O-Bayes15

Book of Abstracts

11th International Workshop Objective Bayes Methodology

Valencia, June 1-5, 2015

Editors:

Carmen Armero
M Eugenia Castellanos
David Conesa
Anabel Forte
Gonzalo García-Donato

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11th International Workshop on Objective Bayes Methodology

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Preface

The International Workshop on Objective Bayes Methodology, O-Bayes15, is held in Valencia, Spain, June 1-5, 2015. This is the 11th meeting of one of the longest running and preeminent meetings in Bayesian statistics, following earlier meetings held in West Lafayette, IN, USA, 1996; Valencia, Spain, 1998; Ixtapa, Mexico, 2000; Granada, Spain, 2002; Aussois, France, 2003; Branson, MO, USA, 2005; Roma, Italy, 2007; Philadelphia, PA, USA, 2009; Shanghai, China, 2011; and Durham, NC, USA 2013.

The principal objectives of O-Bayes15 is to facilitate the exchange of recent research developments in objective Bayes theory, methodology and applications, and related topics, to provide opportunities for new researchers, and to establish new collaborations and partnerships.

O-Bayes15 is dedicated to Susie Bayarri, to celebrate her life and contributions to Bayesian Statistics. O-Bayes15 consists on 21 invited talks and discussants, 3 tutorials and a poster session.

Welcome to Valencia. Enjoy the city and surroundings and have a great conference.

Carmen Armero, M. Eugenia Castellanos, David Conesa, Anabel Forte, Gonzalo García-Donato

Valencia, June 2015

Monday 1		Tuesday 2		Wednesday 3		Thursday 4	Friday 5
		07:30-08:30	Jogging for Susie				
08:30-14:00	Registration	09:30-10:00	Session 2	09:00-09:55	Session 4	Session 6	Excursion
09:00-10:20	Tutorial 1	10:00-10:55	Session 2	09:55-10:50	Session 4	Session 6	
10:20-11:00	Coffe Break	10:55-11:40	Wine Break	10:50-11:30	Coffe Break	Coffe Break	
11:00-12:20	Tutorial 2	11:40-12:35	Session 2	11:30-12:25	Session 4	Session 6	
12:30-13:50	Tutorial 3	12:35-13:30	Session 2	12:25-13:20	Session 4	Session 6	
14:00-15:45	Lunch	13:30-15:15	Lunch	13:30-15:15	Lunch	Lunch	
15:45-16:00	Opening Ceremony	15:15-16:10	Session 3	15:15-16:10	Session 5	Session 7	
16:15-17:10	Session 1	16:10-17:05	Session 3	16:10-17:05	Session 5	Session 7	
17:10-18:05	Session 1	17:05-17:35	Orxata Break	17:05-17:35	Orxata Break	Free afternoon	
				17:35-18:30	Session 5		
19:00	Reception at Botanic Garden	19:30-22:00	Poster Session	19:00		Guided visit and Gala Dinner	

Monday, June 1

Time	Speaker	Title
08:30-14:00	**Registration**	
	Tutorial on Objective Bayes Methodology **Chair: David Conesa**, Universitat de València	
09:00-10:20	**Luis Pericchi** University of Puerto Rico	*Bayesian information conflict resolution and robustness*
10:20-11:00	**Coffee Break**	
11:00-12:20	**Judith Rousseau** Université Paris Dauphine and CREST	*Asymptotic technics for Bayesian procedures*
12:30-13:50	**Christian Robert** Université Paris Dauphine and University of Warwick	*O'Bayes testing and model selection*
14:00-15:45	**Lunch Break**	
15:45-16:00	**Opening Ceremony**	
	Session 1: Objective Bayesian estimation **Chair: Walter Racugno**, Università di Cagliari	
16:15-17:10	**Chris Holmes** Oxford Centre for Gene Function Discussant: Dan Simpson, University of Warwick	*A new look at some old issues in robust Bayesian analysis*
17:10- 18:05	**Veronika Ročková** University of Pennsylvania Discussant: Merlise Clyde, Duke University	*Bayesian Estimation of Sparse Signals with a Continuous Spike-and-Slab Prior*
19:00	**Welcome reception at Botanic Garden**	

Tuesday, June 2

07:30-13:30	**Susie Bayarri's morning**	
08:30-10:00	**Registration**	
07:30-08:30	**Jogging for Susie**	
	Session 2: Susie's session (First part) **Chair: Ed George**, University of Pennsylvania	
Time	**Speaker**	**Title**
09:30-10:00	**Jim Berger** Duke University	*The Exceptional Career of Susie Bayarri*
10:00-10:55	**María Eugenia Castellanos** Universidad Rey Juan Carlos Discussant: Leonhard Held, University of Zurich	*Conditional and Partial predictive p-values nowadays*
10:55-11:40	**Wine Break**	
	Session 2: Susie's session (Second part) **Chair: Carmen Armero**, Universitat de València	
11:40-12:35	**Anabel Forte** Universitat de València Discussant: Elías Moreno, Universidad de Granada	*Past Present and Future of Objective Bayesian Model Selection*
12:35-13:30	**Rui Paulo** Universidad de Lisboa Discussant: Gonzalo García-Donato, Universidad de Castilla-La Mancha	*Susie Bayarri's contributions to the field of computer models*
13:30-15:15	**Lunch Break**	
	Session 3: On aspects of Bayesian testing **Chair: Kerrie Mengersen**, Queensland University of Technology	
15:15-16:10	**Jean-Bernard Salomond** Université Paris Dauphine Discussant: Subhashis Ghosal, North Carolina State University	*Bayesian testing for embedded hypotheses with application to shape constrains*
16:10- 17:05	**James Scott** University of Texas at Austin Discussant:Dimitrios Fouskakis, University of Athens	*False discovery rate smoothing*
17:05-17:35	**Orxata Break**	
19:30-22:00	**Poster Session (Rooftop terrace, 4th floor)**	

Wednesday, June 3

Session 4: The development and study of objective priors

Chair: Marco Ferreira, Virginia Tech

Time	Speaker	Title
09:00-09:55	**Ioannis Ntzoufras** Athens University of Economics and Business Discussant: Abel Rodriguez, University of California	*Power-Expected-Posterior Priors in Generalized Linear Models*
09:55-10:50	**Håvard Rue** Norwegian University of Science and Technology Discussant: Christèle Bioche, Université de Clermont-Ferrand	*Penalising model component complexity: A principled practical approach to constructing priors*
10:50-11:30	Coffee Break	

Session 4: The development and study of objective priors (Second part)

Chair: Monica Musio, Università di Cagliari

11:30-12:25	**Yee-Whye Teh** University College, University of Oxford Discussant: Andrea Riebler, Norwegian University of Science and Technology	*A few priors of computational convenience*
12:25-13:20	**José Bernardo** Universidad de Valencia Discussant: Cristiano Villa, University of Kent	*An overall prior for the five-parameter normal distribution*
13:30-15:15	Lunch Break	

Session 5: Model selection and model uncertainty I

Chair: Marilena Barbieri, Università di Roma

15:15-16:10	**Javier Girón** Universidad de Málaga Discussant: Juan Antonio Cano, Universidad de Murcia	*Comparison of Some Bayes Factors from their Asymptotic and Frequentist Behavior*
16:10- 17:05	**Chris Hans** The Ohio State University Discussant: Mark Steel, University of Warwick	*From a Conditional Lindley's Paradox to Block Hyper-g Priors*
17:05-17:35	Orxata Break	
17:35- 18:30	**María-Eglée Pérez** Universidad de Puerto Rico Discussant: Stefano Cabras, Universidad Carlos III, Università di Cagliari	*Bayesian rescue for the troubled scientist: Can we make Null Hypothesis Significance Testing (NHST) work?*

Thursday, June 4

Session 6: The theory of objective Bayes

Chair: Dongchu Sun, University of Missouri

Time	Speaker	Title
09:00-09:55	**Natalia Bochkina** University of Edinburgh Discussant: Helene Massam, York University	*The Bernstein-von Mises theorem and misspecified nonregular models*
09:55-10:50	**Ismael Castillo** Universities Paris VI & VII Discussant: Sonia Petrone, Università Bocconi	*On some properties of Polya trees posterior distributions*
10:50-11:30	**Coffee Break**	

Session 6: The theory of objective Bayes (Second part)

Chair: Abrie van der Merwe, University of the Free State, South Africa

11:30-12:25	**Jan Hannig** University of North Carolina Discussant: Laura Ventura, University of Padova	*Generalized fiducial Inference: A Review*
12:25-13:20	**Catia Scricciolo** Università Bocconi Discussant: Andriy Norets, Brown University	*Asymptotics for empirical Bayes posteriors*
13:30-15:15	**Lunch Break**	

Session 7: Model selection and model uncertainty II

Chair: Phil Dawid, University of Cambridge

15:15-16:10	**Thais Fonseca** Universidad Federal Río de Janeiro Discussant: Brunero Liseo, Università di Roma	*Objective model selection in AR model*
16:10- 17:05	**David Rossell** University of Warwick Discussant: Guido Consonni, Università Cattolica del Sacro Cuore	*Default model selection with non-local priors*
17:05-19:00	**Free Afternoon**	
19:00	**Guided visit and Gala dinner** (Submarine Restaurant in Oceanographic of Valencia)	

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Invited Contributions

Poster Session

Remembering Susie

Maria Jesús Bayarri, one of the most prominent Bayesian statisticians in the world and a leader in O-Bayes, passed away on August 19, 2014 in Valencia, Spain, after an eighteen month battle with a brain tumor. We are here celebrating her contributions to O-Bayes, statistics, and life.

Susie was born on September 16, 1956 in Valencia, Spain. She studied at the University of Valencia, receiving Masters and Ph.D. degrees in mathematics in 1979 and 1984, respectively. Susie remained at the university for her entire career, becoming Full Professor in the Department of Statistics and Operations Research in 1998.

