THE ISBA BULLETIN

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The official bulletin of the International Society for Bayesian Analysis

A MESSAGE FROM THE PRESIDENT

- Fabrizio Ruggeri -
ISBA President, 2012
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This is my last column as ISBA President and I would like to summarise the achievements of a very exciting year, which reached its apex in Kyoto where we had the largest World Meeting in ISBA history (and the next one in Cancun, Mexico, in 2014 might be even larger: so mark your calendar for mid July 2014!). I would like to thank one more time Igor Pruenster, Hajime Wago and Yasuhiro Omori for the great scientific programme and organisation of ISBA 2012.

In my statement for the 2010 elections I had identified three major areas for ISBA expansion: countries outside our strongholds (USA and Europe), scientists in other fields and young statisticians. I am glad to report that the first Latin American summer school in Bayesian Statistics (with Raquel Prado and Luis Raul Pericchi as lecturers) will be held in Costa Rica in July 2013, followed by a meeting (see my short note elsewhere in the Bulletin). This year the official language of both events will be Spanish to promote diffusion of Bayesian ideas without language barriers. ISBA will provide its "usual" support to students and young researchers. The next schools will be in Mexico near Cancun in 2014 before the ISBA World Meeting and in Medellin (Colombia) in 2015 before COBAL 4. I think both COBAL and the summer school should be organised on a regular basis by the Latin American chapters, involving also Bayesians in countries without a chapter. A contribution in such direction could be provided also by the possible creation of a new Mexican chapter which is currently pursued by Manuel Mendoza and Eduardo Gutiérrez-Peña: I wish them a successful result. I hope my friends in Latin America will follow my suggestion (but keeping the longstanding, successful events like EBEB!): there are great opportunities for Bayesians in your part of the world and, last but not least, attending a meeting in Latin America is always an unforgettable experience for people coming from the rest of the world.

This year we approved, after 20 years of provisional policy, bylaws on how chapters are formed and operated, and interact with ISBA. Precise rules should make the creation of new chapters easier: we just need volunteers (like in Mexico) willing to undertake the goal!

. . . *Continued on page 2.*

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MESSAGE FROM THE PRESIDENT, *Continued from page 1. . . .*

I hope new chapters will start in other parts of the world: Japan and China could be possible "targets" for the future, building on the very successful ISBA World Meeting in Kyoto and the many possibilities offered nowadays in China (where the Objective Bayes section is going to have a regional meeting, after a worldwide one last year, organised by Dongchu Sun). Colleagues in Australia are continuing their very intensive activities (especially enjoying "Bayes on the Beach"), whereas Satyanshu Upadhyay has organised in January 2013 a "regional" meeting in Varanasi (India), which is actually a sort of world meeting, given the number of participants and their affiliations. In Vietnam, ISBA is endorsing a conference next June and organising a course (given by Christian Robert), whereas I am working for a Bayesian meeting in Saudi Arabia in January 2014. I tried to promote a North African meeting in Algeria but it did not work out because of lack of funds (but I am not giving up since there is interest for Bayesian methods over there). A different (positive!) result has been obtained by Lizanne Raubenheimer who is organising a South African chapter meeting next June. As you can see, some work has been done to promote Bayesian ideas in countries around the world but a lot more can be done!

On a personal side, I hope I will have the opportunity to contribute to the diffusion of sound statistical methods in those countries in my new position (as of September 2013) as member of the Council of the International Statistical Institute (a nomination and an election which were definitely affected by my role in ISBA, and not only in ISBIS, an ISI association on business and industrial statistics). We have not forgotten USA/Canada and Europe: ISBA will be a Joint Statistical Meetings partner from 2013 (thanks to the work of the Past President Michael Jordan) whereas Christian Robert will give a distinguished lecture on the 250th anniversary of Bayes Theorem at the 29th European Meeting of Statisticians in Budapest. There is also a long list of meetings organised by our sections or endorsed by ISBA: follow the ISBA Forum or browse through the ISBA website and you will (almost) surely find events of your interest which are, probably, near you. If not, then wait for the next webinar, organised by the newly appointed Continuing Education Committee, chaired this year by Kate Calder. If you missed the very successful first one by Mark Berliner, you can see the video on the web (where you will find also the videos of the four "ISBA Lectures on Bayesian Foundations" given in Kyoto by Don Berry, Christian Robert, Aad van der Vaart and Mike West). I would like to thank the Programme Committee, chaired by Vanja Dukic, for the excellent work done not only for Kyoto but also for all the other events realised this year or planned for the future.

The second point in my 2010 statement was about interaction with scientists in different fields. This year we have created many new sections which should help in achieving such goal (and the success depends on you and your contribution!). We have now sections on Economics, Finance and Business, on Industrial Statistics, on Biostatistics and Pharmaceutical Statistics, on Environmental Sciences (to be approved before the end of the year). A section on Astrophysics (or Physical Sciences) was discussed and there was a decision to postpone its creation since some of the possible leaders are currently involved in the creation of a more general society in the field. I hope those sections will be able to interact with scientists and practitioners, through common work, projects, meetings, courses, books, and teaching. As an example, I just proposed the Industrial Statistics Section Chair, Refik Soyer, to prepare an edited book on (advanced) case studies in Bayesian Industrial Statistics: such a book does not exist and it could give visibility to the section, besides some revenues: it is a sort of comeback, on a smaller scale, of my earlier idea of a series of ISBA books which was not approved by the ISBA Board after a debate on feasibility, product quality and benefits, like those offered by two publishers interested in the idea.

This year we built a structure, identifying topics for possible sections, inviting people to create new ones and accepting proposals, and creating bylaws which should clearly define interactions between ISBA and its sections and section organisation. Now the tough job is ahead: the structure has to be filled with valuable content! The sections should make a difference in the cooperation with people in other fields and both spread the use of sound Bayesian methods and get new lymph from the interaction. Traditional methods, like the ones I just mentioned, should be pursed but they might not be sufficient: sec-

tion officers and members have to find effective ways to interact and communicate with scientists and practitioners. I recently asked Dalene Stangl and Jim Albert of thinking about the feasibility of a section on Teaching Bayes, to promote diffusion of Bayesian courses, mostly in universities. ISBA could develop material (books, software, video lectures, and slides) which could be accessed by people willing to promote the study of Bayesian statistics in universities where "Frequentist Statistics" is often synonym of "Statistics". We could target some geographical areas (e.g. Latin America and China) and fields of study, like Biology and Engineering, preparing ad hoc material (e.g. in Spanish or Chinese or with biological or engineering examples). A relevant role in promoting Bayesian methods can be played by another new section, the one on Bayesian computation. My advice to its section officers, especially after a chat with a senior (frequentist) statistician about Bayes and industrial statistics, is that the section should be not only a community within the Bayesian world, developing more and more sophisticated and/or efficient methods and presenting them in cool meetings like MCMCSki, but also a promoter of (free and/or commercial) software which people in companies/industries could easily use to perform Bayesian analyses. We should think of the many people outside of academia who would like just to push a button and get reliable results which solve their problems.

Last, but not least, I thought that young Bayesians should be more and more involved in ISBA activities. This year j-ISBA has been created, a successful kickoff meeting was held in Kyoto (with some extra social events), a meeting is planned next June in my institute in cooperation with the young members of the Italian Statistical Society (and I hope there will be others in the following years in different parts of the world), an invited section will be organised in a meeting in Ireland endorsed by the Industrial Statistics Section in July, something will happen at the Bayesian Nonparametrics meeting in Amsterdam in June and many other events are in the minds of Andrew Cron, Marian Farah, Francesca Ieva and Perla Reyes. I invite organisers of ISBA events to get in touch with j-ISBA officers to promote young people participation: there are many possibilities, from invited sections to tutorials, prizes and social events (and even more: my imagination is limited with respect to the one of the four officers!). I hope also that young Bayesians will be involved as Editors of the ISBA Bulletin: their enthusiasm could be very helpful for its continuing success. Another contribution, for sure important for ISBA (but probably also for young people), could come from maintaining some parts the ISBA website and helping for the technical aspects of the webinars. Since we are expanding the content of our website and starting a series of webinars, ISBA webmaster and Continuing Education Committee might need some help (and bylaws allow!) and young people are more accustomed than older people like me for this kind of job. Finally, the creation of new sections could provide many young people the opportunity to take responsibilities within ISBA: I hope current section officers will share my opinion and act accordingly.

