IEEE Statistical Signal Processing Workshop 2014

Proposal for a special session on
“Recent Advances in Monte Carlo methods in Statistical Signal and Image Processing”
by Dr Marcelo Pereyra and Prof Peter Green, on behalf of the SuSTaIn initiative, School of Mathematics, University of Bristol, United Kingdom.

With the recent development of fast and affordable electronic signal acquisition and processing devices, digital signals have become fundamental sources of information in science and industry. These now rely strongly on signal processing (SP) methods to improve signals and extract useful information from them. Most modern SP methods exploit statistical theory to solve SP problems, i.e., they use statistical models to describe the signal observation process and the available prior knowledge, and obtain solutions by performing statistical inference (e.g., computing maximum likelihood or Bayesian estimates).

The rapid adoption of SP in many disciplines (e.g. medicine, astronomy, defence, agriculture, environmental sciences, etc.), fuelled by a plethora of new application-specific modalities, has recently sparked an abundance of challenging signal processing problems and put into evidence the need for more complex statistical models as well as new methodologies to use them. This has driven the development of computation-intensive Bayesian SP methods based on Monte Carlo algorithms. This relatively young field at the interface of signal processing and computational statistics has lately gained a lot of attention because of its capacity to handle complex statistical models and apply sophisticated Bayesian statistical inference techniques that deliver accurate and insightful results. So far Bayesian SP methods have mostly used conventional Monte Carlo algorithms such as importance samplers, Gibbs samples and Metropolis-Hastings algorithms. There are many new and powerful Monte Carlo methods that are potentially very interesting for SP and that have yet to be applied.

The aim of this special session on “Recent Advances in Monte Carlo methods in Statistical Signal and Image Processing” will be to bring together world-leading scientists on computational statistics and on Bayesian methods in signal and image processing to discuss recent developments in stochastic simulation and optimization and their application to challenging signal and image processing problems. Also, this session will have the important mission of sustaining the adoption of Bayesian methods and of computational statistics algorithms in SP by raising awareness of modern Bayesian SP methodology to the wider statistical SP community.

The session will have a particular focus on new Monte Carlo methodologies for performing Bayesian inference in high-dimensional inverse problems and in inverse problems involving intractable statistical models, such as marginalized Bayesian models that integrate out unknown latent parameters. It will consist of six invited paper presentations around the following main areas:

- High-dimensional Sequential Monte Carlo (SMC) methods and particle filters.
- Bayesian inference methods and Markov-chain Monte Carlo (MCMC) algorithm for high-dimensional blind and semi-blind inverse problems with application to image processing.
- MCMC-driven stochastic optimisation algorithms for intractable inverse problems.
- Theory and practice of Monte Carlo methods in modern statistical signal processing.

The proposed special session will feature presentations by the following six distinguished scholars from the statistical SP and computational statistics communities:
• Prof Alfred Hero (University of Michigan, USA), on the contrast between the application and the theory of Monte Carlo methods (ACCEPTED).
• Prof Arnaud Doucet (University of Oxford, UK), TBA (ACCEPTED).
• Prof Christophe Andrieu (University of Bristol, UK), on stochastic gradient MCMC algorithms for solving intractable image processing problems (ACCEPTED or co-author).
• Prof Jean-François Giovannelli (University of Bordeaux, France) on Bayesian methods and MCMC algorithms for blind and semi-blind image processing problems (ACCEPTED).
• Prof Petar Djuric (Stony Brook University, USA), on high-dimensional particle filtering (ACCEPTED).
• Prof Steve McLaughlin (Heriot Watt University, UK), on sampling from a multivariate Gaussian distribution truncated on a simplex: a review. (ACCEPTED or co-author).

Organisers:
The SuSTaIn (Statistics underpinning Science, Technology and Industry) initiative at the School of Mathematics of the University of Bristol has the ambitious goal of strengthening the discipline of mathematical statistics by equipping it to face the challenges of future applications. It is funded principally by a 3.5 million pound Science and Innovation award from the British EPSRC research council and supports numerous permanent academic positions, postdoctoral fellowships, PhD studentships and a rich programme of new activities, including a 3-day workshop on “High-dimensional stochastic simulation and optimisation in image processing” featuring 11 invited speaker presentations by distinguished computational statisticians and image processing researchers, which will take place on 27-29 August 2014.

Dr Marcelo Pereyra and Prof Peter Green will be organizing this special session on “Recent Advances in Monte Carlo methods in Statistical Signal and Image Processing” on behalf of SuSTaIn. Dr Pereyra is currently a Brunel Research Fellow in Statistics at the School of Mathematics of the University of Bristol, funded by SuSTaIn as well as by the French Ministry of Defence. His research activities lie at the intersection of statistical image processing and computational statistics, with a particular interest in Bayesian models and methods for inverse problems arising in medical imaging and in remote sensing. He is the recipient of a Brunel Postdoctoral Research Fellowship, a Postdoctoral Research Fellowship from French Ministry of Defence, a Leopold Escande PhD Thesis excellent award from the University of Toulouse (2012), an INFOTEL R&D excellent award from the Association of Engineers of INSA Toulouse (2009), and an ITBA R&D excellence award from the Buenos Aires Institute of Technology (2007).

Prof Peter Green is an Emeritus Professor and Professorial Research Fellow at the University of Bristol, and a Distinguished Professor at the University of Technology, Sydney. He is a statistical scientist, principally interested in Bayesian inference in complex stochastic systems, Markov chain Monte Carlo methodology, forensic genetics, Bayesian nonparametric and graphical models. He is a Fellow of the Royal Society and a Fellow of the British Institute of Mathematical Statistics, as well as the recipient of a Royal Society Wolfson Research Merit award (2006), a Royal Statistical Society Guy Medal in Bronze (1987), and a Royal Statistical Society Guy Medal in Silver (1999). As of January 2014 he is editor of the Statistical Science journal of the Institute of Mathematical Statistics.
References related to the special session:


