ELECTRICAL & COMPUTER ENGINEERING SEMINAR

"Sparse Representations, l_1 Minimization, and the Geometric Separation Problem"

by

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LSC Virginia Dale Room

Abstract & Biography

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 l_1 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 l_1 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).

Biography. Gitta Kutyniok received the PhD degree in Mathematics in 2000 from the Universität Paderborn, Paderborn, Germany. She is currently a full professor of Applied Analysis in the Department of Mathematics at Universität Osnabrück, Germany. She has held visiting positions at Yale University (2008), Stanford University (2007-2008), Princeton University (2007), Washington University in St Louis (2005), and Georgia Institute of Technology (2001,2005). She has won numerous awards including the Research Fellowship of The German Research Foundation in 2004, the Heisenberg Fellowship of The German Research Foundation in 2006, and the von Kaven Prize of the German Research Foundation in 2007. Prof. Kutyniok's research interests are in frame theory, time-frequency analysis, signal and image processing, and sparse representations. She has made fundamental contributions to the mathematics of signal and image processing, including the introduction of shearlets and fusion frames.

Please contact Prof. Ali Pezeshki, pezeshki@engr.colostate.edu, with any questions.