During the year we had many contacts with other societies, first of all SBSS, the Bayesian section of ASA, trying to deepen the current cooperation about awards. We had also contacts with ASA, IMS, Bernoulli, ISI, SIS (Italian Statistical Society), just to mention few. I am glad to report that, thanks to the work of the people who came before us, ISBA has an important, very well recognised role in the statistical community worldwide.

We worked a lot also to "clean the house", approving many bylaws which should make ISBA more efficient, setting well defined policies, and we improved the Book of Procedures started last year which should help in keeping track of who is going to do what, when and how, without being subject to "wheel reinvention" after each change in ISBA officers. Here I would like to thank the Constitution and Bylaws Committee, chaired by David Madigan, which went very carefully through the many bylaws we approved and gave suggestions on how to improve them and make them consistent with the Constitution and the existing bylaws.

We have completed the transition from the "old" bayes-news and Valencia meeting mailing lists to the Bayes Forum. Now ISBA is providing the most important service to get and submit information of interest for Bayesians. Our website is providing a lot of information as well and a lot of work, probably unnoticed by you, has been done to efficiently improve handling of many administrative tasks, communication within ISBA

committees and to/from members. It has been an impressive work and we should thank Merlise Clyde, Chris Hans and Lance Brown. I am just giving you a warning: as soon as Merlise will become President you should learn what Drupal and CiviCRM are (like I did!).

We appointed, based on the nominations by the Editor Search Committee chaired by Alicia Carriquiry, three new ISBA Editors: Marina Vannucci, Feng Liang and Jarad Niemi will replace Herbie Lee, Manuel Mendoza and Chris Hans as Editors of Bayesian Analysis, ISBA Bulletin and ISBA website, respectively. The three outgoing editors did a great job and we expect the same from the new ones! Bayesian Analysis has been moved to the IMS system and Project Euclid: now handling of submissions will be easier and visibility of the journal will increase a lot (and, hopefully, the impact factor as well, although it is already quite high). I would like to thank the Department of Statistics at Carnegie Mellon, and especially Rob Kass, for providing a very valuable support in setting up and operating the old Bayesian Analysis system.

The Nominations Committee, chaired by Mike Jordan, selected an excellent set of candidates and choosing among them was very difficult (as an example, I think both my friends Sonia Petrone and Eduardo Gutiérrez Peña deserved to become President. I hope Eduardo will have another chance!). I would like to thank all those who accepted to run: the "winners" have a tough job ahead whereas I hope the "losers" will have other opportunities (I lost three times: twice when running for President and once in 1994 when I was nominated for Secretary). This year we decided (and modified the bylaws) that, from now on, sections should choose the nominees for their elections, instead of having them selected by the ISBA Nominations Committee. The decision gives more responsibility to the sections, allows for selection by people who know better those who could deserve to be the next officers and relieves the ISBA Nominations Committee from a complex task, sometimes made even harder by the lack of members of the interested sections in it.

Another outstanding job has been done by the Prize Committee, chaired by Mark Steel, in charge of DeGroot Prize, Lindley Prize, Mitchell Prize and Savage Award. We had ceremonies in Kyoto and at the SBSS mixer at the JSM in San Diego to honour the winners of this year's awards. We have been working, since last year, to increase the funds in the endowments of each award to guarantee self-sustainability despite the turmoil in financial markets. We considered various options, including the possibility of reducing the amount of the cash award or eliminating the one for Honourable Mentions in the Savage Award, but then we undertook a campaign targeted to ISBA members, especially past recipients of the awards, which provided us enough resources to be safe in the next few years. I acknowledge the generous support by those members and I invite all of you to support the awards through donations to their funds, without forgetting the Pilar Iglesias Fund to support participation of young statisticians from developing countries to ISBA World Meetings.

After the long list of successes, it is time to mention where some troubles are: finance! ISBA has a lot of reserves in its bank account but we have also a lot of expenses. The expansion of ISBA requires clerical work and help with the website: the Department of Statistical Science at Duke University, chaired by Alan Gelfand (whom I thank), is providing us a lot of help but we have to pay a friendly, but significant for our finances, amount for such work. The move of Bayesian Analysis to the new system had initial setup costs and there are also annual ones. More than 150 students and young researchers were supported (mostly by ISBA) to attend the Kyoto meeting: this is one of our major goals but it has a cost! We also supported young people at other conferences. For all such expenditures there should be an equivalent income to ensure long term financial safety. We decided to appoint a Finance Committee, chaired by the Past President (Mike Jordan, for few weeks more, and then it will be my turn), who should advise the Exec and the Board on investment policies. We have decided to raise the membership fees, still lower than many other statistical societies, but you can pay the 2012 rate if you renew your membership by December, 31st.

We are now going to vote the introduction of Institutional Membership, especially for university departments, publishers and software developers: we will provide them some benefits (free memberships for some associates, discounts on ISBA events, and some ads in the website and in the Bulletin) but we should get a significant

income out of it. We are investing in courses, especially in webinars, to increase incomes and we have created a Continuing Education Committee which is in charge of them. The meeting in Kyoto has been excellent and the organisers worked hard to reduce the expenses, but the cost of life in Japan was so high that no revenue came to ISBA out of the World Meeting. I am sure Andres Christen, the organiser of ISBA 2014, is operating in a better situation from the point of view of costs and we also expect an even larger number of participants, given that Cancun is a very popular place, served by many airlines, with relatively cheap tickets. From ISBA 2014 we should expect a significant income to ISBA to relief our financial situation (for the moment we have paid the Cancun Convention Centre a consistent amount ...).

The major income for ISBA comes from the membership fees and I warmly invite you to renew your membership, possibly adding some sections of your interest and donating to our funds. Only in this way it will be possible for ISBA to guarantee services like Bayes Forum, website, meetings, courses, video lectures, Bayesian Analysis, Bulletin, prizes, travel awards, etc. I am very glad to report that today ISBA has 1040 members (and they should become more by the end of the year!), with approximately 385 which became members in 2012-2013 for the first time (or renewed after some years) whereas 115 members at the end of 2011 did not renew their membership. We worked hard to get the former members back and we had some success but the next ISBA officers should pay a lot of attention to retain members, especially after the recent huge increase, and bring back former ones. The impressive increase has many explanations, like the World Meeting with discounted rate for members and the creation of new sections, but I hope that more and more people felt "natural and obvious", for a Bayesian, to be an ISBA member.

We would like that Bayesians will be proud of being ISBA members and will be more linked to the society. For those reasons and to properly recognise those who contribute significantly to the development and diffusion of Bayesian ideas, we are going to introduce new awards and define better the characteristics of the existing ones (we just need a second approval of the bylaws by the Board). We are keeping the awards for young statisticians to attend meetings (i.e. ISBA New Researchers Travel Award, Pilar Iglesias Travel Award, ISBA Lifetime Members Junior Researchers Award) with a major change: the Lifetime Members award will be more prestigious to recognise junior researchers, attending a World Meeting, who will have given significant contributions in the early stage of their career.

Certificates of Appreciation were already present in our bylaws but they were given only twice in ISBA history. Now they should be given more regularly, but sparingly not to diminish their value, to recognise an outstanding service to ISBA. We are going to replace the Founders Award with another award named after the only person who got it and was the leading force in founding ISBA: the Zellner Medal. The medal, given at each World Meeting at two (at most) persons, will recognise ISBA members who will have rendered exceptional and distinguished service to ISBA over an extended period of time. Finally, we are going to introduce ISBA Fellows, elected at each World meeting and recognising ISBA members who will have made outstanding contributions in some aspect of statistical work (publication, teaching, service, etc.). We have already identified the first set of fellows but you will know their names around Christmas time (sorry but I cannot disclose their names before contacting them and the final approval by the Board). I can only anticipate that it will be our way to celebrate the 20th anniversary since the founding of ISBA in 1992.

In my second failed attempt to become ISBA President in the 2008 elections (when Peter Mueller was elected), I wrote in my statement the sentence "If elected, I promise it will not be a dull year!". I do not know your opinion on what happened in ISBA during this year (and I would like to hear from you at fabrizio@mi.imati.cnr.it) but, for sure, it has not been a dull year for me. The contact with the members has been a pleasure, and not just a duty towards the owners of ISBA (i.e. all of us). I contacted many people for different reasons (e.g. Latin American summer school and Institutional membership), but here I just want to mention when I asked a hundred people to tell me if they had used simple Bayesian models to address and solve real problems. I was expecting just a dozen answers but I got more than seventy and people were so enthusiastic and gave me so many details that it took me ages to summarise them into the very long column I

wrote for the previous issue of the Bulletin.

