

Biomedical and Astronomical Signal Processing (BASP) Group Kick Off Seminar series and Apéro

10th December 2013

Location: Heriot-Watt University, Postgraduate Centre, Room PG201

Schedule: 13.50 until 17.45

- 13.50 - 14.00

Foreword by Dr. Y Wiaux, Director of BASP

- 14.00 - 14.45

PURIFY: a new algorithmic framework for next-generation radio-interferometric imaging

Dr. Rafael Carrillo

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Abstract:

In recent works, compressed sensing (CS) and convex optimization techniques have been applied to radio-interferometric (RI) imaging showing the potential to outperform state-of-the-art imaging algorithms in the field. In this talk, I will review our latest contributions in RI imaging, which leverage the versatility of convex optimization to both handle realistic continuous visibilities and offer a highly parallelizable structure paving the way to significant acceleration of the reconstruction and high-dimensional data scalability. Firstly, I will discuss our recently proposed average sparsity approach, SARA, for compressive imaging, which relies on the observation that natural images exhibit strong average sparsity over multiple coherent frames. Secondly, I will discuss efficient implementations of SARA for large-scale imaging problems based on the simultaneous-direction method of multipliers (SDMM). The new algorithmic structure promoted is implemented in a beta version of an imaging software written in C and dubbed PURIFY that handles various sparsity priors, including SARA.



Dr. Rafael E. Carrillo received the B.S. and the M.S. degrees (with honors) in Electronics Engineering from the Pontificia Universidad Javeriana, Bogota, Colombia, in 2003 and 2006 respectively and the Ph.D. degree in Electrical Engineering from the University of Delaware, Newark, Delaware, in 2011. He was an instructor from 2003 to 2006 at the Department of Electronics Engineering, Pontificia Universidad Javeriana and a research and teaching assistant at the Department of Electrical and Computer Engineering, University of Delaware from 2006 to 2011. Since 2011 he is a postdoctoral researcher with the BASP group at the Institute of

Electrical Engineering, École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. His research interests include signal and image processing, compressive sensing, inverse problems, and robust, nonlinear and statistical signal processing. Dr. Carrillo was the recipient of the "Mejor trabajo de grado" award, given to outstanding master thesis at the Pontificia Universidad Javeriana, in 2006, the University of Delaware Graduate Student Fellowship in 2007 and the Signal Processing and Communications Graduate Faculty Award from the University of Delaware in 2010.

- 14.45 – 15.15

Coffee and Discussion

- 15.15 - 16.00

High-angular resolution diffusion MRI through l_1 -minimisation

Ms. Anna Auria

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Abstract:

Water diffusion in living tissues is highly affected by its cellular organization. In particular, water does not diffuse equally in all directions in highly ordered organs, such as the brain, and this property is useful to study the structure of spatial order in living tissues in a non-invasive way.

In this talk, I will present the model used to describe the intra-voxel structure orientation of the fibers within a voxel through the so-called Fiber Orientation Distribution (FOD) and I will briefly review the State-of-the-Art optimization procedures to recover the number and orientation of fibers in each voxel making use of a sparse deconvolution approach.

I will propose two novel approaches using sparsity as a prior: the first one solves the FOD local reconstruction problem voxelwise minimising more appropriately the l_0 norm of the coefficients through a reweighted l_1 minimisation scheme. The second one solves the problem globally for the whole 3D-volume, therefore allowing spatial regularisation to assure the smoothness of fiber trajectories across the brain.



Anna Auria received her M.S. in Electrical Engineering and in Mathematics from UPC (Universitat Politècnica de Catalunya, Barcelona) in 2006. She did her M.S. final project in the FPMS (Faculté Polytechnique de Mons, Belgium) in 2007. After working for some time as a financial analyst using applied Mathematics, she moved to EPFL (Switzerland), where she joined BASP group at the end of 2011. She is officially pursuing her PhD within the group since mid 2012.

- 16.00 - 16.45

Bayesian Compressed Sensing between Synthesis and Analysis

Ms. Valentina Masarotto

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Abstract:

Bayesian Compressed Sensing (BCS) offers a statistical framework to reconstruct a signal solving the inverse problem of Compressed Sensing (CS). This presentation comes from an imaging-focussed perspective. We start with an overview of Bayesian methods for Compressive Imaging, as well as explaining the concepts of synthesis- and analysis-based reconstruction. Special attention will be given to methods which model sparsity through Laplace priors, and in particular to the hierarchical representation of such a distribution.

After the introduction, two new approaches to BCS will be presented. Such methods find roots in standard BCS methods and are inspired by the Average Sparsity concept promoted with the algorithm SARA. We provide experimental results which compare several CS reconstruction algorithms on 2-D images and show that our method has better performance than the standard Laplace-based BCS algorithm.



Valentina Masarotto obtained her BSc and MSc degree in mathematics respectively from the University of Padova, Italy, in 2006, and jointly from the University of Padova and Leiden (NL) in 2009. After the master she worked first as a guest researcher by TU Delft, The Netherlands, and then at the Space and Technology centre of the European Space Agency. From January 2012 she is working towards her Ph.D. degree in the Statistics Department of the University of Padova, under the supervision of Prof. Yves Wiaux (HW Edimburgh, Head of the Biomedical and Astronomical Signal Processing (BASP) group) and Prof. D. Marinucci (Tor Vergata, Rome). Her research interests focus on Bayesian Method applied to Imaging problems and Compressed Sensing.

- 16.45 – 17.45

Sparkling Apéro and Discussion