STA 741 / ECE 741: Course Information

Compressed Sensing and Related Topics
Duke University, Spring 2016

Basic Information:

Instructor:	Prof. Galen Reeves (email: galen.reeves@duke.edu)
	Office Hours: Wednesday, 11:30 AM - 12:30 AM, 321 Gross Hall
TA:	Mengke Lian (email: mengke.lian@duke.edu)
	Office Hours: Monday, 3:30 PM - 4:30 PM Gross Hall, 3rd floor
Lectures:	Monday and Wednesday, 10:05 AM -11:20 AM in Biological Sciences 155
Website:	https://sakai.duke.edu/

Description:

Compressed sensing (CS) is a recent theory dedicated to the recovery of structured signals from incomplete and inaccurate observations. The canonical CS problem is that of recovering an unknown sparse vector by solving a noisy and underdertermined system of linear equations. Some of the most notable applications of CS to date include increasing the speed of tomography in medical imaging, super-resolution for inverse problems in geophysics and astronomy, and powerful new techniques for inference problems in high-dimensional statistics.

This course has two main objectives. The first objective is to provide an introduction to the basic compressed sensing problems and methodologies. These include the recovery of sparse vectors and low-rank matrices using methods based on convex optimization and approximate message passing.

The second objective of the course is to provide a unified theoretical framework for the analysis of certain CS problems, and in particular, study phase-transitions with respect to stable signal recovery. The analysis of these problems is rich enough that no single discipline can explain the full range of behaviors. Consequently, the course will take a highly interdisciplinary approach, drawing upon ideas from statistical decision theory, high-dimensional convex geometry, information theory, convex optimization, message passing and variational inference with graphical models, and the replica method from statistical physics. The idea is to show how each of these areas provides complementary information about the fundamental and practical limits of stable recovery.

Course Goals/Objectives

- Introduction to compressed sensing problems and methodologies.
- Overview of minimax estimation with Gaussian noise.
- Analysis of convex optimization based recovery algorithms using concentration of measure and Gaussian widths.
- Analysis of approximate message passing algorithms using state evolution
- Analysis of optimal methods using information theory, large deviations, and the replica methods from statistical physics.

Prerequisites:

The course is appropriate for graduate students in statistics, electrical engineering, computer science, mathematics, and related fields who have a strong background in probability and linear algebra.

Assessment Information

Evaluation will be based on the homework and final project