I am very glad of the large number of people who took responsibilities this year in organising events, proposing sections, being part of committees, giving advice and contributing when asked like in the above cases. I believe that officers of a society should not limit themselves to decide on behalf of its members but they should also activate members' energies and coordinate them towards a common goal.

It has been a great pleasure working with you, the ISBA committees and the Board of Directors, whose members survived the many, very long messages I posted in the Board Forum (actually I have to thank them since they devoted a lot of time to ISBA and contributed a lot in shaping this year's policy). Finally, I would like to thank the members of the Executive Committee (Merlise Clyde, Mike Daniels and Mike Jordan) for their support and very friendly cooperation, as well as the open and thorough discussions we had and the joint efforts we made to implement the decisions we took within the Exec and the Board.

I do not like to get a job just to add a line to my CV, so I tried to work hard for respect of the role, of the people who elected me, of the members I have been representing, of myself. Now it is time to step aside and leave Merlise the responsibility of leading the society of which I have been a proud President. *Auguri a tutti voi.* ▲

A MESSAGE FROM THE EDITOR

- Manuel Mendoza -
mendoza@itam.mx

As every December, with the last issue of the year, the ISBA Bulletin witnesses the end of a Presidential era and foresees the start of a new one. In this ocasion, the *Ruggerian* period approaches its end. It has been a year full of highly productive activity for the Society and Fabrizio should be congratulated for his successful Presidency. In particular, as Editor of the Bulletin, I would like to thank Fabrizio for all his support and guidance. In addition to this change, after three years of enjoyable work, it is now also time for a renewal of the Bulletin Editor office, and I would like to take the opportunity to express my deep gratitude to all the Associate Editors who have collaborated with us over these years. It is only because of their work that the Bulletin appears every quarter.

Let me also welcome Feng Liang who will become the new Editor, next January. I am sure that she will make a great job and we'll see a better and more useful Bulletin in the future. As always, I want to encourage all members of ISBA to contribute to the Bulletin with their suggestions, manuscripts and announcements. Please do not hesitate to contact any member of the Editorial Board. ▲

FROM THE PROGRAM COUNCIL

THE INTERNATIONAL YEAR OF (BAYESIAN) STATISTICS

- Vanja Dukic -
Vanja.Dukic@colorado.edu

2013, the International Year of Statistics, will be bustling with Bayesian activities. There will be 4 exciting ISBA Section meetings (Bayesian Young Statisticians, O-Bayes, and Bayes NP) in Italy, China, USA, and The Netherlands. There will also be 2 ISBA Chapter meetings (one in India and another in South Africa) and 7 co-sponsored or endorsed meetings in Ireland (Third Symposium on Games and Decisions in Reliability and Risk), Italy (Bayesian Inference in Stochastic Processes in Milan, and Approximate Bayesian Computation in Rome), Hong Kong (ICSA International Conference), USA (Stochastic Processes and

Their Applications), Spain (Bayesian methods in Biostatistics and Bioinformatics) and Vietnam (Statistics and its Interactions with other Disciplines). In addition, we will have ISBA-endorsed sessions at several of the major meetings, such as EMS, ENAR, and JSM. The full list of meetings can be found at bayesian.org. On behalf of the ISBA Program Council, we wish all Bayesians a very Happy New Year! ▲

FROM THE BOARD OF DIRECTORS

SAVE ON ISBA DUES FOR 2013!

- Merlise Clyde -
ISBA Executive Secretary
clyde@stat.duke.edu

December is renewal month for ISBA annual memberships that expire at the end of the year. You can save $10 on ISBA dues for 2013 by renewing anytime before December 31st. After January 1 regular ISBA dues will increase to $60, while student and reduced-country memberships will increase to $25. ISBA dues help support Bayesian Analysis, the Bayes News Forums, travel awards, prizes and more. ISBA membership provides discounts on registration for ISBA conferences, workshops and continuing education events.

Please visit bayesian.org to join or renew today! Please consider making an unrestricted donation to the ISBA general fund to help support kick off new ISBA activities or join one of ISBA's growing list of sections! New this year, members may join one of several regional Chapter's of ISBA. ▲

INSTITUTIONAL MEMBERSHIP

- Fabrizio Ruggeri -
ISBA President 2012
fabrizio@mi.imati.cnr.it

The ISBA Board of Directors just approved the Institutional Membership (IM), offering benefits to departments, institutions and companies at three different levels (with 50% discount for developing countries).

IM is important not only for institutions (especially with the current expansion of ISBA activities and for the advertising possibilities) but also for ISBA, since IM fees could provide a great help in supporting the many activities ISBA is promoting. We warmly invite you to contact your organisation and promote IM.

Details can be found at Institutional Membership For technical reasons, it is currently possible to sign up only as "Organizational Partner". Soon it will be possible to sign up for Standard and Premium IM; an announcement will be done through the Bayes Forum. ▲

2012 ISBA ELECTION

ISBA 2012 ELECTION RESULTS

- Merlise Clyde -
ISBA Executive Secretary
clyde@stat.duke.edu

We are pleased to announce the results of the recent ISBA elections (posted at bayesian.org) as follows:

ISBA President-Elect

Sonia Petrone,
Bocconi University, Milano, Italy,
sonia.petrone@unibocconi.it

ISBA Executive Secretary

Steve Scott,
Google, USA,
stevescott@google.com

ISBA Board

Paul Fearnhead,
Lancaster University, UK,
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Amy H. Herring,
The University of North Carolina
at Chapel Hill, USA,
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Jaeyong Lee,
Seoul National University, South Korea,
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Håvard Rue,
NTNU, Norway,
hrue@math.ntnu.no

Section on Biostatistics and Pharmacology Chair-Elect

Sylvia Richardson,
Medical Research Council Biostatistics Unit
and University of Cambridge,
United Kingdom,
sylvia.richardson@mrc-bsu.cam.ac.uk

Section on Bayesian Nonparametrics Chair-Elect

Antonio Lijoi,
University of Pavia, Italy,
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Section on Bayesian Nonparametrics Secretary

Surya Tokdar,
Duke University, USA,
tokdar@stat.duke.edu

Section on Finance and Business Chair-Elect

Siddhartha Chib,
Washington University in St. Louis, USA,
chib@wustl.edu

Section on Finance and Business Program Chair

Abel Rodriguez,
University of California, Santa Cruz, USA,
abel@soe.ucsc.edu

Section on Finance and Business Secretary

Emily Fox,
University of Washington, USA,
ebfox@uw.edu

Section on Industrial Statistics Chair-Elect

Ehsan Soofi,
University of Wisconsin-Milwaukee, USA,
esoofi@uwm.edu

Section on Objective Bayes Program Chair

Susie Bayarri,
University of Valencia, Spain,
susie.bayarri@uv.es

Section on Objective Bayes Treasurer

James Scott,
University of Texas at Austin, USA,
james.scott@mccombs.utexas.edu

On behalf of all ISBA members, we congratulate all those named above, thank them for their willingness to serve the profession in these positions, and look forward to their leadership contributions in coming years! We also again thank the candidates who stood for election but were not elected (this year!) ▲

SUMMER SCHOOL AND MEETING IN COSTA RICA

News from Latin America

- Fabrizio Ruggeri -
ISBA President 2012
fabrizio@mi.imati.cnr.it

I am glad to inform you that the Universidad de Costa Rica will host the first "Latin American Summer School in Bayesian Statistics" (name suggested by my one-time consultant for English language, Michael Jordan, who proposed also the short name "LA-Bayes"). The school will be held in San José on July, 22-24, 2013 and it will be followed by a two-days Bayesian meeting and, probably, an excursion on July, 27th.

The lecturers will be Raquel Prado (University of California at Santa Cruz) and Luis Raul Pericchi (University of Puerto Rico); Luis Raul should give an introduction to Bayesian statistics whereas Raquel should talk about time series. This will be the first LA-Bayes school to be followed by one in Mexico in 2014 and one in Colombia in 2015, just before ISBA 2014 and COBAL4, respectively. The official language of the 2013 school and meeting will be Spanish since we would like to favour the participation of the largest number of students and young (and less young ...) researchers from an area where Bayesian methods are hardly taught. The Latin American summer school has the goal to promote the diffusion of Bayesian statistics in the continent, especially allowing for contacts between local young statisticians and outstanding Bayesian researchers which would be hardly possible otherwise and creating a network of young people from different countries which could cooperate in future in scientific works and organisation of further events. ISBA is investing a lot on the project by partially supporting many young people (and donations to ISBA to support these activities are always welcome!).

