Course Syllabus

CSCE 421-200/500 Machine Learning

Course Information

Course Number: 421
Course Title: Machine Learning
Section: 200 (HNR), 500
Time: TR 9:35am-10:50am
Location: ZACH 350
Credit Hours: 3

Instructor Details

Instructor: Yoonsuck Choe
Office: PETR 327
Phone: 979-845-5466
E-Mail: choe@tamu.edu
Office Hours: TR 1:00pm-2:30pm Tuesday/Thursday (Zoom only: **https://tamu.zoom.us/my/yoonsuckchoe (https://tamu.zoom.us/my/yoonsuckchoe)**)

TA: Xilong Zhou
Zoom: **https://tamu.zoom.us/j/3510296288 (https://tamu.zoom.us/j/3510296288)**
E-Mail: zhouxilong199213@tamu.edu
Office Hours: : MF 2-3 pm (Zoom)

TA: Ankit Garg
Zoom: TBA
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Office Hours: TBA

Course Description

From the course catalog: Theoretical foundations of machine learning, pattern recognition and generating predictive models and classifiers from data; includes methods for supervised and unsupervised learning (decision trees, linear discriminants, neural networks, Gaussian models, non-parametric models, clustering, dimensionality reduction, deep learning), optimization procedures and statistical inference.

Specific to this course:

1. learn the theoretical foundations of machine learning,
2. learn various problems and solution strategies in machine learning, and
3. learn practical methodology for applying ML algorithms to problem domain of your choice.

Objectives:

1. Become confident in the basic mathematics and algorithms underlying machine learning.
2. Become confident in applying machine learning techniques to solve novel problems.
3. Become effective in rapidly prototyping machine learning algorithms.
4. Become effective in designing and conducting experiments with machine learning algorithm, and analyzing the results.

Course Prerequisites

Prerequisites: Grade of C or better in MATH 304, MATH 311, or MATH 323; grade of C or better in STAT 211; grade of C or better in CSCE 221 or STAT 404.
Cross Listing: STAT 421/CSCE 421

Special Course Designation

Students taking this course for HNR credit (registered in section 200) will be assigned additional work, on top of the regular homework, programming assignments, and exams.

Course Learning Outcomes

1. Knowledge of basic mathematics and algorithms underlying various machine learning techniques.
2. Knowlege of various supervised, unsupervised, and reinforcement learning algorithms.
3. Ability to implement, from scratch, the above mentioned learning algorithms.
4. Ability to formulate problems in a machine learning framework, and select the most appropriate machine learning algorithm.
5. Ability to design and conduct machine learning experiments.
6. Ability to analyze the results from machine learning experiments.

7. Appreciation of latest advances in machine learning (including but not limited to biologically motivated, neuroscience-inspired machine learning methods).
8. Ability to seek more advanced knowledge in machine learning, as needed.
9. Ability to use Colab for rapid prototyping, experimenting, and documenting.

Textbook and/or Resource Materials

- Main text (required): Ethem Alpaydin (2020) Introduction to Machine Learning, 4th edition, MIT Press. [**Book home page (4th edition)** **(https://mitpress.mit.edu/books/introduction-machine-learning-fourth-edition)**] [**Book home page (3rd edition)** **(http://www.cmpe.boun.edu.tr/~ethem/i2ml3e/)**]
- Secondary text (optional but strongly recommended): Tom Mitchell (1997) Machine Learning, McGraw-Hill. [**Book home page** **(http://www.cs.cmu.edu/~tom/mlbook.html)**]
- Other recommended books:
  - Kevin P. Murphy, "Probabilistic Machine Learning: An Introduction", MIT press, 2021. **[Book web site, with downloadable full text]** **(https://probml.github.io/pml-book/book1.html)**
  - Chris Bishop, "Pattern Recognition and Machine Learning", Springer, 2006. **[Book web site]** **(https://www.microsoft.com/en-us/research/people/cmbishop/prml-book/)** .
  - Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learing", MIT press, 2016. **[Book web site]** **(https://www.deeplearningbook.org/)**
  - Aston Zhang, Zachary C. Lipton, Mu Li, and Alesander J. Smola, "Dive into Deep Learning", **[Book web site, with downloadable jupyter notebook files]** **(http://d2l.ai/)**

Grading Policy

1. 4 assignments (each includes written and programming components), 12% each = 48%.
   - Late policy: 1 point (out of 100 point total) deduction per hour (24/100 per day).
   - All submissions should be done as colab notebooks. Download the ipynb file and submit it to Canvas.
     - After completing each problem in the homework, "pin" the revision.
     - As a separate file, submit the revision logs (turn off "Output", compare current pin with immediate previous pin).
     - Hand-written notes may be included in the notebook (scan or photo).
     - If you are using a local Jupyter notebook install, submit your history (run the following command)
       - %history -g -f filename.log
2. 2 exams (midterm 23%, final 23%) = 46%
   - Exam will be conducted ~~on Canvas~~ in class, in-person.
3. Attendance: 6%
   - 1% deduction per unexcused absence (see TAMU student rules for excusable absences). Per university rule, only one interview is excusable. You should schedule your interview to avoid

the fixed midterm and final dates.
- Forged signatures will lead to 'F'. Use a consistent style. Do not use initials.

