

## **ECE 901: Learning from Small Data**

### **Course description:**

In this course, we will explore the modern topics in machine learning with a focus on learning from small data. This course will have two parts. In the first part, we will focus on building the core tools to understand advanced ML topics, like application of polynomial approximations, method of moments, concentration inequalities, and convex geometry (in particular linear and semi-definite programs). We will also define and compare the use of KL-divergence, total variation distance, and Wasserstein-p distances; learn how to use hypothesis testing problem set-up to derive lower bounds in learning problems. In the second part of the course, we will apply these tools to understand in-depth a collection of selected papers on learning from sparse and small data. Students will be divided into smaller groups and each group will present a paper in the class, identifying the results are proved using the core tools learnt in the first part of the course. Students will critically review the papers and submit reports summarizing the papers, identifying possible extensions and open problems and discuss possible approaches to tackle them.

### **Requirements:**

Probability e.g., ECE 730 or equivalent; Linear Algebra ECE/CS 532 or MATH 541 or equivalent; OR instructor's permission.

### **Learning Outcomes:**

- (1) Become comfortable delving into details of machine learning papers with theoretical analysis
- (2) Learn to identify the main tools used in analysis that involve long proofs
- (3) Critically review research papers
- (4) Learn to identify open research problems
- (5) Understand how core topics in machine learning theory, optimization, statistics and signal processing are used to derive modern results in machine learning
- (6) Work together with peers, learn to discuss proof details and learn how to provide feedback to others