In January we will announce details on the meeting, the school and the travel grants through the Bayes Forum operated by ISBA. In the meanwhile, Luis Raul and myself will work on the international side of the invited programme (we hope to get many people) and Edgar Gutiérrez and Eiliana Montero, the local hosts, will work on the organisation of the events, invitation of people from Costa Rica and website.

If you are interested in attending the school, giving a talk or presenting a poster (slides and posters, if any, in English will be allowed!), please send me a message to fabrizio@mi.imati.cnr.it (later there will be an ad-hoc e-mail address for the events).

P.S. Latest news. The list of speakers at the meeting will include Raquel Prado, Luis Raul Pericchi, Carlos Pereira, Alicia Carriquiry, Abel Rodriguez, Rosangela Loschi, Elias Moreno, Carlos Barrera, Gabriel Huerta, Andres Christen, Manuel Mendoza and others who have to confirm. ▲

BAYESIAN ANALYSIS - A MESSAGE FROM THE EDITOR

UPDATE FROM BA

- Herbie Lee -
Editor-in-Chief
herbie@ams.ucsc.edu

It's hard to believe that three years have already passed, but my term as editor is drawing to a close. I am leaving the journal in excellent hands, as Marina Vannucci is taking over as Editor-in-Chief. Our submissions are up and I am happy to be able to leave the journal in good health to Marina. Two big pieces of news for the journal during this time are the move to Project Euclid (find us at projecteuclid.org) and the move to a new online review system, EJMS, which is shared with the IMS journals (this move is still in progress as I write, but we should be going live very soon). I am grateful to Merlise Clyde for all her help in moving us to Project Euclid. Another rite of passage for the journal was receiving our first impact factor, thanks to the work of the previous EIC Brad Carlin. We have scored very well on article influence and our 5-year impact factor.

Bayesian Analysis is a journal that survives on the hard work of a large team of volunteers. I am immensely thankful for everyone who pitches in. Critical to our success are the Managing Editor Alyson Wilson, the System Managing Editor Pantelis Vlachos, and the Production Editor Kary Myers (and Angelika van der Linde before her). These people put in significant amounts of time and effort, sometimes on short notice, to make it all happen. Our board of editors makes the review process run: Ming-Hui Chen, Kate Cowles, David Dunson, David Heckerman, Valen Johnson, Antonietta Mira, Sonia Petrone, Bruno Sanso, Mark Steel, and Kert Viele, as well as Michael Jordan and Fabrizio Ruggeri who were also on the board in the first part of this period.

The editors are supported by a larger number of associated editors and a vast number of referees. Thank you to all of you who have contributed, and thank you to ISBA for giving me the opportunity to lead this great journal. While we will be sad to see Alyson Wilson stepping down, we are happy to welcome Kassie Fronczyk as the incoming Managing Editor. Alyson has done a great job, so Kassie has a hard act to follow, but I think she will be up to the task. We look forward to great success from the Marina-Kassie team, along with Pantelis and Kary who will be continuing.

Finally, I do want to mention that we have another great issue in the December 2012 issue. The discussion paper is a case study on human fecundity by Sungduk Kim, Rajeshwari Sundaram, Germaine M. Buck Louis and Cecilia Pyper, with discussions from Bruno Scarpa and Joseph Stanford. We have a big issue (and our first volume over one thousand pages) with a variety of other primarily methodological papers including nonparametric modeling and robust modeling. ▲

ISBA - SECTIONS

BAYESIAN COMPUTATION SECTION

- Peter J. Green -
Chair
P.J.Green@bristol.ac.uk

The gestation period of the new BayesComp section has been guided by an informal steering group, consisting of Christian Robert, Antonietta Mira, Håvard Rue, Nicolas Chopin and myself. We are delighted by the enthusiasm shown for this new initiative, in particular by the 115 members (at the time of writing) from 21 countries who have already signed up to join the section. But 115 is not our limit and we hope for many more to sign up. Elections for officers were held in early December, and so we now have a complete set of officers:

Section Chair, to end 2013
Peter Green,
P.J.Green@bristol.ac.uk

Program Chair, to end 2013
Christian Robert,
xian@ceremade.dauphine.fr

Secretary, to end 2014
Antonietta Mira,
antonietta.mira@usi.ch

Treasurer, to end 2014
Galin Jones,
galin@umn.edu

Section Chair-elect, to end 2013
Section Chair, 2014-2015
Håvard Rue,
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We are actively planning our first big event, MCMSki IV, in Chamonix-Mont Blanc, France from 6-8 January 2014, and the plenary speakers are now confirmed as Andrew Gelman (Columbia University, New York), Chris Holmes (University of Oxford), and Michele Parrinello (USI, Lugano and ETH Zürich). Make sure you use the 2013 ski season to get in practice for this conference!

Finally, in our "manifesto" for the Section, we promised a "website of information, tools, and advice as an authoritative central resource for Bayesian computation". We are actively working on our plans for this, and will go public with these soon. In the meantime, I welcome your ideas for what this might include: please be creative in your suggestions, but also generous with your time: ideas for labour-intensive features on the website will be particularly welcome if accompanied by an offer to construct and maintain! ▲

ECONOMICS, FINANCE AND BUSINESS SECTION

- Mike West -
Chair
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The **ISBA Section on Economics, Finance and Business (EFaB)** aims to promote, encourage and reflect the vitality of Bayesian methods in applications across the full spectrum of commercial, financial and economic areas. In this issue of the Bulletin, the first piece of news for ISBA members broadly– as well as EFaB members in particular– is that the ISBA Board formally approved the revised section name recently (to add the "E"). The Section's purview is the full sweep of Bayesian analysis in all areas of economics, finance and business.

Elections: As you will all already know, the annual ISBA elections ended with the following newfaces elected to lead and develop EFaB on behalf of the members. From January 1st 2013, our Executive Committee is completed with the addition of: Siddhartha Chib, EFaB Section Chair-elect for 2013, Chair in 2014; Abel Rodriguez, EFaB Program Chair in 2013-2014 (two year term); Emily Fox, EFaB Secretary in 2013-2014 (two year term). If you have not already done so, please join me in congratulating the new officers, and helping them understand that we expect a great deal from them in the coming two years! I would also like to again thank all other candidates this year– Mike So, Carlos Carvalho, and Hongxia Yang– for their commitments and interests in running for office, and to remind them that there will be continuing opportunities!

Education & Outreach: We would like to invite all EFaB members to consider volunteering to contribute to EFaB's developing short-course initiatives. In early 2013 we will put together a formal *Continuing Education Committee* as an extension of the executive committee, drawing on the membership, of course. Beyond the formalities and developing blueprints and logistics, we are interested in hearing from the membership of EFaB. Two of our three central goals are to *promote education in Bayesian methods in finance and business by developing short-courses for students and practitioners; and (to) promote academic-industry interactions and outreach to the finance and business professions.* We now solicit: (i) ideas and suggestions for topics and speakers for short courses (ranging from 1- or 2-day courses, to "collages" of

3-4 speakers/teachers for one full day together, to tutorial-style and master-class presentations); and (ii) ideas and suggestions for venues– free-standing, academic, commercial, in-house or collaborative with other organisations (whether societal, business, academic, etc), that might be imagined as defining contexts for initial short-courses that would then evolve into "series" of continuing events. Courses (master classes, tutorials, or more specific topic-oriented courses) responding to articulated interests of other groups, business or economic organisations, etc., are of particular interest.

If you are interested in discussing the above, participating, volunteering, (volunteering others), and/or have any other input, please do not hesitate to come forward to help with these central EFaB initiatives. You can to this by emailing any one of the current executive committee members, and maybe most directly discussing with me, as current EFaB Chair, and/or Abel Rodriguez, as EFaB Program Chair beginning on January 1st 2013.

Meetings in 2013: EFaB formally endorses or sponsors workshops and conferences concerned wholly or substantially with Bayesian ideas, methods and applications in the "E", "F" and "B" areas. All members are encouraged to come forward with ideas and proposals for endorsement and/or sponsorship of meetings.

We are currently discussing/finalizing formal EFaB endorsement of several meetings, and will announce details (via the ISBA email lists as well as forthcoming issues of the Bulletin) as they come on stream. Some of these are expected to involve short-course activities of direct interest to EFaB members and Bayesians working in these areas, and EFaB sponsorship as well as endorsement. Of key interest to our members is the news that, in some cases, the endorsement agreement will involve reduced registration fees for ISBA/EFaB members.

