

## Spring 2024

Advanced Machine Learning

Course#: [CSCI-GA.3033-052](#)

Instructor: [Mehryar Mohri](#)

Graders/TAs: Yutao Zhong.

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## Course Description

This course discusses advanced topics in theoretical machine learning, extending beyond the scope of foundational graduate courses. The primary goal is to introduce key concepts not covered in basic ML courses such as [Foundations of Machine Learning](#), while also exploring cutting-edge learning problems that can serve as a springboard for research or the development of novel application-relevant techniques.

A central focus of the course is a rigorous analysis of the rich field of online learning. In addition, the material encompasses a broad range of advanced topics in supervised learning, providing a comprehensive overview of the theoretical underpinnings of modern machine learning methods.

Through a combination of lectures, discussions, and assignments, students will gain a deep understanding of the fundamental principles governing learning algorithms. The course will equip students with the necessary theoretical foundations to conduct cutting-edge research in theoretical machine learning, as well as to develop novel and effective machine learning solutions for real-world problems.

- On-line learning scenario:
  - On-line learning basics.
  - Learning and games.
  - Learning with large expert spaces.
  - Online convex optimization.
  - Bandit problems.
  - Sequential portfolio selection.
- Advanced standard scenario:
  - Learning kernels.
  - Ensemble methods.

- Structured prediction.
- Large-scale learning:
  - Dimensionality reduction
  - Low-rank approximation.
  - Large-scale optimization.
  - Distributed learning.
  - Clustering.
  - Spectral learning.
  - Massive multi-class classification.
- Other non-standard learning scenarios:
  - Domain adaptation and sample bias correction.
  - Transduction and semi-supervised learning.
  - Active learning.
  - Time series prediction.
  - Privacy-aware learning.

It is strongly recommended to those who can to also attend the [Machine Learning Seminar](#).

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## Location and Time

[Warren Weaver Hall](#) Online,  
251 Mercer Street.  
Tuesdays 4:55 PM – 6:50 PM.

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## Prerequisite

Students are expected to be familiar with basic machine learning concepts and must have attended a graduate ML class such as [Foundations of Machine Learning](#) or equivalent, at Courant or elsewhere.

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## Projects and Assignments

There will be 2 homework assignments and a topic presentation and report. The final grade is a combination of the assignment grades and the topic presentation grade. The standard high

level of [integrity](#) is expected from all students, as with all Math and CS courses.

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## Lectures

- Lecture 01: [On-line learning introduction](#).
  - Lecture 02: [Follow-the-perturbed-leader](#).
  - Lecture 03: [Learning and games](#).
  - Lecture 04: [Learning with large expert spaces](#).
  - Lecture 05: [Online convex optimization](#).
  - Lecture 06: [Bandit problems](#).
  - Lecture 07: [Online learning with feedback graphs](#).
  - Lecture 08: [Bandit convex optimization](#) + [BCO slides](#).
  - Lecture 09: Contextual bandit.
  - Lecture 10: [Approachability](#).
  - Lecture 21: [Learning kernels](#).
  - Lecture 22: [Deep boosting](#).
  - Lecture 23: [Structured prediction](#).
  - Lecture 41: [Domain adaptation](#).
  - Lecture 42: [Transduction](#).
  - Lecture 43: [Active learning](#).
  - Lecture 44: [Time series prediction](#).
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## Technical Papers

An extensive list of recommended papers for further reading is provided in the lecture slides.

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## Homework

- [Homework 1](#) [solution].
  - Homework 2 [solution].
  - Topic presentations.
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## Previous years

[2015](#)

[2016](#)

[2017](#)

[2018](#)