MCQMC 2012

Tenth International Conference on
Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing

Sydney, Australia February 13 – 17, 2012

Conference Program and Information

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UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA · NSF · Aust MS Australian Mathematical Society Inc. · AMSI Australian Mathematical Sciences Institute · CSIRO · ANZIAM · Mathematics & Statistics The University of New South Wales

Welcome to Sydney

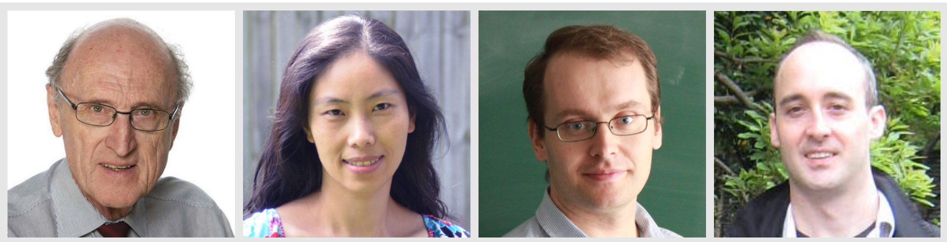
We are pleased to welcome you all to Sydney for the *Tenth International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing*. The MCQMC conference series has become the major event for researchers in the Monte Carlo and quasi-Monte Carlo community. We are glad to host MCQMC in the southern hemisphere for the first time in its history.

We are also very pleased with the efforts of the program committee for their selection of plenary speakers and grateful to our colleagues who have created a record number of special sessions. The speakers come from a variety of scientific backgrounds, countries, institutions and stages of their career. We hope that you have the opportunity to meet colleagues, establish new contacts and get new ideas from this meeting by talking with your fellow participants. If so, this conference will have been a success.

We understand that for most of you it is a long journey to Australia, and we therefore hope you will be rewarded with a rich and interesting scientific program and a memorable experience of beautiful Sydney. In fact, for Wednesday afternoon we have arranged a trip to the city, with a visit to the Art Gallery of New South Wales and a stroll through the Royal Botanic Garden along Sydney Harbour, finishing with a harbour dinner cruise. We sincerely hope you will be able to join us on this tour and enjoy some magnificent views of Sydney.

In closing, we wish you a pleasant, productive and interesting stay at UNSW, Sydney and Australia!

Ian H. Sloan, Frances Y. Kuo, Josef Dick, Gareth W. Peters
MCQMC 2012 Conference Organisers



School of Mathematics and Statistics
University of New South Wales, Sydney, Australia

Conference website: `http://www.mcqmc2012.unsw.edu.au/`
Conference email: `mcqmc2012@unsw.edu.au`

Contents

Behind the Scenes

History

The MCQMC Conference is a biennial meeting devoted to the study of Monte Carlo (MC) and quasi-Monte Carlo (QMC) methods, the relationships between the two classes of methods, and their effective application in different areas. The conference attracts between 150 and 200 participants. Its aim is to provide a forum where leading researchers and users can exchange information on the latest theoretical developments and important applications of these methods. In a nutshell, MC methods study complex systems by simulations fed by computer-generated pseudorandom numbers. QMC methods replace these random numbers by more evenly distributed (carefully selected) numbers to improve their effectiveness. A large variety of special techniques are developed and used to make these methods more effective in terms of speed and accuracy. The conference focuses primarily on the mathematical study of these techniques, their implementation and adaptation for concrete applications, and their empirical assessment.

The conference was initiated by Harald Niederreiter, who co-chaired the first seven conferences in

1. Las Vegas, USA (1994)
2. Salzburg, Austria (1996)
3. Claremont, USA (1998)
4. Hong Kong (2000)
5. Singapore (2002)
6. Juan-Les-Pins, France (2004)
7. Ulm, Germany (2006)

In 2006 Harald Niederreiter announced his wish to step down from the organisational role, and a Steering Committee was formed to ensure and oversee the continuation of the conference series. Two further successful conferences were held in

8. Montreal, Canada (2008)
9. Warsaw, Poland (2010)

Steering Committee

Chair: Stefan Heinrich (Germany)

Fred J. Hickernell (USA)

Alexander Keller (Germany)

Frances Y. Kuo (Australia)

Pierre L'Ecuyer (Canada)

Art B. Owen (USA)

Wolfgang Ch. Schmid (Austria)

Program Committee

Chair: Ian H. Sloan (Australia)

William Chen (Australia)

Ronald Cools (Belgium)

Josef Dick (Australia)

Henri Faure (France)

Alan Genz (USA)

Mike Giles (UK)

Paul Glasserman (USA)

Michael Gnewuch (Germany)

Stefan Heinrich (Germany)

Fred J. Hickernell (USA)

Aicke Hinrichs (Germany)

Stephen Joe (New Zealand)

Aneta Karaivanova (Bulgaria)

Alexander Keller (Germany)

Dirk P. Kroese (Australia)

Frances Y. Kuo (Australia)

Gerhard Larcher (Austria)

Pierre L'Ecuyer (Canada)

Christiane Lemieux (Canada)

Peter Mathé (Germany)

Makoto Matsumoto (Japan)

Kerrie Mengersen (Australia)

Thomas Müller-Gronbach (Germany)

Harald Niederreiter (Austria)

Erich Novak (Germany)

Art B. Owen (USA)

Gareth Peters (Australia)

Friedrich Pillichshammer (Austria)

Leszek Plaskota (Poland)

Eckhard Platen (Australia)

Klaus Ritter (Germany)

Gareth Roberts (UK)

Wolfgang Ch. Schmid (Austria)

Nikolai Simonov (Russia)

Ilya M. Sobol' (Russia)

Jerome Spanier (USA)

Shu Tezuka (Japan)

Xiaoqun Wang (China)

Grzegorz W. Wasilkowski (USA)

Henryk Woźniakowski (Poland/USA)

Local Organisers

Ian H. Sloan, Frances Y. Kuo, Josef Dick, Gareth W. Peters

Kaye Sedgers (Events Coordinator)

Sponsors

School of Mathematics and Statistics, University of New South Wales (UNSW Maths & Stats)
http://www.maths.unsw.edu.au

Australian Mathematical Society (AustMS)
http://www.austms.org.au

Australian and New Zealand Industrial and Applied Mathematics (ANZIAM)
http://www.anziam.org.au

Australian Mathematical Sciences Institute (AMSI)
http://www.amsi.org.au

Commonwealth Scientific and Industrial Research Organisation (CSIRO)
http://www.csiro.au/

National Sciences Foundation (NSF)
http://www.nsf.gov

Special Thanks

The conference organisers thank all our generous sponsors for making this event possible. We thank Professor Merlin Crossley – Dean of the Faculty of Science and Professor Anthony Dooley – Head of School of Mathematics and Statistics for their strong support to host this conference at UNSW.

Heartfelt thanks are also given to many members of the School of Mathematics and Statistics for their help and support during various planning stages of the conference, including Kaye Sedgers, Jan Lin, Halina Wolak, Mary Hervir, Bronwen Smith, Duncan Smith, Thong Le Gia, Thanh Tran, Zdravko Botev, Adelle Coster, Rob Womersley, Bill McLean, Bruce Henry, John Roberts, Jonathan Kress, Gary Froyland, and Catherine Greenhill. Many thanks also to Angelina Enno for her kind assistance in making New College Village our recommended accommodation place.

We wish to extend our gratitude to the entire Steering Committee and Program Committee, and past MCQMC conference organisers for their contribution and support. We also thank our plenary speakers, tutorial speakers, special session organisers, and all session chairs for their help and support with the scientific organisation of the conference. Many thanks to Art Owen for his help in obtaining support from the US National Science Foundation.

Last but not least, we are extremely grateful to many friends who helped us improving the conference website and testing the registration system, including Klaus Ritter, Erich Novak, Ronald Cools, Wolfgang Schmid, Pierre L'Ecuyer, Stephen Joe, Mike Giles, Grzegorz Wasilkowski, Stefan Heinrich, Jerome Spanier, Fred Hickernell, Michael Gnewuch, Harald Niederreiter, Peter Kritzer, Dirk Nuyens, and Roger Monk.

Practical Information

Conference Venue

The conference is hosted by the School of Mathematics and Statistics at the University of New South Wales (UNSW). The UNSW main campus is located in Sydney's eastern suburb Kensington, close to Sydney Airport and Coogee Beach. A map of the campus is printed on the back cover. The School of Mathematics and Statistics is located in the East Wing of the Red Centre (H15 on the campus map). The conference will take place in the Law Building (F8 on the campus map). A schematic map of the theatres and rooms is printed on the back cover of this program book.

There is an iPhone/iPad App called "Unofficial UNSW Map App" which shows the campus map, your position, compass, bus timetable, as well as other useful information. There is also a pamphlet in the registration pack containing detailed information about travelling to/from UNSW on Sydney buses. This pamphlet can also be downloaded from `http://www.sydneybuses.info/network-interchange-maps/UNSW_TransportGuide_2011.pdf`.

Travel to Sydney

If travelling to Sydney from overseas then you will arrive at Sydney's Kingsford Smith International Airport (Terminal 1). Sydney is very well connected to the rest of the world with direct flights from most countries. The airport is about 10km away from UNSW or the city.

From the airport you can take a taxi to UNSW. The journey will last 15 to 20 minutes and should cost around $35. All taxis are licenced and all journeys are metered. Alternatively, the route 400 bus from the airport to Bondi Junction travels up Anzac Parade and stops opposite UNSW. The bus takes about 40 minutes and costs about $3.50.

Warning: if you are travelling from UNSW to the airport, note that not every 400 bus goes to the airport. Please check the timetable carefully and if in doubt, ask the driver before you get on.

If you wish to go to the city from the airport, the Airport Link train runs regularly and takes about 15 minutes to reach Central Station. From there you can take the City Circle train to all central destinations (note that UNSW is not in the city centre).

Most people from within Australia who do not live in Sydney will also arrive by air, at Sydney's Domestic Airport (Terminals 2 & 3). The directions given above also apply for domestic arrivals.

Travel around Sydney

Sydney has an extensive public transport network involving trains, buses and ferries. There is a lot of information on the Transport Infoline webpage `http://www.131500.info/`.

If travelling with a group of people, a taxi could be an affordable alternative. These can be hailed on the street or ordered by telephone.

Travelling to UNSW on public transport will involve getting on a bus. (UNSW does not lie on a rail line.) For general information about Sydney's buses including timetables and maps, visit the Sydney Buses site `http://www.sydneybuses.info/`. More details about how to catch buses to UNSW are given below.

Note that some Sydney bus routes are PrePay-Only at all times, and all bus stops in Sydney's central business district are PrePay-Only between 7am and 7pm on weekdays. If you will be catching buses regularly while in Sydney you should consider buying a MyBus Travel Ten ticket. These are simply ten bus tickets for a discounted price. A MyBus 2 ticket covers the journey from Central Station to UNSW and a MyBus 3 ticket covers the journey from Circular Quay to UNSW or from the Airport to UNSW. You can also get a MyMulti ticket which gives you unlimited travel on all buses, trains and ferries for a day, a week, or more. MyBus and MyMulti tickets are available from most convenience stores and newsagents. More detailed information on bus tickets can be found at `http://www.sydneybuses.info/tickets`.

Travel to the University of New South Wales

The UNSW Transport Guide can be downloaded from `http://www.sydneybuses.info/network-interchange-maps/UNSW_TransportGuide_2011.pdf`. This pamphlet is provided in your registration pack. A short summary is given below.

UNSW is situated on several bus lines. From Central Station catch the 891 Express bus or routes 391, 393, and 395. These depart from Eddy Ave and stop at the UNSW Kensington Campus. The journey takes around 15 minutes on the express and around 25 minutes on the other routes, depending on traffic.

From Circular Quay catch the 392, 394, X94 (express), L94 or 396 to the UNSW Kensington Campus. The journey should take about 30 minutes.

From Bondi Junction take the 400 bus which passes UNSW on its way to the airport.

From Coogee Beach catch the 370 bus which travels along Coogee Bay Road and passes UNSW on High Street.

Parking is restricted on campus, with only a limited number of Pay and Display parking spaces available for those without a permit. A one-day parking permit can be purchased at $17 each.

Registration and Information Desk

The registration and information desk is located in the foyer of the Law Building (F8 on the campus map). Sunday afternoon registration will take place from 12noon to 4pm. Monday morning registration will take place from 7:45am to 10:30am. In addition, Ms Kaye Sedgers will be available during tea and lunch breaks each day if you have any question.

Sunday Tutorials

Sunday afternoon tutorials will be held in the CATS Theatre G02 in the Law Building, starting from 12:30pm and finishing at 5:30pm.

Opening Ceremony

The opening ceremony will be held in the Law Theatre G04 on Monday morning at 8:15am.

Plenary Lectures

Plenary lectures will be held in the Law Theatre G04. Plenary lectures are 50 minutes long plus 10 minutes for questions and discussions. Due to the tight conference schedule, we kindly ask the chair of each lecture to observe the time constraints.

Special Sessions and Technical Sessions

Parallel sessions will be held in the Law Theatre G04, CATS Theatres G02 and G23, and CATS Rooms 101 and 163. All talks in special sessions and technical sessions (contributed talks) are 20 minutes long plus 5 minutes for questions and discussions. There is a 5-minute window after each talk for participants to move between parallel sessions. Due to the tight conference schedule, we kindly ask the chair of each session to observe the time constraints.

Morning and Afternoon Tea

Morning and afternoon tea will be provided at the Roundhouse (E6 on the campus map), outside in the Beergarden (E7), or upstairs in the Club Bar on rainy days.

Lunch

Lunch will *not* be provided. There are plenty of eating places on campus and on Anzac Parade. They are marked on the campus map on the back cover. There is also a pamphlet describing “Food and Services on Campus” in your registration pack.

Monday Welcome Reception

On Monday evening there will be a welcome reception from 6pm to 7:30pm. Drinks and a casual BBQ dinner will be provided at the Roundhouse (E6/E7 on the campus map). Partners and families are very welcome and are free of charge.

Tuesday AMSI presentation

During the lunch break on Tuesday there will be a presentation on AMSI Student Internship Program from 12noon to 12:20pm in the CATS Theatre G02. This presentation is useful for students and academics from Australian institutions.

Tuesday Open Forum

On Tuesday evening there will be an Open Forum chaired by Fred Hickernell. Details are provided on page 50. This will take place from 6:10pm in the CATS Theatre G02. Participants are welcome and encouraged to contribute to the discussion.

Wednesday Group Photo

Before morning tea on Wednesday we will take a group photo at the Roundhouse.

Wednesday Excursion and Conference Dinner

On Wednesday afternoon we will go on an excursion. Buses will depart from Union Road behind the Law Building at 4pm and take us to the Art Gallery next to the Royal Botanic Garden. We will have one hour to visit the gallery and then take an easy stroll downhill through the botanic garden to the Sydney Opera House, ready to board a Sydney Harbour Cruise at 6:45pm. A buffet will be served on-board, and there will be vegetarian options. The cruise will finish at Darling Harbour around 10pm, and buses will take us back to UNSW. Partners and families are very welcome. Ticket for an accompanying adult is AU$88 including GST. Children under 18 are free.

Please note that it is too late to purchase additional tickets at the conference.

Thursday Book Display

There will be a book display in the foyer of the Law Building on Thursday.

Thursday Graphics Tutorial

On Thursday afternoon there will be a tutorial on QMC for computer graphics. Details are provided on page 52. This will take place from 5pm to 6pm in the CATS Theatre G02. This tutorial is open to all participants as well as all staff and students of UNSW who are interested to attend.

Thursday Steering Committee Meeting

On Thursday evening the Steering Committee will have a closed meeting. If you have any comments or suggestions, or would like to propose hosting a future conference, please approach any member of the Steering Committee prior to this meeting.

Equipment in Lecture Theatres and Seminar Rooms

Each seminar room is equipped with a desktop computer running Windows, with USB port access and internet connection, a data projector, an overhead projector, a projection screen, and a whiteboard.

We strongly encourage you to bring your talk in the form of a PDF document on a USB storage device. Please make sure that your talk is copied onto the desktop computer during the break prior to your talk.

The desktop computers in the seminar rooms can display Powerpoint documents but we cannot guarantee that all fonts will be available. Note that postscript files cannot be displayed.

If you require access to other software packages or other audio-visual equipments, please communicate with the organisers well ahead of time to see if it can be arranged. It is possible to connect your personal laptop to the data projector, but we prefer that you avoid this option due to the tight conference schedule. If you need to use your own laptop, please make sure you test the connection well before your talk.

Internet and Computer Access

UNSW has eduroam to provide free wireless access for visitors whose home institutions also have eduroam. For more information on eduroam see `http://www.eduroam.org` or `http://en.wikipedia.org/wiki/Eduroam`. Please check with your institution whether you have access to eduroam and for instructions on how to set up eduroam (this depends on your home institution and not on UNSW).

If you have requested a wireless internet account (different from eduroam) for your personal laptop, then your account access information will be provided to you at the registration desk.

If you have requested a computer account to access a desktop on campus, then your account access information will be provided to you at the registration desk. Computer access is provided in the computer lab M020 in the East Wing of the Red Centre (H15 on the campus map). The lab is open from 8am to 9pm on weekdays. Someone will be available to provide limited assistance from 9am to 5pm.

Please note that we are unable to setup new accounts at the conference.

Printing and Photocopying

Participants with wireless or computer accounts will *not* be able to print documents in the computer lab. The shop "Print Post Plus P^3" (F23 on the campus map) can print documents on a USB memory key for a small fee.

A photocopy card for use in the library (E21 on the campus map) can be purchased from the printing and copying counter on the entry level of the library.

Alternatively, conference organisers may be willing to help you with a small amount of printing or photocopying.

International Phone Calls

You can purchase international calling cards from most convenience stores, with cheap rates such as 2.4 cents per minute to Germany and 1.5 cents per minute to UK and USA. The rates vary for different cards depending on the destination countries and whether you are calling a fixed line or a mobile. Some companies also charge a connection fee (flag fall) per call. To make a call, you need to first dial a local number, follow the voice prompt to enter the codes on the calling card and then enter your destination phone number. Your hotel may charge you for the local call.

Useful Contacts and Services on Campus

The Police, Ambulance and Fire emergency phone number is 000.

To contact the University of New South Wales Campus security dial 56666 from an internal phone or 9385 6666 from an off-campus phone.

The University Health Service is located in the East Quadrangle Building (map reference E17). Visit in person or call 9385 5425 for an appointment to see a doctor.

Taxis can be hailed on the street or booked online at `http://www.taxiscombined.com.au` or by calling 133 300.

The Commonwealth Bank and an Australia Post office are located at F22 on the campus map.

Closing Ceremony

The closing ceremony will be held in the Law Theatre G04 on Friday afternoon immediately after the final plenary lecture which finishes at 2:20pm. There will be a short presentation about MCQMC 2014. Afternoon tea will be served after the closing ceremony.

Tourism

Please see the Official Sydney Guide included in the registration pack as well as the conference website for tourism information about Sydney and surrounds. We hope you enjoy the conference and beautiful Sydney.

Proceedings

Following the tradition of the MCQMC conference series, a selection of strictly refereed papers will be published after the conference as a Springer-Verlag book. Every speaker is welcome to submit a paper based on his/her talk. The deadline for submission is June 30, 2012. Detailed instructions on how to submit will be available later on the conference website.

