CSE 475 Foundations of Machine Learning

(subject to change)

General Information

Class Time & Location: T TH 4:30 pm - 5:45 pm

Contact Information & Office Hours

This course will be delivered through ASU Sync. The lectures and instructor's office hours will be delivered in the Zoom meeting room with link https://asu.zoom.us/j/9531979310.

Instructor: Yingzhen Yang
Email: yingzhen.yang@asu.edu
Office: BYENG 590
Office hours: Tuesday and Thursday, 3-4 pm or by appointment.
Zoom link: https://asu.zoom.us/j/9531979310

TA: Yancheng Wang
Email: ywan1053@asu.edu
Office: BYENG 590
Office hours: Monday and Wednesday, 2-3 pm or by appointment.
Zoom link: https://asu.zoom.us/j/7737185236
Please attend the TA office hours through the above Zoom meeting room link.

Catalog Description: Machine learning techniques: supervised learning, unsupervised learning, and neural networks and deep learning.

Prerequisites

Computer Science BS, Computer Systems Eng BSE and Data Science BS students; CSE 310, MAT 343, IEE 380 with a C or better

Antirequisites

Credit is only allowed for CSE 475 or CSE 494 Introduction to Machine Learning

Course Objectives

With ubiquitous sensors capturing increasing amount of data in many real-world applications, automated analysis of such data has become a necessity. Machine Learning is a primary vehicle

to automated data analysis. The objectives of this course is to introduce the students to the general field of machine learning through studying foundational concepts (such as Bayesian decision theory, dimensionality reduction, kernel methods, etc.), experimenting with key algorithms (such as K-means clustering, Nearest-Neighbor classification), 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)

- Mathematical foundations: self-contained review of key calculus, probability and linear algebra concepts essential to the course. (~1.5 weeks)

- Basics of Bayesian Decision Theory: Concepts of optimal decision under uncertainty; Bayesian formulation; Bayesian decision-making; Bayes nets. (~2.5 weeks)

- Supervised learning: 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. (~4 weeks)

- Unsupervised learning: Data clustering and description; K-means algorithm and variants; Dimensionality reduction and Principal Component Analysis; (~ 2.5 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).

(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. *Pattern Classification, 2nd edition*, R. O. Duda, P. E. Hart, and D. G. Stork, Wiley-Interscience. ISBN *0-471-05669-3.*

2. Pattern Recognition, 4th editon, S. Theodoridis and K. Koutrouumbas. Academic Press.

3. *Machine Learning: a Probabilistic Perspective*, K. Murphy, MIT Press

4. *Pattern Recognition and Machine Learning*, Christopher Bishop. Springer.

5. *Deep Learning*, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press.

6. *Convolutional Neural Networks in Visual Computing: A Concise Guide*, R. Venkatesan and B. Li, CRC Press, 2017, ISBN 9781498770392.

7. Online book: http://neuralnetworksanddeeplearning.com/ Michael Nielson.

Assignments, Project and Exams

There will be five 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, although some might require simple programing. The assignments are due one week after their posting.

The project will be assigned after the second midterm exam. The project will be on employing a machine learning algorithm to solve a problem that involves parameter learning from a training set and evaluation on a testing set. You may be given several options to choose from. The project is due by the last day of class.

There will be two midterm exams. The first midterm exam will be given after completing the topic of Basics of Bayesian Decision Theory. The second midterm exam will be given after completing the topic of Unsupervised Learning.

Grading Policies

Homework:	30% (Five assignments, 6% each)
Quizzes & Attendance	10%
Project:	20%
Midterm Exams:	40% (Two midterms, 20% each)

A total of 5% of extra credit opportunities may be given in the assignments or project or exams.

Final Letter Grade

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

A >=90%
B >=80%
C >=70%
D >= 60%
E < 60%

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.

More details on the assessment scheme will be discussed in the first lecture.

Grade Appeal

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

Absence & Make-up Policies

In general, no extension to assignment submission will be given. **Attendance will be taken at 5 random times throughout the semester. No make-up is possible for absence.** However, there are extra credits that may be earned to compensate for missed attendance (up to 5%). 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 one of the following:

- excused absences related to religious observances/practices that are in accord with ACD 304–04, "Accommodation for Religious Practices"
- excused absences related to university sanctioned events/activities that are in accord with ACD 304–02, "Missed Classes Due to University-Sanctioned Activities"
- excused absences related to missed class due to military line-of-duty activities that are in accord with ACD 304–11

(Please note that, medical emergency/conditions may qualify you for special considerations like late withdrawal, incomplete grade, etc., but do not automatically warrant a make-up; Any request for make-up exams will be evaluated by the instructor according to university guidelines.)

All homework assignments/quizzes/projects are due by its specified due date/time. Without special cases mentioned below, we have a standard 10% deduction policy for each late day, i.e. we have to deduct 10% of the full marks per day for late submissions.

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: Within two days, 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: Within two days, 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.

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 475: (For example, the subject line of your email may read CSE 475: Question about solution to HW1).
- Every email to the instructor must also cc the TA (unless there is a specific and clear reason why the TA should not be cc'ed). (Note: the TA 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.

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.

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. 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

Students in this class must adhere to ASU's 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. In addition, all engineering students are expected to adhere to both the ASU Academic Integrity Honor Code and the **Fulton Schools of Engineering Honor Code**. All academic integrity violations will be reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). The AIO maintains record of all violations and has access to academic integrity violations committed in all other ASU college/schools.

All the assignments, quizzes/exams are individual work unless stated otherwise.

Copyright policy

Course content, including lectures, are copyrighted materials and students may not share outside the class, upload to online websites not approved by the instructor, sell, or distribute course content or notes taken during the conduct of the course (see **ACD 304–06, "Commercial Note Taking Services**" and **ABOR Policy 5-308 F.14** for more information).

You must refrain from uploading to any course shell, discussion board, or website used by the course instructor or other course forum, material that is not the student's original work, unless the students first comply with all applicable copyright laws; faculty members reserve the right to delete materials on the grounds of suspected copyright infringement.

Disability Accommodations

Suitable accommodations will be made for students having disabilities. Students needing accommodations must register with the ASU Disabilities Resource Center and provide documentation of that registration to the instructor. Students should communicate the need for an accommodation in sufficient time for it to be properly arranged. See **ACD 304-08 Classroom and Testing Accommodations for Students with Disabilities**.

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.

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