

## Lecture 0: Course Outline

22nd August 2023

Lecturer: Prof. Nisha Chandramoorthy (she/her)

In this course, we learn the mathematical foundations of modern machine learning methods with the goal of understanding how and when they do work and do not. We will focus on neural networks mainly, but we will spend a few lectures on classical statistical models and algorithms.

### 1 General information

- Class time and location:
- Office hours:
- Instructor email: nishac@gatech.edu
- TAs name and email:
- Prerequisites:

### 2 Resources (not exhaustive)

- The textbook for the course will be [5]. Other books we will cover material from are [1], [3] and [2]. These are available online. Some lectures will be based on research articles, and these will be cited during class and in the corresponding lecture notes.

As modern ML methods grow, so do the mathematical and computational questions around them. Hence, it is important to remember that this course is only a limited view at a vast landscape. Apart from similar courses offered across Georgia Tech, there are other freely available course materials that will certainly enhance this view. Here are a few: [4], [? ].

### 3 Tentative course schedule

#### Part 1: Learning theory and practice – foundations

Lec 1 Least-squares regression, Tikhonov regularization, linear algebra review along the way

## **Part 2: Classical ML, statistics and optimization**

Lec Reinforcement learning, stochastic optimal control

## **Part 3: Recent developments**

Lec n Generative models: Score-based generative models/diffusion models.

Lec n+1 Generative adversarial neural networks

Lec n+2 Optimal transport, mean-field games, stochastic optimal control revisited

Lec Transformers

## **4 Grading information and late policy**

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies> or <http://www.catalog.gatech.edu/rules/18/>.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

## **5 Accommodations for Students with Disabilities**

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

## **6 Student-Faculty Expectations Agreement**

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

## References

- [1] M. Mohri, A. Rostamizadeh, and A. Talwalkar. *Foundations of machine learning*. MIT press, 2018.
- [2] K. P. Murphy. *Probabilistic machine learning: Advanced topics*. MIT press, 2022.
- [3] K. P. Murphy. *Probabilistic machine learning: an introduction*. MIT press, 2022.
- [4] P. Rigollet. *MIT 18.657: Mathematics of Machine Learning*. 2015.
- [5] S. Shalev-Shwartz and S. Ben-David. *Understanding machine learning: From theory to algorithms*. Cambridge university press, 2014.