COMP 7745/8745: Machine Learning
Fall 2025

Instructor Information

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Class Information

Dates: Tuesday, Thursday
Time: 1:00-2:25pm
Classroom: Dunn Hall 351

Course Description

This course introduces fundamental concepts, algorithms, and applications of machine learning. We will cover supervised and unsupervised learning, model evaluation, and introductory deep learning and reinforcement learning. Emphasis will be placed on understanding when and why algorithms work, practical implementation for real-world problems, and critical analysis of the benefits as well as limitations of each approach.

Prerequisites

- Mathematics: basics of linear algebra, multivariable calculus, probability, statistics, discrete mathematics.
- Programming skills: Python (preferred), or R/Matlab with instructor approval.

Course Objectives

After this course, you should be able to

- understand the mathematical and conceptual foundations of common machine learning algorithms
- apply different supervised machine learning algorithms for classification and regression problems
- analyze supervised machine learning algorithms in terms of when an algorithm is likely to work well and why it could fail
- empirically evaluate the performance of supervised machine learning algorithms and interpret their results
- understand metrics for evaluation including precision, recall and f1-score

- apply clustering algorithms to find hidden patterns in data
- understand metrics for clustering and how to interpret clustering results
- analyze trade-offs such as bias–variance and overfitting vs generalization
- use existing software packages (sklearn) to apply machine learning algorithms to different datasets

Textbooks

There is no specific textbook since all materials will be provided electronically. A list of recommended readings is provided below, most of which are available online. Referenced chapters will be mentioned in the lecture slides.

Recommended reading:

- Pattern Recognition and Machine Learning, Chris Bishop, Springer-Verlag, 2006
- Machine Learning, Tom Mitchell, McGraw Hill, 1997
- Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2009
- Deep Learning, Goodfellow et. al., MIT Press
- Machine Learning: A Probabilistic Perspective, Kevin Murphy, MIT Press
- Introduction to Machine Learning, Alex Smola, MIT Press
- Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems

Hardware and Software Requirements

The minimum requirements can be found at
https://www.memphis.edu/uofmglobal/students/requirements.php
We will talk about software environments when the first assignment is published.

Course Topics

1. Introduction and Fundamental Concepts
    - Supervised and unsupervised learning
    - Deterministic and generative models, frequentist and Bayesian models
    - Evaluating machine learning models
2. Supervised Learning
    - Classification problems: decision theory, loss functions

- Classification models: decision trees, nearest neighbors, naive Bayes
- Linear models: linear regression, logistic regression, linear discriminant analysis
- Learning via optimization: gradient descent, Newton's method, boosting, perceptrons and neural networks
- Model selection: validation and cross-validation, regularization, bias-vs-variance trade-off, ensemble models
- Kernel methods: support vector machines, Gaussian processes

3. Unsupervised Learning
    - Clustering: k-means, hierarchical clustering, evaluation of clustering methods
    - Gaussian mixture models and the EM algorithm
    - Representation learning: dimensionality reduction, principal component analysis
4. Reinforcement learning
5. Advanced topics
    - Introduction to deep neural networks
    - Bayesian learning
    - Explainable machine learning

Assessment and Grading

Periodic quizzes and coding assignments will be administered through Canvas and the student can complete online. The specific format for mid-term and end-term exams will be provided later.

Components that determine the final grade:

- Quizzes: 15%
- Assignments: 15%
- Mid-term Exam: 25%
- End-term Exam: 30%
- Project: 15%
- Bonus (participation): 5%

A modified curve may be used for final grades at the instructor's discretion.

Course Ground Rules

Class Attendance and Participation:
Course participation is required. There is a strong correlation between regular attendance and obtaining a good grade. The instructor reserves the right to lower grades for lack of attendance. Students are responsible for any material and contents of missed lectures.

Assignments and Deliverables:

No late assignments will be accepted unless well-documented reasons are presented. All assignments must be individual work. **The use of generative AI tools in writing your reports or codes is not allowed.** However, you may use generative AI to assist you with *learning*, but beware that generative AI tools make errors and it is your responsibility to ensure the correctness of your work. You may be asked to explain the code or re-create aspects of the projects – you must show that you have mastered the fundamentals.

Communication

Students must use the assigned university email address rather than a personal email address. Emails should always include a subject line. Do not send large attachments without permission. Special formatting such as centering, audio messages, html, etc. should be avoided unless necessary to complete an assignment or other communication. Respect the privacy of other class members.

Be cooperative with group members in completing assigned tasks. Be positive and constructive in group discussions. Be organized and respectful when presenting group efforts.

Academic Integrity

Plagiarism, cheating, and other forms of academic dishonesty are prohibited. Students guilty of academic misconduct, either directly or indirectly, through participation or assistance, are immediately responsible to the instructor of the class in addition to other possible disciplinary sanctions which may be imposed through the regular institutional disciplinary procedures.
https://libguides.memphis.edu/academicintegrity/students

Students with Disabilities

Qualified students with disabilities will be provided reasonable and necessary academic accommodations if determined eligible by the appropriate disability services staff at their home institution. Prior to granting disability accommodations in this course, the instructor must receive written verification of a student's eligibility for specific accommodations from the disability services staff at the home institution. It is the student's responsibility to initiate contact with their home institution's disability services staff and to follow the established procedures for having the accommodation notice sent to the instructor.

Syllabus Changes

The instructor reserves the right to make changes as necessary to this syllabus. If changes are necessitated during the term of the course, the instructor will immediately notify students of such changes both by individual email communication and posting both notification and nature of change(s) on the course bulletin board.