Conference Statistics

Number of participants	181
Number of plenary lectures	10
Number of tutorials	4
Number of talks	131
Number of special sessions	26 (104 talks)
Number of technical sessions	13 (27 talks)

Schedule

Sunday 12 February 2012 – Afternoon

12:00 –	Registration – The Law Building Foyer (until 16:00)
12:30 – 14:00	CATS Theatre G02 **Tutorial** ***Art B. Owen*** **Monte Carlo ideas and methods** p.36 Chair: *Josef Dick*
14:00 – 14:15	Break
14:15 – 15:45	CATS Theatre G02 **Tutorial** ***Pierre Del Moral*** **Advanced Monte Carlo integration methods** p.34 Chair: *Gareth W. Peters*
15:45 – 16:00	Break
16:00 – 17:30	CATS Theatre G02 **Tutorial** ***Josef Dick*** **Quasi-Monte Carlo methods** p.35 Chair: *Ronald Cools*

Monday 13 February 2012 – Morning

07:45 –	Registration – The Law Building Foyer (until 10:30)		
08:15 – 08:30	Opening Ceremony – The Law Theatre G04		
08:30 – 09:30	The Law Theatre G04 **Plenary Lecture** ***Mike Giles*** **Multilevel Monte Carlo methods** p.39 Chair: *Ian H. Sloan*		
09:30 – 10:00	Morning Tea – Roundhouse		
	The Law Theatre G04 **Special Session** Theoretical and Computational Aspects of Discrepancy, Part 1 of 2 p.73 Organisers: *Michael Gnewuch* and *Peter Kritzer*	CATS Theatre G02 **Special Session** Computational SPDEs p.59 Organisers: *Fred J. Hickernell* and *Klaus Ritter*	CATS Theatre G23 **Special Session** Fast Computational Methods for Large Scale Bayesian Inference p.61 Organiser: *Kerrie Mengersen*
10:00 – 10:30	*William Chen* Davenport's theorem in classical discrepancy theory p.85	*James Nichols* Fast QMC integration for lognormal random fields p.125	*Christopher Strickland* Bayesian MCMC analysis using Python p.143
10:30 – 11:00	*Henri Faure* Improvements on the star discrepancy of (t, s)-sequences p.91	*Mihaly Kovacs* Strong convergence of a fully discrete approximation of a class of stochastic Volterra equations p.107	*Zdravko Botev* An importance sampling method for marginal likelihood estimation p.82
11:00 – 11:30	*Roswitha Hofer* On the properties and the construction of finite row (t, s)-sequences p.101	*Stig Larsson* On wavelet-Galerkin methods for semilinear parabolic equations driven by additive noise p.111	*John Ormerod* Variational approximations for Bayesian computation p.127
11:30 – 12:00	*Harald Niederreiter* Improved discrepancy bounds for hybrid sequences p.125	*Qi Ye* Approximation of stochastic partial differential equations by a Kernel-based collocation method p.160	*Pattarasuda Sudsaen* Variational Bayesian approximation method for inference in item response models p.144
12:00 – 13:20	Lunch		

Monday 13 February 2012 – Afternoon I

13:20 – 14:20	The Law Theatre G04 **Plenary Lecture** ***Pierre Del Moral*** **Particle Monte Carlo methods in statistical learning and rare event simulation** p.38 Chair: *Gareth W. Peters*			
14:20 – 14:30	Break			
	CATS Theatre G02 **Technical Session** Chair: *Jan Baldeaux*	CATS Theatre G23 **Technical Session** Chair: *Ian C. Marschner*	CATS Room 101 **Technical Session** Chair: *Scott Sisson*	CATS Room 163 **Technical Session** Chair: *Pierre Jacob*
14:30 – 15:00	*Gottlieb Pirsic* A linear-operator point-of-view on digital sequences p.131	*Hermann G. Matthies* Sampling and low rank tensor approximations p.120	*Daniela Calvetti* Time integrator dependent variance reduction for sequential Monte Carlo p.84	*Leonardo Rojas-Nandayapa* Efficient rare-event simulation for sums of dependent random variables p.136
15:00 – 15:30	*Werner Römisch* QMC methods for stochastic programs: ANOVA decomposition of integrands p.137	*Alla Shymanska* Application of Monte Carlo methods in charged particle optics p.141	*Erkki Somersalo* Bayesian methods for analyzing metabolic models p.142	*Bernie Daigle, Jr.* Efficient estimation of rare event probabilities in biochemical systems p.86
15:30 – 16:00	Afternoon Tea – Roundhouse			

Monday 13 February 2012 – Afternoon II

	CATS Theatre G02 **Special Session** Point Sets and Sequences for Quasi-Monte Carlo, Part 1 of 3 p.68 Organisers: *Friedrich Pillichshammer* and *Ronald Cools*	CATS Theatre G23 **Special Session** Random Number and Random Variate Generation p.70 Organiser: *Pierre L'Ecuyer*	CATS Room 101 **Special Session** Approximate Bayesian Computation (ABC) and Likelihood-Free Inference p.57 Organiser: *Scott Sisson*	CATS Room 163 **Special Session** Computational Finance, Part 1 of 2 p.58 Organisers: *Dirk Nuyens* and *Mark Joshi*
16:00 – 16:30	*Peter Kritzer* Finite mixed quasi-Monte Carlo point sets p.108	*Josef Leydold* Generating generalized inverse Gaussian distributed random variates p.114	*Christopher Drovandi* An SMC ABC algorithm for multivariate quantile distributions p.89	*Mark Joshi* Algorithmic Hessians and the fast computation of cross-gamma risk p.103
16:30 – 17:00	*Christoph Aistleitner* Probabilistic methods in quasi-Monte Carlo theory p.76	*Makoto Matsumoto* A deviation of CURAND standard pseudorandom number generator in CUDA for GPGPU p.119	*Anthony Pettitt* Approximate Bayesian computation and adaptive sequential Monte Carlo p.129	*Jan Baldeaux* Exact Simulation of the 3/2 Model p.80
17:00 – 17:30	*Michael Gnewuch* New multilevel algorithms based on polynomial lattice rules and digital nets of higher order p.94	*Hiroshi Haramoto* A nonempirical test on the second and the third lowest bits of pseudorandom p.97	*Yanan Fan* Posterior inference for ABC: a regression density approach p.90	*Nico Achtsis* Covariance matrix decompositions p.76
17:30 – 18:00	*Benjamin Doerr* Randomized and derandomized construction of low-discrepancy point sets p.88	*Pierre L'Ecuyer* On the lattice structure of a special class of multiple recursive generators p.110	*Sarah Filippi* Considerate approaches to ABC model selection and model checking p.91	*Gunther Leobacher* Fast orthogonal transforms and generation of Brownian paths p.113
18:00 – 19:30	Welcome Reception – Roundhouse (BBQ Dinner)			

Tuesday 14 February 2012 – Morning

08:30 – 09:30	The Law Theatre G04 **Plenary Lecture** ***Andreas Neuenkirch*** **Strong approximation of stochastic differential equations under non-Lipschitz assumptions** p.44 Chair: *Klaus Ritter*		
09:30 – 10:00	Morning Tea – Roundhouse		
	The Law Theatre G04 **Special Session** Explicit Error Bounds for Markov Chain Monte Carlo p.60 Organiser: *Daniel Rudolf*	CATS Theatre G02 **Special Session** Multilevel Monte Carlo Methods, Part 1 of 3 p.65 Organiser: *Mike Giles*	CATS Theatre G23 **Special Session** Monte Carlo Methods for Spatial Stochastic Modeling, Part 1 of 2 p.64 Organisers: *Dirk Kroese* and *Volker Schmidt*
10:00 – 10:30	*Wojciech Niemiro* Examples and comparisons of rigorous error bounds for MCMC estimates, Part I p.126	*Mike Giles* Numerical analysis of the multilevel Milstein discretisation p.93	*Volker Schmidt* Model-based 3D simulation of tomographic image data, with applications to virtual materials design p.139
10:30 – 11:00	*Blazej Miasojedow* Examples and comparisons of rigorous error bounds for MCMC estimates, Part II p.121	*Lukasz Szpruch* Efficient multilevel Monte Carlo simulations of non-linear financial SDEs without a need of simulating levy areas p.146	*Gary Delaney* Modelling and quantifying spatially stochastic granular systems p.88
11:00 – 11:30	*Daniel Rudolf* Hit-and-run for numerical integration p.138	*Andreas Rößler* Multi-level Monte Carlo simulation based on approximation schemes with reduced variance p.137	*Bjoern Baumeier* Multiscale bottom-up simulations of charge and energy transport in disordered organic semiconductors p.80
11:30 – 12:00	*Mario Ullrich* Tight mixing bounds at the Potts transition point for single-bond dynamics on the torus p.152	*Erik von Schwerin* Adaptive multilevel Monte Carlo simulation of Ito SDEs p.154	*Jesper Møller* Transforming spatial point processes into Poisson processes using random superposition p.123
12:00 – 13:20	Lunch Special Presentation: AMSI Student Internship Program – CATS Theatre G02 (12:00 – 12:20)		

Tuesday 14 February 2012 – Afternoon I

13:20 – 14:20	The Law Theatre G04 **Plenary Lecture** ***Michael Lacey*** **Estimates for discrepancy function in L^∞ norm** p.42 Chair: *Aicke Hinrichs*			
14:20 – 14:30	Break			
	CATS Theatre G02 **Technical Session** Chair: *Johann Brauchart*	CATS Theatre G23 **Technical Session** Chair: *Quoc Thong Le Gia*	CATS Room 101 **Technical Session** Chair: *Zdravko Botev*	CATS Room 163 **Technical Session** Chair: *Gareth W. Peters*
14:30 – 15:00	*Vasile Sinescu* Quasi-Monte Carlo methods for applications in statistics p.141	*James Propp* Reducing variance with averaging kernels: general theory and an application to quasirandom simulation of Markov chains p.133	*Sergei Kucherenko* Metamodelling and sensitivity analysis of models with dependent variables p.109	*Fred Daum* Exact particle flow for nonlinear filters p.87
15:00 – 15:30	*Hernan Eugenio Leövey* Fast evaluation of mixed derivatives and calculation of optimal weights for integration p.114	*Shin Harase* On the $\mathbb{F}_2$-linear relations of Mersenne Twister p.98	*Chaitanya Joshi* On computationally efficient estimation of the variance of the randomised quasi Monte Carlo estimate p.103	*Francois Giraud* Settings of SMC parameters by Dobrushin analysis p.93
15:30 – 16:00	Afternoon Tea – Roundhouse			

Tuesday 14 February 2012 – Afternoon II

	CATS Theatre G02 **Special Session** Tractability of Multivariate Problems p.74 Organisers: *Erich Novak* and *Henryk Woźniakowski*	CATS Theatre G23 **Special Session** Measures of Pseudorandomness p.62 Organiser: *Arne Winterhof*	CATS Room 101 **Special Session** Monte Carlo Based Inference for Diffusions p.63 Organisers: *Krzysztof Łatuszyński* and *Gareth Roberts*	CATS Room 163 **Special Session** Advances in MCMC Methodology p.56 Organiser: *Yanan Fan*
16:00 – 16:30	*Klaus Ritter* Quadrature on the sequence space p.135	*Alina Ostafe* New trends in pseudorandom number generation p.128	*Yves Atchade* Iterated filtering p.79	*Jonathan M. Keith* Bayesian approaches to the design of Markov chain Monte Carlo samplers p.105
16:30 – 17:00	*Markus Weimar* Linear tensor product problems in (anti-) symmetric Hilbert spaces p.155	*Peter Hellekalek* Assessing randomness via uniform distribution theory: tools from *b*-adic analysis p.99	*Osnat Stramer* Bayesian inference for a generalized class of Heston models p.143	*Jean-Luc Dortet-Bernadet* Quantile regression via auxiliary variables p.89
17:00 – 17:30	*Erich Novak* (In) tractability results for integration p.126	*Domingo Gomez* On the multidimensional distribution of pseudorandom sequences with Dickson polynomials p.95	*Andrew Golightly* MCMC schemes for irreducible diffusions using high frequency imputation p.94	*James M. Flegal* Exact sampling for intractable probability distributions via a Bernoulli factory p.92
17:30 – 18:00	*Henryk Woźniakowski* Rates of convergence and tractability for the approximation problem in various settings p.159	*Arne Winterhof* A survey on recursive nonlinear pseudorandom number generators p.157	*Gareth Roberts* Sequential importance sampling for irreducible diffusions p.136	*Edward Cripps* A time-varying mixture of random effects model for individuals learning behaviour p.85
18:00 – 18:10	Break			
18:10 – 19:00	CATS Theatre G02 **Open Forum: Opportunities and challenges for massively parallel Monte Carlo** p.50 Chair: *Fred J. Hickernell*			

Wednesday 15 February 2012 – Morning

08:30 – 09:30	The Law Theatre G04 **Plenary Lecture** ***Art B. Owen*** **Random projections, reweighting and half-sampling for high-dimensional statistical inference** p.45 Chair: *Fred J. Hickernell*		
09:30 – 10:00	Group Photo Morning Tea – Roundhouse		
	The Law Theatre G04 **Special Session** Point Sets and Sequences for Quasi-Monte Carlo, Part 2 of 3 p.68 Organisers: *Friedrich Pillichshammer* and *Ronald Cools*	CATS Theatre G02 **Special Session** Multilevel Monte Carlo Methods, Part 2 of 3 p.65 Organiser: *Mike Giles*	CATS Theatre G23 **Special Session** Recent Advances in MCMC p.71 Organiser: *James M. Flegal*
10:00 – 10:30	*Tor Sørevik* Good, low degree, rank-1 lattice rules in high dimensions p.147	*Aretha L. Teckentrup* Multilevel Monte Carlo for highly heterogeneous media p.148	*Radu Herbei* Bayesian computation and diffusion processes p.99
10:30 – 11:00	*Dirk Nuyens* Lattice rules for nonperiodic smooth integrands p.127	*Elisabeth Ullmann* Towards efficient simulations of groundwater flow problems in random media p.151	*Colin Fox* Monte Carlo simulation inspired by computational optimization p.92
11:00 – 11:30	*Lutz Kämmerer* Generated sets as sampling schemes for hyperbolic cross trigonometric polynomials p.104	*Jonas Šukys* Multi-level Monte Carlo finite volume methods for nonlinear systems of stochastic conservation laws in multi-dimensions p.144	*Krzysztof Łatuszyński* Why does the Gibbs sampler work on hierarchical models? p.112
11:30 – 12:00	*David Munger* A general software tool for constructing rank-1 lattice rules p.122	*Christoph Schwab* QMC convergence analysis for stochastic and parametric operator equations in infinite dimension p.140	*Hidemaro Suwa* General construction of irreversible kernel in Markov chain Monte Carlo p.145
12:00 – 13:20	Lunch		

Wednesday 15 February 2012 – Afternoon and Evening

13:20 – 14:20	The Law Theatre G04 **Plenary Lecture** ***Leszek Plaskota*** **Noisy information: optimality, complexity, and tractability** p.46 Chair: *Henryk Woźniakowski*			
14:20 – 14:30	Break			
	CATS Theatre G02 **Technical Session** Chair: *Vasile Sinescu*	CATS Theatre G23 **Technical Session** Chair: *Yves Atchade*	CATS Room 101 **Technical Session** Chair: *John Ormerod*	CATS Room 163 **Technical Session** Chair: *Nan Chen*
14:30 – 15:00	*Alexander Keller* Deterministic consistent light transport simulation p.105	*Alexandre H. Thiéry* Scaling analysis of MCMC methods p.149	*Ian C. Marschner* The stochastic EM algorithm for censored mixed models p.117	*Tim Brereton* Efficient quantile estimation p.83
15:00 – 15:30	*Koen Poppe* Gaussian distributed quasi-random samples p.132	*Sebastian Vollmer* On a dimension independent lower bound of the Wasserstein spectral gap for Metropolis-Hastings algorithms with Ornstein-Uhlenbeck proposal p.153	*Venkiteswaran Gopalakrishnan* Stratified Monte Carlo integration and applications p.96	*Henghsiu Tsai* Inference of seasonal long-memory time series with measurement error p.150
15:30 – 16:00	Afternoon Tea – Roundhouse			
16:00 –	Buses departing Union Road (behind the Law Building) for Art Gallery			
16:45 – 18:00	Art Gallery			
18:00 – 18:45	Royal Botanic Garden			
18:45 –	Gathering near Man O'War Jetty for Sydney Harbour Dinner Cruise			
22:15 –	Buses departing Darling Harbour for UNSW			

Thursday 16 February 2012 – Morning

08:30 – 09:30	The Law Theatre G04 **Plenary Lecture** ***Fred J. Hickernell*** **Monte Carlo algorithms where the integrand size is unknown** p.40 Chair: *Harald Niederreiter*		
09:30 – 10:00	Morning Tea – Roundhouse		
	The Law Theatre G04 **Special Session** Small Ball Problems, Discrepancy, and Metric Entropy p.72 Organisers: *Aicke Hinrichs* and *Thomas Kühn*	CATS Theatre G02 **Special Session** Computational Finance, Part 2 of 2 p.58 Organisers: *Dirk Nuyens* and *Mark Joshi*	CATS Theatre G23 **Special Session** Advances in MCMC and SMC Methods: Solutions for Complex Ecological Problems p.55 Organisers: *Keith Hayes* and *Geoff Hosack*
10:00 – 10:30	*Michael Lacey* On the small ball inequality in dimensions 3 and higher p.111	*Dale Roberts* QMC for stochastic volatility models p.135	*Lawrence Murray* Particle Markov chain Monte Carlo methods in marine biogeochemistry p.122
10:30 – 11:00	*Heidi Weyhausen* Asymptotic behavior of average L_p-discrepancies p.156	*Tomáš Tichy* Option pricing by simulation of fuzzy-random variables p.149	*Jonas Knape* Estimation of stage duration distributions from cohort data on arthropods p.106
11:00 – 11:30	*Thomas Kühn* Applications of metric entropy in analysis and probability p.110	*Timothy Ling* On simulation of some functionals of fractional Brownian motion p.116	*Geoff Hosack* General nonlinear dependence structure for multispecies modelling p.101
11:30 – 12:00	*Frank Aurzada* Small ball probabilities and metric entropy p.79	*Kyle Matoba* Figure of merit efficient QMC pointsets for computational finance p.118	*Ken Newman* Spatio-temporal modelling of delta smelt in the San Francisco Estuary p.124
12:00 – 13:20	Lunch		

Thursday 16 February 2012 – Afternoon I

13:20 – 14:20	The Law Theatre G04 **Plenary Lecture** ***Aicke Hinrichs*** **Tractability of multivariate integration - old and new results and open problems** p.41 Chair: *Friedrich Pillichshammer*
14:20 – 14:50	Afternoon Tea – Roundhouse

Thursday 16 February 2012 – Afternoon II

	CATS Theatre G02 **Special Session** Theoretical and Computational Aspects of Discrepancy, Part 2 of 2 p.73 Organisers: *Michael Gnewuch* and *Peter Kritzer*	CATS Theatre G23 **Special Session** Numerics for SDEs p.67 Organiser: *Andreas Neuenkirch*	CATS Room 101 **Special Session** Adaptive MCMC: Theory, Algorithms, and Applications p.54 Organiser: *Scott C. Schmidler*	CATS Room 163 **Technical Session** Chair: *Paul Leopardi*
14:50 – 15:20	*Dmitriy Bilyk* L^2 discrepancy and symmetrization p.82	*Paweł Przybyłowicz* Randomized Euler algorithm for the approximation of stochastic differential equations with time-irregular coefficients p.134	*Scott C. Schmidler* Combining exploration and exploitation strategies in adaptive MCMC p.138	*Samuel Herrmann* A random walk on moving spheres approach for the simulation of Bessel hitting times p.100
15:20 – 15:50	*Friedrich Pillichshammer* L_2 discrepancy of digit scrambled two-dimensional Hammersley point sets p.130	*Martin Altmayer* Quadrature of discontinuous functionals in the Heston model p.78	*Pierre Jacob* Properties of the stochastic approximation schedule in the Wang-Landau algorithm p.102	*Sebastien Lemaire* Neutron and photon next-event estimator benchmarks for intercode comparisons p.113
15:50 – 16:20	*Stephen Joe* Calculation of the intermediate bound on the star discrepancy p.102	*Larisa Yaroslavtseva* On the complexity of computing quadrature formulas for marginal distributions of SDEs p.160	*Faming Liang* Stochastic approximation Monte Carlo for high dimensional generalized linear models and related asymptotics p.115	*Hamza Alkhatib* Nonlinear sequential Monte Carlo filtering for state and adaptive parameter estimation in direct geo-referencing tasks p.77
16:20 – 16:50	*Carola Winzen* Computing star discrepancies via a refined threshold accepting heuristic p.158	*Quoc Thong Le Gia* A QMC-spectral method for elliptic PDEs with random coefficients on the unit sphere p.112	*Ido Nevat* Model selection in wireless communications via Contour Monte Carlo and Trans-dimensional MCMC incorporating stochastic approximation p.124	

Thursday 16 February 2012 – Afternoon III

16:50 – 17:00	Break
17:00 – 18:00	CATS Theatre G02 **Tutorial** ***Alexander Keller*** **Quasi-Monte Carlo methods in photorealistic image synthesis** p.52 Chair: *Frances Y. Kuo*
18:00 –	Steering Committee Meeting (closed) – Red Centre

Friday 17 February 2012 – Morning

08:30 – 09:30	The Law Theatre G04 **Plenary Lecture** ***Eckhard Platen*** **Numerical solution of stochastic differential equations with jumps in finance** p.47 Chair: *Mike Giles*		
09:30 – 10:00	Morning Tea – Roundhouse		
	The Law Theatre G04 **Special Session** Point Sets and Sequences for Quasi-Monte Carlo, Part 3 of 3 p.68 Organisers: *Friedrich Pillichshammer* and *Ronald Cools*	CATS Theatre G02 **Special Session** Multilevel Monte Carlo Methods, Part 3 of 3 p.65 Organiser: *Mike Giles*	CATS Theatre G23 **Special Session** Monte Carlo Methods for Spatial Stochastic Modeling, Part 2 of 2 p.64 Organisers: *Dirk Kroese* and *Volker Schmidt*
10:00 – 10:30	*Aicke Hinrichs* Discrepancy of structured sets p.100	*Stefan Heinrich* Randomized complexity of parametric problems p.98	*Richard Wilson* Prediction of catastrophes in spatio-temporal settings p.157
10:30 – 11:00	*Lev Markhasin* Quasi-Monte Carlo methods for integration of functions with dominating mixed smoothness p.117	*David Anderson* Multilevel Monte Carlo for the continuous time Markov chain models arising in biology p.78	*Georgy Sofronov* Spatial modelling in small area estimation via the cross-entropy method p.142
11:00 – 11:30	*Johann Brauchart* Low-discrepancy point sets lifted to the unit sphere p.83	*Nan Chen* Estimating expectations of functionals of conditional expectations via multilevel nested simulation p.84	*Dirk Kroese* Greedy servers on a torus p.108
11:30 – 12:00	*Robert Womersley* Spherical designs and quasi-Monte Carlo methods for the sphere p.159	*Francisco Bernal* Application of variance reduction techniques in the numerical solution of partial differential equations p.81	*Maurizio Manuguerra* Monte Carlo methods in spatio-temporal regression modelling of migration in the EU p.116
12:00 – 13:20	Lunch		

Friday 17 February 2012 – Afternoon

13:20 – 14:20	The Law Theatre G04 **Plenary Lecture** ***Kerrie Mengersen*** **Addressing the problem: Tailoring Bayesian computation to meet inferential aims** p.43 Chair: *Dirk Kroese*
14:20 – 14:30	Closing Ceremony Presentation about MCQMC 2014 – The Law Theatre G04
14:30 – 15:00	Afternoon Tea – Roundhouse

Sunday Tutorials

Sunday 12 February 2012, 14:15 – 15:45, CATS Theatre G02

Advanced Monte Carlo integration methods

Pierre Del Moral
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Monte Carlo, as well as Markov chain Monte Carlo methods are stochastic algorithms for sampling complex probability distributions. The occupation measure of the random states are used to approximate integrals by empirical averages. The main difficulties to apply these stochastic methods is to find the right importance sampling twisted measure, or to find the right number of Markov chain moves that are needed to converge to the limiting target distribution. Typical examples includes the sampling of Boltzmann-Gibbs measures associated with very low temperature parameters, the computation of conditional distributions of signal paths w.r.t. noisy observation sequences, the calculation of posterior distributions of kinetic parameters in Bayesian inference, the sampling of random processes evolving in a rare event regime, and the computation of the top of the spectrum of Schrödinger operators in molecular chemistry. In all the application domains described above, the target probability distributions are described in terms of Feynman-Kac measures on path space.