By way of initial news about EFaB meeting endorsements for 2013, we are pleased to announce that EFaB endorses the following three meetings.

- **Time Series 2013**, the *1st Vienna Workshop on High Dimensional Time Series in Macroeconomics and Finance*, to be held in (you guessed it!) Vienna in May 2013. On behalf of ISBA, EFaB is officially endorsing *Time Series 2013*. The meeting will focus on factor models and Bayesian methods for forecasting and time series analysis, with applications in EFaB areas. Several EFaB members are involved in organisation and as invited speakers, and the call for contributed presentations is open until January 31, 2013. EFaB members are encouraged to participate and we hope and expect to enjoy a stimulating and eventful meeting, the first of what is expected to be a new series of international workshops on time series methods and applications.

- **RCEA-BEW7**, the *7th Annual Bayesian Econometric Workshop* of the *Rimini Centre for Economic Analysis*. RCEA is an Italian economic research centre with strong links to Canadian economists, and has a growing Bayesian econometrics group that, among other activities, has an annual workshop and is active in encouraging participation of junior Bayesian econometricians. On behalf of ISBA, EFaB is officially endorsing *RCEA-BEW7*. The meeting is in Rimini, Italy, on June 25-26, 2013, and will focus on the broad range of topics in Bayesian econometrics. Several EFaB members are involved in organisation and as invited speakers at the meeting. The full workshop announcement and call for contributed presentations will be available very soon, and we will advise EFaB members via email once details are available at the *RCEA* web site.

- **ESOBE 2013**, the 2013 meeting of the *European Seminar on Bayesian Econometrics (ESOBE)*, a discussion forum for novel and recent research in a wide range of topics in the field of Bayesian econometrics. On behalf of ISBA, EFaB is officially endorsing *ESOBE 2013* as part of a developing relationship involving discussions of potential broader collaborations with ESOBE. The *ESOBE 2013* meeting will be hosted by the Norges Bank in Oslo on August 22-23, 2013. The program will include a rich mix of keynotes and special invited sessions, with opportunities for EFaB members to present talks and/or posters; the meeting scope spans the field of Bayesian methods in econometrics and related areas. Several EFaB members are involved in organisation of the meeting. The conference web site will be "up" before the end of December, and we will advise EFaB members via email as soon as it is available. The call for papers

will have a deadline of April 1, 2013.

We are also expecting that ISBA/EFaB members will receive a modest discount on conference fees, to be announced later on. EFaB members are encouraged to participate in what will surely be a stimulating and eventful meeting on frontier research in methodology and applications of Bayesian methods in econometrics and related areas.

More Meetings in 2013: EFaB@Bayes 250! As announced in the previous Bulletin, all Bayesians should be encouraged to take particular note of events and activities at Duke University in mid-December 2013: *Bayes 250!*. To mark and celebrate the 250th anniversary of the formal reading of Bayes' seminal paper to the Royal Society, ISBA will host the *Bayes 250* meeting at Duke University during the 3rd week of December 2013, and also highlight it in connection with the International Year of Statistics 2013.

As part of this, we will have an EFaB meeting during the 2 days before formal *Bayes 250* talks; the *EFaB@Bayes 250 Workshop* is scheduled for December 15-16, 2013. This EFaB meeting will include tutorial/short course activities along with research talks, and be consistent with EFaB's aims of promoting cross-over between academic and non-academic research, coupled with education and outreach. *Mark your calendars and make pre-holiday travel plans!* We hope and expect to see a major representation of EFaB members at Duke University next December.

In the next few weeks, you will hear from the *EFaB@Bayes 250* Program Committee with more details. This EFaB meeting will be run in coordination with ISBA and also the ISBA/Objective Bayes section who will be running a parallel meeting bracketing *Bayes 250*. EFaB Program Chair (2013-14) Abel Rodriguez is leading this, as chair of the *EFaB@Bayes 250 Workshop Committee.*

We invite and encourage all ISBA members to contact any of us to discuss ideas for EFaB activities of any kind (consistent with the Section aims and bylaws), and especially related to short-courses, workshops and conferences linked to other groups in any areas of business and finance, and other forms of outreach. Please visit the Section web page at the ISBA site.

In closing, I probably do not need to remind all 1-year EFaB members to renew section membership when renewing with ISBA for the coming year(s) .... but will do so: *don't forget to renew!* And all ISBA members not currently involved with EFaB are encouraged to join the Section– you can do this by logging into your ISBA membership account and simply adding the Section membership (either annual or life), or directly via the Section page. Please tell your friends and colleagues, and help us to develop the Section to promote, facilitate and celebrate Bayesian analysis in economics, finance and business.

With good wishes for the holiday season and for a productive, successful and enjoyable Bayesian New Year 2013,

With best regards,

Mike West ▲

NONPARAMETRICS SECTION

- Stephen G. Walker -
Chair
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This will be the final message from me as the Nonparametric Section chair. Steve MacEachern will be taking over in January. I would like to take this opportunity to personally thank all those who have helped out on the committee during this time: Maria Kalli, Ramses Mena, Theo Nicoleris, Thanos Kottas, Michele Guindani and Steve himself.

I wish all the future committees the very best and may Bayes nonparametrics flourish. ▲

JUNIOR SECTION

- Andrew Cron -
Chair
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We are pleased to announce that the Junior ISBA section has been launched and now has over 40 members! We hope to see that number increase over the coming year (it is possible to join us when renewing the ISBA membership), also thanks to the number of initiatives the section is preparing (MAYBE BETTER ANOTHER TERM). In fact, we have multiple conference events this coming year, and we are planning to do multiple web-based events as well.

We are collaborating with the Bayesian Nonparametrics Section in order to have a couple of events dedicated to junior researchers at their next conference in Amsterdam on June 10-14, 2013 (www.bnp9.win.tue.nl). In particular, a prize will be awarded for best poster submitted by a junior researcher, and a lunch event will be hosted specifically for participating junior statisticians. Stay tuned for more details on the conference website and in an email to ISBA members.

We are also endorsing and supporting the BAYSM 2013 - Bayesian Young Statistician Meeting on June 5th and 6th in Milan, Italy (www.mi.imati.cnr.it). The meeting is devoted to let young researchers, dealing with Bayesian Statistics, to discuss and share ideas and projects with the Bayesian community at large. Social events are also planned, in order to let people have fun together and create useful networks for their future work and career. In order to encourage participation and submissions, registration is FREE. Works can be submitted by PhD students, post-docs and MS students with outstanding theses/projects in Bayesian Statistics and will be published in an extended proceeding book after the conference.

We are also organizing a session at GDRR 2013: Third Symposium on Games and Decisions in Reliability and Risk on July 8th-10th in Kinsale, Ireland (www.cs.tcd.ie). The objective of the symposium is to present novel use of game and decision theory in reliability and risk analysis and to bring together researchers from disciplines such as economics, engineering, finance, mathematics, medical sciences, probability and statistics who have a lot to contribute to this theme. There will be a call for abstracts and selected works by junior researchers will be selected to present in the session and for travel support.

Please visit the J-ISBA website for more information, be on the lookout for an email to the members for more information and stay tuned for more information about upcoming events.

If you haven't already, join J-ISBA! ▲

SOFTWARE HIGHLIGHT

CONTINUOUS DOMAIN SPATIAL MODELS IN R-INLA

- Finn Lindgren -
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Traditionally, Markov models in image analysis and spatial statistics have been largely confined to discrete spatial domains, such as lattices and regional adjacency graphs. However, as discussed in Lingren *et al.* (2011), one can express a large class of random field models as solutions to continuous domain stochastic partial differential equations (SPDEs), and write down explicit links between the parameters of each SPDE and the elements of precision matrices for weights in a discrete basis function representation. As shown by Whittle in 1963, such models include those with Matérn covariance functions, which are ubiquitous in traditional spatial statistics, but in contrast to covariance based models it is far easier to introduce non-stationarity into the SPDE models. This is because the differential operators act locally, similarly to local increments in Gibbs-specifications of Markov models, and only mild regularity conditions are required. The practical significance of this is that we can mer-

ge the classical Gaussian random fields with methods based on the Markov property, providing continuous domain models that are computationally efficient, and where the parameters can be specified locally without having to worry about positive definiteness of covariance functions.

In this brief note, I present the basic ingredients of the link between continuous domains and Markov models, and show how to perform Bayesian inference for the simplest of these models, using the `R-INLA` software package (`http://www.r-inla.org`). Special emphasis is placed on the abstractions necessary to simplify the practical bookkeeping for the user of the software.

