Course Syllabus, Fall 2024

ISE-364/464:

Introduction to Machine Learning

Course Information:

Lectures: Monday and Wednesday, 3pm – 4:15pm, Mohler Lab #451

Office Hours: Monday and Wednesday, 4:15pm – 5:15pm, MO #358 or online by appointment

Instructor Information:

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Description: Machine learning (ML) is the study and development of algorithms that learn patterns from data in an automated way and is the bedrock of the field of artificial intelligence. This is an introductory course in ML designed for senior undergraduate students and master students who have a working knowledge of programing and sufficient knowledge of probability, statistics, multivariable calculus, and linear algebra. This course introduces the core principles of ML, fundamental techniques and models, data mining methodology, and prepares for more advanced study in ML. Emphasis will be placed on introducing machine learning models in an intuitive way from fundamental mathematical building blocks and to gain an understanding of the assumptions preceding each algorithm. The learning of these concepts will be facilitated with homework assignments that will consist of a mixture of typed assignments (emphasis will be placed on the mathematics behind the algorithms) and coding assignments (emphasis will be placed on gaining experience applying these models in practice).

Topics: Python for Data Analysis (NumPy, Pandas), Python for Data Visualization (Matplotlib, Seaborn), Python for ML (Scikit-Learn, PyTorch), Learning Paradigm and Optimization Fundamentals, Supervised Learning, Cross-Validation and Bias-Variance Trade-Off, Discriminative Models (Linear Regression, Logistic Regression, K-Nearest Neighbors, Decision Trees, Random Forests, Boosted Trees, Support Vector Machines, Neural Networks), Generative Models (Gaussian Discriminative Analysis, Naïve Bayes, Generative Networks), Unsupervised Learning (K-Means Clustering, Gaussian Mixture Models), Dimensionality Reduction Techniques (Principal Component Analysis, UMAP, T-SNE), Data Mining Fundamentals (Data Cleaning, Exploratory Analysis, Feature Generation, etc.).

Course Objectives: The objectives of this course are for students to do the following:

- Gain an intuitive understanding of classical machine learning algorithms and the mathematical motivations behind them.
- Unify and solidify, in the single topic of machine learning, concepts learned from probability, statistics, calculus, and linear algebra.
- Understand what machine learning is and what it is not. Understand the nuances of model interpretation, the difference between correlation versus causation, and what can and cannot be concluded from a task involving any statistical analysis / inductive reasoning.
- Become comfortable writing software using Python.
- Be able to apply proper techniques to solve real-world data mining problems.
- Understand which ML algorithms to use on different problems and how to compare the performance of different algorithms in a statistically sound way.
- Be able to justify your reasoning behind your choices regarding modeling, data cleaning, feature generation, etc. Be able to identify the assumptions that are made when choosing a specific model.

Prerequisite: CSE 003 - Introduction to Programming, Part A

Course Model: Lectures will be held in person and asynchronously on Panopto for students who cannot attend in person. A Slack workspace has been created to facilitate communication about the course.

Office Hours: Please come to office hours if you have any questions about the course. I am also available by e-mail (always). If I do not respond to an e-mail within 24 hours, then please assume that I have not received it and send a follow-up e-mail. I am also willing to meet at other times, but in such cases please e-mail me in advance to set up a mutually convenient time.

Course Site: Homework assignments, solutions, announcements, and other important material will be posted on Course Site. Important information, corrections, and updates about the course may also be sent by Course Site.

Textbook: There is no formal textbook for this course. You are only responsible for material covered in lectures and posted on Coursesite.

Software: In this class, we will use Python.

Grading: Your grade will be calculated as follows:

Homework:	40%
Final exam:	20%
Final Project:	30%
Participation:	10%

Homework: There will be regular homework assignments throughout the semester (one assignment about every two weeks). The homework assignments are likely to take you a fair amount of time, so get started on them early.

- Each homework must be submitted electronically via Course Site.
- No credit will be given for any late assignment. (Exceptions due to sickness may be provided but must be accompanied by an appropriate note from your healthcare provider.)
- Homework must be clearly organized, and with problems in the correct (assigned) order. If I have difficulty following your homework, I will not go to great lengths to decipher it.
- You are free to consult with other students when working on homework, but the work you submit must be your own. If a student copies any solution (written by someone in the class or otherwise) and submits it to be graded as their own individual work, this will be considered a violation of Lehigh's academic integrity principles and will be reported as such. *You must cite any people or sources (other than the lecture slides) that helped you with a particular problem.* For example: "Jane Doe and I talked about this problem" or "I got help from Jane Doe on problem #3" or "I consulted Linear Programming for Dummies, Section 4.2, by John Doe when solving question #2".

Re-grade Requests: If you disagree with the grade you receive on a homework problem, you may submit a request for that problem to be re-examined. This request must be submitted in writing no more than 48 hours after you receive the graded assignment. It must contain a clear explanation, in no more than one paragraph (one paragraph for each grade being challenged), of why you feel the grade you received is incorrect. Once we re-examine your work and decide whether to change your grade, the decision will be final.

Participation: You are expected to either attend class regularly or watch all recorded lectures in a timely manner and ask questions when you are confused. I strongly encourage active participation during lectures. If you are struggling with the class, then I expect you to come to office hours and show me that you are trying your best. Participation is set up to potentially move you a letter grade.

Collaboration Policy: The sharing of ideas is educationally useful, and you are encouraged to discuss assignments with other students. However, *plagiarism* of any kind is destructive, fraudulent, and unacceptable. You are *strictly* forbidden to copy another student's written work, whole or in part, and submit that work under your name. You are also *strictly* forbidden to make trivial or mechanical changes to another student's written work and submit that work under your name. Note that while electronic plagiarism is easier to perform (via copy-and-paste), it is also easier to detect. Plagiarized work will receive no credit and repeat offenses will result in more severe action. A sure way to avoid this issue is to discuss the assignments with fellow students but write your solutions individually and independently.

Generative Artificial Intelligence tools, such as ChatGPT, may be used for any coding assignment so long as you check the accuracy of the material you submit.

Emergencies: Everyone is responsible for all material covered and announcements made in lectures. If you believe you will miss a long period of time in the course due to illness, a family emergency, etc., then please contact me as early as possible. Under no circumstances will credit be given for missed work unless you have discussed your absence with me in advance.

Accommodations for Students with Disabilities: Lehigh University is committed to maintaining an equitable and inclusive community and welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact Disability Support Services (DSS), provide documentation, and participate in an interactive review process. If the documentation supports a request for reasonable accommodations, DSS will provide students with a Letter of Accommodations. Students who are approved for accommodations at Lehigh should share this letter and discuss their accommodations and learning needs with instructors as early in the semester as possible. For more information or to request services, please contact Disability Support Services in person in Williams Hall, Suite 301, via phone at 610-758-4152, via email at indss@lehigh.edu, or online at https://studentaffairs.lehigh.edu/disabilities.

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If you have questions about Lehigh's Policy on Harassment and Non-Discrimination or need to report harassment or discrimination, contact the Equal Opportunity Compliance Coordinator (Alumni Memorial Building / 610.758.3535 / eocc@lehigh.edu)