Susie had numerous visiting appointments in the US, starting in 1985 at Carnegie-Mellon University, then Purdue University (where she had visiting professorship appointments in 1988 and 1994) and – from 1998 onward – at Duke University and the Statistical and Applied Mathematical Sciences Institute (SAMSI). At Duke she was adjunct professor from 2003-2014 and, at SAMSI, she had numerous leadership roles, including being the Leader of the entire 2006-2007 research program.

Susie made major contributions to both the theory and methodology of Bayesian statistics, helping it become the prominent part of the scientific landscape that it is today. Her continuing long-term interests were selection models and weighted distributions; objective Bayesian methods; Bayesian analysis of queueing systems; Bayesian robustness; model criticism and p-values; model uncertainty and multiple comparisons; and calibration and validation of complex computer models. Susie was author or editor of five books and nearly 70 scientific research papers, three of which won major awards, including the 2006 Frank Wilcoxon Award and the 2008 Jack Youden Prize.

As one of the few early female Bayesian statisticians, Susie served as a role model for many students and younger researchers (both male and female). She instilled her passion for research in the five Masters and seven PhD students she directed, most of whom have gone on to have prominent research careers of their own.

Susie had major leadership roles in the statistics community, including serving as President of the International Society for Bayesian Analysis (ISBA) in 1998 and Presidenta de la Sociedad Española de Biometría from 2001 – 2003. Susie also served on thirteen editorial boards, including being Coordinating Editor of the Journal of Statistical Planning and Inference from 2001 – 2007, and was an organizer of 38 international meetings and conferences.

Susie was a central figure to the development of statistics in Spain and the world. Her extensive funding (as principal investigator) by the Ministry for Science and Education in Spain provided an umbrella for dozens of researchers to collaborate and develop their own research careers in epidemiology, biostatistics, spatial methodology, survival analysis, and foundations. Susie was also

central to the research project "Consolider i-MATH" from 2006-2012, which involved over 300 research teams from Spanish Universities. One of her last leadership roles in Spain was serving as the principal investigator of the BIOSTATNET project, a web-based collaboration of 180 investigators at universities inside and outside Spain and at biomedical institutions. Her international stature was reflected by her also being principal investigator of major grants from the European Community and the US National Science Foundation.

Susie had three hobbies. One was jogging, which she would faithfully do every day for one hour, without really liking it. The other two were wine and food. Susie was one of the original members of Verema – the internationally famous wine society started in Valencia – and she became exceptionally knowledgeable about wine and had a wonderful cellar. Through her activities in Verema, Susie also became a serious food critic; indeed one year she won the Verema award as the top food critic of the year. After that, going out to dinner with Susie in Spain was quite an experience; the chef and restaurant owner would constantly be at the table to make sure everything was perfect.

Susie received numerous honors, including being elected Fellow of the American Statistical Association in 1997, elected to the International Statistical Institute in 1997, elected Fellow of the IMS in 2008 and, in a bittersweet ceremony during the World Conference of ISBA in July, 2014, was in the first elected class of ISBA Fellows. The outpouring of admiration and love for her that was expressed by the attendees at the conference was inspiring.

Jim Berger

Invited Contributions

Session 1: Objective Bayesian estimation

Chairperson: Walter Racugno, University Degli Studi di Cagliari

A new look at some old issues in robust Bayesian analysis

Chris Holmes, Oxford Centre for Gene Function

Discussant: Dan Simpson, University of Warwick

Abstract

Robust Bayesian analysis was a highly active research field in and around the 1980s. Interest subsequently wained as data complexity remained fairly stable throughout the 90's and 00's but advances in computational methods, such as MCMC, and advances in stochastic structures, such as Bayesian nonparametric priors, provided much richer modeling environments alleviating concerns surrounding potential model misspecification. However, in recent times data complexity has grown enormously, the so called "Big Data" era. Fully Bayesian approaches may struggle to scale to modern data applications meaning that approximate methods have to be adopted. This warrants a reappraisal of robust Bayesian analysis under known model misspecification. We discuss recent relevant advances in the fields of robust control (signal processing) and economics, and present new results and suggestions for exploration and quantification of robust decisions taken over models within a Kullback-Leibler neighbourhood of the working model.

Bayesian Estimation of Sparse Signals with a Continuous Spike-and-Slab Prior

Veronika Rocková, University of Pennsylvania

Discussant: Merlise Clyde, Duke University

Abstract We introduce a new framework for estimation of normal means, bridging the gap between popular frequentist strategies (LASSO) and popular Bayesian strategies (spike-and-slab). The main thrust is to introduce the family of Spike-and-Slab LASSO (SS-LASSO) priors, which form a continuum between the Laplace prior and the point-mass spike-and-slab prior. We establish several appealing frequentist properties of SS-LASSO priors, contrasting them with these two limiting cases. To this end, we adopt the penalized likelihood perspective on Bayesian modal estimation and introduce the framework of "Bayesian penalty mixing" with spike-and- slab priors. Of primary interest to us are very non-concave penalties, yielding potentially very multimodal posteriors. Similarly as the LASSO mode, we show that the SS-LASSO global posterior mode is near-minimax rate-optimal under squared error loss (with suitable penalties). Going further, we show that the whole posterior "keeps pace with the global mode" and concentrates at the near-minimax rate, a property that is known not to hold for the single Laplace prior. Furthermore, mimimax-rate optimality is obtained with a suitable class of independent product priors (for known levels of sparsity) as well as with dependent mixing priors (adapting to the unknown levels of sparsity). Up to now, the rate-optimal posterior concentration has been established only for spike-and-slab priors with a point mass at zero. Thus, the SS-LASSO priors, despite being continuous, possess similar optimality properties as the "methodologically ideal" point-mass mixtures. These results provide valuable theoretical justification for our proposed class of priors, underpinning their intuitive appeal and practical potential.

Session 2: Susie's session (first part)

Chairperson: Ed George, University of Pennsylvania

The Exceptional Career of Susie Bayarri

James O. Berger, Duke University

Abstract The major impact that Susie had on Bayesian statistics and statistics in general will be discussed. Her career will be briefly reviewed, with emphasis on major developments for which she was responsible. The talks in this session relate to three of the most significant areas of Susie's research; in these opening remarks, other important research of Susie's will also be highlighted.

Conditional and Partial predictive p-values nowadays

María Eugenia Castellanos, Universidad Rey Juan Carlos

Discussant: Leonhard Held, University of Zurich

Abstract Bayarri and Berger worked on conditional and partial measures of surprise for goodness of fit of Bayesian models in presence of unknown parameters dating back from ISDS Discussion Paper, 1997 up to JASA 2000. They highlighted the problem of "double use" of data by the posterior predictive p-value, and the necessity of other measures for model checking from an objective point of view. In particular, conditional and partial p-values have been more frequently used because they have an appealing property, when considered as random variables, $p(X)$, their null distribution is uniform, at least asymptotically. This endorses p-values with a very desirable property, namely having the same interpretation across problems.
In the context of hierarchical models, Bayarri and Castellanos paper (2007, Statistical Science) adapted these measures to assess the goodness of fit of this type of models. The present work reviews these measures and the use of them from its origin to these days. A summary of other Bayesian measures for goodness of fit is also presented.

(Inspired on my work with Susie Bayarri.)

Session 2: Susie's session (second part)

Chairperson: Carmen Armero, Universitat de València

Past Present and Future of Objective Bayesian Model Selection

Anabel Forte, Universitat de València

Discussant: Elías Moreno, Universidad de Granada

Abstract

No matter which subject you do think about or when you do so you will always find an attempt to understand which is the right theory driving a process. This is the base for model selection, a challenging problem deeply studied by Bayesians and non-Bayesian statisticians.

From an Objective Bayes point of view, and since the pioneering work of Jeffreys (1961), many solutions have been proposed to select from a set of models. Given the computational advances and the increasing capacity to store data, the number of models and its complexity has been growing from the simple two hypothesis test to the non-numerable set of models of any problem in genetics and from normal linear models to hierarchical, non-linear, models.

This talk pretends to be a tour around the methodologies proposed to solve different model selection problems from the beginning of Objective Bayes Model selection to present days.

Susie Bayarri's contributions to the field of computer models

Rui Paulo, ISEG and CEMAPRE, University of Lisbon

Discussant: Gonzalo García-Donato, Universidad de Castilla-La Mancha

Abstract

Susie Bayarri was very enthusiastic about her research in the area of calibration and validation of computer models, and we were fortunate to be involved in some of the many projects that she either led or played a very important part in.

This talk will give you a perspective or her contributions to the field, both methodologial and foundational, starting with the construction of a general framework for the validation of computer models. We will then see how this general strategy was adapted to more and complex situations and also the type of questions raised by these applied problems.

Session 3: On aspects of Bayesian testing

Chairperson: Kerrie Mengersen, Queensland University of Technology

Bayesian testing for embedded hypotheses with application to shape constrains

Jean-Bernard Salomond, Universite Paris Dauphine

Discussant: Subhashis Ghosal, North Carolina State University

Abstract

If Bayesian nonparametric methods have received a great interest in the literature, only a few is known for testing nonparametric hypotheses, and especially the asymptotic properties of such tests. The problem of testing between two nonparametric hypotheses is known to be difficult, but the problem becomes even harder when the hypotheses are embedded. In this work, we propose a method to circumvent these difficulties with a special focus on shape constrains testing. We propose an approach that allows us to derive a Bayesian answer to testing problems that have good asymptotic properties and is easy to use in practice. Furthermore, from our method, we can easily derive posterior separation rate for the tests. To our best knowledge, this particular aspect of the test has not been studied in the Bayesian literature so far. We apply our approach to several testing problems with a special attention to the problems of testing for positivity or monotonicity in a nonparametric regression problem.