Late Work Policy

Late penalty: 1 point (out of 100) per hour. Late submissions will not be accepted 4 days after the deadline and/or after the solution has been posted.

Local Course Policy

- All work should be done **individually** and **on your own**.
- If you find solutions to homeworks or programming assignments on the web (or in a book, etc.), check with the instructor first to determine if you can use it or not.
- Assignments turned in that are significantly similar will be reported to the Aggie Honor System Office.
- **There will be no make up exams** unless it is due to a genuine emergency defined by university rules. Examples of events that **do not** count as an emergency include the following: (1) Merely visiting the doctor's office without an explicit note from the office requesting absence. (2) Interview trips that got scheduled at the last moment, etc. Note that this is not an exhaustive list. All make up exams, if given, will be different from the original exam. Instructor may choose to give an oral exam instead of a written exam.

Course Schedule

Topics:

1. computational learning theory: sample complexity, version space, PAC learning, VC dimension, mistake bound, cross-validation
2. neural networks: perceptrons, multilayer perceptrons, backpropagation, gradient descent, stochastic gradient descent, optimizers, deep neural networks (convolutional networks, recurrent networks, attention)
3. decision tree learning, support vector machines,
4. dimensionality reduction: PCA, factor analysis, multidimensional scaling, Isomap, locally linear embedding
5. genetic algorithms, neuroevolution
6. unsupervised learning and local models: competitive learning, k-means, adaptive resonance theory, self-organizing maps, radial basis functions, regression, learning vector quantization.
7. Bayesian learning: maximum likelihood, minimum description length, Bayes optimal classifiers, Naive bayes classifiers. Bayesian belief network, EM algorithm.
8. Biologically motivated models.

Schedule (rough): See Canvas homepage for reading and more up-to-date info. Homework dues may change.

Week	Tuesday	Thursday	Topic	Announcements	Dues (Tentative)	Comments
1	1/18/2022	1/20/2022	Introduction			1/16: MLK day
2	1/25/2022	1/27/2022	Supervised learning concepts			1/24: last day for add/drop
3	2/1/2022	2/3/2022	Neural networks	hw1 announced		
4	2/8/2022	2/10/2022	Neural networks			
5	2/15/2022	2/17/2022	Reinforcement learning	hw2 announced	hw1 due	
6	2/22/2022	2/24/2022	Reinforcement learning			
7	3/1/2022	3/3/2022	Decision tree learning			
8	3/8/2022	3/10/2022	**Midterm Exam** (in class: Thu)	hw3 announced	hw2 due	3/7: midsemester grades due
9	3/15/2022	3/17/2022	Spring Break			
10	3/22/2022	3/24/2022	Dimensionality reduction			
11	3/29/2022	3/31/2022	Bayesian learning	hw4 announced	hw3 due	
12	4/5/2022	4/7/2022	Bayesian learning			
13	4/12/2022	4/14/2022	Local models			4/15: reading day
14	4/19/2022	4/21/2022	Deep learning			4/19: last day for Q-drop
15	4/26/2022	4/28/2022	Deep learning (Thu is last		hw4 due	4/28: last class

			class)			
16		5/5/2022	5/5(THU) : **Final Exam** 12:30pm-2:30pm			5/3: redefined day (meet Friday classes)

Optional Course Information Items

- All homeworks and programming assignments will be in the form of google colab notebooks (use TAMU NetID to login to colab).
- All submissions will be made through Canvas.

University Policies

This section outlines the university level policies. The TAMU Faculty Senate established the wording of these policies.

***[NOTE**: Faculty members should not change the written statements. A faculty member may add separate paragraphs if additional information is needed.]*

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 (https://student-rules.tamu.edu/rule07/)** 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 (https://student-rules.tamu.edu/rule07/)** 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 (https://student-rules.tamu.edu/rule07/)).**

"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 (https://student-rules.tamu.edu/rule07/)**).

Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. **(See Student Rule 24 (https://student-rules.tamu.edu/rule24/)).**

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 (https://aggiehonor.tamu.edu/Rules-and-Procedures/Rules/Honor-System-Rules)**).

Texas A&M at College Station

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

Texas A&M at Galveston

You can learn more about the Honor Council Rules and Procedures as well as your rights and responsibilities at ***tamug.edu/HonorSystem.*** **(https://www.tamug.edu/HonorSystem/)**

Texas A&M at Qatar

You can learn more about academic integrity and your rights and responsibilities at Texas A&M University at Qatar by visiting the ***Aggie Honor System*** **(https://www.qatar.tamu.edu/students/academic-services/aggie-honor-system)** *website.*

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 office on your campus (resources listed below). 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.