Think continuous

When building and using hierarchical models with latent random fields it is important to remember that the latent fields often represent real-world phenomena that exist independently of whether they are observed in a given location or not. Thus, we are not building models solely for *discretely observed data*, but for approximations of *entire processes* defined on continuous domains. For a spatial field $x(\mathrm{s})$, while the data likelihood typically depends only on the values at a finite set of locations, $\{\mathrm{s}_1, \ldots, \mathrm{s}_m\}$, the model itself defines the joint behaviour for all locations, typically $\mathrm{s} \in \mathbb{R}^2$ or $\mathrm{s} \in \mathbb{S}^2$ (a sphere/globe). In the case of lattice data, the discretisation typically happens in the observation stage, such as integration over grid boxes (e.g. photon collection in a camera sensor). Often, this is approximated by point-wise evaluation, but there is nothing apart from computational challenges preventing other observation models.

As discussed in the introduction, an alternative to traditional covariance based modelling is to use SPDEs, but carry out the practical computations using Gaussian Markov random field (GMRF) representations. This is done by approximating the full set of spatial random functions with weighted sums of simple basis functions, which allows us to hold on to the continuous interpretation of space, while the computational algorithms only see discrete structures with Markov properties. Beyond the main paper Lingren *et al.* (2011), this is further discussed in Simpson *et al.* (2012a) and (2012b).

The simplest model for $x(\mathrm{s})$ currently implemented in `R-INLA` is the SPDE/GMRF version of the stationary Matérn family,

$$(\kappa^2 - \Delta)^{\alpha/2}(\tau x(\mathrm{s})) = \mathcal{E}(\mathrm{s}), \quad \mathrm{s} \in \mathbb{R}^2,$$

where Δ is the Laplacian, κ is the spatial scale parameter, α controls the smoothness of the realisations, and τ controls the variance. The right-hand side of the equation, $\mathcal{E}(\mathrm{s})$ is spatial white noise process. The link to the Matérn smoothness ν and variance σ^2 is $\nu = \alpha - d/2$ and $\sigma^2 = \Gamma(\nu)(\Gamma(\alpha)(4\pi)^{d/2}\kappa^{2\nu}\tau^2)^{-1}$, where d is the spatial dimension. From this we can identify the exponential covariance with $\nu = 1/2$ and $\alpha = 3/2$, and note that fields with $\alpha \leq 1$ give $\nu \leq 0$ and that such fields have no point-wise interpretation (but do have well-defined integration properties). From spectral theory one can show that integer values for α gives continuous domain Markov fields, and these are the easiest for which to provide discrete basis representations. In `R-INLA`, the default value is $\alpha = 2$, but $0 \leq \alpha < 2$ are also available, though not as extensively tested (for the non-integer α values the approximation method introduced in the authors' discussion response in Lingren *et al.* (2011) is used).

The models discussed in Lingren *et al.* (2011) and implemented in `R-INLA` are built on a basis representation

$$x(\mathrm{s}) = \sum_{i=1}^{n} \psi_i(\mathrm{s}) x_i,$$

where the joint distribution of $\mathrm{x} = \{x_1, \ldots, x_n\}$ is chosen so that the distribution of the functions $x(\mathrm{s})$ approximates the distribution of solutions to the SPDE. To obtain a Markov structure, and to preserve it when conditioning on observations, we use basis function with local support. The construction is done by projecting the SPDE onto the basis representation in what is essentially a Finite Element method. To allow easy and explicit evaluation, we use piece-wise linear basis functions defined by a triangulation of the domain of interest. This yields a diagonal matrix C and a sparse matrix G such that the appropriate precision matrix for the weights is given by

$$\mathrm{Q} = \tau^2(\kappa^4\mathrm{C} + 2\kappa^2\mathrm{G} + \mathrm{G}\mathrm{C}^{-1}\mathrm{G})$$

for the default case $\alpha = 2$, so that the elements of Q have explicit expressions as functions of κ and τ. The default internal representation of the parameters in the model interface we will use here is $\log(\tau) = \theta_1$ and $\log(\kappa) = \theta_2$, where θ_1 and θ_2

have a joint normal prior distribution (by default independent).

There is a vast range of possible extensions to the simple model described here, including non-stationary versions (see Lingren *et al.* (2011) and Bolin & Lindgren (2011) for examples). For currently implemented models, the recent paper Cameletti *et al.* (2012) is a case-study using a straightforward space-time version including the full R code. A non-stationary extension by defining spatially varying models for $\kappa(s)$ and $\tau(s)$ is also implemented, and will be mentioned briefly later on.

While the full theory behind fractional stochastic partial differential equations is challenging at best, the major challenge when designing a general software package for practical use of these models is rather that of bookkeeping. To solve this, a bit of abstraction is needed to avoid cluttering the interface with details of internal storage. Thus, instead of visibly keeping track of mappings between triangle mesh node indices and data locations, one can use sparse matrices to encode these relationships, and provide wrapper functions to manipulate these matrices and associated index and covariate vectors.

The first step is to create the triangulated mesh on top of which the SPDE/GMRF representation is to be built. The example here illustrates a common usage case, which is to have semi-randomly scattered observation locations in a region of space such that there is no physical boundary, just a limited observation region. When dealing with only covariances between data points, this distinction is often unimportant, but here it becomes a possibly vital part of the model, since the SPDE will exhibit boundary effects. In the R-INLA implementation, Neumann boundaries are used, which increases the variance near the boundary. If we intend to model a stationary field across the entire domain of observations, we must therefore extend the model domain far enough so that the boundary effects do not influence the observations. However, note that the reverse is also true: if there *is* a physical boundary, the boundary effects may actually be desirable. The helper function `inla.mesh.create.helper()` allows us to create a mesh with small triangles in the domain of interest, and use larger triangles in the extension used to avoid boundary effects. This minimises the extra computational work needed due to the extension.

```
m = 100
points = matrix(runif(m*2),m,2)
mesh = inla.mesh.create.helper(
  points=points,
  cutoff=0.05,
  offset=c(0.1,0.4),
  max.edge=c(0.05,0.5) )
plot(mesh)
points(points[,1],points[,2])
```

The `cutoff` parameter is used to avoid building many small triangles around clustered input locations, `offset` specifies the size of the inner and outer extensions around the data locations, and `max.edge` specifies the maximum allowed triangle edge lengths in the inner domain and in the outer extension. The overall effect of the triangulation construction is that, if desired, one can have smaller triangles, and hence higher accuracy of the field representation, where the observation locations are dense, larger triangles where data is more sparse (and hence provides less detailed information), and large triangles where there is no data and spending computational resources would be wasteful. However, note that there is neither any guarantee nor any requirement that the observation locations are included as nodes in the mesh. If one so desires, the mesh can be designed from different principles, such as lattice points with no relation to the precise measurement locations. This emphasises the decoupling between the continuous domain of the field model and the discrete data locations.

Defining an SPDE model object can now be as simple as

```
spde=inla.spde2.matern(mesh,alpha=2)
```

but in practice we need to also specify the prior distribution for the parameters, and/or modify the parameterisation to suit the specific situation. This is true in particular when the models are used as simple smoothers, as there is then rarely enough information in the likelihood to fully identify the parameters, giving more importance to the prior distributions.

The empirically derived expression $\sqrt{8\nu}/\kappa$ can be used as a measure of the spatial range of the model, which allows us to construct a model with known range and variance for $(\theta_1, \theta_2) = (0, 0)$, via

```
sigma0 = 1
range0 = 0.2
kappa0 = sqrt(8)/range0
tau0 = 1/(sqrt(4*pi)*kappa0*sigma0)
spde=inla.spde2.matern(mesh,
```

```
B.tau=cbind(log(tau0),1,0),
B.kappa=cbind(log(kappa0),0,1),
theta.prior.prec=1)
```

Here, `B.tau` and `B.kappa` can be generalised into matrices where the first column specifies a spatially varying offset for $\log(\tau)$ and $\log(\kappa)$, and the other columns specify basis functions, together defining a non-stationary SPDE model with parameters given by the log-linear models

$$\log(\tau(\mathrm{s})) = b_0^\tau(\mathrm{s}) + \sum_{k=1}^{p} b_k^\tau(\mathrm{s})\theta_k$$

$$\log(\kappa(\mathrm{s})) = b_0^\kappa(\mathrm{s}) + \sum_{k=1}^{p} b_k^\kappa(\mathrm{s})\theta_k$$

where $B_{ik}^{\cdot} = b_k^{\cdot}(\mathrm{s}_i)$, with the columns indexed from 0 and s_i are the locations of the mesh nodes. Setting sensible priors for θ in these models in general is beyond the scope of this note, and the default priors in the package are likely to change in the near future as we gain more experience with their behaviour, in particular for non-stationary models. The model defined here will give an approximate prior mean variance of $\sigma_0^2 = 1$ for the field, and approximate prior mean range 0.2 with a prior variance for the range distribution to reach the size of the domain, but not very far beyond.

