Workshop on Harmonic Analysis and Sampling Theory

Department of Mathematics, University of Central Florida

9am–4pm, February 2, 2018

Titles and Abstracts

Akram Aldroubi (akram.aldroubi@vanderbilt.edu) – Vanderbilt University

Frames induced by the action of the powers of an operator

Abstract: We investigate systems of the form $\{A^t g : g \in \mathcal{G}, t \in [0, L]\}$ where $A \in B(\mathcal{H})$ is a normal operator in a separable Hilbert space $\mathcal{H}$, $\mathcal{G} \subset \mathcal{H}$ a countable set, and L a positive real number. Although the main goal of this work is to study the frame properties of $\{A^t g : g \in \mathcal{G}, t \in [0, L]\}$, as intermediate steps, we explore the completeness and Bessel properties of such systems, which are of interest by themselves. Beside the theoretical appeal of investigating such systems, their connection to dynamical and mobile sampling make them fundamental for understanding and solving several major problems in engineering and science.

Wenjing Liao (wliao60@gatech.edu) – Georgia Institute of Techology

Multiscale methods for high-dimensional data with low-dimensional structures

Abstract: Many data sets in image analysis and signal processing are in a high-dimensional space but exhibit a low-dimensional structure. We are interested in building efficient representations of these data for the purpose of compression and inference. In the setting where a data set in R^D consists of samples from a probability measure concentrated on or near an unknown d-dimensional manifold with d much smaller than D, we consider two sets of problems: low-dimensional geometric approximation to the manifold and regression of a function on the manifold. In the first case, we construct multiscale low-dimensional empirical approximations to the manifold and give finite-sample performance guarantees. In the second case, we exploit these empirical geometric approximations of the manifold and construct multiscale approximations to the function. We prove finite-sample guarantees showing that we attain the same learning rates as if the function was defined on a Euclidean domain of dimension d. In both cases our approximations can adapt to the regularity of the manifold or the function even when this varies at different scales or locations.

Chang Eon Shin (shinc@sogang.ac.kr) – Songang University

Stability, Wiener's Lemma, Norm-controlled inversion of operators

Abstract: In this talk, we will overview mathematical problems of stability, Wiener's lemma and norm-controlled inversion of infinite matrices and integral operators. I will present some old results in this area and also recent results regarding stability and norm-controlled inversion of infinite matrices on graph and stability of integral operators on a space of homogeneous type.

Qiyu Sun (qiyu.sun@ucf.edu) – University of Central Florida

Phaseless sampling and reconstruction of real signals

Abstract: A spatial signal is defined by its evaluations on the whole domain. In this talk, we consider stable reconstruction of real-valued signals, up to a sign, from their magnitude measurements on the whole domain or their phaseless samples on a discrete subset. FRI signals appear in many engineering applications such as magnetic resonance spectrum, ultra wide-band communication and electrocardiogram. For an FRI signal, we plan to introduce an undirected graph to describe its topological structure. We establish the equivalence between the graph connectivity and phase retrievability of FRI signals, and we apply the graph connected component decomposition to find all FRI signals that have the same magnitude measurements as the original FRI signal has. In my talk, we also propose a stable algorithm with linear complexity to reconstruct FRI signals from their phaseless samples on the above phaseless sampling set. The proposed algorithm is demonstrated theoretically and numerically to provide a suboptimal approximation to the original FRI signal in magnitude measurements.

The talk is based on a joint work with Cheng Cheng (Duke Univ. and SAMSI).

Sui Tang (`stang@math.jhu.edu`) – John Hopkins University

Universal constructions of spatiotemporal sampling sets in dynamical sampling

Abstract: Dynamical sampling is a new area in sampling theory that deals with processing signals that evolve in time. It is motivated by spatiotemporal sampling problem in a diffusion field in which we want to recover the initial distribution function from its coarsely sampled snapshots at multiple time instances. In this talk, I will discuss how to construct minimal universal spatiotemporal sampling sets in a discrete version of linear diffusion field and show a connection between this problem and the sparse signal processing theory and polynomial interpolation theory.