 9	**Module 10 Quiz** **Submit Homework 4** **Begin Homework 5** **Submit Team Project Mid-Stage Report**
#11: Nov. 15	Genetic Algorithms	Mitchell, Chapter 9 Marsland, Chapters 10	**Module 11 Quiz**
#12: Nov. 22	Thanksgiving Holiday. No class		

#13: Nov. 29	Introduction to Deep Learning (1)	Géron, Chapters 11 and 14	**Module 12 Quiz** **Submit Homework 5**
#14: Dec. 6	Introduction to Deep Learning (2)	Géron, Chapter 15 and 16 Invited talk	**Module 13 Quiz**
#15: Dec. 13	Introduction to Deep Learning (3)	Invited talk	**Module 14 Quiz**
#16. Dec. 15	**Submit 1) Final Report and 2) Presentation Video**		

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.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses
- Basic computer and web-browsing skills
- Navigating Canvas

Technology skills necessary for this specific course
- Live web conferencing using Zoom
- Recording, editing, and uploading video via Zoom

Required Equipment
- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Required Software
- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint
- Latex
- Anaconda with Jupyter Notebook

GRADING PROCEDURES

Grades will be based on:

Homework	30%
Quizzes	30%
Mid-term Exam	10%
Team Project	30%

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.

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 on the Office of Graduate Academics web page.

EXAM 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 Conditions on the quiz or exam.
1. Students may use the following materials during quizzes and/or exams. Any materials that are not mentioned in the list below are not permitted.

Material	Permitted?	
	Yes	No
Handwritten Notes Conditions: i.e. size of note sheet	X	

Typed Notes Conditions: i.e. size of note sheet	X	
Textbooks Conditions: i.e. specific books	X	
Readings Conditions: i.e. specific documents	X	
Other (specify)		

2. Students allowed to other quizzes ... are/are NOT work with or talk to students during 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.

For more information about Disability Services and the process to receive accommodations, visit https://www.stevens.edu/student-diversity-and-inclusion/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.