The second part of this tutorial is concerned with these stochastic models, and their genetic type interacting particle interpretations. These particle sampling methodologies are also termed Sequential Monte Carlo, or Interacting MCMC method in statistics, Particle Filters in advanced signal processing, multi-splitting algorithms in rare event analysis, as well as Diffusion or Quantum Monte Carlo in numerical physics. We end this tutorial with some key results on the performance analysis of these particle models.

Sunday 12 February 2012, 16:00 – 17:30, CATS Theatre G02

Quasi-Monte Carlo methods

Josef Dick
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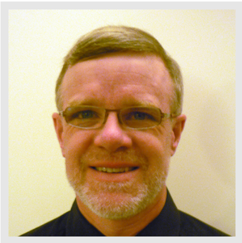
Quasi-Monte Carlo methods are equal weight quadrature rules which are used to approximate integrals over the s-dimensional unit cube $[0,1]^s$, that is

$$\frac{1}{N}\sum_{n=0}^{N-1} f(\boldsymbol{x}_n) \approx \int_{[0,1]^s} f(\boldsymbol{x})\,\mathrm{d}\boldsymbol{x}.$$

The quadrature points $\boldsymbol{x}_0, \ldots, \boldsymbol{x}_{N-1}$ are chosen in a deterministic way such that the worst-case integration error over some function class is small.

In this introductory tutorial we discuss several construction methods for good quadrature points and show for which function classes one can obtain good error bounds. To help the intuition, we provide geometrical interpretations when possible.

Sunday 12 February 2012, 12:30 – 14:00, CATS Theatre G02



Monte Carlo ideas and methods

Art B. Owen
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This tutorial introduces Monte Carlo methods, which roughly means using simulated randomness to solve numerical problems. Monte Carlo begins with computer simulation of random numbers. These numbers are transformed into various non-uniform random numbers and then to random vectors, processes and more complicated objects required by the problem contexts. Two problems permeate the Monte Carlo world. The first is that for some problems it is extremely hard to get the desired random behaviour by any known means. The second is that even with the desired random behaviour, the resulting methods may not be accurate enough. The first problem is handled by acceptance-rejection sampling and, in advanced contexts, by Markov chain Monte Carlo (MCMC). The second problem is handled by variance reduction methods, with quasi-Monte Carlo (QMC) being the most sophisticated. There are followup tutorials on MCMC and QMC. This one addresses the more basic methods of sample generation and variance reduction.

Plenary Lectures

Monday 13 February 2012, 13:20 – 14:20, The Law Theatre G04

Particle Monte Carlo methods in statistical learning and rare event simulation

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This talk is concerned with a new class of interacting particle Monte Carlo methods arising in Bayesian statistical learning, and in risk analysis. This rather recent particle sampling methodology is also termed Sequential Monte Carlo or interacting Markov Chain Monte Carlo methods in Bayesian statistics, Particle Filters in advanced signal processing, Diffusion or Quantum Monte Carlo techniques in numerical physics, as well as multi-splitting branching techniques in rare event simulation.

From the pure probabilistic viewpoint, all of these Particle Monte Carlo methods can be interpreted as a single universal population Monte Carlo sampling model, equipped with an interacting and recycling sampling mechanism. In the first part of the talk, we present some mathematical foundations of these advanced Monte Carlo models. In the second part, we briefly review some application domains including nonlinear filtering computation, and fixed parameter estimation in hidden Markov chain problems, rare events simulation and uncertainty propagations in numerical codes.

Monday 13 February 2012, 08:30 – 09:30, The Law Theatre G04

Multilevel Monte Carlo methods

Mike Giles
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In the last 5 years there has been a growing amount of research on multilevel Monte Carlo methods by a number of groups. In this lecture I will give an overview of this work, with a particular emphasis on:

- the simplicity of the approach
- its applicability to a wide range of problems
- the scope for creativity in designing particularly efficient multilevel algorithms
- progress in the numerical analysis of multilevel algorithms

Applications which will be discussed include:

- SDEs driven by Brownian motion
- jump-diffusion and Lévy processes
- SPDEs
- stochastic models for chemical reactions

This talk will be based on research with a number of collaborators, as well as research by others. Further information on multilevel Monte Carlo research is available from: http://people.maths.ox.ac.uk/gilesm/mlmc_community.html

Thursday 16 February 2012, 08:30 – 09:30, The Law Theatre G04

Monte Carlo algorithms where the integrand size is unknown

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(Quasi-)Monte Carlo algorithms approximate integrals by sample averages. The errors of these algorithms are proportional to some measure of *size* or *spread* of the integrand, $\sigma(\cdot)$. For example, $\sigma(f) \geq 0$ may denote the standard deviation of f or the variation of f. Size measures satisfy $\sigma(cf) = |c|\sigma(f)$. To design an automatic multivariate cubature based on Monte Carlo methods, one must estimate $\sigma(f)$ to determine the number of samples, n, required to guarantee a specified absolute error tolerance, $\varepsilon > 0$. Estimating $\sigma(f)$ numerically turns the original non-adaptive algorithm into an adaptive one while introducing another source of numerical error.

This talk presents an error analysis for a simple adaptive Monte Carlo algorithm that is guaranteed to estimate the integral within ε of the true value with probability $1-\alpha$, without a priori knowledge of $\sigma(f)$. The guarantee requires that the kurtosis of f, a scale-invariant measure, be not too large. Preliminary results for guaranteed quasi-Monte Carlo algorithms are also presented, but here the error estimation is more delicate.

It is suggested that our present error analyses of (quasi-)Monte Carlo methods, which typically assume bounded $\sigma(f)$, should be extended to the case where $\sigma(f)$, or the error itself, needs to be estimated, and the sample size adjusted adaptively to fit the error tolerance required. This will facilitate more practical algorithms.

Thursday 16 February 2012, 13:20 – 14:20, The Law Theatre G04

Tractability of multivariate integration - old and new results and open problems

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Multivariate integration is one of the prime examples for complexity studies of high dimensional problems. In this talk we review more or less well-known results for deterministic and randomized algorithms, present some new approaches and look at related open problems.

We discuss in some detail positive results on the power of randomized algorithms, in particular importance sampling. An abstract but nonconstructive approach gives a rather general tractability theorem for integration of functions from reproducing kernel Hilbert spaces. We exhibit cases for which the sampling density for the algorithm can be given explicitly based on certain Sobolev type inequalities.

We also discuss negative results in the deterministic setting such as the curse of dimensionality even for some small classes of smooth functions.

Tuesday 14 February 2012, 13:20 – 14:20, The Law Theatre G04

Estimates for discrepancy function in L^∞ norm

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Coauthor(s): Dmitriy Bilyk and Armen Vagharshakyan.

A grand question on the theory of the discrepancy function concerns the correct order of growth for the minimal L^∞ norm of the discrepancy function, as the number of points tends to infinity. This question was resolved by Wolfgang Schmidt many years ago, but remains a mystery in dimensions three and higher. Until recently, the best known lower bounds in dimension four and higher followed from the famous bound of Klaus Roth, which was in fact simply an average case bound. We will discuss a striking argument of Jozsef Beck in dimension three, and its variant in higher dimensions, that gives an improvement of the bound of Klaus Roth, in all dimensions greater than 3. We will conclude with speculative remarks on the role of bounded mean oscillation in these questions.

Friday 17 February 2012, 13:20 – 14:20, The Law Theatre G04

Addressing the problem: Tailoring Bayesian computation to meet inferential aims

Kerrie Mengersen
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Modern Bayesian modelling and analysis depends critically on efficient, effective computational algorithms. Often, however, the development of the models and the refinement and creation of computational methods are conducted independently. How much more might we gain if we consider these two key components simultaneously?

In this presentation, we will review some of the inferential capabilities and demands of Bayesian modelling and information-based criteria for establishing 'good' models. Common parametric, semiparametric and nonparametric models for solving equivalent problems will be discussed.

We will then consider representatives of computational algorithms that are commonly used in Bayesian analysis. These include MCMC, importance sampling, approximations such as variational Bayes, Laplace approximations and Approximate Bayesian Computation (ABC) and hybrid approaches that combine components of these algorithms. Criteria for establishing 'good' algorithms will be reviewed.

Finally, we will consider both of these components in parallel and evaluate methods for choosing models and algorithms that will best suit the problem at hand. We will consider this in general, and then evaluate it in the context of some medical and environmental case studies drawn from our experience.

Tuesday 14 February 2012, 08:30 – 09:30, The Law Theatre G04

Strong approximation of stochastic differential equations under non-Lipschitz assumptions

Andreas Neuenkirch
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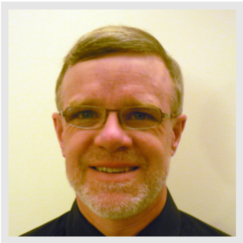
The traditional convergence analysis for the strong approximation of stochastic differential equations (SDEs) relies on the global Lipschitz assumption. However, in applications as molecular dynamics or mathematical finance, this assumption is often violated, so the standard results do not apply here. A prototype example is the Heston model, which is a popular stochastic volatility model in mathematical finance and contains square-root coefficients.

Starting with a seminal work by Higham, Mao and Stuart in 2002, the strong approximation of SDEs with non-globally Lipschitz coefficients has been an active field of research in the last years. In this talk, I will give an overview of the recent developments, which include the divergence of the Euler method for SDEs with superlinear coefficients and the derivation of strong convergence rates for discretization schemes for the Heston model.

Wednesday 15 February 2012, 08:30 – 09:30, The Law Theatre G04



Random projections, reweighting and half-sampling for high-dimensional statistical inference

Art B. Owen
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Coauthor(s): Sarah Emerson, Dean Eckles

This talk looks at some new Monte Carlo methods for high dimensional statistical problems motivated by biology and electronic commerce.

In the biological problems we may have 1000s of variables (e.g. genes or voxel intensities) measured on a few dozen human subjects. Low dimensional random projections are of interest in comparing groups, such as healthy versus diseased.

In the e-commerce problems, there are large cross-classifications, such as movies x reviewers or web pages x visitors or even three factor tables. The cross-classification structure generates a complex tangle of correlations among the observations that brings severe challenges for statistical inference. Ignoring the correlations can underestimate the variance by an enormous factor (up to 50,000 fold for the Netflix movie data). Furthermore, McCullagh (2000) proved that no bootstrap procedure can correctly estimate variances for such problems. However, some strategies based on random data reweighting can be shown to be mildly conservative, giving only slight over-estimates of the variances.

Wednesday 15 February 2012, 13:20 – 14:20, The Law Theatre G04

Noisy information: optimality, complexity, and tractability

Leszek Plaskota
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Although *noise* is always present in available data, we often pretend the noise does not exist in numerical computations and simply apply algorithms that work well in the noiseless situation. This approach may be justified only when the noise is small; otherwise one has to apply specially designed algorithms.

In this talk, we present selected results on the optimal solution of linear problems based on noisy information, where the noise can be deterministic or random. This will be done in the framework of IBC, and the main focus is on the following questions:

(i) what is an optimal algorithm for given noisy information?

(ii) what is the ε-complexity of a problem with noisy information?

(iii) when is a multivariate problem with noisy information tractable?

The answers will be given for the worst case, average case, and randomized settings. For (ii) and (iii) we present a computational model in which the cost of information depends on the noise level. For instance, for integrating a function $f : D \to \mathbb{R}$ available information may be given as

$$y_i = f(t_i) + x_i, \qquad 1 \le i \le n,$$

with a Gaussian noise $x_i \sim \mathcal{N}(0, \sigma_i^2)$. For this information one pays $\sum_{i=1}^n c(\sigma_i)$ where $c : [0, \infty) \to [0, \infty)$ is a given *cost function*. We will see how the complexity and tractability of a linear multivariate problem depend on the cost function, and compare the obtained results with the noiseless case $c \equiv 1$.

Friday 17 February 2012, 08:30 – 09:30, The Law Theatre G04

Numerical solution of stochastic differential equations with jumps in finance

Eckhard Platen
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In financial and actuarial modelling and other areas of application, stochastic differential equations with jumps have been employed to describe the dynamics of various state variables. The numerical solution of such equations is more complex than that of those only driven by Brownian motions. The aim of this lecture is to present various numerical methods used in quantitative finance for models involving stochastic differential equations with jumps. It emphasises mathematical concepts, techniques and intuition crucial for modern numerical methods in derivative pricing and risk management. Questions of numerical stability and convergence will be discussed. Several recent results on higher-order methods will be presented for scenario and Monte Carlo simulation, including implicit, predictor corrector and extrapolation methods.

Reference: Platen, E. & Bruti-Liberati, N.: Numerical Solution of Stochastic Differential Equations with Jumps in Finance. Springer, 2010.

Open Forum

Tuesday 14 February 2012, 18:10 – 19:00, CATS Theatre G02

Opportunities and challenges for massively parallel Monte Carlo

Fred J. Hickernell
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The scientific computing community has achieved petascale computing and is pushing towards exascale computing by the end of this decade. Exascale computing will not be achieved simply by speeding up what we do already, but by taking advantage of emerging architectures and new computing paradigms. Exascale computers will have $\mathcal{O}(10^6)$ nodes, each containing $\mathcal{O}(10^3)$ cores. This will make floating point operations very cheap. On the other hand, the amount of memory per core will be small, and the cost of moving data to memory will be large. This presents several questions for the Monte Carlo community to consider:

What kind of random number generators are needed to do reliable Monte Carlo calculations?

What kind of computational cost model is suitable for these new exascale architectures, and what Monte Carlo algorithms will be most efficient?

What Monte Carlo algorithms will outperform traditional algorithms in these new computing environments?

What can the Monte Carlo community contribute to exascale computing?

This open forum provides a chance for us to discuss these issues.

Graphics Tutorial

Thursday 16 February 2012, 17:00 – 18:00, CATS Theatre G02

Quasi-Monte Carlo methods in photorealistic image synthesis

Alexander Keller
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The tutorial surveys the state of the art in quasi-Monte Carlo rendering algorithms as used for image synthesis in the movie industry and product design.

The synthesis of photorealistic images comprises the simulation of light transport, which consists in identifying all light transport paths that connect the cameras and the light sources and summing up their contributions. The tutorial explains how to generate transport paths using quasi-Monte Carlo points and presents deterministic parallel algorithms for image synthesis.

The tutorial is self contained, provides many references for further study and research, and points out open problems. Techniques like high performance ray tracing, the high speed generation of (t, s)-sequences, parallel quasi-Monte Carlo integration, or treating weak singularities in a robust way have many applications outside computer graphics, too.

Special Sessions

Adaptive MCMC: Theory, Algorithms, and Applications

Organiser:

Scott C. Schmidler
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schmidler@stat.duke.edu

Session Description:

Markov chain Monte Carlo methods are the core computational tool in modern Bayesian statistics, statistical physics, and areas of computer science. However for complex high-dimensional target distributions, Markov chain Monte Carlo methods often require significant expertise and tuning. Adaptive MCMC methods address this by attempting to perform online learning from the sample history. This session brings together several of the leading researchers in this area to provide recent results on theoretical guarantees, new algorithms, and applications of adaptive MCMC.

Thursday 16 February 2012, 14:50 – 16:50, CATS Room 101

Advances in MCMC and SMC Methods: Solutions for Complex Ecological Problems

Organisers:

Keith Hayes
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`keith.hayes@csiro.au`

Geoff Hosack
CSIRO
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Session Description:

Dynamical ecological processes are typically non-linear and rarely observed precisely. This session will demonstrate the application of MCMC and SMC methods to ecological systems and in doing so highlight the estimation, prediction and model selection challenges that these systems pose. The session will provide an opportunity for researchers interested in ecological applications of MCMC and SMC methods to share experiences and discuss potential solutions to a range of challenging problems.

Thursday 16 February 2012, 10:00 – 12:00, CATS Theatre G23

Advances in MCMC Methodology

Organiser:

Yanan Fan
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Session Description:

Markov chain Monte Carlo methods have become a staple in Bayesian inference. However on-going methodological development of the methods are still needed in complex problems. The theme of this session is to showcase some recent advances both in methodological development and application of Markov chain Monte Carlo.

Tuesday 14 February 2012, 16:00 – 18:00, CATS Room 163

Jonathan M. Keith
Bayesian approaches to the design of Markov chain Monte Carlo samplers p.105

Jean-Luc Dortet-Bernadet
Quantile regression via auxiliary variables p.89

James M. Flegal
Exact sampling for intractable probability distributions via a Bernoulli factory p.92

Edward Cripps
A time-varying mixture of random effects model for individuals learning behaviour p.85

Approximate Bayesian Computation (ABC) and Likelihood-Free Inference

Organiser:

Scott Sisson
University of New South Wales
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Session Description:

For an increasing number of high-impact research problems from the biological, ecological and medical sciences, the primary models of interest are often sufficiently complex that the likelihood function is computationally intractable. Rather than discard these models in favour of inferior alternatives, a class of Bayesian "likelihood-free" techniques (often termed Approximate Bayesian Computation (ABC)) has emerged in the last few years, which avoids direct likelihood computation through repeated sampling of data from the model. Many standard computational algorithms have been adapted for this setting. As such, ABC methods permit Bayesian inference in challenging scenarios which would otherwise not be considered by the applied scientist. While effective and simple to use, the theory of current ABC approximations is not yet fully understood, and in practice several important practical aspects of the methods are often implemented in an ad-hoc fashion. ABC is currently an emerging area of active research.

In essence, the challenge is in performing integrals over computationally intractable (likelihood) functions. The aim of this session would be both to introduce the area to the MCQMC community, to showcase local expertise, and to hopefully initiate collaboration between ABC and MCQMC researchers.

