Course Information

Course Number:	CSCE-633
Course Title:	Machine Learning
Section:	Spring 2022
Course Website	https://people.engr.tamu.edu/guni/csce633
Time:	TR, 8:00 – 9:15
Location:	ZACH 310
Credit Hours:	3

Instructor Details

Instructor:	Dr. Guni Sharon
Office:	PETR 316
Phone:	
E-Mail:	guni@tamu.edu
Office Hours:	Tuesday, 9:00-10:00am

Course Description

Machine learning is a sub-field of Artificial Intelligence that gives computers the ability to learn and/or act without being explicitly programmed. Applications of machine learning have permeated many aspects of every-day life and can be found among others in self-driving cars, speech recognition, computer vision, and genomics. The course will cover important advances in the theory and algorithms that form the foundation of this field. This course will provide a broad introduction to the field of machine learning.

Course Prerequisites

- MATH 304
- STAT 211,
- (CSCE 221 or STAT 404)

Recommended Background

- **Proficiency in Python**. All class assignments will be in Python. For those who aren't as familiar with Python, please follow this tutorial: https://www.w3schools.com/python/python_intro.asp. In the tutorial, go over all topics under "Python Tutorial", "Python NumPy". It will also be beneficial to go over all topics under "Machine Learning".

- **College Level Calculus, Linear Algebra**. You should be comfortable taking derivatives and understanding matrix vector operations and notation. Go over the "Essence of linear algebra" and "Essence of calculus" playlists by "3Blue1Brown" at https://www.youtube.com/c/3blue1brown/playlists
- **Basic Probability and Statistics**. You should be familiar with basics of probabilities, Gaussian, Beta, and Binomial distributions, mean, standard deviation, etc. Go over the "Probabilities of probabilities" playlist by "3Blue1Brown" at https://www.youtube.com/c/3blue1brown/playlists
- **Foundations of Machine Learning**. We will be formulating cost functions, taking derivatives, and performing optimization with gradient descent. Some optimization tricks will be more intuitive with some knowledge of convex optimization.

Special Course Designation

None

Course Learning Outcomes

The objective of this course is to teach fundamental methods of machine learning with focus on the theoretical underpinnings, practical implementations, and experimentation. Upon completion of the course students will:

1. Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
2. Gain an understanding of the strengths and weaknesses of many popular machine learning approaches.
3. Uncover the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and unsupervised learning.
4. Be able to design and implement various machine learning algorithms in a range of real-world applications.

Textbook and/or Resource Materials

Books as pdf are available for free through the curse's website.

- Machine Learning Refined, 2nd Edition, Watt, Borhani, and Katsaggelos
- Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig.
- Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
- Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.

Grading Policy

Online quizzes (10%): Short (~15 minutes) online quizzes will be given at the end of each topic.
Programing Assignments (50%): Students will implement various ML algorithms throughout the course of the semester. Note that not all assignments bare the same weight in the final grade.

Written Assignments (10%): Written assignments will be given at the end of each topic. Note that not all assignments bare the same weight in the final grade.
Midterm Exam (30%): A midterm exam covering all topics up to the exam.

Grading Scale

A = 90-100
B = 80-89
C = 70-79
D = 60-69
F = <60

Late Work Policy

You can use 6 late days.
A late day extends the deadline by 24 hours.
You are allowed up to 2 late days per assignment. If you hand an assignment in after 48 hours, it will be worth at most 50%. No credit will be given to assignments handed in after 72 hours — contact us if you think you have an extremely rare circumstance for which we should make an exception. This policy is to ensure that feedback can be given in a timely manner.
On a joint submission, group members cannot pool late days: in other words, to use 1 late day all group members must allocate 1 late day.

Course Schedule

Event	Week	Description	Required reading
Assignment(p0)	1	Warmup: Python, NumPy, Pandas	
Lecture1	1	Introduction	1. Linear Algebra Review 2. Probability Review 3. python tutorial
Lecture2	1	k-nearest neighbors	1. explanation of nearest neighbors 2. videos of different values of k
Assignment(w1)	2	Written assignment KNN	
Lecture3	2	Perceptron	Article in the New Yorker on the Perceptron
Assignment(p1)	2	Programing assignment Perceptron	
Lecture4	2	Generative models	
Assignment(w2)	3	Written assignment Generative models	
Lecture 5	3	Probabilistic reasoning	
Lecture6	3	Bayesian networks	
Lecture7	4	Naïve Bayes	1. Tom Mitchell's book chapter on **Naive Bayes** (chapters 1-3) 2. Youtube videos on **Naive Bayes**

