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Editorials

Wavelets and Other Multiscale Methods

It is a great pleasure to introduce this excellent volume of work on multiscale methods, which reflects a wide range of research in the area and will also be a lasting resource for those seeking a survey of the field. An overview of the papers demonstrates how they cover a wide array of variations on the general theme.

The classical assumptions of nonparametric regression, particularly convenient in the wavelet context, were equally spaced data points, and Gaussian independent noise. It is part of the coming-of-age of wavelet methods that the original wavelet regression approaches have now been relaxed to deal with more general data structures, and the paper by Antoniadis, Gijbels and Poggi extends these assumptions in two directions, to data which are spaced unequally, and to heavy-tailed noise.

Bochkina and Sapatinas consider wavelet regression estimators in the more standard context, but push the boundaries in a different direction, by exploring many aspects of Bayes factor estimates under different risks.

One of the problems facing any newcomer to wavelet methods is the plethora of different approaches to threshold choice and model complexity. Chesneau and Lecué pursue a fascinating line of enquiry relevant to this issue, by aggregating a number of different estimators to obtain the estimator studied in more detail.

I was particularly interested to read the paper by Chu, Clyde and Liang, because this picks up on the idea of approximating unknown functions in an overcomplete function dictionary of continuously parametrised wavelets. It is very gratifying to see the practical implementation and investigation the authors provide.

Huo and Ni move the volume in a rather different direction, by considering a problem in image detection, that of spotting a convex-shaped object in a noisy image. In addition to its original contribution, their paper contains a very useful survey of a wide range of potential applications. It is noteworthy that their applications range from the microscopic (cryo-electron microscopy) to the very large (astronomical data), and from medical imaging to work relevant to detecting rooftops in aerial images.

Ko, Qu and Vannucci consider partial regression models. These are models that have a parametric part (for example a linear or low order polynomial fit) and, in addition, a nonparametric part. In most of the literature, the parametric part is a spline fit or other linear smoother, and so it is interesting to see the use of a wavelet estimator instead. This is particularly appropriate in the case of long-range dependence, because of the attractive behavior of the wavelet transform in this case.

Kulik and Raimondo have also written on the use of wavelet estimators on data with long-range correlated noise, including drawing some fascinating connections with inverse problems in white noise. It is particularly sad that Marc Raimondo died on 10 August 2008 after a short illness, and that this is therefore one of the last papers published by one of the most promising researchers in this general area.

Nunes and Nason consider another extension of the standard model for wavelet regression, this time to the case of the estimation of the proportion parameter of a binomial process. They introduce new methodology and illustrate it particularly in the context of DNA isochore detection.

Moving away from the wavelet theme towards a different multiscale approach, C. Park, Hannig and Kang develop aspects of the SiZer methodology for moderately correlated time series. Their method makes use of a range of smoothed versions of the observed series, using kernels with different bandwidths. Care is taken to allow for the effects of the correlation in the data, to ensure that there is good assessment of the significance of observed effects.

Finally, J. Park and C. Park return to the wavelet theme, remaining with correlated time series data. Their paper considers the estimation of the Hurst parameter of processes such as those that arise in observing internet data traffic. They use wavelets to develop a robust estimate of the long-range dependence parameter. The aim is to carry out the estimation in a way that is not influenced excessively by local non-stationary effects of various sorts.

Reviewing these papers will be particularly gratifying to those of us who have been following the progress of wavelets and other multiscale methods over the last twenty years. Most of the papers are in the area of wavelets in statistics and data processing. Wavelet methods are now firmly established not only in statistics, but in many other areas of mathematics; they are used in many contexts in substantive fields as the method of choice for the analysis and conceptualization of data. This is a rather recent phenomenon and it is interesting to ask what was the cause of this "wavelet revolution"? Somehow wavelets managed to come along at exactly the right time in the development of serious computer power and they had a special combination of practical potential and depth of theoretical interest. The papers in the current volume illustrate this, with some extending the practical potential of wavelet methods and some proving interesting theoretical results (and some doing both!). It is this interplay of theory and practice that has given particular impetus to the whole development of computational statistics over the last few decades.

Looking ahead, I find it hard to imagine that there will be any slowdown in the pace of research in this overall field. The enormous data sets collected in fields such as genome sequencing and the analysis of internet traffic, the recognition by theoreticians of the subtle and fascinating theoretical issues raised by multiscale methods, and the increase in computing power, particularly in multi-array processing, are all likely to give the field a great deal of energy well into the future, and no doubt there will be many more special issues in the years to come!

——— Bernard W. Silverman

Bernard W. Silverman is, until the end of 2009, Master of St Peter's College, Oxford. He completed his PhD from Cambridge in 1977 *under the supervision of David Kendall, and has held substantive and visiting posts at a number of universities in the UK and the US. He is Professor of Statistics at the University of Oxford, with Senior Research Fellowship posts at the Smith School of Enterprise and the Environment, and the Wellcome Trust Centre for Human Genetics. He has written about 100 published research papers, mainly in mathematical and computational statistics but also in fields as diverse as library science, law and genomics. He is the author of four books: Density Estimation for Statistics and Data Analysis* (1984)*;* (*with P. J. Green*) *Nonparametric Regression and Generalized Linear Models: a Roughness Penalty Approach* (1994)*;* (*with J. O. Ramsay*) *Functional Data Analysis* (1997*; second edition* 2005) *and Applied Functional Data Analysis* (2002)*. He has edited several other books and substantial official and professional reports. He has served as President of the Institute of Mathematical Statistics and Editor of the Annals of Statistics, and will be President of the Royal Statistical Society in* 2010 *and* 2011*. He is a Fellow of the Royal Society.*