Monday 13 February 2012, 16:00 – 18:00, CATS Room 101

Computational Finance

Organisers:

Dirk Nuyens
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Mark Joshi
University of Melbourne
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Session Description:

In financial engineering the price of a product can be expressed as an expectation of a random variable based on a stochastic model of the underlying assets. Such expectations can be approximated by Monte Carlo and quasi-Monte Carlo sampling. In the session on computational finance we focus on the efficiency of such sampling methods.

Part 1	Monday 13 February 2012, 16:00 – 18:00, CATS Room 163

Mark Joshi
Algorithmic Hessians and the fast computation of cross-gamma risk p.103

Jan Baldeaux
Exact Simulation of the 3/2 Model p.80

Nico Achtsis
Covariance matrix decompositions p.76

Gunther Leobacher
Fast orthogonal transforms and generation of Brownian paths p.113

Part 2	Thursday 16 February 2012, 10:00 – 12:00, CATS Theatre G02

Dale Roberts
QMC for stochastic volatility models p.135

Tomáš Tichy
Option pricing by simulation of fuzzy-random variables p.149

Timothy Ling
On simulation of some functionals of fractional Brownian motion p.116

Kyle Matoba
Figure of merit efficient QMC pointsets for computational finance p.118

Computational SPDEs

Organisers:

Fred J. Hickernell
Illinois Institute of Technology
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Klaus Ritter
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Session Description:

Monte Carlo methods, originally developed for high dimensional integrals, have been extended to solving partial differential equations where a randomness plays a significant role. Randomness may be present in the coefficients of the equations. A more significant source of randomness is a time and/or spatially dependent stochastic process. This session presents efficient Monte Carlo methods for computing the solutions of stochastic partial differential equations.

Monday 13 February 2012, 10:00 – 12:00, CATS Theatre G02

James Nichols
Fast QMC integration for lognormal random fields p.125

Mihaly Kovacs
Strong convergence of a fully discrete approximation of a class of stochastic Volterra equations p.107

Stig Larsson
On wavelet-Galerkin methods for semilinear parabolic equations driven by additive noise p.111

Qi Ye
Approximation of stochastic partial differential equations by a Kernel-based collocation method p.160

Explicit Error Bounds for Markov Chain Monte Carlo

Organiser:

Daniel Rudolf
Friedrich-Schiller-University Jena
daniel.rudolf@uni-jena.de

Session Description:

In the last decade Markov chain Monte Carlo attracted more and more attention. Such methods are used for approximate sampling in complex systems and for numerical integration with respect to some partially known measure. Many scientists studied the asymptotic behavior of Markov chain Monte Carlo such as ergodic theorems. In this session we want to focus on non-asymptotic properties of Markov chains. In particular we are interested in bounds of the mean square error, confidence estimates and on different convergence properties of Markov chains. The state spaces might be continuous or discrete. The topic is related to different fields of mathematics, namely applied probability theory, Bayesian statistics, combinatorics and numerical analysis.

Tuesday 14 February 2012, 10:00 – 12:00, The Law Theatre G04

Fast Computational Methods for Large Scale Bayesian Inference

Organiser:

Kerrie Mengersen
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Session Description:

Bayesian modelling and analysis is being applied to increasingly complex problems, many of which are based on increasingly large datasets. This requires new ways of thinking about efficient computation. In this session, a number of approaches, based on a range of different perspectives, will be presented and discussed. The discussions will involve the properties of the approaches and their application to real problems encountered by the presenters. There will also be opportunity for audience participation, in the form of discussion of the proposed approaches and review of their own experiences.

Monday 13 February 2012, 10:00 – 12:00, CATS Theatre G23

Measures of Pseudorandomness

Organiser:

Arne Winterhof
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Session Description:

Pseudorandom numbers have several application areas as numerical integration using the Monte Carlo method, simulation, cryptography or wireless communication. Their suitability depends on the application and is measured with different quality measures for their pseudorandomness as discrepancy for uniform distribution and thus suitability for MC or linear complexity for unpredictability and thus suitability in cryptography.

The four talks shall contribute to different aspects of the analysis of pseudorandom numbers involving different measures of pseudorandomness.

Tuesday 14 February 2012, 16:00 – 18:00, CATS Theatre G23

Monte Carlo Based Inference for Diffusions

Organisers:

Krzysztof Łatuszyński
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Gareth Roberts
Univeristy of Warwick
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Session Description:

Inference for diffusion process from discretely observed data is very challenging due to several intrinsic difficulties, such as

- transition probabilities of the diffusion are typically not available in closed form,
- the measures on the diffusion path space are typically mutually singular for different parameter values,
- some of the coordinates of the underlying diffusion process may not be observed at all, i.e. constitute a hidden process.

As a consequence of the above, Monte Carlo algorithms for inference for diffusion process often suffer from slow mixing and/or bias due to Euler-type discretization of the diffusion measure.

There is substantial recent progress in dealing with some of these issues in certain classes of diffusion models of practical importance, including the large class of particularly challenging multivariate irreducible diffusions, i.e. such that can not be transformed to have constant diffusion coefficient. The session will cover some of these recent advances.

Tuesday 14 February 2012, 16:00 – 18:00, CATS Room 101

Yves Atchade
Iterated filtering p.79

Osnat Stramer
Bayesian inference for a generalized class of Heston models p.143

Andrew Golightly
MCMC schemes for irreducible diffusions using high frequency imputation p.94

Gareth Roberts
Sequential importance sampling for irreducible diffusions p.136

Monte Carlo Methods for Spatial Stochastic Modeling

Organisers:

Dirk Kroese
University of Queensland
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Volker Schmidt
Ulm University
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Session Description:

Spatial statistics involves the statistical modelling and analysis of spatial variability and uncertainty. Important applications can be found in geology, ecology, climatology, and spatial planning, and it is also increasingly applied to model micro structures in nanotechnology. The purpose of this session is to showcase and stimulate important connections between the areas of Monte Carlo Methods and Spatial Statistics.

Part 1	Tuesday 14 February 2012, 10:00 – 12:00, CATS Theatre G23

Volker Schmidt
Model-based 3D simulation of tomographic image data, with applications to virtual materials design p.139

Gary Delaney
Modelling and quantifying spatially stochastic granular systems p.88

Bjoern Baumeier
Multiscale bottom-up simulations of charge and energy transport in disordered organic semiconductors p.80

Jesper Møller
Transforming spatial point processes into Poisson processes using random superposition p.123

Part 2	Friday 17 February 2012, 10:00 – 12:00, CATS Theatre G23

Richard Wilson
Prediction of catastrophes in spatio-temporal settings p.157

Georgy Sofronov
Spatial modelling in small area estimation via the cross-entropy method p.142

Dirk Kroese
Greedy servers on a torus p.108

Maurizio Manuguerra
Monte Carlo methods in spatio-temporal regression modelling of migration in the EU p.116

Multilevel Monte Carlo Methods

Organiser:

Mike Giles
University of Oxford
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Session Description:

Multilevel Monte Carlo methods reduce the computational cost of achieving a certain user-specified accuracy by combining simulations with different levels of resolution, or through some other form of recursive control variate strategy. This extended session will have papers spanning a range of SDE and SPDE applications, and will address both the construction of efficient numerical methods and their numerical analysis.

Part 1: SDEs
Part 2: SPDEs
Part 3: other related work

Part 1	Tuesday 14 February 2012, 10:00 – 12:00, CATS Theatre G02

Mike Giles
Numerical analysis of the multilevel Milstein discretisation p.93

Lukasz Szpruch
Efficient multilevel Monte Carlo simulations of non-linear financial SDEs without a need of simulating levy areas p.146

Andreas Rößler
Multi-level Monte Carlo simulation based on approximation schemes with reduced variance p.137

Erik von Schwerin
Adaptive multilevel Monte Carlo simulation of Ito SDEs p.154

Part 2	Wednesday 15 February 2012, 10:00 – 12:00, CATS Theatre G02

Aretha L. Teckentrup
Multilevel Monte Carlo for highly heterogeneous media p.148

Elisabeth Ullmann
Towards efficient simulations of groundwater flow problems in random media p.151

Jonas Šukys
Multi-level Monte Carlo finite volume methods for nonlinear systems of stochastic conservation laws in multi-dimensions p.144

Christoph Schwab
QMC convergence analysis for stochastic and parametric operator equations in infinite dimension p.140

Part 3	Friday 17 February 2012, 10:00 – 12:00, CATS Theatre G02

Stefan Heinrich
Randomized complexity of parametric problems p.98

David Anderson
Multilevel Monte Carlo for the continuous time Markov chain models arising in biology p.78

Nan Chen
Estimating expectations of functionals of conditional expectations via multilevel nested simulation p.84

Francisco Bernal
Application of variance reduction techniques in the numerical solution of partial differential equations p.81

Numerics for SDEs

Organiser:

Andreas Neuenkirch
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Session Description:

This special session is devoted to recent developments in the area of computational stochastic differential equations. Its topics include the approximation of stochastic differential equations (SDEs) with irregular coefficients and the construction of efficient deterministic and random quadrature rules for (non-smooth) functionals of SDEs.

Thursday 16 February 2012, 14:50 – 16:50, CATS Theatre G23

Paweł Przybyłowicz
Randomized Euler algorithm for the approximation of stochastic differential equations with time-irregular coefficients p.134

Martin Altmayer
Quadrature of discontinuous functionals in the Heston model p.78

Larisa Yaroslavtseva
On the complexity of computing quadrature formulas for marginal distributions of SDEs p.160

Quoc Thong Le Gia
A QMC-spectral method for elliptic PDEs with random coefficients on the unit sphere p.112

Point Sets and Sequences for Quasi-Monte Carlo

Organisers:

Friedrich Pillichshammer
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Ronald Cools
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Session Description:

Quasi-Monte Carlo rules are based on nodes with excellent uniform distribution properties. A common measure for the quality of the distribution of a point set or a sequence is its discrepancy. This special session is devoted to the construction and analysis of point sets and sequences with low discrepancy such as the Halton sequence, (polynomial) lattice point sets or (t, s)-sequences and others.

Part 1	Monday 13 February 2012, 16:00 – 18:00, CATS Theatre G02

Part 2	Wednesday 15 February 2012, 10:00 – 12:00, The Law Theatre G04

Part 3	Friday 17 February 2012, 10:00 – 12:00, The Law Theatre G04

Aicke Hinrichs
Discrepancy of structured sets p.100

Lev Markhasin
Quasi-Monte Carlo methods for integration of functions with dominating mixed smoothness p.117

Johann Brauchart
Low-discrepancy point sets lifted to the unit sphere p.83

Robert Womersley
Spherical designs and quasi-Monte Carlo methods for the sphere p.159

Random Number and Random Variate Generation

Organiser:

Pierre L'Ecuyer
University of Montreal
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Session Description:

This session is on the development and study of efficient methods to generate uniform random numbers and non-uniform random variates from specific distributions. In particular, it covers the statistical testing of random number generators, uncovering hidden structural defects of certain types of generators, and the design of efficient generators for parallel graphical processing units.

Monday 13 February 2012, 16:00 – 18:00, CATS Theatre G23

Josef Leydold
Generating generalized inverse Gaussian distributed random variates p.114

Makoto Matsumoto
A deviation of CURAND standard pseudorandom number generator in CUDA for GPGPU p.119

Hiroshi Haramoto
A nonempirical test on the second and the third lowest bits of pseudorandom p.97

Pierre L'Ecuyer
On the lattice structure of a special class of multiple recursive generators p.110

Recent Advances in MCMC

Organiser:

James M. Flegal
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Session Description:

Markov chain Monte Carlo (MCMC) algorithms, such as the Gibbs sampler and Metropolis-Hastings algorithm, have become extremely popular tools, especially for Bayesian inference. Simply put, MCMC is a method for using a computer to generate data and subsequently using standard large sample statistical methods to estimate fixed, unknown quantities of a given target distribution. This session will focus on recent advances on the theoretical aspects of MCMC methods and algorithms.

Wednesday 15 February 2012, 10:00 – 12:00, CATS Theatre G23

Radu Herbei
Bayesian computation and diffusion processes p.99

Colin Fox
Monte Carlo simulation inspired by computational optimization p.92

Krzysztof Łatuszyński
Why does the Gibbs sampler work on hierarchical models? p.112

Hidemaro Suwa
General construction of irreversible kernel in Markov chain Monte Carlo p.145

Small Ball Problems, Discrepancy, and Metric Entropy

Organisers:

Aicke Hinrichs
Friedrich-Schiller-University Jena
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Thomas Kühn
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Session Description:

The notion of discrepancy - originally introduced to study the irregularity of distributions - plays a central role in high-dimensional numerical integration. Moreover it is related to the so-called small ball inequality for Haar functions, which in turn has connections to many other interesting problems, e.g. to metric entropy in function spaces of dominating mixed smoothness and to small deviations of Brownian sheets. In each of these areas there are some long-standing hard problems which have been fully solved only in low dimensions $d = 1$ and $d = 2$; in higher dimensions there is some recent progress, but still only partial results are known.

The scope of this special session is to present some new results concerning small balls, (weighted) discrepancy and metric entropy, thus illustrating the intimate relationship between these areas. In particular, Michael Lacey will discuss some aspects of his plenary lecture in more detail.

Thursday 16 February 2012, 10:00 – 12:00, The Law Theatre G04

Theoretical and Computational Aspects of Discrepancy

Organisers:

Michael Gnewuch
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Peter Kritzer
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Session Description:

In many applications, notably quasi-Monte Carlo integration, point sets in the high dimensional unit cube with excellent distribution properties are required. A common measure for the quality of the distribution of a point set is the so-called discrepancy. In our special session we would like to cover theoretical aspects of discrepancy theory, ranging from general discrepancy bounds to the analysis of special low-discrepancy sequences such as digital nets or lattice point sets. Furthermore, we would like to cover some computational aspects of discrepancy theory such as the approximation of the discrepancy of arbitrary point sets or the efficient construction of distinguished low-discrepancy point sets. This double special session brings together young researchers and leading experts in discrepancy theory.

Part 1	Monday 13 February 2012, 10:00 – 12:00, The Law Theatre G04

Part 2	Thursday 16 February 2012, 14:50 – 16:50, CATS Theatre G02

Tractability of Multivariate Problems

Organisers:

Erich Novak
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Henryk Woźniakowski
Columbia University and University of Warsaw
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Session Description:

Tractability of a problem $S_d : F_d \to G_d$, where F_d is a class of d-variate functions, roughly means that the complexity of approximating S_d is not exponential in d. Hence we do not have the curse of dimensionality.

Many multivariate problems are not tractable in the worst case setting for classical function spaces and therefore one studies weighted spaces and other settings (average case, randomized) to obtain tractability.

The lecture of Ritter is about infinite dimensional problems and the lecture of Weimar is about a new condition (symmetry, anti-symmetry) to obtain tractability. Some new intractability results for integration are presented in the lecture of Novak. The rates of convergence and tractability results for the L_p approximation problem are compared in the lecture of Woźniakowski for algorithms that use function values or general linear information.

Tuesday 14 February 2012, 16:00 – 18:00, CATS Theatre G02

Klaus Ritter
Quadrature on the sequence space p.135

Markus Weimar
Linear tensor product problems in (anti-) symmetric Hilbert spaces p.155

Erich Novak
(In) tractability results for integration p.126

Henryk Woźniakowski
Rates of convergence and tractability for the approximation problem in various settings p.159

Abstracts

Monday 13 February 2012, 17:00 – 17:30, CATS Room 163

Covariance matrix decompositions

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Coauthor(s): Ronald Cools, Dirk Nuyens

Special session: Computational Finance p.58

Monte Carlo (MC) and quasi-Monte Carlo (QMC) methods are often used in pricing complex derivatives. The merit of QMC is that, theoretically at least, higher convergence rates can be obtained than regular MC. However, the payoff function is usually non-smooth and high-dimensional, eliminating the advantage of using QMC. Imai & Tan (2006) introduced the LT method which minimizes the effective dimension of the problem by transforming the normal variates using an orthogonal transformation, thereby improving the QMC method. So far, this orthogonal transformation has only been constructed for Asian options. We will introduce optimal transformations for other types of derivatives, thereby increasing the efficiency of the LT algorithm for different classes of payoffs.

Monday 13 February 2012, 16:30 – 17:00, CATS Theatre G02

Probabilistic methods in quasi-Monte Carlo theory

Christoph Aistleitner
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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

There exist many classical constructions of low-discrepancy sequences. The discrepancy bounds for such sequences usually only provide useful results if the number of sampling points N is very large in comparison with the dimension d. To analyze this problem the *inverse of the discrepancy* $n(d,\varepsilon)$ has been introduced, which is the minimal number of points which is necessary to achieve discrepancy $\leq \varepsilon$ in dimension d. Heinrich *et al.* proved that the inverse of the discrepancy satisfies $n(d,\varepsilon) \leq cd\varepsilon^{-1}$, where c is an absolute constant. We present the probabilistic tools which are used to prove this and similar results, including methods from the theory of empirical processes and bracketing entropy. Furthermore, we show how these method can be applied in a semi-random environment, for example in the context of so-called hybrid sequences.

Thursday 16 February 2012, 15:50 – 16:20, CATS Room 163

Nonlinear sequential Monte Carlo filtering for state and adaptive parameter estimation in direct geo-referencing tasks

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In many fields of geodesy applications, state and parameter estimation are of major importance within modeling of on-line processes. The fundamental block of such processes is a filter for recursive estimation. Kalman filter (KF) is the well known filter as an optimal recursive Bayesian estimator for a somewhat restricted class of linear Gaussian problems. However, in the case that state or measurement functions are non-linear and the density function of process or measurement noise are non-Gaussian, classical filters do not yield satisfying estimates. So it is necessary to adopt alternative filtering techniques in order to provide optimal results. The main focus lays in this paper on the sequential Monte Carlo (SMC) estimation. The SMC filter allows to reach this goal numerically, and works properly with nonlinear state estimation. The main idea behind the SMC filter is to approximate the posterior PDF by a set of random particles, which can be generated from a known PDF By means of the particles the true mean and the covariance of the state vector are estimated. However, the computational cost of SMC filter has often been considered as their main disadvantage. This occur due to the large, sufficient particles to be drawn. Therefore a more efficient approach will be presented, which is based on the combination of SMC filter and the KF. The efficiency of the developed filters will be demonstrated through application in direct geo-referencing tasks for a geodetic system.

Thursday 16 February 2012, 15:20 – 15:50, CATS Theatre G23

Quadrature of discontinuous functionals in the Heston model

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Special session: Numerics for SDEs p.67

The Heston model is a popular stochastic volatility model in mathematical finance. While there exist several numerical methods to compute functionals of the Heston price, the convergence order is typically low for discontinuous functionals.

In this talk, we will study an approach which is based on the integration by parts procedure of Malliavin calculus, to overcome this problem: the original function is replaced by a function involving its antiderivative and by a Malliavin weight. For this, we will give a precise analysis of the Malliavin smoothness of the Heston model – since the SDE for the Heston model contains square root coefficients, the standard results of Malliavin calculus for SDEs are not applicable. Moreover, we will also address efficient approximation of the arising Malliavin weight, which involves a Skorohod integral.

Friday 17 February 2012, 10:30 – 11:00, CATS Theatre G02

Multilevel Monte Carlo for the continuous time Markov chain models arising in biology

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Coauthor(s): Des Higham

Special session: Multilevel Monte Carlo Methods p.65

In this talk, I will show how to extend multi-level Monte Carlo to the continuous time Markov chain setting, with a special emphasis on the models arising in cell biology and biochemistry. In a stark departure from other implementations of multi-level Monte Carlo, we show how to produce an unbiased estimator that is significantly less computationally expensive than the usual unbiased estimator arising from exact algorithms in conjunction with crude Monte Carlo. I will show the main idea behind the method, which involves a coupling between two processes that utilizes a random time change representation of Poisson processes. While stochastic models of biochemical systems are the model problem, the methods developed are applicable to essentially all continuous time Markov chain models, and therefore could be used on a diverse set of applications.

Tuesday 14 February 2012, 16:00 – 16:30, CATS Room 101

Iterated filtering

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Coauthor(s): Bhadra, Ionides, King

Special session: Monte Carlo Based Inference for Diffusions p.63

Inference for partially observed Markov process models has been a longstanding methodological challenge with many scientific and engineering applications. In this talk we present Iterated filtering, an algorithm that maximizes the likelihood function for partially observed Markov process models by solving a recursive sequence of filtering problems. We will present new theoretical results on the convergence of iterated filtering algorithms implemented via sequential Monte Carlo filters.

