M664: Compressive Sensing

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Course description: Recent years have witnessed the birth of a fascinating field at the intersection of Mathematics, Engineering, and Computer Science. It is called Compressive Sensing, because of its premise that data acquisition and compression can be performed at the same time. As such, the basic objective of Compressive Sensing is to provide concrete protocols for sensing and compressing data simultaneously. This is essential when limited sensing capabilities force the reconstruction of data from sets of measurements that seem highly incomplete at first sight. It turns out that, not only is the reconstruction possible in theory, it can also be carried out efficiently in practice. Such a conclusion is drawn from recent theoretical results that bring appropriate measurement schemes and efficient reconstruction algorithms to light. The course will keep an eye on the application side, but will mainly focus on the underlying mathematical theory. The goal is to provide a comprehensive background for research in this popular field.

Course content: The following topics will (tentatively) be covered:
- Applications, motivations, and extensions
- Sparse solutions of underdetermined systems
- Greedy and thresholding-based algorithms
- Convex optimization
- Basis pursuit
- Coherence of a matrix
- Restricted isometry property
- Random matrices
- Structured random matrices
- Lossless expanders
- High-dimensional geometry
- Recovery of random signals

Course requirement: The course is accessible to Mathematics, Engineering, and Computer Science students alike. It assumes some basic knowledge of linear algebra, analysis, and probability. Familiarity with MATLAB is a plus.

Textbook: *A Mathematical Introduction to Compressive Sensing* by S. Foucart and H. Rauhut.