Time & Location: March 28, 2019 at 10:00 AM in HEC 356
Title: Sparse signal recovery under sensing and physical hardware constraints

This dissertation focuses on information recovery under two general types of sensing constraints and hardware limitations that arise in practical data acquisition systems. We study the effects of these practical limitations in the context of signal recovery problems from interferometric measurements such as for optical mode analysis.

The first constraint stems from the limited number of degrees of freedom of an information gathering system, which gives rise to highly constrained sensing structures. In contrast to prior work on compressive signal recovery which relies for the most part on introducing additional hardware components to emulate randomization, we establish performance guarantees for successful signal recovery from a reduced number of measurements even with the constrained interferometer structure obviating the need for non-native components. Also, we propose control policies to guide the collection of informative measurements given prior knowledge about the constrained sensing structure. In addition, we devise a sequential implementation with a stopping rule, shown to reduce the sample complexity for a target performance in reconstruction.

The second limitation considered is due to physical hardware constraints, such as the finite spatial resolution of the used components and their finite aperture size. Such limitations introduce non-linearities in the underlying measurement model. We first develop a more accurate measurement model with structured noise representing a known non-linear function of the input signal, obtained by leveraging side information about the sampling structure. Then, we devise iterative denoising algorithms shown to enhance the quality of sparse recovery in the presence of physical constraints by iteratively estimating and eliminating the non-linear term from the measurements. We also develop a class of clipping-cognizant reconstruction algorithms for modal reconstruction from interferometric measurements that compensate for clipping effects due to the finite aperture size of the used components and show they yield significant gains over schemes oblivious to such effects.

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Approved for distribution by George Atia, Committee Chair, on March 14, 2019.

The public is welcome to attend.