IEEE SG WIE AG Technical Talk

Sparse Representations, l1 Minimization and the Geometric Separation Problem

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Friday July 24th 2009
16:30-17:30
Executive Seminar Room (S2.2 B2-53)
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Abstract

During the last two years, sparsity has become a key concept in various areas of applied mathematics, computer science, and electrical engineering. Sparsity methodologies explore the fundamental fact that many types of data/signals can be represented by only a few non-vanishing coefficients when choosing a suitable basis or, more generally, a frame. If signals possess such a sparse representation, they can in general be recovered from few measurements using l1 minimization techniques.

One application of this novel methodology is the geometric separation of data, which is composed of two (or more) geometrically distinct constituents - for instance, pointlike and curvelike structures in astronomical imaging of galaxies. Although it seems impossible to extract those components - as there are two unknowns for every datum - suggestive empirical results using sparsity considerations have already been obtained.

In this talk we will first give an introduction into the concept of sparse representations and sparse recovery. Then we will develop a very general theoretical approach to the problem of geometric separation based on these methodologies by introducing novel ideas such as geometric clustering of coefficients. Finally, we will apply our results to the situation of separation of pointlike and curvelike structures in astronomical imaging of galaxies, where a deliberately overcomplete representation made of wavelets (suited to pointlike structures) and curvelets/shearlets (suited to curvelike structures) will be chosen. The decomposition principle is to minimize the l1 norm of the frame coefficients. Our theoretical results show that at all sufficiently fine scales, nearly-perfect separation is indeed achieved.

This is joint work with David Donoho (Stanford University).

Speakers' Biography

http://www.ewh.ieee.org/r10/singapore/wie/Activities/Activities2009/20090724BiographyGitta.pdf

Biography

Gitta Kutyniok completed her Diploma in Mathematics and Computer Science in 1996 at the Universität Paderborn in Germany. She was then employed as a Scientific Assistant and in 2000 received her Ph.D. degree in the area of time-frequency analysis from the same university. In 2001, she spent one term as a Visiting Assistant Professor at the Georgia Institute of Technology. After having returned to Germany, she accepted a position as a Scientific Assistant at the Justus-Liebig-Universität Giessen. In 2004, she was awarded a Research Fellowship by the DFG-German Research Foundation, with which she spend one year at Washington University in St. Louis and at the Georgia Institute of Technology. She then returned to Germany, completed her Habilitation in Mathematics in 2006 and received her venia legendi. In 2007 and 2008, being awarded one of the highly competitive "Heisenberg Fellowships" by the DFG-German Research Foundation, she spent half a year at each, Princeton University, Stanford University, and Yale University. After returning to Germany in October 2008, she became a full professor for Applied Analysis at the Universität Osnabrück.

Gitta Kutyniok was awarded various prizes for both her teaching and research, among which were the "Weierstrass Prize for outstanding teaching of the Universität Paderborn" in 1998, the "Research Prize of the Universität Paderborn" in 2003 as well as the "Prize of the University Gießen" in 2006. Just recently, in 2007, she received the prestigious "von Kaven Prize" awarded annually by the DFG-German Research Foundation.

Since 2007, she is an Associate Editor for the Journal of Wavelet Theory and Applications, and since 2009, she is a Corresponding Editor for Acta Applicandae Mathematicae. She was a panelist for the NSF in 2008 and serves as a reviewer for the NSF, GIF, NWO, WWTF as well as for over 30 journals.

Her research interests include the areas of applied harmonic analysis, numerical analysis, and approximation theory, in particular, sparse approximations, compressed sensing, geometric multiscale analysis, sampling theory, time-frequency analysis, and frame theory with applications in signal and image processing.