False discovery rate smoothing

James Scott University of Texas at Austin

Discussant: Dimitrios Fouskakis, University of Athens

Abstract Many approaches for multiple testing begin with the assumption that all tests in a given study should be combined into a global false-discovery-rate analysis. But this may be inappropriate for many of today's large-scale screening problems, where test statistics have a natural spatial lattice structure (voxels in the brain, distance along the chromosome), and where a combined analysis can lead to poorly calibrated error rates. To address this problem, we introduce an empirical-Bayes approach called false-discovery-rate smoothing. FDR smoothing automatically finds spatially localized regions of significant test statistics. It then relaxes the threshold of statistical significance within these regions, and tightens it elsewhere, in a manner that controls the overall false-discovery rate at a given level. This results in increased power and cleaner spatial separation of signals from noise. The approach requires solving a non-standard high-dimensional optimization problem, for which an efficient augmented-Lagrangian algorithm is presented. We demonstrate that FDR smoothing exhibits state-of-the-art performance on simulated examples. We also apply the method to a data set from an fMRI experiment on spatial working memory, where it detects patterns that are much more biologically plausible than those detected by existing FDR-controlling methods. All code for FDR smoothing is publicly available in Python and R.

With Wesley Tansey, Sanmi Koyejo and Russ Poldrack.

Session 4: The development and study of objective priors

Chairperson: Marco Ferreira, Virginia Tech

Power-Expected-Posterior Priors in Generalized Linear Models

Ioannis Ntzoufras, Athens University of Economics and Business

Discussant: Abel Rodriguez, University of California

Abstract

The Power-Expected-Posterior (PEP) priors have been developed for variable selection in normal regression models; they combine ideas from the power-prior and expected-posterior prior relying on the concept of random imaginary data. In this work the PEP methodology is extended to Generalized Linear Models (GLMs). Furthermore, we consider mixtures of PEP priors in a similar manner to the hyper-g prior. We define the new class of PEP priors under the GLM setting and we present various posterior representations which can be used for model-specific posterior inference or for variable selection. Finally we consider possible extensions of the methodology to large p small n settings by appropriately specifying the baseline prior. The method is implemented to a Poisson log-linear and a logistic regression example.

With D. Fouskakis, and K. Perrakis,

Penalising model component complexity: A principled practical approach to constructing priors

Håvard Rue, Norwegian University of Science and Technology

Discussant: Christèle Bioche, Université de Clermont-Ferrand

Abstract

Setting prior distributions on model parameters is the act of characterising the nature of our uncertainty and has proven a critical issue in applied Bayesian statistics. Although the prior distribution should ideally encode the users' uncertainty about the parameters, this level of knowledge transfer seems to be unattainable in practice and applied statisticians are forced to search for a "default" prior. Despite the development of objective priors, which are only available explicitly for a small number of highly restricted model classes, the applied statistician has few practical guidelines to follow when choosing the priors. An easy way out of this dilemma is to re-use prior choices of others, with an appropriate reference.

In this talk, I will introduce a new concept for constructing prior distributions. We exploit the natural nested structure inherent to many model components, which defines the model component to be a flexible extension of a base model. Proper priors are defined to penalise the complexity induced by deviating from the simpler base model and are formulated after the input of a user-defined *scaling* parameter for that model component, both in the univariate and the multivariate case. These priors are invariant to reparameterisations, have a natural connection to Jeffreys' priors, are designed to support Occam's razor and seem to have excellent robustness properties, all which are highly desirable and allow us to use this approach to define default prior distributions. Through examples and theoretical results, we demonstrate the appropriateness of this approach and how it can be applied in various situations, like random effect models, spline smoothing, disease mapping, Cox proportional hazard models with time-varying frailty, spatial Gaussian fields and multivariate probit models. Further, we show how to control the overall variance arising from many model components in hierarchical models.

With Daniel P. Simpson, Thiago G. Martins, Andrea Riebler, Geir-Arne Fuglstad (NTNU) and Sigrunn H. Sørbye (Univ. of Tromsø),

Session 4: The development and study of objective priors (second part)

Chairperson: Monica Musio, Università di Cagliari

A few priors of computational convenience

Yee-Whye Teh, University College, University of Oxford

Discussant: Andrea Riebler, Norwegian University of Science and Technology

Abstract In this golden age of statistics when data, the raw material of statistical analyses, are in such abundance, the bottleneck is increasingly the computational efficiency of algorithms used for inference. In this talk I will give an idiosyncratic computational view of priors used in bayesian nonparametric modelling. In particular I will describe the thinking behind the some of the choices of priors we made in past works and how these were often driven by computational convenience rather than real subjective prior knowledge or objective theoretical properties.
http://www.stats.ox.ac.uk/ teh/research/compling/WooArcGas2009a.pdf
http://arxiv.org/abs/1406.2673

An overall prior for the five-parameter normal distribution

José Bernardo, Universitat de València

Discussant: Cristiano Villa, University of Kent

Abstract Reference priors In multi-parameter models depend on the parameter of interest, and this is necessary to produce objective posterior distributions with optimal properties. However, there are, many situations where one is simultaneously interested in all the parameters of the model it would then be useful to have a single objective prior that could safely be used to produce reasonable posterior inferences for all the parameters. In this paper, the reference distance method for selecting a single objective prior (Berger, Bernardo and Sun, 2015, Bayesian Analysis 10, 189-246 with discussion) is used to derive an appropriate overall objective prior for the five-parameter bivariate normal distribution.

Session 5: Model selection and model uncertainty I

Chairperson: Marilena Barbieri, Università de Roma

Comparison of Some Bayes Factors from their Asymptotic and Frequentist Behavior

Javier Girón Universidad de Málaga

Discussant: Juan Antonio Cano, Universidad de Murcia

Abstract

Several Bayes factors for comparing nested linear regression models have been proposed in the literature from different perspectives, including the Bayes factor for intrinsic priors, and those based on g-priors and mixtures of g-priors. These Bayes factors are alternatives to the Schwarz criterion –that works well for small models– but performs very poorly for comparing models with a large number of regressors.

In this paper we compare the asymptotic behavior of some Bayes factors when the dimension of the models grows with the sample size at different rates of growth. In particular, we compare the Bayes factor for intrinsic priors with the recently introduced robust Bayes factor of Bayarri et al. (2012), and a new simple approximation of the Bayes factor for intrinsic priors which works fairly well for comparing models of dimension O(n) not necessarily nested. Finally, frequentist behavior of the three Bayes factors for small and moderate sample sizes is shown.

With E. Moreno and M.L. Martínez

From a Conditional Lindley's Paradox to Block Hyper-g Priors

Chris Hans, The Ohio State University

Discussant: Mark Steel, University of Warwick

Abstract Thick-tailed mixtures of g priors have gained traction as a default choice of prior distribution in Bayesian regression settings. The motivation for these priors usually focuses on properties of model comparison and variable selection (e.g., asymptotic consistency of model posterior prBochkinaobabilities), as well as computational considerations. Standard mixtures of g priors mix over a single, common scale parameter that shrinks all regression coefficients in the same manner, and the particular form of the mixture distribution determines the model comparison properties. In this paper we focus on the effect of the mono-shrinkage induced by mixing over a single scale parameter and propose new mixtures of g priors that allow for differential shrinkage across collections of regression coefficients. We introduce a new "conditional information asymptotic" that is motivated by the common data analysis setting where at least one regression coefficient is much larger than others. We analyze existing mixtures of g priors under this limit and reveal two new behaviors, "Essentially Least Squares (ELS)" estimation and the "Conditional Lindley's Paradox (CLP)", and argue that these behaviors are, in general, undesirable. As the driver behind both of these behaviors is the use of a single, latent scale parameter that is common to all coefficients, we propose a block hyper-g prior, defined by first partitioning the covariates into groups and then placing independent hyper-g priors on the corresponding blocks of coefficients. We provide conditions under which ELS and the CLP are avoided by the new class of priors, and provide consistency results under traditional sample size asymptotics.

With Agniva Som (Duke University) and Steven MacEachern (Ohio State University).

Bayesian rescue for the troubled scientist: Can we make Null Hypothesis Significance Testing (NHST) work?

María-Eglée Pérez, Universidad de Puerto Rico

Discussant: Stefano Cabras, Universidad Carlos III, University of Cagliari

Abstract In recent years there has been an important discussion on the validity of methods for Null Hypothesis Significance Testing (NHST). As a worrying consequence of this controversy, statistical inference methods are losing the trust of sectors of the scientific community, as it is reflected by the recent editorial of Basic and Applied Social Psychology (Trafimow and Marks, 2015) banning the use of procedures as p-values, confidence intervals and related methods from the papers published in BASP. As the editors remark, "In the NHSTP, the problem is in traversing the distance from the probability of the finding, given the null hypothesis, to the probability of the null hypothesis, given the finding". Increasingly large sections of the scientific community are speaking load and clear: p-values should no longer be the deciding balance of science.

In an attempt to link simple and effective Bayesian procedures easily availble to prac- titioners, we extend on the ideas in Pérez and Pericchi (2014), and introduce calibrations of p-values that not only provide an asymptotical behavior coherent with that of a Bayes factor, but also allow interpreting them as bounds of the posterior probability for the null hypothesis. For this we build on objective lower bounds presented, for example, in Sellke, Bayarri and Berger (2001) but include an adjustment with the sample size for controlling the asymptotic behavior. P-values may be bad, but they are available for virtually any statistical model. Calibration of p-values, may ironically be the fastest way to popularize the use of Bayes Factors.

With Luis R. Pericchi.

Session 6: The theory of objective Bayes

Chairperson: Dongchu Sun, University of Missouri

The Bernstein-von Mises theorem and misspecified nonregular models

Natalia Bochkina, University of Edinburgh

Discussant: Helene Massam, York University

Abstract

Asymptotic behaviour of the posterior distribution is studied in a broad class of statistical models that can be misspecified, that is, the true distribution of the data does not belong to the considered parametric family of models. We focus on the case where the best parametric model that approximates the true distribution is non-regular, that is, where the parameter corresponding to the best parametric model is on the boundary of the parameter set. We show that in this case the posterior distribution has not only Gaussian components as in the case of regular misspecified models but also Gamma distribution components. The form of these components depends on the behaviour of the prior distribution near the boundary, and the rate of convergence is faster than the parametric rate. These results will be illustrated on real data from medical imaging.

