CSE 575 Statistical Machine Learning

(The course syllabus outlines a general plan for the course;

deviations announced by the instructor may be necessary.)

General Information

Class Time & Location: M W 1:30 pm - 2:45 pm

Contact Information & Office Hours

Instructor: Kookjin Lee
Email: kookjin.lee@asu.edu
Office: BYENG 568
Office hours: TBA
Zoom: TBA

TA: Jesse Jing
Email: cjing@asu.edu
Office: contact the TA
Office hours: TBA
Zoom: https://asu.zoom.us/j/6813602161

Catalog Description: Machine learning techniques: supervised learning, unsupervised learning, and neural networks and deep learning. Probability distributions, maximum likelihood estimation, Bayesian network.

Prerequisites

Computer Science BS, Computer Systems Eng BSE and Data Science BS students; CSE 310, CSE 475, MAT 343, IEE 380 with a C or better. Linear Algebra, Probability, Statistics, proficiency in Python

Course Objectives

The objectives of this course is to provide an in-depth understanding on machine learning and statistical pattern recognition through

- studying foundational concepts (such as regression, classification, etc.),
- experimenting with key algorithms (such as logistic regression, support vector machine), and
- employing recent software packages for solving a problem (such as using a deep-learning package for image classification).

Expected Learning Outcomes

Upon completion of this course, students will be able to:

- define and recognize key paradigms in machine learning;
- explain and differentiate the inner working of representative machine learning algorithms;
- implement a set of foundational machine learning algorithms;
- apply and test commonly used off-the-shelf algorithms and packages;
- identify existing challenges in machine and deep learning.

Topics to Cover & Tentative Timeline

Topics to be covered include (subject to revision throughout the semester, based on feedback from the class):

- Introduction to Machine Learning: What is Machine Learning; supervised vs. unsupervised learning; data representations; sample applications. (~0.5 week)
- Probability basis and statistical learning basics (~2 weeks)
- Supervised learning: Linear regression, Logistic regression; Generative models vs. discriminative model; Kernel methods for classification (Support vector machines); Cross validation; Introduction to concepts of cost functions, regularization, hyper parameters; Intro. to decision trees, Naïve Bayes, Bayes classifier, Gaussian process (~4 weeks)
- Unsupervised learning: Data clustering and description; K-means algorithm and variants; Dimensionality reduction and Principal Component Analysis; (~ 3.5

weeks)

- Neural Networks and Deep Learning: Basics of neural learning via multi-layer feedforward networks; Back prop, Stochastic Gradient descent; Overview of hyper parameter tuning & training techniques; Convolutional neural networks; Auto- encoders; Deep-learning models for sequential data. (~4 weeks)
- Current research trends & existing challenges (covered throughout the semester aligning with the relevant topics).

Emphasis will be given on statistical aspects of the topics listed.

(Estimated time for each topic includes time for covering corresponding applications/software.)

Time permits, the class may invite other faculty or senior PhD students who have relevant research work and recent publications to give guest lectures.

Reference books

There is no required textbook. Lecture notes (including additional reading materials) will be the primary resource for learning. The following reference books may be of help for your study.

1. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Trevor Hastie Robert Tibshirani and Jerome Friedman, Springer.
2. *Pattern Recognition and Machine Learning, Christopher M. Bishop, 2006.*
3. *Machine Learning*, Tom Mitchell, McGraw Hill.
4. *Deep Learning*, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press.

Assignments, Exams, and Projects.

