

# ECE 598: Interplay between Control and Machine Learning

Instructor: Bin Hu

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Email: [binhu7@illinois.edu](mailto:binhu7@illinois.edu)

Office Hours: T/Th 3-4pm

Office: CSL 145

Class Hours: T/Th 12:30-13:50pm

Class Room: 3020 ECEB

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## Course Description

Advanced graduate course focuses on interplay between control and machine learning. The first half of the course focuses on tailoring control tools to study algorithms in large-scale machine learning. In the second half of the course, students will study how to combine reinforcement learning and model-based control methods for control design problems.

We will cover some (or all) of the following topics: empirical risk minimization; first-order methods for large-scale machine learning; stochastic optimization; dissipation inequality; jump system theory; Lur'e-Postkinov type Lyapunov functions; integral quadratic constraints; KYP Lemma; graphical interpretations for optimization methods; adaptive control and ADAM; stable manifold theorem; Lyapunov measure; implicit bias of gradient descent on least square and logistic regression;  $\mathcal{H}_\infty$  theory; algorithmic stability; policy gradient on linear quadratic regulator (LQR) problems; learning model predictive control for iterative tasks; zeroth-order optimization and evolutionary strategies; robust control via DK-iteration and IQC-synthesis; adversarial reinforcement learning; imitation learning.

## Course Objectives

The purpose of this course is to inspire students to think about potential research at the intersection of control and learning. Upon successful completion of the course, students will be able to explain two basic ideas: (i) applying control methods for learning; (ii) applying learning methods for control. Students will be able to understand the mathematics underlying such interdisciplinary research. Students will be prepared to tailor their own expertise (in either control or machine learning) for research at the intersection of control and machine learning.

## Required Materials

There is no required textbook for the class. All course material will be presented in class and/or provided online as notes. Links for relevant papers will be listed in the course website.

## Prerequisites

Math 415, ECE 313, ECE 490 (or any similar course on optimization), and ECE 515 are required. ECE 534 is recommended, but not required.

## Grading

60% regular homework sets; 40% written research report

## Disability Accommodations

To determine if you qualify for disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TTY), or email a message to [disability@uiuc.edu](mailto:disability@uiuc.edu).

## Other Policies

- There is zero tolerance on academic misconduct. Individuals suspected of committing academic dishonesty will be directed to the Dean of Students Office as per University policy. **Penalty for academic misconduct** (up to 100%).
- We expect you to conduct yourselves in accordance with the University's Student Code. <http://studentcode.illinois.edu/>
- Emergencies can happen anywhere and at any time, so it's important that we take a minute to prepare for a situation in which our safety could depend on our ability to react quickly. Take a moment to learn the different ways to leave this building. If there's ever a fire alarm or something like that, you'll know how to get out and you'll be able to help others get out. Next, figure out the best place to go in case of severe weather - we'll need to go to a low-level in the middle of the building, away from windows. And finally, if there's ever someone trying to hurt us, our best option is to run out of the building. If we cannot do that safely, we'll want to hide somewhere we can't be seen, and we'll have to lock or barricade the door if possible and be as quiet as we can. We will not leave that safe area until we get an Illini-Alert confirming that it's safe to do so. If we can't run or hide, we'll fight back with whatever we can get our hands on. If you want to better prepare yourself for any of these situations, visit [police.illinois.edu/safe](http://police.illinois.edu/safe). Remember you can sign up for emergency text messages at [emergency.illinois.edu](http://emergency.illinois.edu).