Thursday 16 February 2012, 11:30 – 12:00, The Law Theatre G04

Small ball probabilities and metric entropy

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Coauthor(s): I.A. Ibragimov, M.A. Lifshits, J.H. van Zanten and F. Gao, T. Kühn, W.V. Li, Q. Shao

Special session: Small Ball Problems, Discrepancy, and Metric Entropy p.72

The talk outlines the connection between small ball probabilities for Gaussian processes and the metric entropy of the related operator. Further, we give an overview of other applications of small ball probabilities. Then we consider some recent results on small ball probabilities for some concrete processes.

Monday 13 February 2012, 16:30 – 17:00, CATS Room 163

Exact Simulation of the 3/2 Model

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Special session: Computational Finance p.58

In this talk, we discuss the exact simulation of the stock price process underlying the 3/2 model. Using a result derived by Craddock and Lennox using Lie Symmetry Analysis, we adapt the Broadie-Kaya algorithm for the simulation of affine processes to the 3/2 model. We also discuss variance reduction techniques and find that conditional Monte Carlo techniques combined with quasi-Monte Carlo point sets result in significant variance reductions.

Tuesday 14 February 2012, 11:00 – 11:30, CATS Theatre G23

Multiscale bottom-up simulations of charge and energy transport in disordered organic semiconductors

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

The rational design of materials for organic electronic devices, such as organic solar cells, is driven by the understanding – and subsequent optimization – of charge and energy transfer processes within them. These processes are strongly influenced by an interplay of effects on different length scales, ranging from macroscopic morphological order to quantum phenomena at an atomic resolution. In this talk, a combination of Molecular Dynamics, Quantum Chemistry, and (Kinetic) Monte Carlo methods will be presented that allows to numerically study charge and energy dynamics. This multiscale methodology is based on the fact that transfer processes in organic semiconductors occur via hopping on an asymmetrically-weighted directed graph. Each spatial localization point of a charge carrier is represented by a vertex of the graph, while vertices are connected by edges whose weights are given by hopping rates determined from quantum-chemical calculations. The multiscale procedure used to construct the graph based on a simulated nanomorphology will be demonstrated and it will be shown how the solution of the Master Equation for the dynamics can be obtained by a Kinetic Monte-Carlo approach. An analysis of, e.g., the relation between charge mobility and the topological connectivity of the system reveals the strong impact of the morphology on the performance of devices and highlights the need for accurate simulation of even larger-scale morphologies of realistic device architectures.

Friday 17 February 2012, 11:30 – 12:00, CATS Theatre G02

Application of variance reduction techniques in the numerical solution of partial differential equations

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Special session: Multilevel Monte Carlo Methods p.65

In this work, we incorporate Variance Reduction (VR) techniques into the Probabilististic Domain Decomposition (PDD) algorithm put forward by Acebrón et al. [1], for efficiently solving partial differential equations (PDEs) using a parallel computer. In order to do so, the PDE domain is typically divided into many subdomains, which are small enough to be handled by the individual processors. The hallmark of PDD is that stochastic representations of the considered PDE are exploited to approximate its solution on the subdomain interfaces, via a Monte Carlo method - thus providing each individual processor with a well-posed, independent problem. Therefore, PDD requires neither iterations nor communication between the processors and is fully parallelizable.

Moreover, because PDD can readily construct a global numerical solution throughout the entire domain based on the Monte Carlo interfacial values, it is also suitable for the inclusion of VR techniques. The idea is to construct a rough approximation with the initial Monte Carlo realizations, from which control variates for the subsequent realizations can be derived. In this way, the Monte Carlo (statistical) error objective can be attained with less computational effort.

[1] J.A. Acebrón, M.P. Busico, P. Lanucara, R. Spigler, Domain decomposition solution of elliptic problems via probabilistic methods,SIAM J. Sci. Comput., 27 (2005) 440-457

Thursday 16 February 2012, 14:50 – 15:20, CATS Theatre G02

L^2 discrepancy and symmetrization

Dmitriy Bilyk
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Coauthor(s): V. Temlyakov, R. Yu

Special session: Theoretical and Computational Aspects of Discrepancy p.73

In 1956, Davenport constructed the first example of a finite set in dimension 2 with optimal order of L^2 discrepancy, $\sqrt{\log N}$, by symmetrizing the irrational lattice $\{k/N, \{k\alpha\}\}_{k=1}^N$, where α has bounded partial quotients. However, the question whether this symmetrization is really necessary has been left open. In 1979, Sos and Zaremba partially answered this question by proving that if the partial quotients of the (finite or infinite) continued fraction of α are all equal, then even without the symmetrization the L^2 discrepancy of the lattice is optimal. We completely characterize lattices that have this property and demonstrate that much finer arithmetic properties of α come into play. In particular, the L^2 discrepancy is tightly connected with the growth of the alternating sums of partial quotients. We also obtain an exact formula for the L^2 discrepancy of such lattices and present some favorable results of numerical experiments.

Monday 13 February 2012, 10:30 – 11:00, CATS Theatre G23

An importance sampling method for marginal likelihood estimation

Zdravko Botev
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Special session: Fast Computational Methods for Large Scale Bayesian Inference p.61

In this talk we present a novel adaptive importance sampling approach for Bayesian marginal likelihood estimation. The approach relies on computing a (mean-field or factored) variational approximation to the posterior density and then using this approximation in an importance sampling scheme. We show that for certain Bayesian models the suggested computation approach can be more efficient than the more popular MCMC and SMC estimation methods.

Friday 17 February 2012, 11:00 – 11:30, The Law Theatre G04

Low-discrepancy point sets lifted to the unit sphere

Johann Brauchart
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Coauthor(s): Josef Dick

Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

Digital Nets and sequences as introduced by H. Niederreiter [Monatsh. Math. 104 (1987)] provide a very efficient method to generate low-discrepancy sequences of point sets in the d-dimensional unit cube. Lifted to the unit sphere $\mathbb{S}^d$ in $\mathbb{R}^{d+1}$ by means of an area-preserving mapping they give rise to quasi-Monte Carlo rules on the sphere with explicit constructible node configurations. We present theoretical and numerical results concerning the quality of these rules measured with respect to the worst-case error in certain Sobolev spaces and various concepts of discrepancies (including the spherical cap discrepancy, spherical "rectangle" discrepancy and isotropic discrepancy). Spherical qMC-rules derived from Fibonacci lattices will be also discussed.

Spherical digital nets and sequences and spherical Fibonacci lattices can be used to form sequences of approximate spherical t-designs on $\mathbb{S}^d$. Such designs yield qMC-rules which are, in general, not exact for all polynomials of degree $\leq t$ but still achieve the asymptotic bounds for the worst-case error for functions from the unit ball in certain Sobolev spaces associated with spherical t-designs. The number of points $N = N(t)$ can be (almost – up to a power of $\log N$) made optimal. Numerical evidence suggest that the logarithmic factor can be dropped.

Wednesday 15 February 2012, 14:30 – 15:00, CATS Room 163

Efficient quantile estimation

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It is often necessary to estimate certain quantiles of a random variable. These could describe the risk associated with a financial portfolio, the critical values of a test statistic, or the typical length of a path through a stochastic activity network. Quantiles often need to be calculated using potentially expensive Monte Carlo methods. In this talk, I describe the application of the Improved Cross-Entropy method to the problem of quantile estimation. This method makes use of a number of key techniques in simulation, including Markov Chain Monte Carlo, splitting and the Cross-Entropy method.

Monday 13 February 2012, 14:30 – 15:00, CATS Room 101

Time integrator dependent variance reduction for sequential Monte Carlo

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Many important applications give rise to problems where it is necessary to estimate the kinetic parameters identifying the underlying dynamical system. Sequential Monte Carlo methods based on particle filters require the propagation of the dynamic particles. We propose a method which preserves the Markov model structure while respecting the stability and accuracy of the underlying time integrator. The degree of stiffness of the dynamical system determines whether an explicit ODE solver can be used or an implicit method must be employed to use a reasonable time discretization. In either case, by resorting to high accuracy time integrator methods for the propagation of the particles we can reduce the variance of the innovation, which is proportional to the local truncation error of the ODE solver. We illustrate the performance of the method by applying it to problems arising from cellular metabolism.

Friday 17 February 2012, 11:00 – 11:30, CATS Theatre G02

Estimating expectations of functionals of conditional expectations via multilevel nested simulation

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Special session: Multilevel Monte Carlo Methods p.65

In this paper we investigate an efficient Monte Carlo simulation scheme to compute expected function values of conditional expectations. This problem finds wide applications in finance, statistics and decision sciences. The existing literature (e.g. Gordy and Juneja (Management Science 2010)) suggests a nested structure to deal with the function nonlinearity, which will incur a substantial computational cost and poses a challenge on how to allocate time budget efficiently. We present a multilevel scheme to resolve the tradeoff between the bias and the variance of the estimator in this paper: in the initial levels, most of computational time is used to reduce the variance; in the later levels, the computation focus is shifted to bias reduction and the variance is still under control with the help of knowledge built up in the previous levels. We show that the complexity of our method is $O(\epsilon^{-2}(\log\epsilon)^2)$ in the cases of Lipschitz functions and $O(\epsilon^{-7/3})$ in the cased of non-Lipschitz, if we set the target mean square error (MSE) of estimation to be no more than ϵ^2.

Monday 13 February 2012, 10:00 – 10:30, The Law Theatre G04

Davenport's theorem in classical discrepancy theory

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Special session: Theoretical and Computational Aspects of Discrepancy p.73

There are many different ways to prove Davenport's 1956 theorem on the upper bound of the classical L^2 discrepancy problem. In this short talk, we give some insight into the various approaches, and compare their similarities and differences.

Tuesday 14 February 2012, 17:30 – 18:00, CATS Room 163

A time-varying mixture of random effects model for individuals learning behaviour

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Special session: Advances in MCMC Methodology p.56

Although substantial advances in Bayesian methodology have been made during recent decades, the mathematical and computational complexity involved in implementing these techniques has meant a large proportion of them have not been embraced by researchers outside of statistics. This work applies recent developments in Bayesian mixture modeling to current research questions in psychology, discussing the complexities of MCMC algorithm construction for applied Bayesian statisticians. In psychology the implicit theory of abilities proposes that individuals are classified as one of two groups: entity theorists who believe ability is innate and incremental theorists who believe ability is an acquired set of skills. Entity theorists are more likely to interpret failure as evidence of a lack of ability and doubt their future capacity to learn the task. The hypothesis is that learning performances of entity theorists are more prone to downward spirals than incremental theorists. We model the performance of individuals as a function of personality self-classification using a time-varying mixture of constrained random effects. Performance is modeled dynamically by allowing for the commencement of the spiral to be a function of time and to vary with individuals. So for each individual we average over another class of models which are the possible locations of the spiral, and performance is predicted by weighting all possible models by their posterior probability.

Monday 13 February 2012, 15:00 – 15:30, CATS Room 163

Efficient estimation of rare event probabilities in biochemical systems

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In biochemical systems, the occurrence of a rare event can be accompanied by serious consequences. Characterization of these events using Monte Carlo simulation is often intractable, as the number of realizations needed to witness a rare event can be very large. The weighted stochastic simulation algorithm (wSSA) alleviates this difficulty with importance sampling (IS), which biases the system toward the desired rare event. However, identification of favorable biasing parameters requires a computationally prohibitive manual search. We developed a novel wSSA modification-the doubly weighted SSA (dwSSA)-that makes possible an automated method for rare event probability estimation. Specifically, our approach combines the cross-entropy method of Rubinstein with the dwSSA to compute optimal biasing parameters. These parameters are then used by the dwSSA to produce low variance rare event probability estimates. When applied to example systems, our method reduced the computational cost of rare event characterization by multiple orders of magnitude. More recently, we developed a state-dependent IS extension of the dwSSA (sdwSSA). Like its predecessor, the sdwSSA provides for fully automated, efficient probability estimation. Importantly, use of the sdwSSA further reduces the computational cost of rare event characterization by up to two orders of magnitude. This talk will discuss the derivation of the dwSSA and sdwSSA and demonstrate their performance on several biochemical systems.

Tuesday 14 February 2012, 14:30 – 15:00, CATS Room 163

Exact particle flow for nonlinear filters

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We have solved the well known and important problem of particle degeneracy using a new theory, called particle flow. Our filter is four orders of magnitude faster than standard particle filters for any given number of particles, and we require many orders of magnitude fewer particles to achieve the same filter accuracy. Therefore, the net reduction in computational complexity is roughly seven orders of magnitude relative to standard particle filters for the same accuracy. Moreover, our filter beats the EKF accuracy by several orders of magnitude for difficult nonlinear problems. We show many numerical results for various nonlinearities, with both stable and unstable plants, varying process noise, measurement noise, initial uncertainty of the state vector, and dimension of the plant from $d = 1$ to 30. Our theory uses exact particle flow to compute Bayes rule, rather than a pointwise multiply. We do not use resampling or proposal densities or importance sampling or any other MCMC method. But rather, we design the particle flow with the solution of a linear first order highly underdetermined PDE, like the Gauss divergence law in electromagnetics. We study over a dozen methods to solve this PDE.

Tuesday 14 February 2012, 10:30 – 11:00, CATS Theatre G23

Modelling and quantifying spatially stochastic granular systems

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

Disordered granular structures are a recurrent feature in nature, present in a diverse range of geological and biological systems. They are also central to many industries, with granular materials such as sands, soils and powders playing a critical role in construction, manufacturing, food processing and pharmaceuticals.

We employ sophisticated discrete particle simulation methods to investigate how the shape of the individual particles affects the physical and structural properties of jammed granular packings. We utilize Monte Carlo type methods that allow us to probe the set of possible jammed packings a given set of grains can produce. We further consider stochastic sequential packing models, which are useful in investigating the effects of very large grain polydispersity and as simplified models from which more broadly applicable theories can be developed.

We use a range of metrics to quantify how the shape of the individual particles affects the structure of the packing. We find that the degree of rotational symmetry and the surface curvature of the individual particles are crucial in determining the type and amount of order present in the packing.

Monday 13 February 2012, 17:30 – 18:00, CATS Theatre G02

Randomized and derandomized construction of low-discrepancy point sets

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

A number of recent papers showed that randomized rounding and its derandomization can be used to generate point sets exhibiting a low star discrepancy. So far, the randomized constructions were based on independent randomized rounding, or randomized rounding respecting disjoint cardinality constraints was used. In this work, we explore to what extent more complicated random experiments and the corresponding derandomizations yield better point sets.

Tuesday 14 February 2012, 16:30 – 17:00, CATS Room 163

Quantile regression via auxiliary variables

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Special session: Advances in MCMC Methodology p.56

Quantile regression offers a powerful alternative to ordinary mean regression and has become these last decades a technique intensively used in many areas of Statistics. This work concerns Bayesian quantile regression fitting with spline functions. The proposed model allows a curve fitting with knots number and locations driven by the data. Its formulation as a variable selection problem and the introduction of auxiliary variables avoid the need of RJMCMC and the proposed method retains the simplicity of a Metropolis-within-Gibbs sampler for inference. Some examples are presented along with some extensions to a multivariate setting.

Monday 13 February 2012, 16:00 – 16:30, CATS Room 101

An SMC ABC algorithm for multivariate quantile distributions

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Special session: Approximate Bayesian Computation (ABC) and Likelihood-Free Inference p.57

Approximate Bayesian computation (ABC) is a likelihood-free approach where the likelihood is replaced via simulation from the model and comparing the resulting summary statistics with those of the observed data. In order to obtain accurate approximation of the true posterior distribution, it is often necessary to apply a very stringent matching condition on the simulated and observed summaries. Therefore it is critical to devise an algorithm to increase the probability of satisfying this rare event so reducing the number of model simulations required. Sequential Monte Carlo (SMC) methods have proved successful for this task. In this talk I will discuss an efficient SMC ABC algorithm. The application is to newly developed multivariate quantile distributions, which can be used to model financial returns. The SMC uses an MCMC kernel for diversity, which for this application can be constructed using component-wise updates that require only a comparison of summary statistics within each marginal rather than on the full set of summaries.

Monday 13 February 2012, 17:00 – 17:30, CATS Room 101

Posterior inference for ABC: a regression density approach

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Special session: Approximate Bayesian Computation (ABC) and Likelihood-Free Inference p.57

Approximate Bayesian computation (ABC) methods (also known as likelihood-free methods) have been receiving increasing interest in recent times, as an alternative to performing Bayesian inference in the presence of intractable likelihood functions.

ABC algorithm require the availability of simulated data from the intractable likelihood, $L(\mathbf{y} \mid \theta)$, for a given parameter set θ. Almost all ABC algorithms proceed by sampling θ from the prior $\pi(\theta)$ and compares the simulated data $\mathbf{x} \sim L(\mathbf{y} \mid \theta)$ with the observed data $\mathbf{x_0}$, and posterior samples for arising from $\pi(\theta \mid \mathbf{x_0})$ are obtained probabilistically according to some arbitrary weighting function or kernel $K_\delta(||\mathbf{x} - \mathbf{x_0}||)$ depending on the discrepancy δ, between the simulated data and the observed data.

The problem with specifying the value of δ is two-fold. Firstly, δ should be small enough so that the approximation to the posterior is accurate. Secondly, for large dimensions, it may not be computationally feasible to obtain posterior samples for arbitrarily small δ. In this talk, we consider a regression density approach, which does not rely on the specification of a weighting function or δ. The method is very general, and would extend well into high dimensional problems.

Monday 13 February 2012, 10:30 – 11:00, The Law Theatre G04

Improvements on the star discrepancy of (t, s)-sequences

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Special session: Theoretical and Computational Aspects of Discrepancy p.73

In this communication, we will report on recent improvements on the star discrepancy of arbitrary (t, s)-sequences, especially in an even base. Recall that (t, s)-sequences are low-discrepancy sequences satisfying the bound $D^*(N, X) \leq c_s(\log N)^s + O((\log N)^{s-1})$. Constants c_s for (t, s)-sequences were first computed by Sobol' and Faure in special cases and then achieved in general form by Niederreiter. Then, quite recently, Kritzer improved these constants for $s \geq 2$ by factors $\frac{1}{2}$ for an odd base and $\frac{b}{2(b+1)}$ for an even base. Our aim is to further improve the result in the case of an even base by a factor $\frac{2(b+1)}{b}\left(\frac{b-1}{b}\right)^{s-1}$, hence obtaining the ratio $\frac{3}{2^{s-1}}$ for $b = 2$. Our proof relies on a method of Atanassov to bound the discrepancy of Halton sequences. Using a different approach, we will also investigate arbitrary $(t, 1)$-sequences.

Monday 13 February 2012, 17:30 – 18:00, CATS Room 101

Considerate approaches to ABC model selection and model checking

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Special session: Approximate Bayesian Computation (ABC) and Likelihood-Free Inference p.57

For nearly any challenging scientific problem evaluation of the likelihood is problematic if not impossible. Approximate Bayesian computation (ABC) allows us to employ the whole Bayesian formalism to problems where we can use simulations from a model, but cannot evaluate the likelihood directly. When summary statistics of real and simulated data are compared rather than the data directly information is lost, unless the summary statistics are sufficient. Here we employ an information-theoretical framework that can be used to construct (approximately) sufficient statistics by combining different statistics until the loss of information is minimized. Such sufficient sets of statistics are constructed for both parameter estimation and model selection problems. We apply our approach to a range of illustrative and real-world model selection problems. We also comment on the appropriate choice of summary statistics for model checking.

Tuesday 14 February 2012, 17:00 – 17:30, CATS Room 163

Exact sampling for intractable probability distributions via a Bernoulli factory

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Special session: Advances in MCMC Methodology p.56

Many applications in the field of statistics require Markov chain Monte Carlo methods. Determining appropriate starting values and run lengths can be both analytically and empirically challenging. A desire to overcome these problems has led to the development of exact, or perfect, sampling algorithms which convert a Markov chain into an algorithm that produces i.i.d. samples from the stationary distribution. Unfortunately, very few of these algorithms have been developed for the distributions that arise in statistical applications, which typically have uncountable support. Here we study an exact sampling algorithm using a geometrically ergodic Markov chain on a general state space. Our work provides a significant reduction to the number of input draws necessary for the Bernoulli factory, which enables exact sampling via a rejection sampling approach. We illustrate the algorithm on a bivariate Gibbs sampler and a Bayesian version of the one-way random effects model with data from a styrene exposure study.

