Abstract:

The sparsity of signals and images in a certain transform domain or dictionary has been exploited in many applications in signal and image processing, including compression, denoising, and notably in compressed sensing, which enables accurate reconstruction from undersampled data. These various applications used sparsifying transforms such as DCT, wavelets, curvelets, and finite differences, all of which had a fixed, analytical data-independent form. Likewise, the acquisition in compressed sensing used mostly random sparse sampling schemes, chosen in a universal way, independent of the data.

Recently, sparse representations that are directly adapted to the data have become popular, especially in applications such as image denoising, and inpainting. In contrast, the adaptation of the acquisition to the data in compressed sensing has been little explored.

We describe three contributions to adaptive sparse representation and acquisition. The first contribution, is an approach for simultaneously learning the sparse representation dictionary and reconstructing the image from highly undersampled data, also known as blind compressed sensing. The second contribution, is a new formulation for data-driven learning of sparsifying transforms, which improves on approaches involving learnt synthesis or analysis dictionaries, at much lower computational cost. The third contribution, is a novel framework for improved adaptive sampling schemes for highly undersampled compressed sensing in Fourier imaging.

The various methods are applied to image representation, to denoising, and to compressed sensing in MRI and CT, showing substantial improvements in reconstruction error, undersampling factor, and computational cost.

Biography of the Speaker:

Dr. Yoram Bresler is a Professor of Department of Electrical and Computer Engineering, and Department Bioengineering at the University of Illinois, Urbana-Champaign. He received the B.Sc. (cum laude) and M.Sc. degrees from the Technion, Israel Institute of Technology, in 1974 and 1981 respectively, and the Ph.D degree from Stanford University, in 1986, all in Electrical Engineering. In 1987 he joined the University of Illinois at Urbana-Champaign, where he is currently a Professor at the Departments of Electrical and Computer Engineering and Bioengineering, and at the Coordinated Science Laboratory. Yoram Bresler is also President and Chief Technology Officer at InstaRecon, Inc., a startup he co-founded to commercialize breakthrough technology for tomographic reconstruction developed in his academic research. His current research interests include Big Data, and multi-dimensional and statistical signal processing and their applications to inverse problems in imaging, and in particular compressed sensing, computed tomography, and magnetic resonance imaging. Dr. Bresler has served on the editorial board of a number of journals including the IEEE Transactions on Signal Processing, the IEEE Journal on Selected Topics in Signal Processing, Machine Vision and Applications, and the SIAM Journal on Imaging Science, and on various committees of the IEEE. He received two Senior Best Paper Awards from the IEEE Signal Processing society, and a paper he coauthored with one of his students received the Young Author Best Paper Award from the same society. His honors include the NSF Presidential Young Investigator Award, the Technion (Israel Inst. of Technology) Faculty Fellowship, the Xerox Senior Award for Faculty Research, University of Illinois Scholar, Associate at the Center for Advanced Study of the University, and Faculty Fellow at the National Center for Supercomputing Applications. Dr. Bresler is a fellow of the IEEE and of the AIMBE.