Models with range larger than the domain size are usually indistinguishable from intrinsic random fields, which can be modelled by fixing κ to zero (or rather some small positive value) with `B.tau=cbind(log(tau0),1)` and `B.kappa=cbind(log(small),0)`. Note that the sum-to-zero constraints often used for lattice based intrinsic Markov models are inappropriate due to the irregular mesh structure, and a *weighted* sum-to-zero constraint is needed to reproduce such models. A future version of the software will include an automatic option to construct such appropriate constraints.

Helper functions in the package can produce precision matrices for given parameter values, as well as samples, so we can generate a synthetic sample:

```
Q=inla.spde2.precision(
    spde,theta=c(0,0))
x=as.vector(inla.qsample(n=1,Q))
proj = inla.mesh.projector(mesh)
image(inla.mesh.project(
        proj,field=x))
```

Here, the `inla.mesh.project/or()` functions are used to map between the basis function weights for the mesh nodes and a lattice format more suited to the standard plotting routines, by default a 100×100 lattice covering the mesh domain.

Bayesian inference

We will now look at a simple example of how to use the SPDE models in latent Gaussian models when doing direct Bayesian inference based on integrated nested Laplace approximations as introduced in Rue *et al.* (2009).

Let us consider a simple Gaussian linear model involving two independent realisations (replicates) of a latent spatial field $x(\mathrm{s})$, observed at the same m locations, $\{\mathrm{s}_1, \ldots, \mathrm{s}_m\}$, for each replicate. For each $i = 1, \ldots, m$,

$$\begin{aligned} y_i &= \beta_0 + c_i\beta_c + x_1(\mathrm{s}_i) + e_i, \\ y_{i+m} &= \beta_0 + c_{i+m}\beta_c + x_2(\mathrm{s}_i) + e_{i+m}, \end{aligned}$$

where c_i is an observation-specific covariate, e_i is measurement noise, and $x_1(\cdot)$ and $x_2(\cdot)$ are the two field replicates. Note that the offset, β_0, can be interpreted as a spatial covariate effect, constant over the domain.

We use the basis function representation of $x(\cdot)$ to define a sparse matrix of weights A such that $x(\mathrm{s}_i) = \sum_j A_{ij}x_j$, where $\{x_j\}$ is the joint set of weights for the two replicate fields. If we only had one replicate, we would have $A_{ij} = \psi_j(\mathrm{s}_i)$. The matrix can be generated by `inla.spde.make.A()`, which locates the points in the mesh and organises the evaluated values of the basis functions for the two replicates:

```
A=inla.spde.make.A(
  mesh,
  loc=points,
  index=rep(1:m,times=2),
  repl=rep(1:2,each=m) )
```

For each observation, `index` gives the corresponding index into the matrix of measurement locations, and `repl` determines the corresponding replicate index. In case of missing observations, one can either keep this `A`-matrix while setting the corresponding elements of the data vector `y` to `NA`, or omit the corresponding elements from `y` as well as from the `index` and `repl` parameters above. Also note that the row-sums of A are 1,

since the piece-wise linear basis functions we use sum to 1 at each location.

Rewriting the observation model on vector form gives

$$\begin{aligned} \mathrm{y} &= 1\beta_0 + \mathrm{c}\beta_c + \mathrm{A}\mathrm{x} + \mathrm{e} \\ &= \mathrm{A}(\mathrm{x} + 1\beta_0) + \mathrm{c}\beta_c + \mathrm{e} \end{aligned}$$

Using the helper functions, we can generate a synthetic sample from our model for the latent fields and observations:

```
Q=inla.spde.precision(
    spde,theta=c(0,0))
x=as.vector(inla.qsample(n=2,Q))
covariate = rnorm(m*2)
y = 5 + covariate*2 +
    as.vector(A %*% x) +
    rnorm(m*2)*0.01
```

The `formula` in `inla()` defines a linear predictor η as the sum of all effects, and a `NA` in a covariate or index vector is interpreted as *no effect*. To accommodate predictors that involve more than one element of a random effect, one can specify a sparse matrix of weights defining an arbitrary linear combination of the elements of η, giving a new predictor vector η^*. The linear predictor output from `inla()` then contains the joint vector (η^*, η). To implement our model, we separate the spatial effects from the covariate by defining

$$\eta_e = \begin{bmatrix} \mathrm{x} + 1\beta_0 \\ \mathrm{c}\beta_c \end{bmatrix},$$

and construct the predictor as

$$\begin{aligned} \eta_e^* &= \mathrm{A}(\mathrm{x} + 1\beta_0) + \mathrm{c}\beta_c \\ &= \begin{bmatrix} \mathrm{A} & \mathrm{I} \end{bmatrix} \eta_e \\ &= \mathrm{A}_e \eta_e \end{aligned}$$

so that now $E(\mathrm{y}|\eta_e) = \eta_e^*$. The bookkeeping required to describe this to `inla()` involves concatenating matrices and adding `NA` elements to the covariates and index vectors:

$$\begin{aligned} \mathrm{A}_e &= \begin{bmatrix} \mathrm{A} & \mathrm{I}_{2m} \end{bmatrix} \\ \texttt{field0} &= (1, \ldots, n, 1, \ldots, n) \\ \texttt{field} &= (\texttt{field0}, \texttt{NA}, \ldots, \texttt{NA}) \\ \texttt{offset} &= (1, \ldots, 1, \texttt{NA}, \ldots, \texttt{NA}) \\ \texttt{cov} &= (\texttt{NA}, \ldots, \texttt{NA}, c_1, \ldots, c_{2m}) \end{aligned}$$

Doing this by hand with `cBind()`, `c()`, and `rep()` quickly becomes tedious and error-prone, so one can instead use the helper function `inla.stack()`, which takes blocks of data, weight matrices, and effects and joins them, adding `NA` where needed. Identity matrices and constant covariates can be abbreviated to scalars, with a complaint being issued if the input is inconsistent or ambiguous.

We also need to keep track of the two field replicates, and use `inla.spde.make.index()`, which gives a list of index vectors for indexing the full mesh and its replicates (it can also be used for indexing Kronecker product `group` models, e.g. in simple multivariate and spatio-temporal models). The code

```
mesh.index=inla.spde.make.index(
  name="field",
  n.mesh=mesh$n, n.repl=2)
```

generates a list `mesh.index` with three index vectors,

$$\begin{aligned} \texttt{field} &= (1, \ldots, n, 1, \ldots, n), \\ \texttt{field.repl} &= (1, \ldots, 1, 2, \ldots, 2), \\ \texttt{field.group} &= (1, \ldots, 1, 1, \ldots, 1). \end{aligned}$$

The predictor information for the observed data can now be collected, using

```
st.est=inla.stack(
  data=list(y=y),
  A=list(A,1),
  effects=list(
    c(mesh.index,list(offset=1)),
    list(cov=covariate)),
  tag="est")
```

Each "`A`" matrix must have an associated list of "`effects`", in this case `A`:(`field`, `field.repl`, `field.group`, `offset`) and `1`:(`cov`). The `data` list may contain anything associated with the "left hand side" of the model, such as exposure `E` for Poisson likelihoods. By default, duplicates in the effects are identified and replaced by single copies (`compress=TRUE`), and effects that do not affect η^* are removed completely (`remove.unused=TRUE`), so that each column of the resulting `A` matrix has a least one non-zero element.