Wednesday 15 February 2012, 10:30 – 11:00, CATS Theatre G23

Monte Carlo simulation inspired by computational optimization

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Special session: Recent Advances in MCMC p.71

The quasi-MC methods draw inspiration from lattice rules in numerical quadrature to improve computational efficiency in Monte Carlo integration. In a similar spirit, we look at ways to use algorithmic ideas from computational optimization to build efficient simulation algorithms – that draw samples from a desired distribution – for use in MCMC. A well-established connection is the equivalence of Gibbs samplers applied to a Gaussian and Gauss-Seidel optimization of a quadratic. An immediate consequence is polynomial acceleration of the Gibbs sampler that gives many orders of magnitude speed-up. The past few years have seen development of sampling algorithms based on Krylov space and quasi-Newton optimization algorithms that achieve spectacular performance in some settings. We review these advances, and look forward to the potential acceleration of Metropolis-Hastings using these ideas.

Tuesday 14 February 2012, 10:00 – 10:30, CATS Theatre G02

Numerical analysis of the multilevel Milstein discretisation

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Special session: Multilevel Monte Carlo Methods p.65

In this talk I will present the numerical analysis of multilevel Monte Carlo simulation for scalar SDEs using the first order Milstein approximation. The analysis builds on previous work by Giles, Higham and Mao (Finance & Stochastics, 2009) for the Euler discretisation, and again uses an approach in which “extreme” paths are proven to have a negligible contribution, and the contribution of “non-extreme” paths to the multilevel correction variance is bounded through asymptotic analysis. The numerical analysis is performed for a range of different financial payoffs (put/call, digital, Asian, lookback and barrier options) and the results match the order of convergence observed in numerical experiments.

Tuesday 14 February 2012, 15:00 – 15:30, CATS Room 163

Settings of SMC parameters by Dobrushin analysis

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The convergence of particule mutation/selection-based algorithms has been clearly related to the stability of Feynman-Kac's dynamic measure system. We have studied this stability under assumptions on the selection functions' logarithmic oscillation, and mixing properties of the Markov kernels in the sense of Dobrushin.

To quantify the impact of this stability on the algorithm, we mainly use a concentration inequality. Special attention is devoted to the particular case of Gibbs' measures' simulation, and settings of the parameters of temperature and Markov kernels' iteration numbers, to ensure the convergence.

We finally focus on applications of this algorithm on the simulation of posterior distributions in electromagnetic inverse problems, particularly a toy-problem based on the analysis of reflection coefficients on the surface of a multilayer material.

Monday 13 February 2012, 17:00 – 17:30, CATS Theatre G02

New multilevel algorithms based on polynomial lattice rules and digital nets of higher order

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

In many important applications one has to deal with integration problems for functions of a finite (but a priori unknown) number of variables or of infinitely many variables.

In this talk we want to discuss this type of infinite-dimensional numerical integration problem for integrands in weighted reproducing kernel Hilbert spaces. We present new upper bounds for the convergence rates of deterministic and randomized quasi-Monte Carlo multilevel algorithms based on polynomial lattice rules and on digital nets for higher order convergence. We analyze the performance of those algorithms for function space decompositions of anchored and ANOVA type and for different type of weights.

Tuesday 14 February 2012, 17:00 – 17:30, CATS Room 101

MCMC schemes for irreducible diffusions using high frequency imputation

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Special session: Monte Carlo Based Inference for Diffusions p.63

We consider Bayesian inference for parameters governing nonlinear multivariate diffusion processes using discretely observed data that may be incomplete and subject to measurement error. Typically, inference proceeds by replacing unavailable transition densities with an Euler-Maruyama approximation and adopting a high frequency imputation approach to allow sufficient accuracy of the approximation. We consider a recently proposed particle MCMC scheme which jointly updates parameters of interest and the missing data and present a vanilla approach that only uses forward simulation of the process before examining improvements based on bridge constructs. This method is illustrated by using some examples arising in systems biology.

Tuesday 14 February 2012, 17:00 – 17:30, CATS Theatre G23

On the multidimensional distribution of pseudorandom sequences with Dickson polynomials

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Special session: Measures of Pseudorandomness p.62

Pseudorandom sequences are basic for quasi-Monte Carlo methods. The quality of the sequence depends on the distribution of the points. One way of obtaining pseudorandom sequences is using nonlinear methods, however there are no tests that guarantee the quality of such sequences.

In this talk, we discuss the multidimensional distribution of pseudorandom sequences generated by iterations of Dickson polynomials over prime finite fields. These results follow the path of earlier work, where the bounds of the exponential sums only applied to the 1-dimensional case over the period. We will use the new ideas of Alina Ostafe and Igor Shparlinski to get new results.

Wednesday 15 February 2012, 15:00 – 15:30, CATS Room 101

Stratified Monte Carlo integration and applications

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For numerical integration and for some simulation algorithms, quasi-Monte Carlo (QMC) methods may be more efficient than Monte Carlo (MC) schemes. A drawback of the QMC approach is that it is often difficult to estimate the error. There is no confidence interval and the deterministic error bounds are usually very pessimistic. A possibility is to use randomized QMC algorithms where a random parameter is introduced in the construction of the quasi-random points.

Stratified sampling is a variance reduction technique for MC schemes. For integration on the s-dimensional unit interval I^s, a simple stratified sampling strategy is to divide I^s into boxes with the same measure and to choose one sample per box. If the boxes are "elementary intervals", the points share equidistribution properties with randomized nets.

In this presentation, we first use simple stratified sampling for numerical quadratures. We focus on integration of non-smooth functions, since we have experienced that numerical simulation problems can be reduced to numerical integration of indicator functions of irregularly-shaped domains. Theoretical variance bounds are proved and effectiveness of variance reduction is assessed through numerical experiments. We next extend our simple stratified sampling strategy to simulation of some Markov chains.

Monday 13 February 2012, 17:00 – 17:30, CATS Theatre G23

A nonempirical test on the second and the third lowest bits of pseudorandom

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Special session: Random Number and Random Variate Generation p.70

A nonempirical test on pseudorandom number generators (PRNG), named the weight-discrepancy test, was introduced by [1]. This test measures the discrepancy of distributions of a function on random variates generated by the PRNGs from the ideal distributions, and estimates the sample sizes for which a χ2-test reveals the defects of the PRNGs. The key for this analysis is MacWilliams identity. The weight-discrepancy test is available for the least significant bit for lagged-Fibonacci type generators, but not for other bits.

In this talk, we focus on the second least significant bit (and the third) of the outputs of a PRNG. Using a more general MacWilliams identity for $Z/2^n$, the exact distribution of the weight of the second bit (and the third) of some consecutive outputs can be obtained. The exact distribution of the weight provides the sample size with significance level 0.99 (the risky sample size) and with significance level 0.75 (the safe sample size).

We show the distribution for several PRNGs, and compare with the results of simulations. For example, comparing with an ideal binomial distribution, an output of the second significant bit of random() is rejected for the sample size 50000. Empirical simulation results agree with our theoretical analysis.

[1] Matsumoto, M., Nishimura, T.: A Nonempirical Test on the Weight of Pseudorandom Number Generators. In: Monte Carlo and Quasi-Monte Carlo methods 2000. Springer-Verlag 2002, 381–395.

Tuesday 14 February 2012, 15:00 – 15:30, CATS Theatre G23

On the $\mathbb{F}_2$-linear relations of Mersenne Twister

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Some of fast and long-period pseudorandom number generators currently available are $\mathbb{F}_2$-linear generators. Such generators are usually assessed via the dimension of equidistribution. For computing these dimensions, some lattice basis reduction methods have been proposed. Tezuka (1994) proposed the resolution-wise lattice method. Couture and L'Ecuyer (2000) improved it by using the dual lattice. Recently, the faster methods SIS and PIS were introduced by the author, Matsumoto, and Saito. The new methods are based on the original resolution-wise lattice, not the dual one.

In this talk, we consider a merit of the dual lattice again. Usually, we only see the norm of the shortest vectors in the dual lattice, and other information is neglected. Here, we turn our attention to the $\mathbb{F}_2$-linear relations on the output obtained from the dual lattice, especially the minimal linear relations. We numerically analyze the $\mathbb{F}_2$-linear generator Mersenne Twister MT19937 (Matsumoto and Nishimura, 1998), and show that there exist some simple constant $\mathbb{F}_2$-linear relations on the most significant bits in the higher dimensions than 623. From this, we pick up certain non-successive output values with the lacunary filters, and make low-dimensional vectors, similarly to (L'Ecuyer and Touzin, 2004). Then, such vectors are rejected or have suspicious p-values in the birthday spacings tests of the TestU01 package.

Friday 17 February 2012, 10:00 – 10:30, CATS Theatre G02

Randomized complexity of parametric problems

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Special session: Multilevel Monte Carlo Methods p.65

We present a general scheme of solving parameter-dependent numerical problems in classes of smooth functions by the Monte Carlo method. The algorithm is a multilevel procedure. As an application, we consider parametric indefinite integration. The latter is then used to study the randomized complexity of solving parameter-dependent initial value problems for ordinary differential equations.

Comparisons to the deterministic setting are given, as well.

Tuesday 14 February 2012, 16:30 – 17:00, CATS Theatre G23

Assessing randomness via uniform distribution theory: tools from b-adic analysis

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Special session: Measures of Pseudorandomness p.62

How to assess randomness of a finite string of numbers or digits? Among the present numerical measures for this task, several figures of merit stem from the theory of uniform distribution of sequences.

In our talk, we will show different possibilities to estimate discrepancy and to define diaphony of finite point sets in the s-dimensional unit cube. We will explore relations to b-adic harmonic analysis and introduce new versions of the spectral test.

Our approach leads to new criteria in this area and also prepares for new construction methods for sequences of various types.

Wednesday 15 February 2012, 10:00 – 10:30, CATS Theatre G23

Bayesian computation and diffusion processes

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Special session: Recent Advances in MCMC p.71

Sampling intractable posterior distributions is typically done by using one of the classical samplers: Gibbs, Metropolis-Hastings or a hybrid version. In recent years, several algorithms for simulating diffusion processes have been developed. In this work we show how simulating solutions of stochastic differential equations can be used in the context of Bayesian computation from two points of view: (1) as a tool for sampling posterior distributions and (2) as a tool for efficient likelihood evaluation via probabilistic representations of an important class of forward models. From a computing perspective, we show the advantages of using parallel computing on graphics cards (GPU). We apply the proposed methods to several complex data sets from earth sciences.

Thursday 16 February 2012, 14:50 – 15:20, CATS Room 163

A random walk on moving spheres approach for the simulation of Bessel hitting times

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The Laplace transform permits in general to describe the hitting times of Bessel processes but seems difficult to be used for simulations. The aim of the talk is to present a new simulation method. This efficient algorithm used for hitting times of a general Bessel process needs two essential tools : first the method of images (Daniels) associated with the first time the Brownian motion hits a moving boundary and secondly the walk on spheres algorithm usually used for solving the heat equation.

Comparing with Euler scheme this new method allows to approach unbounded stopping times. Numerically, the algorithm needs only few steps.

Friday 17 February 2012, 10:00 – 10:30, The Law Theatre G04

Discrepancy of structured sets

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

It is notoriously difficult to compute or even sensibly estimate the star discrepancy of arbitrary concrete sets in high dimensional unit cubes. Nevertheless we know from a result of S. Heinrich, E. Novak, G. Wasilkowski and H. Woźniakowski that there exist n-point sets with star discrepancy smaller than $c\sqrt{d/n}$ where c does not depend on the dimension d. We investigate explicitly constructible sets with additional structure which allows estimates for the star discrepancy. This approach is unlikely to yield sets with a star discrepancy as good as the bound of Heinrich et al. guarantees if the dimension is really high. On the other hand we obtain in relatively high dimensions explicit sets with the best known star discrepancy. In particular, we find a point set with cardinality less than 1528 and discrepancy 1/4 in dimension 15, which solves one of the instances of the Open Problem 42 in the monograph *Tractability of Multivariate Problems* of E. Novak and H. Woźniakowski.

Monday 13 February 2012, 11:00 – 11:30, The Law Theatre G04

On the properties and the construction of finite row (t, s)-sequences

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Special session: Theoretical and Computational Aspects of Discrepancy p.73

We consider the special class of digital (t, s)-sequences where the generator matrices are finite row matrices, that are $\mathbb{N} \times \mathbb{N}$-matrices satisfying that each row consists of only finitely many nonzero entries. We discuss different ways of constructing such finite row generator matrices and identify certain interesting properties of these matrices and the corresponding low-discrepancy sequences.

Thursday 16 February 2012, 11:00 – 11:30, CATS Theatre G23

General nonlinear dependence structure for multispecies modelling

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Special session: Advances in MCMC and SMC Methods: Solutions for Complex Ecological Problems p.55

We develop several novel multi-species statistical models that account for temporal changes in the mean population size of each species. The mean population sizes evolve according to multivariate doubly stochastic Poisson processes, where the latent intensity of each species is a stochastic process that uses a parametric Gompertz model to capture ecological density-dependence. We consider several types of homogeneous temporal dependence among species: independence, linear dependence, and nonlinear dependence. These dependence structures are constructed from parametric copulas; we consider the Gaussian copula, Student-t copula, Archimedean copulas, and mixtures of the latter. We develop a unique solution for the stochastic count process by introducing this dependence into environmental stochasticity that drives the latent process. Our goal is to estimate differences in time series forecasts for small pelagic fish and probabilities of extinction risk for avian populations. We therefore derive Bayesian models with the required full conditional posterior distributions for each model that allows us to use a special version of an MCMC sampler, known as the slice sampler, to perform estimation of parameters in each model. The slice sampler is selected as it is efficient and available now in standard software packages, such as R and Matlab, that are used by ecologists. We demonstrate our models and estimation methodology on both synthetic and real data sets.

Thursday 16 February 2012, 15:20 – 15:50, CATS Room 101

Properties of the stochastic approximation schedule in the Wang-Landau algorithm

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Special session: Adaptive MCMC: Theory, Algorithms, and Applications p.54

We consider variations of the Wang-Landau algorithm that use the Flat Histogram criterion. This is an adaptive MCMC algorithm in the sense that the target distribution changes over the iterations. It relies on a stochastic approximation type of decreasing schedule, which decreases only when some criterion, computed using the history of the chain, is met. The decreasing schedule is hence stochastic, and whether the schedule actually decreases in finite time or not is still largely unsettled. We consider the problem as the study of an adaptive MCMC algorithm where no "diminishing adaptation" condition holds, and propose a convergence study of it. Eventually we study the possibility of simply removing the stochastic schedule and show that the algorithm remains valid in some sense.

Thursday 16 February 2012, 15:50 – 16:20, CATS Theatre G02

Calculation of the intermediate bound on the star discrepancy

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Special session: Theoretical and Computational Aspects of Discrepancy p.73

At the previous MCQMC conference, an intermediate bound on the star discrepancy was introduced. For a d-dimensional rank-1 lattice rule with n points and with generating vector $\boldsymbol{z}$, this intermediate bound depended on a quantity labelled $W(\boldsymbol{z}, n)$.

This $W(\boldsymbol{z}, n)$ is the lattice rule quadrature error in approximating the integral of

$$\prod_{i=1}^{d} F_n(x_i), \quad \text{where} \quad F_n(x) = 1 + \frac{1}{n} \sum_{\substack{-n/2<h\leq n/2 \\ h\neq 0}} G(|h|/n) e^{2\pi i h x}, \qquad x \in [0,1).$$

Here G is a particular piecewise continuous function.

Calculation of $W(\boldsymbol{z}, n)$ as a quadrature error requires $O(n^2 d)$ operations. Here we show how $W(\boldsymbol{z}, n)$ may be calculated to a fixed precision in $O(nd)$ operations. This is based on an asymptotic expansion of F_n. For example, $F_n(j/n)$ for j sufficiently large may be calculated to an accuracy of $\varepsilon = 10^{-18}$ by using 20 terms of the asymptotic expansion.

Tuesday 14 February 2012, 15:00 – 15:30, CATS Room 101

On computationally efficient estimation of the variance of the randomised quasi Monte Carlo estimate

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Randomised versions of the Quasi Monte Carlo Methods are used to enable estimation of uncertainty associated with the estimate. However, accurate estimation of variance for RQMC estimates is non-trivial. The method capable of accurately estimating this variance is computationally expensive and thus negates the computational advantage that RQMC methods otherwise enjoy over the usual MC methods. Although the theoretical upper-bounds for the variance are known for integrands with certain properties, using these bounds in practice may result in conservative estimates.

In this work, we aim to develop a computationally efficient methodology which will enable accurate estimation of the variance of the RQMC estimate for a wide range of integrands. We explore a novel approach to estimate the variance. We illustrate our ideas using simple examples which also throw an interesting insight into RQMC covariance structures.

Monday 13 February 2012, 16:00 – 16:30, CATS Room 163

Algorithmic Hessians and the fast computation of cross-gamma risk

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Special session: Computational Finance p.58

We introduce a new methodology for computing Hessians from algorithms for function evaluation, using backwards methods. We show that the complexity of the Hessian calculation is a linear function of the number of state variables times the complexity of the original algorithm. We apply our results to computing the Gamma matrix of multi-dimensional financial derivatives including Asian Baskets and cancellable swaps. In particular, our algorithm for computing Gammas of Bermudan cancellable swaps is order $O(n^2)$ per step in the number of rates. We present numerical results demonstrating that computing all the $n(n+1)/2$ Gammas in the LIBOR market model takes roughly $n/3$ times as long as computing the price.

Wednesday 15 February 2012, 11:00 – 11:30, The Law Theatre G04

Generated sets as sampling schemes for hyperbolic cross trigonometric polynomials

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

A straightforward discretization of high dimensional problems often leads to an exponential growth in the number of degrees of freedom. So, computational costs of even efficient algorithms like the fast Fourier transform increase similar.

Trigonometric polynomials with frequencies only supported by hyperbolic crosses allow for a good approximation of functions of appropriate smoothness and decrease the number of used Fourier coefficients strongly.

We consider sampling sets generated by a vector similar to rank-1 lattices. Therewith an easy and fast evaluation of trigonometric polynomials at all sampling nodes is guaranteed. Some additional assumptions ensure a stable reconstruction of trigonometric polynomials from the sampling values.

We discuss some existence results and search strategies for suitable generating vectors. In addition to known search strategies for rank-1 lattices we can use continuous optimization methods here.

Tuesday 14 February 2012, 16:00 – 16:30, CATS Room 163

Bayesian approaches to the design of Markov chain Monte Carlo samplers

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Special session: Advances in MCMC Methodology p.56

In the decades since Markov chain Monte Carlo methods were first introduced, they have revolutionised Bayesian approaches to statistical inference. Each new advance in MCMC methodology produces near immediate benefits for Bayesian practitioners, expanding the range of problems they can feasibly solve. In this paper, I explore ways in which Bayesian approaches can return something of the debt owed to MCMC, by using explicitly Bayesian concepts to aid in the design of MCMC samplers.

The art of efficient MCMC sampling lies in designing a Markov process that a) has the required limiting distribution, b) has good mixing properties and c) can be implemented in a computationally efficient manner. In this paper, I explore the idea that the selection of an appropriate process, and in particular the tuning of the parameters of the process to achieve the above goals, can be regarded as a problem of estimation. As such, it is amenable to a conventional Bayesian approach, in which a prior distribution for optimal parameters of the sampler is specified, data relevant to sampler performance is obtained and a posterior distribution for optimal parameters is formed. Sampling from this posterior distribution can then be incorporated into the MCMC sampler to produce an adaptive method.

Wednesday 15 February 2012, 14:30 – 15:00, CATS Theatre G02

Deterministic consistent light transport simulation

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So far tensor product quasi-Monte Carlo techniques have been the only deterministic approach to consistent density estimation. We improve the convergence by introducing a new quasi-Monte Carlo scheme that is based on a combination of deterministic replication and scrambling. Applying the technique to transport simulation algorithms provides new insight and generalizes previous approaches.

Thursday 16 February 2012, 10:30 – 11:00, CATS Theatre G23

Estimation of stage duration distributions from cohort data on arthropods

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Special session: Advances in MCMC and SMC Methods: Solutions for Complex Ecological Problems p.55

Insects and other arthropods develop through a series of distinct life stages, perhaps from eggs to larvae to pupae into adults. Estimating the time individuals spend within each of these stages is important for biological understanding of population dynamics and in applications such as pest management. Many arthropod species are small, and following individual organisms through their life cycle can be difficult or virtually impossible, even in controlled laboratory environments. As an alternative, data may be collected by following a cohort of individuals and sample or count the number of individuals within each of the stages. Current methods for estimating duration distributions from such data are not very flexible. We discuss Monte Carlo approaches to address this problem under different sampling methods that are common in ecological studies of structured development.