These results can be applied for adjusting the posterior distribution, in particular its variability, in various cases where the model is misspecified deliberately, e.g. by doing approximate computation for complex high dimensional models. Another application of the results is a diagnostic tool for possible model misspecification, for instance, incorrect link function generalised linear models or incorrect order of autoregressive models.

With Peter Green

On some properties of Polya trees posterior distributions

Ismael Castillo, Universities Paris VI & VII

Discussant: Sonia Petrone, Università Bocconi

Abstract In Bayesian nonparametrics, Polya tree distributions form a popular and flexible class of priors on distributions or density functions. In the problem of density estimation, for certain choices of parameters, Polya trees have been shown to produce asymptotically consistent posterior distributions in a Hellinger sense.
In this talk, after reviewing some general properties of Polya trees, I will show that the previous consistency result can be made much more precise in two directions: 1) rates of convergence can be derived 2) it is possible to characterise the limiting shape of the posterior distribution in a functional sense. We will discuss a few applications to Donsker-type results on the cumulative distribution function and to the study of some functionals of the density.

Session 6: The theory of objective Bayes (second part)

Chairperson: Abrie van der Merwe, University of the Free State, South Africa

Generalized fiducial Inference: A Review

Jan Hannig, University of North Carolina

Discussant: Laura Ventura, University of Padova

Abstract R. A. Fisher, the father of modern statistics, proposed the idea of fiducial inference in the 1930's. While his proposal led to some interesting methods for quantifying uncertainty, other prominent statisticians of the time did not accept Fisher's approach because it went against the ideas of statistical inference of the time. Beginning around the year 2000, the authors and collaborators started to re-investigate the idea of fiducial inference and discovered that Fisher's approach, when properly generalized, would open doors to solve many important and difficult inference problems. They termed their generalization of Fisher's idea as generalized fiducial inference (GFI).
After more than a decade of investigations, the authors and collaborators have developed a unifying theory for GFI, and provided GFI solutions to many challenging practical problems in different fields of science and industry. Overall, they have demonstrated that GFI is a valid, useful, and promising approach for conducting statistical inference. The goal of this paper is to deliver a timely and concise introduction to GFI, to present some of the latest results, as well as to list some related open research problems. It is the authors' hope that their contributions to GFI will stimulate the growth and usage of this exciting approach for statistical inference.

Asymptotics for empirical Bayes posteriors

Catia Scricciolo, Universita Bocconi

Discussant: Andriy Norets, Brown University

Abstract Empirical Bayes methods are widely used especially when a data-driven choice of the prior hyper-parameters is adopted as a convenient way to bypass difficulties arising from prior specification. A plug-in estimate solution is expected to lead to inferential answers that are similar, for large sample sizes, to those of fully Bayes hierarchical solutions. Understanding of this commonly believed asymptotic agreement between Bayes and empirical Bayes solutions and, more generally, of the theoretical performance of empirical Bayes methods in non-parametric problems is difficult at this stage, having been so far studied only in a limited number of special cases. In this talk, assuming that (empirical) Bayes methods are evaluated under the assumption that the data are generated from a given "true" parameter, we first present some results on the asymptotic agreement, in terms of merging, between empirical Bayes and Bayesian posterior distributions, which turns out to be equivalent to concentration of the empirical Bayes posterior measure around the "truth", the main argument used to deal with data-dependent priors being based on the idea of shifting the effect of data in the prior to the likelihood by a suitable parameter transformation. We then refine the analysis providing tools for the study of empirically selected priors in non-parametrics, with a focus on optimal and adaptive posterior concentration rates, stating sufficient conditions that are exemplified in two illustrations: (conditional) density estimation with Dirichlet mixtures, along with the related inverse problem of density deconvolution, and estimation of intensity functions in Aalen models. On the whole, when the hyper-parameter does not affect the posterior concentration rates, there is a lot of flexibility in the choice of the estimator: different choices are indistinguishable in terms of the posterior behavior they induce and the empirical Bayes posterior concentration rates are the same as those of any prior associated with a fixed hyper-parameter. In those cases where the hyper-parameter has an influence on the posterior concentration rates, the choice of the plug-in estimator may instead be crucial and require special care.

Session 7: Model selection and model uncertainty II

Chairperson: Phil Dawid, University of Cambridge

Objective model selection in AR model

Thais Fonseca, Universidad Federal Rio de Janeiro

Discussant: Brunero Liseo, Università di Roma

Abstract In several model selection problems one might be interested in being as objective as possible. An interesting direction is the use of noninformative priors for the parameters of interest. In this work, the Bayesian bridge is considered as a generalization of the lasso, ridge and elastic net as a shrinkage method for variable selection and a reference prior for the parameters in the model is developed. In particular, the order of an autoregressive (AR) model is estimated based on the reference prior proposed. The order selection is objective in the sense the reference prior proposed does not depend on tuning parameters. The resulting analysis is automatic as besides considering a general shrinkage approach, the prior for the parameters do not depend on hyperparameters. We compare the proposed prior with the well known Litterman prior for order selection in the AR models in a simulated study. Indeed the reference prior is more efficient in the order selection than the Litterman prior in several scenarios.

Default model selection with non-local priors

David Rossell, University of Warwick

Discussant: Guido Consonni, Università Cattolica del Sacro Cuore

Abstract We aim to develop default Bayes approaches that remain effective in high-dimensional and non-standard problems. A recurrent theme is to induce parsimony, as this helps simultaneously to explain the studied phenomenon in an easier manner and improve prediction accuracy. Although the Bayesian model selection paradigm automatically induces some parsimony, we recently showed that the extent to which parsimony is induced is insufficient in high dimensions, e.g. posterior probabilities in variable selection failing to converge and spurious parameters being incorporated into the model. We investigate the use of non-local priors (NLPs), a family shown to be a necessary condition to achieve consistency of posterior probabilities (hence parsimony). We illustrate that, with a straightforward incorporation of the model separation principle into our favourite Bayesian formulation, we may improve statistical inference at a negligible computational effort. We also illustrate that with a bit more work NLPs may in fact reduce computational costs by an order of magnitude. Beyond foundational considerations, we show some practical implications such as parameter estimation, flexible residual models or mixture models.

I

Poster Session

Mixture of Poisson estimation for expressed sequence tag sampling

Danilo Alunni Fegatelli and Luca Tardella (Sapienza Università di Roma, Italy)

Expressed sequence tag (EST) clustering is a process that identifies and assembles ESTs which correspond to the same gene. A cDNA library can be sampled and the number of tags observed from each distinct gene are often summarized in terms of a gene cluster profile $(n_1, ..., n_j, ...n_T)$ where n_j represents the number of genes that had j ESTs in the sample. This profile has been used for gene capture prediction and overlap estimation in EST sequencing based on the appropriate modelling of the so-called frequency of frequencies (Susko, E. and Roger, A.J., 2004; Wang et al. 2005). We focus on the estimation of the unobserved expressed genes and we propose a novel moment-based flexible Bayesian approach comparing the new estimator with those already available and we discuss computational and inferential challenges.

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Dirichlet-multinomial model: the impact of prior distributions

Danilo Alvares, Carmen Armero, Anabel Forte (Universitat de Vàlencia) and Luis Rubio (Valencian Institute for Agricultural Research)

The Dirichlet-multinomial model is the generalization of the beta-binomial model to multiple (more than 2) classes or categories. This model has a wide scope of applications in which the focus is to analyze data from rates of multiple distinct outcomes.

In this paper, we study the sensitivity of the posterior distribution of a Dirichlet-multinomial model to the main Dirichlet objective priors of the literature.

Variational Bayesian SEM for undirected Network recovery using external data

Gino Bertrand Kpogbezan, Aad van der Vaart (Leiden University), Wessel N. van Wieringen (VU Amsterdam and VUmc Amsterdam), Gwenael G.R. Leday (Cambridge Institute of Public Health) and Mark van der Wiel (VU Amsterdam and VUmc Amsterdam)

Recently we developed a Bayesian structural equation model (SEM) framework with shrinkage priors for undirected network reconstruction. It was shown that Bayesian SEM in combination with variational Bayes is particularly attractive as it performs well, is computationally very fast and a flexible framework. A posteriori variable selection is feasible in our Bayesian SEM and so is the use of shrinkage priors. These shrinkage priors depend on all regression equations allowing borrowing of information across equations and improve inference when the number of features is large. An empirical Bayes procedure is used to estimate our hyperparameters. We also showed in simulations that our approach can outperform popular (sparse) methods. Here, we focus on addressing the problem of incorporating external data and/or prior information into network inference. In many settings information regarding network connectivity is often available. It is then natural to take such information into account during network reconstruction. Based on Bayesian SEM we propose a new model that focuses on the use of external data. It performs better than that of our Bayesian SEM when the external information is relevant, and as good when it is not.

Approximation of improper priors

Christèle Bioche and Druilhet Pierre (Université Blaise Pascal)

We propose a convergence mode for positive Radon measures which allows a sequence of probability measures to have an improper limiting measure. We define a sequence of vague priors as a sequence of probability measures that converges to an improper prior. We consider some cases where vague priors have necessarily large variances and other cases where they have not. We study the consequences of the convergence of prior distributions on the posterior analysis. Then, revisit the Jeffreys-Lindley paradox.