There will be 4~6 homework assignments. The assignments will focus the topics that are just completed. Most of the assignments will be problems that are to be solved by paper and pencil, and simple programing. [40%]

There will be two midterm exams. The first midterm and the second midterm will be given in class on [TBD] (15%) and [TBD] (15%). Both exams will be closed book exams. [30%]

The project will be a group project group of 4-5. It can be an implementation and a comparative study of existing methods, a review of a specific topic, or the development of new ideas. Each team will submit a proposal (5%), a progress report (10%), presentation (5%), and a final project report (10%). [30%]

[Not finalized yet]

Grading Policies

Final Letter Grade

The following are the most likely cutoffs for the letter grade:

A group (A+, A, A-)>=90%,

B group (B+, B, B-)>=80%

C group (C+, C)>=70%

D >= 60%

E < 60%

A+, B+ (top 20% in A, B groups),

A-, B- (bottom 20% in A, B groups)

Y/I grade We offer Y (satisfactory) / I (incomplete) grade. Students earn hours for a "Y" grade, but the grade is not used for computing the GPA. "Y" grade can be used to count this course in students' major and satisfy the prerequisite for other courses. The "I" Incomplete grade may be a very appropriate option for students who are struggling this semester. Students with grade at least C (that is, the final grade >= 70%) can choose to convert their letter grade to a "Y" grade.

Grade Appeal

Any grade appeal must happen within one week of the grade's posting. Later appeal will not be considered.

Absence Policies

Excused absences for classes will be given without penalty to the grade in the case of (1) a university-sanctioned event [ACD 304-02]; (2) religious holidays [ACD 304-04]; a list of religious holidays can be found here https://eoss.asu.edu/cora/holidays]; (3) work performed in the line-of-duty according [SSM 201-18]. Students who request an excused absences must follow the policy/procedure guidelines. Excused absences do not relieve students of responsibility for any part of the course work required during the period of absence.

For exams, if you missed any of them, there will not be makeups unless you have genuine emergencies supported by proper documentations or your absence qualifies as the excused absences.

Anticipated absences for university - sanctioned events, religious holidays, or line - of - duty activity should be communicated to the instructor by email at least 7 days before the expected absence.

Excused absences do not relieve students from responsibility for any part of the course work required during the period of absence.

All homework assignments/projects are due by its specified due date/time. In general, no extension to assignment submission will be given.

If you fall into one of the special cases stated below, you need to talk to the instructor early. It is the instructor's decision whether or not you will receive an extension or an opportunity for makeup without penalty.

I will honor the following special cases (rules stated):

1 Medical Problems: At least two days ahead of the due dates, you need to submit a statement with the signature of the doctor and the seal of the hospital saying that you cannot come to class and perform academic activity during a particular time.

2 Travel Accident: At least two days ahead of the due dates, you need to submit a

police report stating that you are involved in an accident.

3 Death of an Immediate Family Member: If you need to attend the funeral of an immediate family member (defined as grand-parent, parent, spouse, sibling or child), you need the instructor's prior approval. Proof is required.

Recordings

Note that class sessions may be recorded, and recordings provided to enrolled students, instructors, or instructional support personnel. If you have concerns about being recorded, please contact the course instructor.

Recordings may be used to accommodate student absences.

Lecture Notes

Lecture notes will be available only via ASU Canvas.

The notes will be posted before each lecture.

Notice: All contents of these lectures, including notes and assignments distributed to the class, are under copyright protection. They may not be redistributed, sold or commercialized without the express permission of the instructor.

In addition to the posted notes, some examples may be worked out during the lectures. The examples may not be included into the posted lecture notes, and it is the students' responsibility to study such examples by attending the classes.

Policy regarding expected student behavior

Students in this class are expected to acknowledge and embrace the FSE student professionalism expectation located at: https://engineering.asu.edu/professionalism/.

Email Policy

All email communications need to follow the guidelines enumerated below:

- Email communication regarding this class MUST include in the subject line the prefix CSE 575: (For example, the subject line of your email may read CSE 575: Question about solution to HW1).

- Every email to the instructor must also cc the TAs (unless there is a specific and clear reason why the TA should not be cc'ed). (Note: the TAs and Grader are official class staff members and have full access to the Grade Center on Blackboard.)
- Emails will be read once a day, M-F. The TA will directly answer your email, unless the TA (or in some cases, the student) feel that my direct assistance is needed.
- Email should be clear, self-contained, and to the point.
- Email should not ask questions whose answers are obviously shown in the course syllabus, class notes/class materials, or other materials on Blackboard.
- Avoid asking questions in email that should be raised either in class, or in individual consultation with the TA during office hours.
    - These include questions of an excessively conceptual nature, and questions that require an unreasonable amount of time from the instructor/TA.
    - A good rule of thumb: if your question cannot be answered in a short paragraph, then it is not appropriate for email.