Monday 13 February 2012, 10:30 – 11:00, CATS Theatre G02

Strong convergence of a fully discrete approximation of a class of stochastic Volterra equations

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Special session: Computational SPDEs p.59

We investigate a discrete approximation in space and time of a linear stochastic evolution equation with a positive-type memory term driven by an additive noise of the form

$$du + \left(\int_0^t b(t-s) Au(s)\, ds \right) dt = dW, \quad u(0) = u_0 \in H, \quad t \in [0, T],$$

where W is a Q-Wiener process on an Hilbert space $H = L_2(\mathcal{D})$ and b is a 3-monotone real-valued positive definite integrable kernel on $\mathbb{R}_+$ such that the homogeneous equation remains parabolic. In particular, we assume that

$$\beta := \frac{2}{\pi} \sup\{|\arg \widehat{b}(\lambda)|,\ \mathrm{R}e(\lambda) \geq 0\} \in (0, 1),$$

where $\widehat{b}$ denotes the Laplace transform of b.

We let A be a densely defined, unbounded, self-adjoint, positive linear operator on H. We also assume that there exists $\alpha > 0$ such that $A^{-\alpha}$ has finite trace and that Q is bounded from H into $D(A^\kappa)$ for some $\kappa \geq 0$.

The numerical scheme is based on the implicit Euler scheme and a Laplace transform convolution quadrature in time (with parameter $\Delta t = T/N$), and a continuous piecewise linear finite element method in space (with parameter h). Let u_n^h be the discrete solution. We show that

$$\left(\mathrm{E}\|u_N^h - u(T)\|^2 \right)^{1/2} \leq C(h^\nu + \Delta t^\gamma),$$

for any $\gamma < \min(\frac{1}{2}, \frac{1-\rho(\alpha-\kappa)}{2})$ and $\nu \leq \min(2, \frac{1}{\rho} - \alpha + \kappa)$.

Monday 13 February 2012, 16:00 – 16:30, CATS Theatre G02

Finite mixed quasi-Monte Carlo point sets

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

Quasi-Monte Carlo (QMC) methods are useful tools in numerical integration. For the point sets serving as the integration nodes in QMC algorithms, it is advantageous if they are evenly spread in the integration domain. A recent topic in this field of research is that of mixed QMC point sets, which are finite or infinite sequences of points in the unit cube, the components of which stem from two or more different other QMC point sets. In this talk, we present results on finite sequences that are obtained by mixing Hammersley point sets with lattice points. We consider the star discrepancy, which gives information about the quality of distribution of finite or infinite sequences. We present existence results for finite mixed point sets with low discrepancy, thereby making analogous results for infinite sequences more explicit.

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Friday 17 February 2012, 11:00 – 11:30, CATS Theatre G23

Greedy servers on a torus

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

Queuing systems in which customers arrive at a continuum of locations, rather than at a finite number of locations, have been found to provide good models for certain telecommunication and reliability systems. In this talk the continuum is the unit square, where the opposite edges have been glued together to form a flat *torus*. Points arrive according to a Poisson process with a fixed arrival rate and are removed by one or more servers. The configuration of waiting customers thus forms a two-dimensional dynamic point process. We investigate properties of this spatial system under various server strategies. We find that the greedy strategy, where a server simply heads for its closest point, results in a stable system and we analyse the equilibrium distribution. The greedy strategy is inefficient, in part because multiple greedy servers coalesce. We investigate the expected time until this occurs and identify improvements to the greedy strategy.

Tuesday 14 February 2012, 14:30 – 15:00, CATS Room 101

Metamodelling and sensitivity analysis of models with dependent variables

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For computationally expensive models the replacement of complex models by metamodels is a practical way of making computations tractable. The majority of known methods deal with models with independent input variables. We present two different metamodelling techniques for models with dependent input variables. Both techniques are based on applications of ANOVA decomposition and polynomial chaos expansions. Coefficients of decomposition are evaluated by the Quasi Monte Carlo method based on Sobol sequences. The first technique consists of transforming the dependent input vector into a Gaussian independent random vector and then applying decomposition of the model using tensored Hermite polynomial basis. The second approach is based on the direct decomposition of the model function using a basis which consists of the marginal distributions of the input components and their joint distribution. The copula technique is used in both methods. We aslo present a novel approach for estimation of variance based global sensitivity indices for models with dependent variables. Both the first order and total sensitivity indices are derived as generalizations of Sobol sensitivity indices for independent variables. Formulas and Monte Carlo numerical estimates similar to Sobol formulas are derived. The behaviour of sensitivity indices depends on the relative predominance of interactions and correlations. We present numerical and analytical results for benchmark test cases.

Thursday 16 February 2012, 11:00 – 11:30, The Law Theatre G04

Applications of metric entropy in analysis and probability

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Special session: Small Ball Problems, Discrepancy, and Metric Entropy p.72

The notion of metric entropy is very general and flexible, and so it has found over the years many important applications in such diverse branches of mathematics as approximation theory, functional analysis, PDEs, probability, and more recently also in learning theory and compressed sensing.

In the talk some of these applications will be presented, in particular in connection with eigenvalues distributions of operators in Banach spaces, compact embeddings of Sobolev and Besov spaces, and small deviations of Gaussian processes. Moreover I will discuss how the corresponding results depend on the dimension (of the underlying domain of the function spaces, or the index set of the processes, respectively).

Monday 13 February 2012, 17:30 – 18:00, CATS Theatre G23

On the lattice structure of a special class of multiple recursive generators

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Special session: Random Number and Random Variate Generation p.70

We examine some properties of the points produced by certain classes of long-period linear multiple recursive random number generators proposed by Deng and his co-authors in a series of papers. These generators have their parameters selected in special ways to make the implementation faster by reducing the number of required multiplications. The main idea is to have only a small number of distinct nonzero values for the coefficients of the recurrence. We show that as a result, the points produced by these generators have a poor lattice structure, and a poor initialization of the state can have a long-lasting impact, because of the limited diffusion capacity of the recurrence. We study the lattice structure of points constructed by taking output values from this generator at specific lags and we provide theoretical bounds on the corresponding spectral test values. We also compare these bounds with the actual spectral test values computed for several examples of proposed generators.

Thursday 16 February 2012, 10:00 – 10:30, The Law Theatre G04

On the small ball inequality in dimensions 3 and higher

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Special session: Small Ball Problems, Discrepancy, and Metric Entropy p.72

We will state the conjectural small ball inequality, review progress towards proving it. There are some subcases of the conjecture that should be much easier, but are still quite hard. A heuristic argument for the correctness of the conjecture is recalled.

Monday 13 February 2012, 11:00 – 11:30, CATS Theatre G02

On wavelet-Galerkin methods for semilinear parabolic equations driven by additive noise

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Special session: Computational SPDEs p.59

We consider the semilinear stochastic heat equation perturbed by additive noise. After time-discretization by Euler's method the equation is split into a linear stochastic equation and a non-linear random evolution equation. The linear stochastic equation is discretized in space by a non-adaptive wavelet-Galerkin method. This equation is solved first and its solution is substituted into the nonlinear random evolution equation, which is solved by an adaptive wavelet method. We provide mean square estimates for the overall error.

Wednesday 15 February 2012, 11:00 – 11:30, CATS Theatre G23

Why does the Gibbs sampler work on hierarchical models?

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Special session: Recent Advances in MCMC p.71

Gibbs sampling and related MCMC have been incredibly successful in Bayesian statistics during the last 20 years. However, a theoretical understanding of exactly why the methods work so well on important classes such as hierarchical models still eludes us. This talk will shed some light on the problem by describing qualitative convergence results for Gibbs samplers on hierarchical models such as uniform, geometric and sub geometric ergodicity.

Thursday 16 February 2012, 16:20 – 16:50, CATS Theatre G23

A QMC-spectral method for elliptic PDEs with random coefficients on the unit sphere

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Special session: Numerics for SDEs p.67

We present an quasi-Monte Carlo spectral method for a class of elliptic partial differential equations (PDEs) with random coefficients defined on the unit sphere. We follow a model studied by Kuo-Sloan-Schwab for a class of stochastic PDEs on bounded domains. However our assumptions are more concrete, imposed on the eigenvalues of the integral operators arising from the covariance kernel rather than the eigenfunctions themselves.

Thursday 16 February 2012, 15:20 – 15:50, CATS Room 163

Neutron and photon next-event estimator benchmarks for intercode comparisons

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In this work we report on benchmark calculations with three Monte-Carlo codes namely DIANE, TRIPOLI and MCNP. Comparisons are based on two geometries both intentionally simple. One is cylindrical with eight detectors positioned around the cylinder ; the other is typical from a radiographic test problem with a two dimensional flux tally. In both cases we evaluate flux using the next-event estimator method. For the cylindrical case, the study will report on the results obtained with different source particles (neutron and gamma) and different energy-material combinations. In the radiographic case, we will compare results obtained with the three above-mentioned code for the unscattered and scattered radiographs.

Monday 13 February 2012, 17:30 – 18:00, CATS Room 163

Fast orthogonal transforms and generation of Brownian paths

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Special session: Computational Finance p.58

We present a couple of fast constructions of discrete Brownian paths that can be used as alternatives to principal component analysis and Brownian bridge for stratified Monte Carlo and quasi-Monte Carlo. By fast we mean that a path of length n can be generated in $O(n \log(n))$ floating point operations.

We present practical examples of fast and efficient construction algorithms combined with quasi-MC integration.

Tuesday 14 February 2012, 15:00 – 15:30, CATS Theatre G02

Fast evaluation of mixed derivatives and calculation of optimal weights for integration

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We present a new method for fast and accurate evaluation of mixed derivatives for functions $f : \mathbb{R}^d \to \mathbb{R}$ by means of algorithmic differentiation. We assume that f is evaluated by a procedure that can be interpreted as a sequence of elementary arithmetic operations and intrinsic functions, which is the case in many practical applications. For a fixed given function f, weights are required for construction of lattice rules for integration. The weights define the embedding of f on a weighted unanchored Sobolev space. 'Optimal weights' are chosen to minimize certain upper bounds for the worst case integration error over these spaces. We use the new algorithmic differentiation technique for a low cost computation of 'optimal weights', and consider examples related to finance.

Monday 13 February 2012, 16:00 – 16:30, CATS Theatre G23

Generating generalized inverse Gaussian distributed random variates

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Special session: Random Number and Random Variate Generation p.70

We discuss methods for sampling Generalized Inverse Gaussian (GIG) distributed random variates both in the fixed and in the varying parameter case. In particular we present a new algorithm for the varying parameter case. It is based on the acceptance-rejection method and has, different to all algorithms presented in the literature, a uniformly bounded rejection constant.

Thursday 16 February 2012, 15:50 – 16:20, CATS Room 101

Stochastic approximation Monte Carlo for high dimensional generalized linear models and related asymptotics

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Special session: Adaptive MCMC: Theory, Algorithms, and Applications p.54

We propose a new prior setting for high dimensional generalized linear models (GLMs), which leads to a Bayesian subset regression (BSR). Under mild conditions, we establish consistency of the posterior. The posterior is sampled using an adaptive MCMC algorithm—stochastic approximation Monte Carlo. Further, we propose a variable screening procedure based on the marginal inclusion probability and show that this procedure shares the same properties of sure screening and consistency with the existing sure independence screening (SIS) procedure. However, since the proposed procedure makes use of joint information of all predictors, it generally outperforms SIS and its improved version in real applications. For subject classification, we propose a selected Bayesian classifier based on the goodness-of-fit test for the models sampled from the posterior. The new classifier is consistent and robust to the choice of priors. The numerical results indicate that the new classifier can generally outperform the Bayesian model averaging classifier and the classifier based on the high posterior probability models. We also make extensive comparisons of BSR with the popular penalized likelihood methods, including Lasso, elastic net, SIS and ISIS. Our numerical results indicate that BSR can generally outperform the penalized likelihood methods: The models selected by BSR tend to be sparser and, more importantly, of higher generalization ability. In addition, we find that the performance of the penalized likelihood methods tend to deteriorate as the number of predictors increases, while this is not significant for BSR.

Thursday 16 February 2012, 11:00 – 11:30, CATS Theatre G02

On simulation of some functionals of fractional Brownian motion

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Special session: Computational Finance p.58

The problem of calculations of functionals of fractional Brownian motion (fBm) often arises in different applications of modern finance and statistics of random processes but analytical methods for solving this problem are yet to be developed. At the beginning of the talk we describe a fast method for simulation of trajectories of fBm which is based on the use of parallel computations. Then we illustrate the performance of the method for two long-standing unsolved problems: calculation of moments of integral functionals of fBm and the distribution of the maximum of fBm.

Friday 17 February 2012, 11:30 – 12:00, CATS Theatre G23

Monte Carlo methods in spatio-temporal regression modelling of migration in the EU

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

Spatio-temporal regression models are well developed in disciplines such as, for example, climate and geostatistics, but have had little application in the modelling of economic phenomena. In this study we have modelled migrations of workers and firms across the European Union during the period 1988-2005. The data set has been extracted from Eurostats Labour Force Survey (LFS) and contains information stratified by European region. It is interesting to determine whether the spatial component in the migration patterns is based either on neighbourhood, on distance or on some other metric (such as travel time). A preliminary test for spatial autocorrelation in residuals from an estimated linear model (Morans I test) suggests the existence of a significant spatial effect. The complete spatio-temporal model has been implemented using conditional auto- regressive (CAR) and simultaneously autoregressive (SAR) random effects in the Bayesian framework. In recent years, Bayesian methods have been widely applied to spatio-temporal modelling since they enable the use of Markov chain Monte Carlo (MCMC) samplers to estimate parameters of the model. In this talk, we consider various Monte Carlo approaches (including advanced MCMC methods) to estimate model parameters, and we compare different computing schemes.

Friday 17 February 2012, 10:30 – 11:00, The Law Theatre G04

Quasi-Monte Carlo methods for integration of functions with dominating mixed smoothness

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

In a celebrated construction, Chen and Skriganov gave explicit examples of point sets achieving the best possible L_2-norm of the discrepancy function. We consider the discrepancy function of the Chen-Skriganov point sets in Besov spaces of dominating mixed smoothness and show that they also achieve the best possible rate in this setting. The proof uses a b-adic generalization of the Haar system and corresponding characterizations of the Besov space norm. Results for further function spaces and integration errors are concluded.

Wednesday 15 February 2012, 14:30 – 15:00, CATS Room 101

The stochastic EM algorithm for censored mixed models

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The stochastic EM algorithm is an MCMC method for approximating the regular EM algorithm in missing data situations where the E-step is intractable. It produces a stationary Markov chain iterative sequence where each iteration is the result of applying a complete data MLE to a single simulation of the complete data conditional on the observed data. Similarly to other MCMC methods, the final estimate is the mean of the iterative sequence after a suitable burn-in period. The method will be considered for censored mixed models, a computationally challenging context. The stochastic EM algorithm is particularly simple to apply to either linear or nonlinear mixed models with censoring. All that is required is a routine to simulate censored multinormal observations, and a routine to fit the desired uncensored mixed model. An application will be presented involving repeated measures of HIV viral load subject to left censoring caused by a lower detection limit of the assay. The analysis provides insights into sources of variation in the rate of increase of viral load after loss of viral suppression. It is found that crude methods ignoring the censoring are biased compared to the stochastic EM results.

Thursday 16 February 2012, 11:30 – 12:00, CATS Theatre G02

Figure of merit efficient QMC pointsets for computational finance

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Special session: Computational Finance p.58

Recent work by Matsumoto, Saito, and Matoba presents the idea, informed by a similar notion from coding theory, of employing a random search for a good pointset upon which to perform QMC integration, guided by a measure they term the "Walsh figure of merit", or WAFOM. WAFOM is a simple, computable statistic defined for $\mathbb{F}_2$ linear pointsets that offers a Koksma-Hlawka type upper bound (due to Josef Dick) on QMC integration error.

The speed of computation, make a principled random search for good pointsets possible. This paper collects some results and guidance, both experimental and theoretical, related to the efficiency of this method. In particular, we present *particular* pointsets of practical size and dimensionality that have a WAFOM near a hypothesized lower bound. The efficacy of this theoretical bound is examined on some canonical problems in computational finance, where the performance on certain types of integrals that is far better than can be shown formally is noted.

Monday 13 February 2012, 16:30 – 17:00, CATS Theatre G23

A deviation of CURAND standard pseudorandom number generator in CUDA for GPGPU

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Special session: Random Number and Random Variate Generation p.70

CUDA is a developing environment for General Purpose computation by Graphic Processing Units (GPGPU). In 2010, CUDA released a pseudorandom number generator curand. This is the xorwow generator introduced by Marsaglia, which is a combination of a xorshift (i.e. a vector-wise $\mathbb{F}_2$-linear shift register generator) of period $2^{160} - 1$ and an additive generator of period 2^{32}.

The generation speed of xorwow is excellent, but we found its observable deviations on the lower bits of the outputs, through a well-known statistical test suits BIG-CRUSH in TESTU01 by Simard and L'Ecuyer.

If we take the difference of the outputs modulo 1, namely, if we test $y_n := x_n - x_{n-1}$ *modulo* 1, then the deviation of the sequence is more serious: The sequence is rejected by many other tests, including a gap test, which tests the numbers as real numbers (i.e. not testing the lower bits only).

We analyze this deviation. Roughly saying, the xorshift generator component has too sparse transition matrix and the output sequence has linear relations with small number of terms, which results in a strong deviation of the outputs. The deviation of the xorshift generator is improved by the additive generator, but taking difference turns out to remove large part of this effect.

Monday 13 February 2012, 14:30 – 15:00, CATS Theatre G23

Sampling and low rank tensor approximations

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Most (quasi)-Monte Carlo procedures can be seen as computing some integral over an often high-dimensional domain. If the integrand is expensive to evaluate we are thinking of a stochastic PDE (SPDE) where the coefficients are random fields and the integrand is some functional of the PDE-solution there is the desire to keep all the samples for possible later computations of similar integrals. This obviously means a lot of data. To keep the storage demands low, and to allow evaluation of the integrand at points which were not sampled, we construct a low-rank tensor approximation of the integrand over the whole integration domain. This can also be viewed as a representation in some problem-dependent basis which allows a sparse representation. What one obtains is sometimes called a surrogate or proxy model, or a response surface. This representation is built step by step or sample by sample, and can already be used for each new sample. In case we are sampling a solution of an SPDE, this allows us to reduce the number of necessary samples namely in case the solution is already well-represented by the low-rank tensor approximation. This can be easily checked by evaluating the residuum of the PDE with the approximate solution. The procedure will be demonstrated in the computation of a compressible transsonic Reynolds-averaged Navier-Strokes flow around an airfoil with random/uncertain data.

Tuesday 14 February 2012, 10:30 – 11:00, The Law Theatre G04

Examples and comparisons of rigorous error bounds for MCMC estimates, Part II

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Special session: Explicit Error Bounds for Markov Chain Monte Carlo p.60

In the vast literature on nonasymptotic analysis of Markov chains, rigorous and explicit bounds on MCMC errors are not very numerous. Available results include exponential inequalities, bounds on MSE or, more generally, the L^p-norm of error, combined with application of the median trick. Techniques used to derive these results involve martingale theory, spectral decomposition, concentration of measure, renewal theory. In the case of general state space, most of known explicit bounds are expressed in terms of conductance, minorization constants or drift conditions.

In our talk we will attempt to compare some of the above mentioned bounds in several examples, ranging from toy examples to more challenging realistic MCMC algorithms in statistical models of practical relevance. This talk is the second of two parts, based on a joint paper [K. Łatuszyński, B. Miasojedow, W. Niemiro: Nonasymptotic bounds on the estimation error of MCMC algorithms, arXiv:1106.4739, 2011]. It will focus on examples in which the chains are either uniformly or polynomially ergodic.

Wednesday 15 February 2012, 11:30 – 12:00, The Law Theatre G04

A general software tool for constructing rank-1 lattice rules

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Coauthor(s): Pierre L'Ecuyer

Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

We present Lattice Builder, a software tool and library written in C++, that implements a variety of construction algorithms for good rank-1 lattice rules. Exhaustive search, Korobov, CBC and random CBC constructions are supported for any number of points, both for the weighted $\mathcal{P}_{2\alpha}$ discrepancy and for figures of merit based on the spectral test, with projection-dependent weights. For the $\mathcal{P}_{2\alpha}$ criterion, more efficient specializations of the CBC algorithm are provided for order-dependent and product weights. For numbers of points that are integer powers of a prime base, the construction of embedded rank-1 lattice rules is supported through any of the above algorithms, and also through the fast CBC algorithm. Different choices are available for the normalization of the merit values of individual embedded levels and for their combination into a single figure of merit. The library is extensible thanks to the splitting of the algorithms into independent components that allow users to implement new types of weights, new search domains, new figures of merit, etc.

