CSE 6740, Fall 2023, Georgia Tech

Lecture 0: Course Outline

22nd August 2023

Lecturer: Nisha Chandramoorthy

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 Resources (not exhaustive)

- The textbook for the course will be [5]. Other books we will cover material from are [1], [3] and [2]. 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], [**?**].

2 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

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.