Using BaySTDetect for syndromic surveillance

Areti Boulieri and Marta Blangiardo (Imperial College London)

Disease surveillance is an important public health practice, as it provides information which can be used to make successful interventions. Innovative surveillance systems are being developed to improve early detection and investigation of outbreaks, with the syndromic surveillance systems attracting a lot of interest recently. These make use of non-diagnostic data (syndromes) in order to detect any potential outbreak as rapidly as possible. Outbreak detection requires a system that will be able to flag areas that are differentially expressed. Both test-based and model-based techniques exist in the literature. Within the Bayesian framework, spatio-temporal hierarchical models are able to give robust estimates due to their flexibility. Through the specification of spatially and/or temporally

structured random effects information is shared between areas and/or time points, increasing the strength of the parameter estimates. These models are designed to provide estimates and describe risk patterns, however very limited research exists in models that are able to provide a detection mechanism. In addition, these do not correct for multiple testing which is common in these studies, where a large set of comparisons is conducted. The BaySTDetect method is a recently developed method by Li et al. (2012) that is able to detect outbreaks, and also to control for multiple testing through the specification of the False Discovery Rate (FDR).
The objective of this work is to analyse syndromic data on asthma disease by using the BaySTDetect method. GP drug prescription data are released monthly by the English National Health Service (NHS) for all general practices in England and all drugs. The dataset that is currently available to be used in this project includes 8004 practices along with the number of prescribed drugs for asthma each month. The temporal coverage is from August 2010 to November 2013.
The BaySTDetect model fitted to the data includes a spatial random effect component at super output area (SOA) level and a temporal effect component at month level. The temporal coverage is from August 2010 to November 2013. OpenBUGS software is used for the implementation of the models, and GIS for the mapping.

Predictive Bayesian Bandits

Pierpaolo Brutti, Fulvio De Santis and Stefania Gubbiotti (Sapienza University of Rome)

A multi-armed bandit problem models an agent that simultaneously attempts to acquire new information (exploration) and optimizes the decisions based on existing knowledge (exploitation). In clinical trials, this framework applies to Bayesian multi-armed randomized adaptive designs. The allocation rule of experimental units involves the posterior probability of each treatment being the best. The trade-off between gain in information and selection of the most promising treatment is modulated by a quantity c, typically prefixed or linearly increasing with accumulating sample size. We propose a predictive criterion for selecting c that also allows its progressive reassessment based on interim analyses data.

Bayesian Intensity Model for Lexis Diagram

Anna But, Jari Haukka (University of Helsinki, Department of Public Health) and Tommi Härkänen (National Institute for Health and Welfare)

Our aim is to introduce a Bayesian intensity model for the Lexis diagram, which represents individual follow-up times on two time scales. Our approach to model the event history data is based on the point process on the Lexis diagram. We focus on right-censored survival data with either a single event or censoring recorded for on two time scales, though the approach introduced here can be directly extended to more general designs.
Specification of the model becomes more transparent due to use of Lexis diagram from which we proceed to its isomorphic representation allowing a simple discretization of the process with respect to one of the two time scales. Discretization is accomplished through the partition of the observational

plane into strips. For each strip, we assign a hazard function. We model the hazard functions using piecewise constant functions, which are parameterized by jump points and constant hazard levels between them. We specify a prior for the jump points as a time-homogeneous Poisson process, and assign a random walk Gamma prior for the hazard levels. Furthermore, our specification of the prior distribution provides a smoothing mechanism in both within-strip and between-strip directions. Inference under such nonparametric Bayesian model requires a numerical integration. We apply the reversible jump Metropolis-Hastings algorithm to sample from the posterior distribution and to allow changes in the dimension of the parameter space. We use a simulated data to demonstrate the applicability of the method.

A Markovian process representation of multiple testing

Stefano Cabras, (Universidad Carlos III de Madrid and Università di Cagliari)

The problem of multiple hypothesis testing, can be represented as a Markov process where a new hypothesis is accepted in accordance with its relative evidence to the current accepted one. This virtual process provides the most probable set of non null hypotheses given the data. In order to obtain such representation it is enough to have, for each test, barely defined Bayes Factors (BFs), e.g. BFs obtained up to an unknown constant. Such BFs may either arise from using default and improper priors or from calibrating p-values with respect to their corresponding BF lower bound. Each of both sources of evidence is used to form a Markov transition kernel on the space of hypotheses. The approach leads to easy interpretable results and involves very simple formulas suitable to analyze large datasets as those arising from microarray expression data, which is the main application setup here considered.

Conditional Predictive p-value an ABC revisits

Stefano Cabras (Universidad Carlos III de Madrid and Universitàdi Cagliari), María Eugenia Castellanos (Universidad Rey Juan Carlos) and Oliver Ratmann (Imperial College London)

One approach to evaluate the goodness of fit of statistical models, is via calibrated p-values that are uniformly distributed in [0,1] under the true model. While such p-values are available for very simple models, these are prohibitively expensive to calculate for complex ones. Here, we show that, even for models whose likelihood is not available in a closed form expression, conditional predictive p-values can be efficiently obtained as a by-product of Approximate Bayesian Computations. We illustrate the technique in some examples.

Nonparametric hierarchical models and their predictive structure

Federico Camerlenghi (Università degli Studi di Pavia)

Hierarchical models are becoming increasingly popular in Bayesian nonparametric inference, being especially appropriate to analyze data from different and related studies. The hierarchy has the effect to induce a borrowing strength phenomenon across diverse groups of observations. A large

variety of applications can be handled through these models, the most popular being classification of documents in a corpus, on the basis of different topics. The hierarchical structure allows for a two-stage classification: as for topic modeling, each document is considered as a distribution across topics, that are in turn distributions across words.

The hierarchical models introduced so far are based on the Dirichlet and the Pitman-Yor processes. We will show how to construct them on the basis of a broader class of discrete random probability measures that can be represented as transformations of random measures, extending the results already known in literature. From the theoretical point of view, we aim to investigate the properties of the induced partition structure and the prediction rules. On the other hand we propose applications to different problems in genomics and survival analysis. In the first case, conditionally on a basic population, we will devise a novel Gibbs sampler algorithm in order to determine: the number of new species detected in an additional sample of arbitrary length, the probability of discovering a new species and the sample coverage. With respect to inference on survival data, we will develop a Bayesian nonparametric model to manage heterogeneous groups of observations, such as in clinical trials where groups of patients undergo different treatments in different hospitals.

On Bayesian Transformation Selection: Comparison of Results Based on Different Forms of Bayes Factors

Efstratia Charitidou, Dimitris Fouskakis (National Technical University of Athens) and Ioannis Ntzoufras (Athens University of Economics and Business)

The problem of transformation selection is very important in various application fields of modern research, such as quality control, economics or even survival analysis. The assumption of normality is fundamental in most frequentist parametric statistical procedures with special reference to the - routinely employed - linear model and associated error terms. Furthermore, normality is essentially related to the notion of conjugacy in Bayesian analysis which reduces computational complexity. In this work, the problem of transformation selection is thoroughly treated using a variety of Bayes factor forms.

Four uniparametric families of transformations are considered and compared with each other with a view of achieving normality of a transformed dataset: *Box-Cox*, *Modulus*, *Yeo & Johnson* and *Dual*. Markov Chain Monte Carlo algorithms have been constructed in order to sample from the posterior distribution of the transformation parameter λ_T associated with each competing family T.

Subjective elicitation of the prior for λ_T is a difficult task. Furthermore, little prior information for λ_T can be expected and therefore an objective method is required. In the case of the transformed normal linear model, Bayes factors (BF) are calculated based on a power-prior approach for λ_T using imaginary data y^* in order to construct compatible priors that account for the different interpretation of λ_T among families. In addition, two appropriate mechanisms that permit the direct use of an improper prior for λ_T are the intrinsic Bayes factor (IBF) and the fractional Bayes factor (FBF). In order to explore the behavior of each approach, we have employed both simulated and real-life examples.

Circular Modelling of Teacher Behavior: Application and Interpretation of a Bayesian Longitudinal Model

Jolien Cremers and Irene Klugkist (Utrecht University)

One of the disciplines in which circular data may be encountered is the educational sciences, where they measure teachers' positions on the interpersonal circumplex. However, in the literature this type of data is not yet analyzed using circular statistics even though theoretically it is assumed that the data are circular. This results in a discrepancy between the questions that researchers are interested in and the questions that can be answered with the (linear) methods that are currently employed by the researchers who have longitudinal circular data. Using an example dataset in which secondary school teachers' position on the interpersonal circumplex was measured during the first 16 weeks of the schoolyear, a Bayesian longitudinal model for circular data is presented. This model was originally developed by Nuñez-Antonio and Gutiérrez-Peña (2014) and is a mixed-effects model based on a projected normal distribution. This model assumes that the circular outcome variable in the data has an underlying linear bivariate normal distribution which was projected on the unit circle to produce a circular variable. Due to this nature of the projected normal distribution, the parameters of this model are given on two linear components. Ideally however, we would like to interpret these parameters on a circular scale. The present research attempts to provide both graphical and quantitative ways of interpreting circular fixed and random effects.

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Chain Event Graphs model selection using Non-Local Priors

Rodrigo A. Collazo and Jim Q. Smith (University of Warwick)

Chain Event Graphs (CEGs) have been a useful class of graphical model especially to capture context-specific conditional independences. This model class contains all discrete context-specific BNs as a special case. Being built from a tree a CEG has a huge number of free parameters that makes the class extremely expressive but also very large.

In order to search the massive CEG model space it is necessary to a priori specify those models that are most likely to be useful. One property that is widely evoked is to bias the selection towards parsimony. Most applied BF selection techniques use local priors; that is, priors that keep the null model's parameter space nested in the alternative model's parameter space. However, recent analyses of BF model selection in other contexts have suggested that the use of such prior settings tends to choose models that are not sufficiently parsimonious.

To sidestep this phenomenon, non-local priors (NLPs) have been successfully developed for Gaussian BN model selection. These priors vanish when a candidate larger model approaches a simpler one. This enables the fast identification of the simpler model when it really does drive the data generation process.

In this work, both to ensure parsimony and stability of selection to the setting of hyperparameters we define three new families of NLPs designed to be applied specifically to discrete processes defined through trees. In doing this, we develop a framework for CEG model search which looks both robust and computationally efficient.
The efficacy of our method has been tested in two extensive computational experiments. The first of these examples uses survey data concerning childhood hospitalisation. The second much larger example selects between competing models of prisoners' radicalisation in British prisons: because of its size an application beyond the scope of earlier Bayes Factor search algorithms.