Texas A&M at College Station

Disability Resources is located in the Student Services Building or at (979) 845-1637 or visit ***disability.tamu.edu*** **(https://disability.tamu.edu/).**

Texas A&M at Galveston

Disability Resources is located in the Student Services Building or at (409) 740-4587 or visit ***tamug.edu/counsel/Disabilities*** **(https://www.tamug.edu/counsel/Disabilities.html).**

Texas A&M at Qatar

Disability Services is located in the Engineering Building, room 318C or at +974.4423.0316 or visit ***https://www.qatar.tamu.edu/students/student-affairs/disability-services.*** **(https://www.qatar.tamu.edu/students/student-affairs/disability-services)**

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 (https://rules-saps.tamu.edu/PDFs/08.01.01.M1.pdf)**):

- 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, a person who is subjected to the alleged conduct 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.

Texas A&M at College Station

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with ***Counseling and Psychological Services*** **(https://caps.tamu.edu/)** *(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*** **(https://titleix.tamu.edu/).**

Texas A&M at Galveston

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with the Counseling Office in the Seibel Student Center, or call (409)740-4587. For additional information, visit ***tamug.edu/counsel*** **(http://www.tamug.edu/counsel).**

Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the Galveston Campus' ***Title IX webpage*** **(https://www.tamug.edu/hrd/Title%20IX.html).**

Texas A&M at Qatar

Texas A&M University at Qatar students wishing to discuss concerns in a confidential setting are encouraged to visit the ***Health and Wellness*** **(https://www.qatar.tamu.edu/students/student-affairs/health-and-wellness/)** *website for more information.*

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*** **(https://titleix.tamu.edu/).**

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 healthy self-care by utilizing available resources and services on your campus.

Texas A&M College Station

Students who need someone to talk to can contact ***Counseling & Psychological Services (https://caps.tamu.edu/)*** *(CAPS) or call the* ***TAMU Helpline*** **(https://caps.tamu.edu/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*** **(https://suicidepreventionlifeline.org/).**

Texas A&M at Galveston

Students who need someone to talk to can call (409) 740-4736 from 8:00 a.m. to 5:00 p.m. weekdays or visit ***tamug.edu/counsel*** **(https://www.tamug.edu/counsel/Disabilities.html)** *for more information. For 24-hour emergency assistance during nights and weekends, contact the TAMUG Police Dept at (409) 740-4545. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at* ***suicidepreventionlifeline.org*** **(https://suicidepreventionlifeline.org/).**

Texas A&M at Qatar

Texas A&M University at Qatar students wishing to discuss concerns in a confidential setting are encouraged to visit the ***Health and Wellness*** **(https://www.qatar.tamu.edu/students/student-affairs/health-and-wellness/)** *website for more information.*

Campus Specific Policies

Texas A&M at Galveston

Classroom Access and Inclusion Statement

Texas A&M University is committed to engaged student participation in all of its programs and courses and provides an accessible academic environment for all students. This means that our classrooms, our virtual spaces, our practices and our interactions are as inclusive as possible and we work to provide a welcoming instructional climate and equal learning opportunities for everyone. If you have an instructional need, please notify me as soon as possible.

The Aggie Core values of respect, excellence, leadership, loyalty, integrity and selfless service in addition to civility, and the ability to listen and to observe others are the foundation of a welcoming instructional climate. Active, thoughtful and respectful participation in all aspects of the course supports a more inclusive classroom environment as well as **our (https://rules-saps.tamu.edu/PDFs/12.01.99.M2.pdf) mutual (https://www.tamug.edu/studentrules/Students_Rights_Responsibilities.html)** responsibilities to the campus community.

The following statements below are optional. Leave as is to include, or delete if preferred. Either way, delete this note.

Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings. Currently enrolled students wishing to withhold any or all directory information items may do so by going to **howdy.tamu.edu (https://howdy.tamu.edu/)** and clicking on the "Directory Hold Information" link in the Student Records channel on the MyRecord tab. The complete **FERPA Notice to Students (http://registrar.tamu.edu/Catalogs%2C-Policies-Procedures/FERPA/FERPA-Notice-to-Students#0-StatementofRights)** and the student records policy is available on the Office of the Registrar webpage.

Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class.

Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees honors and awards received, participation in officially recognized activities and sports, medical residence location and medical residence specialization.

COVID safety

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 healthy self-care by utilizing available resources and services on your campus.

To help protect Aggieland and stop the spread of COVID-19, Texas A&M University urges students to be vaccinated and to wear masks in classrooms and all other academic facilities on campus, including labs. Doing so exemplifies the Aggie Core Values of respect, leadership, integrity, and selfless service by putting community concerns above individual preferences. COVID-19 vaccines and masking — regardless of vaccination status — have been shown to be safe and effective at reducing spread to others, infection, hospitalization, and death.

Texas A&M College Station