Sparse blind signal separation methods of spectral sensing mixtures and applications

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School of Physical and Mathematical Sciences

Spectral sensing involves a range of technologies for detecting, identifying chemicals and biological agents. An important application is in homeland security where a critical problem is identification of unknown explosives. Though modern imaging and spectroscopy technology have made it possible to classify pure chemicals by spectra, realistic data are often composed of mixtures of chemicals and environmental noise, also subject to changing background.

In most cases, one has to deal with a so-called blind signal (source) separation (BSS) problem. Conventional approaches such as NMF and ICA are non-convex and too general to be robust and reliable in real-world applications. Based on a partial knowledge of the data (e.g. local spectral sparseness), we are able to reduce the problem to a series of convex sub-problems. The methods we developed consist of data clustering, model reduction, geometric sub-manifold identification, and $\ell_1$ optimization. Compressive sensing algorithms are also brought into play for recovering more signals than the number of spectral measurements. The methods will be illustrated in processing of real-world data-sets in NMR, DOAS, and Raman spectroscopy.

Speaker Biography
Dr. Yuanchang Sun is a visiting assistant professor at math department of UC Irvine. He earned his Ph.D. in applied math from Michigan State University in 2009. Dr. Sun’s research areas include mathematical modeling and signal processing, computational modeling of nano optics, numerical PDEs, and their applications. He is currently working on a research project sparse blind signal separation algorithms funded by NSF/ADT. Besides conducting research, Dr. Sun has been lecturing a variety of undergrad math courses including calculus (single and multi-variables), numerical methods and their laboratory, ODEs, and PDEs at MSU and UCI.

Host: Prof. Bernhard Schmidt, Division of Mathematical Sciences, School of Physical and Mathematical Sciences