If we want to obtain the posterior prediction of the combined spatial effects at the mesh nodes, $x(\mathrm{s}_i) + \beta_0$, we can define

$$\begin{aligned} \eta_p &= \mathrm{x} + 1\beta_0 \\ \eta_p^* &= \mathrm{I}\eta_p = \mathrm{A}_p \eta_p \end{aligned}$$

and construct the corresponding information stack with

```
st.pred=inla.stack(
  data=list(y=NA),
  A=list(1),
  effects=list(
    c(mesh.index,list(offset=1))),
  tag="pred")
```

We can now join the estimation and prediction stack into a single stack,

```
stack = inla.stack(st.est,st.pred)
```

This stacks the information, and simplifies the result by removing duplicated effects:

$$\begin{aligned}
\eta_s^* &= \begin{bmatrix} \mathrm{A}_e & 0 \\ 0 & \mathrm{A}_p \end{bmatrix} \begin{bmatrix} \eta_e \\ \eta_p \end{bmatrix} \\
&= \begin{bmatrix} \mathrm{A} & \mathrm{I} & 0 \\ 0 & 0 & \mathrm{I} \end{bmatrix} \begin{bmatrix} \mathrm{x}+1\beta_0 \\ \mathrm{c}\beta_c \\ \mathrm{x}+1\beta_0 \end{bmatrix} \\
&= \begin{bmatrix} \mathrm{A} & \mathrm{I} \\ \mathrm{I} & 0 \end{bmatrix} \begin{bmatrix} \mathrm{x}+1\beta_0 \\ \mathrm{c}\beta_c \end{bmatrix} \\
&= \mathrm{A}_s\eta_s
\end{aligned}$$

In this simple example, the second block row of A_s (generating $\mathrm{x}+1\beta_0$) is not strictly needed, since the same information would be available in η_s itself if we specified `remove.unused=FALSE` when constructing `stack.pred` and `stack`, but in general such special cases can be hard to keep track of.

We are now ready to do the actual estimation. Note that we must explicitly remove the default intercept from the η-model, since that would otherwise be applied twice in the construction of η^*, and the constant covariate `offset` is used instead:

```
formula =
  y ~ -1 + offset + cov +
      f(field, model=spde,
        replicate=field.repl)
inla.result =
  inla(formula,
    data=inla.stack.data(stack),
    family="normal",
    control.predictor=
      list(A=inla.stack.A(stack),
           compute=TRUE))
```

The function `inla.stack.data()` produces the list of variables needed to evaluate the formula (use `inla.stack.data(stack)$E` to extract the Poisson exposures mentioned earlier) and `inla.stack.A()` extracts the A_s matrix.

Since the SPDE-related contents of `inla.result` can be hard to interpret, the helper function `inla.spde2.result()` can be used to extract the relevant bits and transform them into more user-friendly information, such as posteriors for range and variance instead of raw distributions for θ:

```
result = inla.spde2.result(
  inla.result, "field", spde)
plot(result[
  "marginals.range.nominal"][[1]])
```

The posterior means and standard deviations for the latent fields can be extracted and plotted as follows, where `inla.stack.index()` provides the necessary mappings between the `inla()` output and the original data stack specifications:

```
index=inla.stack.index(
  stack,"pred")$data
image(inla.mesh.project(proj,
 inla.result[[
  "summary.linear.predictor"
  ]]$mean[
  index[mesh.index$field.repl==1]]))
```

As a final note, the `R-INLA` package is in constant development, with new models added as they are needed and developed. The current work for the SPDE models is focusing on completing the documentation, as well as tying together the last bits of the interface for one-dimensional models and simple space-time models. Most of the code for this is already in place, but still in a slightly esoteric form. Also in the pipeline is a separate package for computing level excursion sets with joint excursion probabilities, as well as contour uncertainty regions, mainly developed by David Bolin.

Acknowledgements

I want to thank my collaborators David Bolin, Michela Cameletti, Peter Guttorp, Janine Illian, Johan Lindström, Daniel Simpson, and last but not least Håvard Rue, who is also the main developer of `R-INLA`. I am also grateful to the ISBA Bulletin editors for providing this opportunity to discuss the SPDE/GMRF part of the `R-INLA` software, and giving me a chance to climb onto a few, though arguably diminutive, soap-boxes regarding spatial modelling philosophy.

The R-code from this note is available at http://people.bath.ac.uk/fl353/isba/isbaspde.R, including code for generating more appealing images than the `image()` function provides.

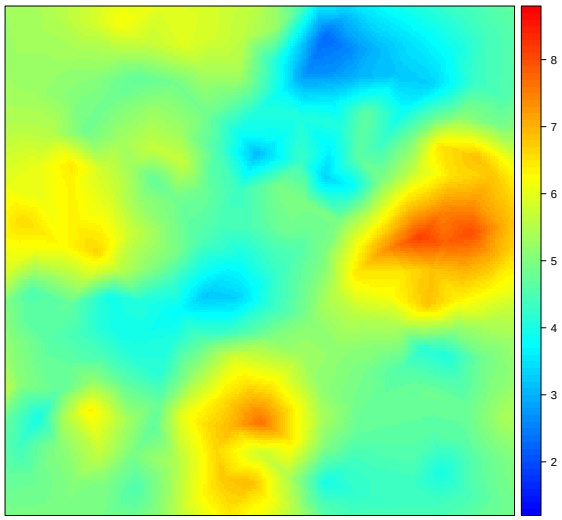

Figure 1: *Posterior mean*

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NEWS FROM THE WORLD

Announcements

2014 ISBA World Meeting

Stay tuned! ISBA2014 will be coming to Cancun, México! Tentative dates are July 14-18, so be sure to block your calendar.

Meetings and conferences

International Conference on Mathematical Finance, Miami , Florida. 22-24 March 2013.

Developments in the theory, application and practice of mathematical Finance/Financial Engineering/Computational and Quantitative Finance continue at a rapid pace. This conference is intended to expand the knowledge of theory, application of mathematical finance as well as to enhance the interchange of understandings between academics and practitioners of mathematical finance in its variety of spins and flavors as it applies to application of mathematics, numerical methods and statistics to financial issues.

The conference is expected to include experts from both academia and industry talking on subjects relevant to models as well as solutions to existing and developing models. The conference is expected to consist predominantly of multiple sessions with peer reviewed paper presentations, with discussants and question and answer opened to the floor. There will also be presentations by invited speakers and panel discussion which will also be opened to the floor. Working sessions

may be arranged. Additional information can be found at http://www.bradley.edu/academic/continue/professionals/imfc/index.dot.

9th Conference on Bayesian Nonparametrics, Amsterdam, Holland. 10 - 14 June, 2013.

The Bayesian nonparametrics (BNP) conference is a bi-annual international meeting bringing together leading experts and talented young researchers working on applications and theory of nonparametric Bayesian statistics. It is an official section meeting of the Bayesian nonparametrics section of the International Society for Bayesian Analysis (ISBA) and is co-sponsored by the Institute of Mathematical Statistics (IMS).

Additional information can be found at http://www.bnp9.win.tue.nl/.

First Bayesian Young Statisticians Meeting, CNR IMATI in Milano on June 5-6, 2013.

BAYSM 2013 is a fantastic opportunity to present and discuss your work with other young statisticians in a relaxed and friendly atmosphere, with senior discussant giving you suggestions and comments aimed at improving your work.

Attendees are encouraged to give a talk and/or submit a poster. The meeting is aimed at early career statisticians, i.e. people carrying out a PhD, post-doc or finishing the Master Degree with outstanding theses/projects dealing with Bayesian statistics. Presentations on current PhD research are therefore welcomed as well as talks on work in progress on applied experience.

All information on BAYSM 2013, including the sign-up link for the conference and accommodation, can be found on the conference website at http://www.mi.imati.cnr.it/conferences/BAYSM2013/index.html.

Bayesian Modeling for Cognitive Science, A WinBUGS Workshop, University of Amsterdam on August 12-16, 2013.

This workshop is meant for researchers who want to learn how to apply Bayesian inference in practice. Most applications we discuss are taken from the field of cognitive science. Because the workshop is based on a set of book chapters and concrete exercises of varying difficulty, the course material is appropriate for researchers with a wide range of prior knowledge and interests. Although some basic knowledge of Bayesian inference is an advantage, this is not a prerequisite. In the course we use WinBUGS in combination with R or Matlab (the choice is yours), and therefore somebasic knowledge of either R or Matlab is also an advantage.

All information can be found on the conference website at http://bayescourse.socsci.uva.nl.

8th Workshop on Bayesian Inference in Stochastic Processes (BISP8), CNR IMATI in Milano, Italy, on June 6-8, 2013.

The workshop is organised by CNR IMATI, in cooperation with George Washington University, and it is endorsed by ISBA (International Society for Bayesian Analysis) and SIS (Italian Statistical Society). Provisional programme and list of invited speakers are available. A guided tour of Pinacoteca di Brera, one of the most important art museums in Italy, is under planning, along with a dinner in a typical restaurant.

All information can be found on the conference website at http://www.mi.imati.cnr.it/conferences/BISP8/.

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