

Title: Sensing the real world: Sparse Sampling meets Strang-Fix and Baron de Prony

Abstract:

Modelling signals as sparse in a proper domain has proved fruitful in many signal and image processing applications.

Recently, the notion of sparsity has led to new sampling theories that have demonstrated that the prior knowledge that signals can be sparsely described in a basis or in a parametric space can be used to sample and perfectly reconstruct such signals at a significantly reduced rate.

The insight that sub-Nyquist sampling can, under some circumstances, allow perfect reconstruction is revolutionizing signal processing, communications and inverse problems.

In this talk we first recall that sampling involves the reconstruction of continuous-time or continuous-space signals from discrete measurements (samples) and show how to relate the discrete measurements to some properties of the original continuous signal (e.g., its Fourier transform at specific frequencies). This is achieved by using the theory of approximation of exponentials and the so called generalized Strang-Fix conditions.

Given this partial knowledge of the original signal, we then reconstruct it by using sparsity priors and in particular we provide exact reconstruction formulas for specific classes of 1-D and 2-D signals.

The reconstruction algorithms are all based around variations of the evergreen Prony's method.

We then consider applications of these ideas

in super-resolution imaging, neuroscience and inverse problems.

In particular, we present a method for enhancing image resolution by one order of magnitude, a new fast algorithm for calcium-transients detection from two-photon calcium imaging and a method for estimating diffusion fields driven by localized sources using spatio-temporal sensor measurements.

This is joint work with M. Vetterli (EPFL), T. Blu (CUHK), J. A. Uriguen (ICL), J. Onativia Bravo (ICL) J. Murray-Bruce (ICL), X. Wei (ICL), S. Reynolds (ICL) and S. Schultz (ICL).

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Bio:

Pier Luigi Dragotti is Professor of Signal Processing in the Electrical and Electronic Engineering Department at Imperial College London and a fellow of the IEEE. He received the Laurea Degree (summa cum laude) in Electronic Engineering from the University Federico II, Naples, Italy, in 1997; the Master degree in Communications Systems from the Swiss Federal Institute of Technology of Lausanne (EPFL), Switzerland in 1998; and PhD degree from EPFL, Switzerland, in April 2002. He has held several visiting positions.

Specifically, he was a visiting student at Stanford University, Stanford, CA in 1996, a summer researcher in the Mathematics of Communications Department at Bell Labs, Lucent Technologies, Murray Hill, NJ in 2000 and a visiting scientist at Massachusetts Institute of Technology (MIT) in 2011. Before joining Imperial College in November 2002, he was a senior researcher at EPFL working on distributed signal processing for sensor networks for the Swiss National Competence Center in Research on Mobile Information and Communication Systems.

Dr Dragotti was Technical Co-Chair for the European Signal Processing Conference in 2012, Associate Editor of the IEEE TRANSACTIONS ON IMAGE PROCESSING from 2006 to 2009 and an Elected Member of the IEEE Image, Video and Multidimensional Signal Processing Technical Committee. He is currently a member of the IEEE Signal Processing Theory and Methods Technical Committee and a recipient of an ERC Starting investigator Award for the project RecoSamp. His research interests include sampling theory, wavelet theory and its applications, image super-resolution and image-based rendering.