JOINT ELECTRICAL & COMPUTER ENGINEERING AND APPLIED MATH SEMINAR

"Imaging Science Meets Compressed Sensing"

by

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Abstract: Modern imaging data are often composed of several geometrically distinct constituents. For instance, neurobiological images could consist of a superposition of spines (pointlike objects) and dendrites (curvelike objects) of a neuron. A neurobiologist might then seek to extract both components to analyze their structure separately for the study of Alzheimer specific characteristics. However, this task seems impossible, since there are two unknowns for every datum.

Compressed sensing is a novel research area, which was introduced in 2006, and since then has already become a key concept in various areas of applied mathematics, computer science, and electrical engineering. It surprisingly predicts that high-dimensional signals, which allow a sparse representation by a suitable basis or, more generally, a frame, can be recovered from what was previously considered highly incomplete linear measurements, by using efficient algorithms.

Utilizing the methodology of compressed sensing, this geometric separation problem can indeed be efficiently solved numerically by iterative thresholding using wavelets to capture the pointlike structures and shearlets to capture the curvelike structures. We then analyze this methodology theoretically by considering a distributional model situation and prove asymptotically perfect separation. Surprisingly, it turns out that the thresholding index sets even converge to the wavefront sets of the point- and curvilinear singularities in phase space and that those wavefront sets are perfectly separated by the thresholding procedure.

Biography: Gitta Kutyniok completed her Diploma in Mathematics and Computer Science in 1996 at the Universitat Paderborn in Germany. She received her Ph.D. degree in the area of time-frequency analysis from the same university in 2000. She completed her Habilitation in Mathematics in 2006 and received her venia legendi. In 2007, she was awarded a Heisenberg Fellowship by the DFG-German Research Foundation.

From 2001 to 2008 she held visiting appointments at several US institutions, including Princeton University, Stanford University, Yale University, Georgia Institute of Technology, and Washington University in St. Louis.

After returning to Germany in October 2008, she became a full professor of mathematics at the Universitat Osnabrueck, and headed the Applied Analysis Group. Since October 2011, she has an Einstein Chair at the Technical University of Berlin and is head of the Applied Functional Analysis Group (AFG).

Her research and teaching have been recognized by various awards, including the von Kaven Prize by the German Research Foundation, awards by the University Paderborn and the Justus-Liebig University Giessen for Excellence in Research, as well as the Weierstrass Prize for Outstanding Teaching. She is an Associate Editor and also Corresponding Editor for several journals in the area of applied mathematics. She is also a board member of the Berlin Mathematical School, a member of the council of the MATHEON "Mathematics for key technologies" in Berlin, and the chair of the GAMM activity group on "Mathematical Signal- and Image Processing".

Please contact Ali Pezeshki (ali.pezeshki@colostate.edu) with any questions.