



Instructor:	Samir T. Mammadov
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Office:	B315
Office hours:	Wednesday, 13:00-15:00 Saturday, 16:00-18:00
Schedule:	Wednesday/Friday, 10:00-11:15, B302

Synopsis

In this course we will cover a broad range of machine learning and statistical pattern recognition techniques. Topics include supervised learning, unsupervised learning, computational learning theory, and deep learning. The course will also discuss recent applications of machine learning, such as computer vision and natural language processing.

Machine learning techniques enable us to automatically extract features from data so as to solve predictive tasks, such as speech recognition, object recognition, machine translation, question-answering, anomaly detection, medical diagnosis and prognosis, automatic algorithm configuration, personalization, robot control, time series forecasting, and much more. Learning systems adapt so that they can solve new tasks, related to previously encountered tasks, more efficiently. This course will introduce the field of Machine Learning, focusing on the core concepts of supervised and unsupervised learning. In supervised learning we will discuss algorithms which are trained on input data labelled with a desired output, for instance an image of a face and the name of the person whose face it is and learn a function mapping from the input to the output. Unsupervised learning aims to discover latent structure in an input signal where no output labels are available, an example of which is grouping webpages based on the topics they discuss. Students will learn the algorithms which underpin many popular Machine Learning techniques, as well as developing an understanding of the theoretical relationships between these algorithms. The practicals will concern the application of machine learning to a range of real-world problems.

Outcomes

Upon successful completion of this course you should be able to:

- Be able to formulate machine learning problems corresponding to different applications.
- Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.
- Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.
- Ability to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
- Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.
- Ability to integrate machine learning libraries and mathematical and statistical tools with modern technologies.
- Be able to read current research papers and understand the issues raised by current research.

Prerequisites

- Senior Standing

- Foundational knowledge of Probability & Statistics and Calculus is an advantage, albeit not an official requirement.

Reading

Primary sources:

- James, G., Witten, D., Hastie, T., Tibshirani, R., Taylor, J. *Introduction to Statistical Learning with Applications in Python*. 2023.
- Aurelien, G. *Hands-On Machine Learning with Scikit-Learn and TensorFlow, 3rd edition*. 2022.

Supplementary sources:

- Hastie, T., Tibshirani, R., Friedman, J. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd edition*. 2016.
- Huyen, C. *Designing Machine Learning Systems*. 2022

Grading

- | | |
|----------------------|------------|
| • Assignments | 30% |
| • Project | 20% |
| • Midterm | 20% |
| • Final | 30% |

Topics

The following list gives an overview of the core topics intended to be covered during the semester. This list is not absolute and due to changes, by adding or removing some topics, as the instructor considers necessary.

- **Supervised Learning**
 - K-Nearest Neighbors
 - Linear Regression
 - Logistic Regression
 - Tree-Based Methods
 - Kernel Methods
 - Naïve Bayes
- **Unsupervised Learning**
 - Principal Component Analysis
 - Clustering Techniques
- **Computational Learning Theory**
 - Resampling Methods
 - Regularization
 - Bias-Variance Tradeoff
 - Ensemble Learning
- **MLOps**

Resources

Support services on campus:

- Students are encouraged to consult with the Writing Center for checking their papers and assignments. Please visit the Writing Center or contact them by email: writingcenter@ada.edu.az
- Adjusting to student life, pursuing academic and personal goals can be emotionally stressful and challenging. Students are encouraged to make individual appointments with the Office of Student Success to receive professional and psychological support. Please contact the Office of Student by email: studentsuccess@ada.edu.az

Tips for success

Students will need to read the course readings throughout the term to learn the material and to be able to contribute to class discussions.

Here are some words of wisdom from Dr. Morgan Liu of The Ohio State University on “How to Read an Academic Book or Article”: Reading an academic article/book is not like reading a newspaper or novel. Following these guidelines will help keep you from being overwhelmed, and make you better prepared for discussions & essays.

1. Read actively, not passively. You read because you are trying to mine the text for insights. You are not reading because you have to get through it. Take an active posture while reading: you are trying to take something away from the reading.
2. Before you begin, ask yourself: what is my purpose for reading this? First ask yourself: What topic is the course covering this week? What are the active issues and recurrent themes? What sorts of insights do I hope to get out of the reading? The Reading Questions will help you get a grip.
3. Do not always read from start to finish. Read the introduction or opening paragraphs. Then skip to the back and read the conclusion to see where the thing is going. Flip through the article/book and take note of the section or chapter titles. Read the beginning & end of each section to see what they’re about. Stop. Think about what this article/book is trying to accomplish and how it will get there. Get a sense of the overall arguments first, and how the author will develop them. Then step back, close your eyes and think, what are the most important parts that I must read? What can I skim over for now?
4. Read selectively. Do not read every word in the text. Read the most important parts first, and see what else you need to read as you go. You can always go back. You have my permission to skip the less important parts – no guilt, really!! But you got to be thoughtful to figure what those are. Better to read the most important parts thoughtfully, than try to get through the entire thing like a zombie.
5. Stop frequently and ask yourself: what did I just learn? Make notes as you go. Write down questions. Don’t get bogged down in unimportant details. If your mind starts to wander, stop and refocus on the big picture: what’s been happening in the text, and where is it.

Disclaimer

This syllabus, including the course schedule, is subject to change as necessary.