Equivalence results for fixed- and random-effects linear models in high dimensions: Empirical Bayes, ridge regression, and efficient variance estimation

Lee Dicker (Rutgers University) and Murat A. Erdogdu (Stanford University)

We consider high-dimensional linear models with random predictors, and show that there is little difference between the fixed-effects model and Gaussian random-effects model, under the specified conditions. In the fixed-effects model, we argue that the regression coefficients "inherit" randomness from the predictors and, consequently, many methods and results for random-effects models may be ported to the fixed-effects setting. In particular, following an empirical Bayes strategy, we derive high-dimensional optimality results for ridge regression, and asymptotically efficient estimators for the residual variance in high dimensions; these results are applicable in both the fixed- and random-effects models. High-dimensional residual variance estimation has recently received increased attention in the statistical literature, with important applications in model selection, regression diagnostics, and applied fields, such as genomics. Our results for estimating the residual variance estimation do not require any sparsity assumptions on the regression parameters (which are common in other approaches) and appear to be the first high-dimensional efficiency results of their kind.

Improving the INLA approach for approximate Bayesian inference for latent Gaussian models

Egil Ferkingstad (Norwegian University of Science and Technology and University of Iceland), Håvard Rue (Norwegian University of Science and Technology)

Latent Gaussian models is an important and huge class of models, which covers a large part of the statistical models used today. Integrated Nested Laplace Approximations (INLA) were introduced in 2009 as a tool to do approximate Bayesian inference in these models. The INLA approach has shown both to be very accurate in practice and extremely fast due to the Markov properties of the Gaussian fields used in all the "Laplace" approximations; see www.r-inla.org for software. In a few cases, there is a little error in these approximations. We present our experience with a class of improved approximations based on Gaussian copulas, which often do not add any computational costs.

Objective Bayes analysis for Gaussian dynamic linear models

Marco Ferreira (Virginia Tech)

We develop objective Bayes analysis for Gaussian dynamic linear models. First, we obtain the Jeffreys-rule prior, independence Jeffreys prior, and reference prior for the general univariate case. After that, we obtain explicit expressions for objective Bayes priors for the first- and second-order polynomial models. These results are extremely important for the practical application of Gaussian dynamic linear models as they provide explicit expressions of objective Bayes priors for the difficult to estimate signal-to-noise ratio parameter. In addition, we study the posterior propriety of the resulting posterior distributions. Finally, we perform a simulation study to assess the frequentist properties of our objective Bayes procedures.

A Bayesian nonparametric approach to quantifying dependence between random variables

Sarah Filipp and Chris Holmes (University of Oxford)

Nonparametric and nonlinear measures of statistical dependence between pairs of random variables have proved themselves important tools in modern data analysis, where the emergence of large data sets can support the relaxation of linearity assumptions implicit in traditional association scores such as correlation. Recent proposals based around estimating information theoretic measures such as Mutual Information (MI) have been particularly popular. Here we describe a Bayesian nonparametric procedure that leads to a tractable, explicit and analytic quantification of the probability of dependence, using Polya tree priors on the space of probability measures. Our procedure can accommodate known uncertainty in the form of the underlying sampling distribution and provides an explicit posterior probability measure of both dependence and independence. Well known advantages of having an explicit probability measure include the easy comparison of evidence across different studies, the inclusion of prior information, and the integration of results within decision analysis.

Susie Bayarri's contributions to Bayesian methods in finite populations

M. Begoña Font-Belaire (University of Valencia)

Susie made major contributions to the theory and methodology of Bayesian statistics but she also made a original contribution to Bayesian methods in finite populations. This communication is devoted to our research in this field and it could be summarize in two 94' year posters. The first one, titled "Non-random samples in finite population", was presented on the ISBA-2. It concentrates on the implications that the design has on the inferences about some characteristics of the finite population, and in a critic comparison among some usual designs. The second one, titled "Bayesian analysis of random routes", was presented on the 5th International Meeting on Bayesian Statistics. It shows a Bayesian analysis of random routes that incorporates the information provided but carefully takes into account the non-randomnes in the selection of the units. These posters were the antecedents of two scientific research papers:

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`BayesVarSel`: Hypothesis Testing and Variable Selection in `R`

Gonzalo García-Donato (Universidad de Castilla-La Mancha) and Anabel Forte (Universitat de Vàlencia)

In this poster we introduce the R package BayesVarSel. The software has been conceived to provide simple access to Bayes factors in linear models and then to give a formal Bayesian answer to testing and variable selection problems. From a theoretical side, the emphasis is placed on the prior distributions and BayesVarSel is armed with many of the most popular proposals: Liang et al. (2008); Zellner and Siow (1980, 1984); Zellner (1986); Bayarri et al. (2012); Fernández et al. (2001). The interaction with the package is through a friendly interface that syntactically mimics the well-known R command lm. Additionally, BayesVarSel incorporates abilities to handle problems with a large number of potential explanatory variables through parallel and heuristic versions (García-Donato and Martínez-Beneito (2013)) of the main commands. The resulting objects can be easily explored providing the user very valuable information (like marginal, joint and conditional inclusion probabilities of potential variables; the highest posterior probability model, HPM; the median probability model, MPM) about the structure of the true -data generating- model.

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Jeffreys's priors for mixture estimation

Clara Grazian (Université Paris-Dauphine, Sapienza Università di Roma) and Christian P. Robert (CEREMADE, Université Paris-Dauphine)

Mixture models may be a useful and flexible tool to describe data with a complicated structure, for instance characterized by multimodality or asymmetry. The literature about a Bayesian analysis of mixture models is huge, nevertheless an "objective" Bayesian approach for these models is not widespread, because it is a well established fact that one needs to be careful in using improper prior distributions, since the posterior distribution may not be proper, but noninformative priors are often improper. In this work a preliminary analysis based on the use of a dependent Jeffreys prior in the setting of mixture models will be presented. The Jeffreys prior for the parameters of a Gaussian mixture model is shown to be improper and the conditional Jeffreys prior for each group of parameters is studied. The Jeffreys prior for the complete set of parameters is then used to approximate the derived posterior distribution via a Metropolis-Hastings algorithm and the behavior of the simulated chains is investigated to reach evidence in favor of the properness of the posterior distribution.

Bayesian Bivariate Meta-analysis with Interpretable Priors

Jingyi Guo, Håvard Rue and Andrea Riebler (Norwegian University of Science and Technology)

In a bivariate meta-analysis the number of diagnostic studies involved is often low and data are sparse. This may cause problems, such as non-convergence when using frequentist methods. Since the use of priors can stabilise the analysis, Bayesian inference has recently become attractive and advantageous in this context. However, Bayesian analysis is often computationally demanding and a well-motivated prior for the covariance matrix of the bivariate random effects is crucial due to the limited amount of data available. Integrated nested Laplace approximations (INLA) provide an efficient solution to the computational issues as no MCMC sampling is involved, but the important question about prior elicitation remains. We apply the new penalised complexity (PC) prior framework to derive priors for the variance parameters and the correlation parameter. This allow us an intuitive specification of the hyperpriors based on interpretable contrasts motivated from medical expertise. Using a simulation study we further show that the new priors perform better than previously suggested priors in terms of sharpness, MSE and the proper Dawid-Sebastiani score. All methodology is implemented in the new

user-friendly R-package meta4diag which provides a GUI for easy model specification and output inspection and can be downloaded from R-forge http://meta4diag.r-forge.r-project.org/.

A Robust Bayesian Gaussian Analysis

Morten Holm Falk, Håvard Rue and Andrea Riebler (Institute of Mathematical Sciences, Norwegian University of Science and Technology (NTNU))

Working in analysis, fitting the right model to the data is of key importance for several reasons: prediction, inference, etc. The problem we often run into is when the data at best closely resembles that of the assumed model, but clearly some outliers or other descrepancies do not fit the underlying model assumptions. For the sake of Gaussian analysis, we would like to start at a broader framework and establish a method of estimation that is able to reciprocate the base Gaussian model, if the data fits the model. At the same time we also aim to maintain some flexibility to accomodate possible descrepancies in the data. In this case, we introduce a measure of skewness to the Gaussian distribution and concentrate on the skew Guassian model.

Bayesian Variable Selection with Heredity Constraints

Woncheol Jang, Johan Lim and Yongdai Kim (Seoul National University), Joungyoun Kim (Research Institute for Future Medicine, Samsung Medical Center)

In this paper, we propose a Bayesian variable selection model for linear regression models with high order interactions. Our model automatically enforces the heredity constraint, that is, a higher order interaction term can exist in the model only if both of its parent terms exist in the model. Based on the stochastic search variable selection (George and McCulloch 1993), we propose a novel hierarchical prior which fully takes the heredity constraint into account and at the same time controls the degree of sparsity flexibly. For Bayesian inference, we develop a Markov chain Monte Carlo (MCMC) algorithm to explore the space model efficiently while accounting for the heredity constraint by modifying the Shotgun Stochastic Search algorithm (Hans et al. 2007). The performance of the new model is demonstrated through comparison with other methods. Numerical studies on both real data analysis and simulation show that our new method tends to find relevant variable more effectively when higher order interaction terms are considered. Also our MCMC algorithm converges much faster than the other methods.

Unifying Strategies to Improve the Performance of Gibbs-Type Samplers

Xiyun Jiao and David A. van Dyk (Statistics Section, Department of Mathematics, Imperial College London)

The Gibbs samplers and Data Augmentation (DA) algorithm, which is a special Gibbs sampler, are widely used Markov Chain Monte Carlo methods to sample from highly structured models. While easy

to implement, they can be slow to converge. To improve their convergence properties, numerous algorithms have been developed. We pay special attention to the Marginal Data Augmentation (MDA) algorithm (Meng and van Dyk, 1999), Partially Collapsed Gibbs (PCG) sampling (van Dyk and Park, 2008) and Ancillarity-Sufficiency Interweaving Strategy (ASIS) (Yu and Meng, 2011). These algorithms have many applications in objective Bayesian analysis.