Lecture8	4	Logistic Regression	1. Tom Mitchell's book chapter on Naive Bayes and Logistic Regression 2. Youtube videos on Logistic Regression
Lecture 9	5	Gradient decent	1. blogpost on Gradient Descent, Adagrad, Newton's method
Lecture10	5	Linear Regression	1. https://machinelearningmastery.com/linear-regression-for-machine-learning/
Assignment(p2)	5	Logistic and Linear regression	1.
Lecture11	6	Linear SVM	
Lecture12	6	Empirical Risk Minimization	
Lecture13	7	ML Debugging, Over-Underfitting	1. Andrew Ng's lecture on ML debugging
Lecture14	7	Kernelization	
Lecture15	8	Kernel functions	
Lecture 16	8	Kernel Machines	
Assignment(p3)	8	Kernel SVM	
Lecture 17	9	Decision trees	
Lecture18	9	Bagging	
Lecture19	10	Boosting	
Assignment(p4)	9	Decision trees	
Lecture20	10	Artificial Neural Networks / Deep Learning	Deep Learning book Chp 2
Lecture21	11	Python Automatic Differentiation libraries	
Assignment(p5)	11	Programing assignment+ contest PyTorch	
Lecture22	11	Derivative free optimization	CMA-ES
Lecture24	12	Multi-armed bandits	SB (Sutton and Barton) Chp 2
Lecture25	13	Markov-decision processes	SB Chp 3
Assignment(w3)	13	MDP	
Lecture24	14	Value Iteration	
Assignment(p6)	14	Value iteration	

University Policies

Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments.

Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor.

Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines.

Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1).

"The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do."

"Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20).

You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at aggiehonor.tamu.edu.

***NOTE**: Faculty associated with the main campus in College Station should use this Academic Integrity Statement and Policy. Faculty not on the main campus should use the appropriate language and location at their site.*

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit disability.tamu.edu. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

***NOTE**: Faculty associated with the main campus in College Station should use this Americans with Disabilities Act Policy statement. Faculty not on the main campus should use the appropriate language and location at their site.*

Title IX and Statement on Limits to Confidentiality

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking.

With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1):

- The incident is reasonably believed to be discrimination or harassment.
- The incident is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, you will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University's goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS).

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University's Title IX webpage.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors that influence a student's academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.

COVID-19 Temporary Amendment to Minimum Syllabus Requirements

The Faculty Senate temporarily added the following statements to the minimum syllabus requirements in Fall 2020 as part of the university's COVID-19 response.

Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, Texas A&M University has adopted policies and practices for the Fall 2020 academic term to limit virus transmission. Students must observe the following practices while participating in face-to-face courses and course-related activities (office hours, help sessions, transitioning to and between classes, study spaces, academic services, etc.):

- Self-monitoring—Students should follow CDC recommendations for self-monitoring. **Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.**
- Face Coverings—Face coverings (cloth face covering, surgical mask, etc.) must be properly worn in all non-private spaces including classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource and support offices, and outdoor spaces where 6 feet of physical distancing is difficult to reliably maintain. Description of face coverings and additional guidance are provided in the Face Covering policy and Frequently Asked Questions (FAQ) available on the Provost website.
- Physical Distancing—Physical distancing must be maintained between students, instructors, and others in course and course-related activities.
- Classroom Ingress/Egress—Students must follow marked pathways for entering and exiting classrooms and other teaching spaces. Leave classrooms promptly after course activities have concluded. Do not congregate in hallways and maintain 6-foot physical distancing when waiting to enter classrooms and other instructional spaces.
- To attend a face-to-face class, students must wear a face covering (or a face shield if they have an exemption letter). If a student refuses to wear a face covering, the instructor

should ask the student to leave and join the class remotely. If the student does not leave the class, the faculty member should report that student to the Student Conduct office for sanctions. Additionally, the faculty member may choose to teach that day's class remotely for all students.

Personal Illness and Quarantine

Students required to quarantine must participate in courses and course-related activities remotely and **must not attend face-to-face course activities**. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities.

Students experiencing personal injury or Illness that is too severe for the student to attend class qualify for an excused absence (See Student Rule 7, Section 7.2.2.) To receive an excused absence, students must comply with the documentation and notification guidelines outlined in Student Rule 7. While Student Rule 7, Section 7.3.2.1, indicates a medical confirmation note from the student's medical provider is preferred, **for Fall 2020 only, students may use the Explanatory Statement for Absence from Class form in lieu of a medical confirmation. Students must submit the Explanatory Statement for Absence from Class within two business days after the last date of absence.**

Operational Details for Fall 2020 Courses

For additional information, please review the FAQ on Fall 2020 courses at Texas A&M University.

College and Department Policies

College and departmental units may establish their own policies and minimum syllabus requirements. As long as these policies and requirements do not contradict the university level requirements, colleges and departments can add them in this section.