Classroom Behavior

Cell phones and pagers must be turned off during class to avoid causing distractions. The use of recording devices is not permitted during class. Any violent or threatening conduct by an ASU student in this class will be reported to the ASU Police Department and the Office of the Dean.

Policy against threatening behavior, per the Student Services Manual, SSM 104–02

Students, faculty, staff, and other individuals do not have an unqualified right of access to university grounds, property, or services (see SSM 104-02). Interfering with the peaceful conduct of university-related business or activities or remaining on campus grounds after a request to leave may be considered a crime. All incidents and allegations of violent or threatening conduct by an ASU student (whether on- or off-campus) must be reported to the ASU Police Department (ASU PD) and the Office of

the Dean of Students.

Academic Integrity

All engineering students are expected to adhere to the ASU Student Honor Code and the ASU academic integrity policy, which can be found at https://provost.asu.edu/academic-integrity/policy). Students are responsible for reviewing this policy and understanding each of the areas in which academic dishonesty can occur. If you have taken this course before, you may not reuse or submit any part of your previous assignments without the express written permission from the instructor.

All student academic integrity violations are reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). Withdrawing from this course will not absolve you of responsibility for an academic integrity violation and any sanctions that are applied. The AIO maintains a record of all violations and has access to academic integrity violations committed in all other ASU college/schools.

All the homework assignments/exams/project are individual work unless stated otherwise.

All work submitted for the course cannot have been submitted for any other course or any previous section of this same course. Student academic integrity violations are reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). Withdrawing from this course will not absolve you of responsibility for an academic integrity violation and any sanctions that are applied. The AIO maintains a record of all violations and has access to academic integrity violations committed in all other ASU college/schools.

Generative AI is a technology that can often be useful in helping students learn the theories and concepts in this course. However, unless explicitly allowed by your instructor, the use of generative AI tools to complete any portion of a course assignment or exam will be considered academic dishonesty and a violation of the ASU Academic Integrity Policy. Students confirmed to be engaging in non-allowable use of generative AI will be sanctioned according to the academic integrity policy and FSE sanctioning guidelines.

Copyright policy

The contents of this course, including lectures and other instructional materials, are copyrighted materials. Students may not share outside the class, including uploading, selling or distributing course content or notes taken during the conduct of the course. Any recording of class sessions by students is prohibited, except as part of an accommodation approved by the Disability Resource Center. (see ACD 304–06, "Commercial Note Taking Services" and ABOR Policy 5-308 F.14 for more information).

You must refrain from uploading to this course shell, discussion board, website used by the course instructor or any other course forum, material that is not your own original work, unless you first comply with all applicable copyright laws. Course instructors reserve the right to delete materials from the course shell on the grounds of suspected copyright infringement.

Harassment and Sexual Discrimination

Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination, harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information.

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs.

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling is available if you

wish to discuss any concerns confidentially and privately. ASU online students may access 360 Life Services, https://goto.asuonline.asu.edu/success/online-resources.html.

Disability Accommodations

Suitable accommodations are made for students having disabilities. Students needing accommodation must register with the ASU Student Accessibility and Inclusive Learning Services office and provide documentation of that registration to the instructor. Students should communicate the need for an accommodation in enough time for it to be properly arranged. See ACD 304-08 Classroom and Testing Accommodations for Students with Disabilities.

Photo Requirement

Arizona State University requires each enrolled student and university employee to have on file with ASU a current photo that meets ASU's requirements (your "Photo"). ASU uses your Photo to identify you, as necessary, to provide you educational and related services as an enrolled student at ASU. If you do not have an acceptable Photo on file with ASU, or if you do not consent to the use of your photo, access to ASU resources, including access to course material or grades (online or in person) may be negatively affected, withheld or denied.

Notice: Any information in this syllabus (other than grading and absence policies) may be subject to change with reasonable advance notice.