We propose combining several strategies into one sampler. Sometimes, it is necessary to do so. For example, we use an Metropolis-Hastings (MH) algorithm within a Gibbs-type sampler when direct sampling from some conditionals is difficult. (e.g., van Dyk and Jiao (2015).) But more intriguingly, when the model is sophisticated, there can be more than one parameter whose convergence requires improvement. It is sometimes the case that one strategy can significantly improve the convergence of one parameter but has little effect on other parameters, while another strategy has the opposite effect. Under this circumstance, we can gain more efficiency by combining two or more strategies than by using either alone. Even if one strategy alone is fairly good for all the parameters, we prefer a combination, as long as the gained efficiency can compensate the extra computational burden. We use both a factor analysis and a hierarchical t model as examples to illustrate our idea of combining several strategies into one sampler. Finally, we briefly describe general theoretical convergence results for combining algorithms.

Construction of prior information with data-mining approach

Katarzyna Kaczmarek and Olgierd Hryniewicz (Systems Research Institute, Polish Academy of Sciences)

Selecting appropriate predictive model and its assumptions becomes very challenging task in many practical contexts of time series forecasting. We propose automatic approach for the construction of the prior probability distributions. The proposed method combines selected data-mining techniques and the bayesian averaging. The performance of the proposed method is illustrated with simulation study.

On a novel mixture parameterization

Kaniav Kamary (CEREMADE, Université Paris-Dauphine), Kate Lee (Auckland University of Technology, New Zealand) and Christian P. Robert (CEREMADE, Université Paris-Dauphine)

We introduce a novel parametrization for the mixture model when the mixture components have location-scale parameters. The key idea in our approach is to start the parameterization of the mixture distribution with its (global) mean and variance, since the remaining parameters are then all constrained to simplexes. This restriction then allows for the use of improper priors, hence for a non-informative approach to the mixture inference problem. We verify the consequence of our modeling in terms of label switching and analyze the sensitivity of the resulting posterior distribution on the prior choice and also the convergence of the posterior estimations of the parameters.

Testing Hypotheses via a Mixture Estimation Model

Kaniav Kamary (Universite Paris-Dauphine, CEREMADE), Kerrie Mengersen (Queensland University of Technology, Brisbane), Christian P. Robert (Universite Paris-Dauphine, CEREMADE Dept. of Statistics, University of Warwick, and CREST), Judith Rousseau (Universite Paris-Dauphine, CEREMADE, and CREST, Paris)

In this presentation we present a new Bayesian approach to testing hypotheses and model comparison, based on recasting the testing problem as one of estimation and constructing a mixture representation whereby the mixture weights reflect the strength of support for a given hypothesis. In addition to being easy to use and interpret, the approach has a number of appealing features such as the ability to use improper priors and hence provide a resolution of the Lindley Jeffreys paradox.

Linking Statistical Emulators

Ksenia Kyzyurova (Duke University)

Gaussian processes, together with an objective Bayesian implementation of the processes, have become a common tool for emulating (approximating) complex computer models of processes. Sometimes more than one computer model needs to be utilized for the predictive goal. For instance, to model the true danger of a pyroclastic flow, one might need to combine the flow model (which can produce the flow size and force at a location) with a computer model that provides an assessment of structural damage, for a given flow size and force. Direct coupling of the computer models is often difficult, for computational and logistical reasons. In this work, we focus on coupling two such computer models by coupling separately developed Gaussian process emulators of the models. The research involves both developing the overall coupled emulator, and then evaluating its performance as an emulator of the true coupled computer models.

A key issue in developing the coupled emulators is to produce an accurate way of quantifying the uncertainty in the emulator. The fact that we utilize to couple the emulators is that in certain parametrization one can give closed form expressions for the overall mean and variance of the coupled emulator. With analytic expressions available for the mean and variance of the coupled emulator, we form confidence intervals for the coupled prediction assuming normality. The coupled emulator is not actually normally distributed, so part of the study is to assess the effect of this assumption. This is done both analytically with Taylor's series approximations, and via simulation and examples.

The initial investigation has been with simple test functions as the simulators, to see if the approach being taken makes sense. The application to complex computer models of the types mentioned at the beginning of the abstract is demonstrated as well.

Jeffreys's Correlation Test Based on Criteria of Bayarri, Berger, Forte, and Garcia-Donato (2012)

Alexander Ly, Maarten Marsman and Eric-Jan Wagenmakers (University of Amsterdam)

The objective Bayesian approach to model selection was initiated by Harold Jeffreys's development of Bayes factors as alternatives to the tests of significance proposed by Ronald Fisher. For each Bayes factor in his "Theory of Probability" (fist edition 1939, second edition 1948, third edition 1961) Jeffreys chose priors depending on the models that were being compared. The principles that Jeffreys used to select the priors for a test of the nullity of a normal mean forms the basis for more general criteria of Bayesian model choice (Bayarri, Berger, Forte and Garcia-Donato, 2012).

Not all Bayes factors in Jeffreys's "Theory" received an extensive justification, however; a prominent example concerns Jeffreys's test for the presence of a correlation. For this test, Jeffreys hardly explains his prior choice. We therefore reanalyzed Jeffreys's correlation Bayes factor based on the methodological approach in Bayarri et al. (2012). We justify Jeffreys's decision to take the prior on the correlation coefficient, ρ, orthogonal to the common parameters. In accordance with Jeffreys's philosophy we then integrate out the common parameters from the likelihood; this yields a likelihood that can be expressed in terms of a hypergeometric function as proposed by previous authors. In addition, we were able to decompose the resulting likelihood into an even and an odd function of ρ. From this decomposition and the predictive matching criterion it can then be easily shown that one requires symmetric priors on ρ. Furthermore, with symmetric beta priors B(α,α) that are scaled to [-1,1] on ρ we were able to construct correlation Bayes factors of closed form, which we denote as BF10(α). The tuning parameter with $\alpha = 1$ recovers Jeffreys's proposal of a uniform prior on ρ; unfortunately, this choice of α violates the information consistency criterion, as BF10(1) = 2 when n = 3 and |r| = 1. However, this Bayes factor does divert to infinity whenever n = 4 and |r| = 1. Hence, the correlation Bayes factor that Jeffreys intuitively proposed, almost adhere to the general criteria. Lastly, we show that the correlation Bayes factors BF10(α) is only information consistent when $\alpha \leq 1/2$.

Nonparametric Bayes for causal inference - Dynamic treatment regimes

Peter Mueller, Yanxun Xu (UT Austin), Peter Thall (MD Anderson) and Abdus Wahed (U Pittsburgh)

We discuss inference for multi-stage clinical trials (dynamic treatment regimes). The motivating example are multi-stage chemotherapy regimes for acute leukemia. Patients were randomized among initial chemotherapy treatments but not among later salvage therapies. We propose a Bayesian nonparametric (BNP) approach to account for the lack of randomization in the later stages. We argue that the BNP approach can provide an objective evaluation of a causal effect of competing treatment regimens, adjusting for the lack of randomization. In a simulation study we compare the BNP approach with standard doubly robust causal inference methods and show how the BNP approach compares favorably as an objective method that does not rely on particular model assumptions for a response or model for treatment assignment.

Singular value shrinkage priors for Bayesian prediction

Takeru Matsuda and Fumiyasu Komaki (University of Tokyo)

We develop singular value shrinkage priors for the mean matrix parameters in the matrix-variate normal model with known covariance matrices. Our priors are superharmonic and put more weight on matrices with smaller singular values. They are a natural generalization of the Stein prior. Bayes estimators and Bayesian predictive densities based on our priors are minimax and dominate those based on the uniform prior in finite samples. In particular, our priors work well when the true value of the parameter has low rank.

Longitudinal mediation models using ML and Bayesian estimation

Milica Miocevic, M.A., David P. MacKinnon and Roy Levy (Arizona State University)

The aim of this project was to compare the computations of the longitudinal mediated effect in a three-wave mediation model using conventionally used frequentist methods, ML and the bootstrap, and Bayesian SEM. Two Bayesian methods for mediation analysis were used: the method of coefficients (Yuan and MacKinnon, 2009), and the method of covariances (Enders, Fairchild, and MacKinnon, 2013). For Bayesian methods estimates from waves 1 and 2 were used as prior information for relationships between variables at waves 2 and 3. The numerical values of confidence and credibility limits for the mediated effect of interest were comparable between methods, however, credibility intervals were slightly narrower than confidence intervals. Implications of this comparison and future directions for the field of Bayesian longitudinal mediation analysis are discussed.

Extending Bayesian analysis of circular data to comparison of multiple groups

Kees Mulder and Irene Klugkist (Utrecht University)

Circular data are data measured in angles and occur in a variety of scientific disciplines. Bayesian methods promise to allow for flexible analysis of circular data, for which few methods are available. Three existing MCMC methods (Gibbs, Metropolis-Hastings, and Rejection) for a single group of circular data were extended to be used in a between-subjects design, providing a novel procedure to compare groups of circular data. Investigating the performance of the methods by simulation study, all methods were found to overestimate the concentration parameter of the posterior, while coverage was reasonable. The rejection sampler performed best. In future research, the MCMC method may be extended to include covariates, or a within-subjects design.

Bayesian Model Selection Based on Proper Scoring Rules

Monica Musio (University of Cagliari) and Alexander Philip Dawid (University of Cambridge)

Bayesian model selection with improper priors is not well-defined because of the dependence of the marginal likelihood on the arbitrary scaling constants of the within-model prior densities. We show how this problem can be evaded by replacing marginal log-likelihood by a homogeneous proper scoring rule, which is insensitive to the scaling constants. When applied prequentially, this will typically enable consistent selection of the true model.

Adaptive Bayesian Estimation of Conditional Densities

Andriy Norets (Brown University) and Debdeep Pati (Florida State University)

We consider a non-parametric Bayesian model for conditional densities. The model is a finite mixture of normal distributions with covariate dependent multinomial logit mixing probabilities. A prior for the number of mixture components is specified on positive integers. The marginal distribution of covariates is not modeled. We study asymptotic frequentist behavior of the posterior in this model. Specifically, we show that when the true conditional density has a certain smoothness level, then the posterior contraction rate around the truth is equal up to a log factor to the frequentist minimax rate of estimation. As our result holds without a priori knowledge of the smoothness level of the true density, the established posterior contraction rates are adaptive. Moreover, we show that the rate is not affected by inclusion of irrelevant covariates in the model.

Minimum Bayes factors that depend on the sample size

Manuela Ott and Leonhard Held (Epidemiology, Biostatistics and Prevention Institute, University of Zurich)

Minimum Bayes factors are commonly used to transform two-sided P values to lower bounds on the posterior probability of the null hypothesis. Several proposals exist in the literature, but none of them depends on the sample size. However, the evidence of a P value against a point null hypothesis is known to depend on the sample size.
We propose two new minimum Bayes factors that depend on sample size and converge to existing bounds as the sample size goes to infinity. It turns out that the maximal evidence of a P value against the null hypothesis increases with sample size.

Bayesian Disease Mapping. Application to the unemployment rate estimation by Portuguese NUTS III

Soraia Pereira (Faculty of Sciences, University of Lisbon)

The unemployment measure takes a huge social and political importance in contemporary societies. In Portugal, the National Institute of Statistics (NIS), as an entity responsible for the production and publication of official statistics, provides quarterly estimates about the labour market to a national

and regional level (NUTS I and NUTS II), calculated based on a direct method. However, for more disaggregated levels, namely NUTS III, the same method does not produce estimates with acceptable accuracy.
The aim of this study is to use methods to take into account the spatial dependence between neighbouring NUTS III and the time dependence between consecutive quarters, in order to improve the estimates produced for the unemployment rate in these regions.
We use Hierarchical Bayesian methods proposed by Bernardinelli (1995) and Knorr-Held (2000), generally used in the bayesian disease mapping area in an epidemiological and environmental context. When applied to the Labour Force Survey data from the 1st quarter 2011 to the 4th quarter of 2013, these methods produced estimates of the unemployment rate at NUTS III level with good accuracy, in contrast to the direct method.

Reconciling two Popular Approaches for Summarizing Case Influence in Bayesian Models

Mario Peruggia, Steven MacEachern, Zachary Thomas (The Ohio State University)

Methods for summarizing case influence in Bayesian models take essentially two forms: (1) use common divergence measures for calculating distances between full-data posteriors and case-deleted posteriors, and (2) measure the impact of infinitesimal perturbations to the likelihood to gain information about local case influence. Methods based on approach (1) lead naturally to considering the behavior of case-deletion importance sampling weights (the weights used to approximate samples from the case-deleted posterior using samples from the full posterior). Methods based on approach (2) lead naturally to considering the curvature of the Kullback-Leibler divergence of the full posterior from the case-deleted posterior. By examining the connections between the two approaches, we establish a rationale for employing low-dimensional summaries of case influence that are obtained entirely via the variance-covariance matrix of the log importance sampling weights.

Bayesian Estimation of the Prevalence of Latent Tuberculosis Infection in Hospital Workers of Public Hospital Network of Medellin-Colombia

Isabel Cristina Ramírez Guevara y Carlos Mario Lopera Gómez (Universidad Nacional de Colombia Sede Medellín), Alba Luz León Alvarez, María Patricia Arbeláez Montoya y Jesús Ernesto Ochoa Acosta (Universidad de Antioquia, Facultad Nacional de Salud Pública, Medellín)

Tuberculosis is a millenary illness but it is still a very infectious human disease present in our modern times and that causes great mortality. Several studies point out that the incidence of infectious latent tuberculosis (ILT) is greater among health workers than in general public due to more exposure within the work environment. Tuberculin test (TT) has been used for more than one hundred years to diagnose ILT. Nowadays we have other methods to diagnose tuberculosis such as tests that quantifies the generation of Interferon Gamma (Interferon-Gamma- ReleaseAssays: IGRAs). This test is more specific for people already vaccinated with BCG, and do not have the kind of operative difficulties

as TT does. In this work a latent class model was used with a Bayesian approach to estimate the probability of having ILT in a population composed by a cohort of 683 health workers from the public hospital net of Medellín. The two laboratory tests were administered to these workers. The model assume that observed data from the standard test (TT) and the new test (IGRAs) are all imperfect measures of a latent variable that represents the true state of ILT. Observed data were modeled with a multinomial distribution where the probabilities of combinations of laboratory results can be expressed in terms of sensitivity, specificity and prevalence of ILT. Some decision rules were established based on the estimation of sensitivity and specificity for each test with the purpose of promoting the following of ILT in health workers and to establish control plans for tuberculosis in the public hospital net of the city of Medellín.

Posterior distributions from robust M-estimating functions via approximate Bayesian computation

Erlis Ruli, Nicola Sartori and Laura Ventura (Department of Statistical Sciences, University of Padova)

We illustrate a novel approach for obtaining robust posterior distributions using Approximate Bayesian Computation (ABC) methods with bounded M-estimating func- tions. This is formally motivated by the use of likelihood score functions as automatic summary statistics in ABC when the model is correctly specified, and here extended to robust M-estimating functions in order to obtain robustness with respect to the presence of outliers or model misspecifications. Examples with robust M-estimating functions in the context of income distribution and linear mixed models are considered.

Improved Laplace Approximation for Marginal Likelihoods

Erlis Ruli, Nicola Sartori and Laura Ventura (Department of Statistical Sciences, University of Padova)

Intractable multidimensional integrals arise very often both in Bayesian and frequentist applications. The Laplace formula is widely used to approximate such integrals. However, in large dimensions, when the shape of the integrand function is far from that of the Gaussian density and/or the sample size is small, the standard Laplace approximation can be inaccurate. We propose an improved Laplace approximation which increases asymptotically the accuracy of the standard Laplace formula by one order of magnitude, and which is also accurate in high-dimensions. Applications to Bayesian inference in nonlinear regression models and to frequentist inference in a generalized linear mixed model with crossed random effects demonstrate the superiority of the proposed method with respect to the standard Laplace formula. The accuracy of the proposed method is comparable with that of other existing methods, which are computationally more demanding.

Sample Inflation for Efficient Sampling in Models with factorizing posteriors

Ingmar Schuster (University of Leipzig)

Models with a certain factorizing posterior structure allow for recombination of samples to generate new dependent samples. This technique, dubbed Sample Inflation (SI), allows to generate a number of samples that grows polynomially in the number of likelihood evaluations and exponentially in the number of posterior factors. Examples of models to which SI applies are Dirichlet Mixture Models, DPMMs, as well as Factor Analysis and many other probabilistic matrix factorization models. The implementation of Sample Inflation for both MCMC and Importance Sampling is discussed.

A Hierarchical Model for the Age of Galactic Halo White Dwarfs

Shijing Si, David van Dyk (Imperial College London) and Ted von Hippel (Embry Riddle Aeronautical University)

We have the black-box code for fitting one unit at a time, but sometimes we want to use hierarchical model to analyse data. In this research, we build a empirical Bayes method to infer the hierarchical model by taking advantage of the available black-box code.

An Objective Method to Select the Order of Smoothness for Nonparametric Regression

Daniel Taylor-Rodriguez (SAMSI, Duke University), Sujit Ghosh (NCSU, SAMSI)

The order of smoothness chosen in nonparametric estimation problems is critical. This choice balances the tradeoff between model generality and data overfitting. The most common approach used in this context is cross-validation. However, cross-validation is computationally costly and precludes valid post-selection inference without further considerations. As an alternative, we take an objective Bayes approach not only to select the appropriate order of smoothness but also to simultaneously assess the uncertainty in such a selection. The proposed methods are automatic, in the sense that no user input is required as noninformative priors are used on model parameters, are computationally inexpensive, and can be extended to the case with multiple predictors. We explore this problem in greater generality, presenting comparative analyses using both simulated and real data. Extensions to non-normal data and multiple predictors are also considered.

Objective Bayesian Reference Analysis for the Generalized Normal Regression Model: Local Influence and an Application on data of Brazilian Eucalyptus Clones

Vera Tomazella, Sandra de Jesus Rego (Federal University of São Carlos-UFSCar) and Francisco Louzada Neto (University of São Paulo-São Carlos)

This article proposes the use of the objective Bayesian reference analysis approach to estimate the parameters of the generalized normal regression model. It is shown that the reference prior leads to a proper posterior distribution, while the Jeffreys's prior leads to an improper one. For inferential purposes a Bayesian approach via Markov Chain Monte Carlo (MCMC) is considered. Furthermore, diagnostic techniques based on Kullback-Leibler divergence are used. The proposed method is illustrated using artificial data and real data. Keywords: Bayesian inference, generalized normal regression model, normal regression model, reference prior, Jeffreys prior, Kullback-Leibler divergence.

Alternatives for Ghosal-Ghosh-Vaart priors

Yanyun Zhao (Universidad Carlos III de Madrid) and Bas Kleijn (University of Amsterdam)

The study of the asymptotic frequentist behaviors of the posterior distribution usually includes sufficiency of prior mass in sharpened Kullback-Leibler neighbourhoods described in Ghosal, Ghosh and van der Vaart (2000). In this article, we try to relax this condition to accommodate a wide range of priors. To that end, we formulate an alternative rates-of-posterior-convergence theorem, based on the approach proposed in Kleijn (2015). The aim is to strengthen model conditions and gain flexibility in the choice for a prior, while maintaining optimality of the posterior rate of convergence. Additionally, the general results are illustrated through the examples in the areas of nonparametric estimation, semiparametric inference and survival analysis.