Thursday 16 February 2012, 10:00 – 10:30, CATS Theatre G23

Particle Markov chain Monte Carlo methods in marine biogeochemistry

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Special session: Advances in MCMC and SMC Methods: Solutions for Complex Ecological Problems p.55

We report on progress in applying particle Markov chain Monte Carlo (PMCMC) methods for state and parameter estimation in the domain of marine biogeochemistry, motivated by a desire to quantify uncertainty in forecasts used for environmental management. Process models in this area combine physical ocean models with highly nonlinear biology, and may have significant dimensionality. We highlight advances in dealing with the particular challenges that these cases pose: the absence of a closed-form transition density, sensitivity to initial conditions and sparse observation regimes among others. Along the way we draw general lessons as to the behaviour of PMCMC methods in the wild, and strategies for improving their performance on this difficult class of problems.

Tuesday 14 February 2012, 11:30 – 12:00, CATS Theatre G23

Transforming spatial point processes into Poisson processes using random superposition

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

Most finite spatial point process models specified by a density are locally stable, implying that the Papangelou intensity is bounded by some integrable function β defined on the space for the points of the process. It is possible to superpose a locally stable spatial point process X with a complementary spatial point process Y to obtain a Poisson process $X \cup Y$ with intensity function β. Underlying this is a bivariate spatial birth-death process (X_t, Y_t) which converges towards the distribution of (X, Y). In Møller and Berthelsen (2012; to appear in Advances in Applied Probability, 44) we study the joint distribution of X and Y, and their marginal and conditional distributions. In particular, we introduce a fast and easy simulation procedure for Y conditional on X. This may be used for model checking: given a model for the Papangelou intensity of the original spatial point process, this model is used to generate the complementary process, and the resulting superposition is a Poisson process with intensity function β if and only if the true Papangelou intensity is used. Whether the superposition is actually such a Poisson process can easily be examined using well known results and fast simulation procedures for Poisson processes. We illustrate this approach to model checking in the case of a Strauss process.

Thursday 16 February 2012, 16:20 – 16:50, CATS Room 101

Model selection in wireless communications via Contour Monte Carlo and Trans-dimensional MCMC incorporating stochastic approximation

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Coauthor(s): Ido Nevat, Gareth W. Peters, Jinhong Yuan, Francois Septier

Special session: Adaptive MCMC: Theory, Algorithms, and Applications p.54

We study a class of wireless communications problems involving estimation of the physical wireless channel which requires solution to a statistical problem of model selection. We develop two solutions, one which involves a Contour Monte Carlo (Wang Landau) approach incorporating a Birth and Death Reversible Jump Markov chain Monte Carlo (MCMC) algorithm and the second which involves an adaptive Trans-dimensional MCMC algorithm. The proposal in the second approach is constructed via incorporation of stochastic approximation and Conditional Path Sampling. We compare the performance of these two solutions on a challenging signal processing problem in OFDM wireless communication models.

Thursday 16 February 2012, 11:30 – 12:00, CATS Theatre G23

Spatio-temporal modelling of delta smelt in the San Francisco Estuary

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Special session: Advances in MCMC and SMC Methods: Solutions for Complex Ecological Problems p.55

A spatially explicit state-space model for the population dynamics of the endangered delta smelt was fit using data collected from multiple surveys over recent decades. Probability of movement between regions was informed by hydrodynamic model output. Data from multiple surveys reflected different life history stages of the fish, and co-located biotic and abiotic environmental data were used to model vital rates. The ultimate aim of the model is to use it for doing population viability analyses, and, in particular, to assess the effects of management actions. Model fitting and assessment was done in a Bayesian framework.

Monday 13 February 2012, 10:00 – 10:30, CATS Theatre G02

Fast QMC integration for lognormal random fields

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Special session: Computational SPDEs p.59

Partial differential equations with lognormal random fields in the coefficients are notoriously high-dimensional problems and consequently are difficult calculate integrals or expected values on. Here we present recent results on obtaining convergence of QMC quadrature, in particular results relevant to the "smoothness" of the random field, and examine computational results on the porous-media Darcy flow problem.

Monday 13 February 2012, 11:30 – 12:00, The Law Theatre G04

Improved discrepancy bounds for hybrid sequences

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Special session: Theoretical and Computational Aspects of Discrepancy p.73

Hybrid sequences were introduced by Spanier with a view to combine advantageous features of Monte Carlo methods and quasi-Monte Carlo methods. A hybrid sequence in a multidimensional unit cube is obtained by mixing two different types of sequences, usually a low-discrepancy sequence and a sequence of pseudorandom numbers or vectors. Discrepancy bounds for hybrid sequences have been established by the speaker and several other authors in recent years. This talk presents a new method of bounding the discrepancy of hybrid sequences which leads to improvements on earlier results.

Tuesday 14 February 2012, 10:00 – 10:30, The Law Theatre G04

Examples and comparisons of rigorous error bounds for MCMC estimates, Part I

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Coauthor(s): K. Łatuszyński, B. Miasojedow

Special session: Explicit Error Bounds for Markov Chain Monte Carlo p.60

In the vast literature on nonasymptotic analysis of Markov chains, rigorous and explicit bounds on MCMC errors are not very numerous. Available results include exponential inequalities, bounds on MSE or, more generally, the L^p-norm of error, combined with application of the median trick. Techniques used to derive these results involve martingale theory, spectral decomposition, concentration of measure, renewal theory. In the case of general state space, most of known explicit bounds are expressed in terms of conductance, minorization constants or drift conditions.

In our talk we will attempt to compare some of the above mentioned bounds in several examples, ranging from toy examples to more challenging realistic MCMC algorithms in statistical models of practical relevance. This talk is the first of two parts, based on a joint paper [K. Łatuszyński, B. Miasojedow, W. Niemiro: Nonasymptotic bounds on the estimation error of MCMC algorithms, arXiv:1106.4739, 2011]. It will contain a brief review of general bounds and then will focus on examples in which the chains are geometrically ergodic.

Tuesday 14 February 2012, 17:00 – 17:30, CATS Theatre G02

(In) tractability results for integration

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Coauthor(s): Aicke Hinrichs, Henryk Woźniakowski

Special session: Tractability of Multivariate Problems p.74

I will speak about some old and new (in) tractability results for integration.

The basic problem is: How many function values do we need to compute the integral of $f \in F_d$ up to an error ε? Here f depends on d variables.

For which classes F_d is this number $n(\varepsilon, F_d)$ polynomial in d (the problem is tractable) or exponential in d (curse of dimension)?

Wednesday 15 February 2012, 10:30 – 11:00, The Law Theatre G04

Lattice rules for nonperiodic smooth integrands

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Coauthor(s): Josef Dick, Friedrich Pillichshammer

Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

We show that lattice rules can achieve convergence rates of $O(N^{-\alpha+\delta})$, for arbitrary small $\delta > 0$, for nonperiodic smooth functions and without random shifting. For this we consider a reproducing kernel Hilbert space of cosine series where the smoothness is measured as the decay rate of the cosine coefficients. This function space is in between the standard Korobov and Sobolev spaces.

Monday 13 February 2012, 11:00 – 11:30, CATS Theatre G23

Variational approximations for Bayesian computation

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Special session: Fast Computational Methods for Large Scale Bayesian Inference p.61

Mean field variational Bayes, commonly acronymed VB, is the stock standard or standard type of variational approximation for Bayesian inference. VB is an extremely fast deterministic alternative to MCMC. Unfortunately VB suffers from two main drawbacks: flexibility and accuracy. In this talk I will discuss some alternatives to standard VB approximations which aim to tackle these drawbacks including tangent, parametric, structured, delta, finite mixture, auxiliary and quadrature variational approaches. Together these constitute a veritable arsenal of variational approximations to be used to tackle many real world problems of interest in an efficient manner.

Tuesday 14 February 2012, 16:00 – 16:30, CATS Theatre G23

New trends in pseudorandom number generation

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Special session: Measures of Pseudorandomness p.62

The goal of this talk is to present the state-of-the-art construction of pseudorandom number generators (PRNGs) using multivariate polynomials or rational functions. We recall that all previously known results are nontrivial only for those polynomial generators that produce sequences of extremely large period, which could be hard to achieve in practice. The reason behind this is that typically the degree or the number of terms of iterated polynomials grows exponentially, and that in all previous results the saving over the trivial bound has been logarithmic. To overcome these limitations, we present some new constructions of multivariate polynomial dynamical systems with a polynomial degree growth of its iterates (instead of the "typical" exponential growth) or a sparse representation. Dynamical systems generated by iterations of these polynomials have proved to admit good estimates of exponential sums along their orbits, which immediately imply nontrivial estimates on the discrepancy of such pseudorandom vectors. Constructing "good" PRNGs has made it clear that further progress here can only be achieved if more detailed information about the algebraic structure of polynomial iterates (such as irreducibility, non-singularity, etc) is available. Motivated by these applications we also discuss some (mostly widely open) questions associated to algebraic dynamical systems generated by multivariate polynomials or rational functions, which are of independent interest.

Monday 13 February 2012, 16:30 – 17:00, CATS Room 101

Approximate Bayesian computation and adaptive sequential Monte Carlo

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Special session: Approximate Bayesian Computation (ABC) and Likelihood-Free Inference p.57

For statistical modelling for investigations in diverse areas such as biological sciences, technology and finance, realistic models can be sufficiently complex so that the likelihood function is computationally intractable. Instead of discarding such models, so-called likelihood free techniques have been developed which depend upon efficient repeated simulation of data from the likelihood for different parameter values. In the context of Bayesian statistics, priors are introduced and approximations are required for the posterior distribution of unknown parameters, giving rise to Approximate Bayesian Computation (ABC). In the talk we describe a sequential Monte Carlo algorithm for ABC that is completely adaptive and requires very little tuning. This methodological development is illustrated by an application involving data on a parasite population and its evolution over time which is modelled by a multivariate stochastic process for which there is no tractable likelihood function. In order to find a near sufficient summary of the data we use an indirect inference approach where an auxiliary model is fitted to the data and numerical maximum likelihood estimates (MLE) provides the near sufficient summary of the data. The MLEs for the auxiliary model are used in the ABC algorithm to measure discrepancy between observed data and simulated data. Some issues of the choice of summary statistics and model choice are also discussed.

Thursday 16 February 2012, 15:20 – 15:50, CATS Theatre G02

L_2 discrepancy of digit scrambled two-dimensional Hammersley point sets

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Coauthor(s): Henri Faure

Special session: Theoretical and Computational Aspects of Discrepancy p.73

The two-dimensional Hammersley point set is a prototype of many point sets with low discrepancy. While the star discrepancy of the two-dimensional Hammersley point set is of best possible order of magnitude with respect to the general lower bound of Schmidt this is not the case for the L_2 discrepancy compared with Roth's general lower bound. This disadvantage can be overcome by introducing digit scramblings.

In a series of papers we analyzed the discrepancy of digit scrambled two-dimensional Hammersley point sets and provided digit scramblings which lead to the optimal order of magnitude for the L_2 discrepancy. The advantage of our approach is that in addition to obtaining the optimal order also the leading constants can be kept small. In this talk we give an overview of our results.

Monday 13 February 2012, 14:30 – 15:00, CATS Theatre G02

A linear-operator point-of-view on digital sequences

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Coauthor(s): R. Hofer

We introduce the view-point obtained by considering generator matrices of digital (t, s)-sequences as linear operators on polynomials. Primarily, this has the advantage that many of the classical constructions, such as Faure and Niederreiter sequences as well as their linearly scrambled versions have a rather lucid interpretation. This also applies to the more recent Hofer-Larcher (or finite-row) matrices and their sequences (also note the talk of R. Hofer on a related topic). Furthermore, the t-parameter can be obtained with a basically "noncombinatoric" condition (i.e., without ranging over the partitions of m for all $m \geq 0$), but rather in a form that resembles Riemann-Roch spaces. (While this may seem to complicate matters unnecessarily, it can also be argued that such a form leads to a more "natural" condition, possibly leading to very broad generalizations.) The verification of the t-parameters of the above-mentioned sequences very nicely involves unique factorization. In further developments the duality of sequences as introduced by Dick and Niederreiter might be incorporated within our view-point, in a further extension perhaps also the celebrated algebraic-geometric constructions (e.g., Niederreiter-Xing sequences) and possibly a more algebraic view on digital higher order nets (also called $(t, \alpha, \beta, n \times m, s)$-nets) could be obtained. (Research of G. Pirsic is funded by the Austrian Science Fund (FWF), Project P23285-N18.)

Wednesday 15 February 2012, 15:00 – 15:30, CATS Theatre G02

Gaussian distributed quasi-random samples

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Coauthor(s): Dirk Nuyens, Ronald Cools

The Box–Muller transformation is a well known method to generate bivariate normally distributed variables. When used in combination with LCGs there is a clearly visible spiral configuration. These spirals also appear when the input points are lattices or other structured point sets.

We developed quality criteria for the resulting two-dimensional point sets in a number of ways: based on geometrical reasonings, by defining discrepancy measures, using a suitable set of test-functions and by means of a worst-case error in a reproducing kernel Hilbert space setting.

The main focus here is the extension of both the Box–Muller transformation and the quality criteria to moderate dimension. This leads to point sets that are suitable in the context of quasi-Monte Carlo methods for integration with Gaussian weight function over the entire space.

Tuesday 14 February 2012, 14:30 – 15:00, CATS Theatre G23

Reducing variance with averaging kernels: general theory and an application to quasirandom simulation of Markov chains

James Propp
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Suppose one wants to estimate the long-run average of some random process using a quasirandom process as a surrogate. One might think that the optimal estimate, given n successive values of the quasirandom process, would be the ordinary average of these values. But when the quasirandom process exhibits some form of periodicity or almost periodicity, appropriate non-uniform averages will be better estimators than the uniform average, and can "break the $O(1/n)$ barrier".

I will show how averaging kernels can be applied to the quasirandom simulation of Markov chains via rotor-routing, in particular to the estimation of stationary probabilities, mean hitting times, and escape probabilities. Here I consider randomized space-time rotor-routing, which is similar to the version of rotor-routing discussed in Cooper and Spencer, 2004 (`http://arxiv.org/abs/math/0402323`) and Holroyd and Propp, 2009 (`http://arxiv.org/abs/0904.4507`) but uses randomized rotors, so that individual runs are unbiased. For rotor-routing, the uniform average, as an estimator, has error $O(1/n)$; the use of the triangle kernel or quadratic kernel brings the error down to $O(1/n^{3/2})$.

Thursday 16 February 2012, 14:50 – 15:20, CATS Theatre G23

Randomized Euler algorithm for the approximation of stochastic differential equations with time-irregular coefficients

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Special session: Numerics for SDEs p.67

We study optimal approximation of the scalar SDEs:

$$\begin{aligned} dX_t &= a(t, X_t)dt + b(t)dW_t, \quad t \in [0,1], \\ X_0 &= \eta. \end{aligned} \tag{1}$$

We assume that $\mathbb{E}\eta^2 < +\infty$ is finite and η is independent of the Brownian motion $\{W_t\}_{t\in[0,1]}$. For a coefficient $a : [0,1] \times \mathbf{R} \to \mathbf{R}$ we assume that for all $y \in \mathbf{R}$, $a(\cdot, y) : [0,1] \to \mathbf{R}$ is bounded and measurable and for all $t \in [0,1]$, $a(t,\cdot) : \mathbf{R} \to \mathbf{R}$ is globally Lipschitz continuous in $\mathbf{R}$. For $b : [0,1] \to \mathbf{R}$ we assume that it is piecewise Hölder continuous in $[0,1]$ with the exponent $\varrho \in (0,1]$.

Under such assumptions on a we have the lack of convergence in the worst case model of error, as long as we sample a coefficient a with respect to the time variable t only at points chosen in deterministic way. This obstacle can be overcome by considering Monte Carlo algorithms. We construct the randomized version of the classical Euler algorithm, which evaluates function a at randomly chosen points. This extends the approach used in [1] for the ODEs (1) with $b \equiv 0$ to cover also the case of SDEs (1) with Carathéodory coefficients a. We show that the error of the algorithm is $O(n^{-\min\{1/2,\varrho\}})$ and this bound is sharp.

Finally, we show that numerical examples confirm obtained theoretical results.

[1] A. Jentzen, A. Neuenkirch, A random Euler scheme for Carathéodory differential equations, J. Comp. and Appl. Math. 224 (2009), 346-359.

Tuesday 14 February 2012, 16:00 – 16:30, CATS Theatre G02

Quadrature on the sequence space

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Special session: Tractability of Multivariate Problems p.74

We study numerical integration with respect to product measures on the sequence space $\mathbb{R}^{\mathbb{N}}$, where the integrands are assumed to belong to a reproducing kernel Hilbert space with a weighted tensor product kernel. In the first part of the talk we discuss the orthogonal decomposition of integrands, and in the second part we present numerical experiments, which partially correspond to theoretical results.

Thursday 16 February 2012, 10:00 – 10:30, CATS Theatre G02

QMC for stochastic volatility models

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Special session: Computational Finance p.58

We propose a quasi Monte Carlo algorithm for the pricing of contingent claims under a stochastic volatility regime such as the Heston stochastic volatility model. Using a bridge sampling approach, we focus on exotic options such as barrier, cliquets, and lookbacks and compare our results against existing methods.

Tuesday 14 February 2012, 17:30 – 18:00, CATS Room 101

Sequential importance sampling for irreducible diffusions

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Special session: Monte Carlo Based Inference for Diffusions p.63

This talk will present recent work on a sequential importance sampler which provides online unbiased estimation for irreducible diffusions (that is ones for which the reduction to the unit diffusion coefficient case by the Lamperti transform is not possible). For this family of processes, exact simulation (ie free from discretisation error) using recently developed retrospective simulation techniques is typically not possible. Thus the work significantly extends the class of discretisation error-free Monte Carlo methods available for diffusions. The methods are most useful in the multi-dimensional setting, where many interesting families of models (particularly in finance and population modelling) exhibit the irreducibility property.

Monday 13 February 2012, 14:30 – 15:00, CATS Room 163

Efficient rare-event simulation for sums of dependent random variables

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Coauthor(s): José H. Blanchet

We propose asymptotically efficient simulation algorithms for approximating the tail probability of $\mathbb{P}(\mathrm{e}^{X_1} + \cdots + \mathrm{e}^{X_d} > u)$ as $u \to \infty$ where the random variables $X_1, \ldots, X_n$ are not independent.

The first algorithm proposed is based on Conditional Monte Carlo and it assumes that $(X_1, \ldots, X_d)$ has an elliptical distribution; the efficiency of this algorithm is proved under mild assumptions on the radial component. This algorithm is applicable to a large class of models in finance as we illustrate with examples.

In addition, we propose a second algorithm that can be applied under an arbitrary dependence structure provided that one can simulate efficiently $(X_1, \ldots, X_d | X_j > b)$ for large b. It is proved that it is asymptotically optimal under mild assumptions on the marginal distributions.

Monday 13 February 2012, 15:00 – 15:30, CATS Theatre G02

QMC methods for stochastic programs: ANOVA decomposition of integrands

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Coauthor(s): H. Heitsch, I. H. Sloan

Randomly shifted lattice rules show a favorable behavior when applied to stochastic programs. But, the integrands of linear two-stage stochastic programs are piecewise linear or quadratic and neither smooth nor of bounded variation (Hardy and Krause). It is shown that, under suitable conditions, all terms of their ANOVA decomposition except the one of highest order are infinitely differentiable if the densities are infinitely smooth as well. Sharpness and generic nature of the imposed algebraic conditions are discussed.

Tuesday 14 February 2012, 11:00 – 11:30, CATS Theatre G02

Multi-level Monte Carlo simulation based on approximation schemes with reduced variance

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Special session: Multilevel Monte Carlo Methods p.65

The multi-level Monte Carlo simulation proposed by Mike Giles (2008) has become an important method for the weak approximation of stochastic differential equations. It is applied especially to the problem of option valuation in computational finance. Compared to the multi-level Monte Carlo method based on the Euler-Maruyama scheme, better orders of convergence can be attained if discretization schemes are applied which allow better variance estimates. Therefore, some results on L^p estimates for one-step approximation schemes are presented allowing the use of simplified random variables for reduced variances. Further, implementation issues are discussed for the multi-dimensional case. An explicit scheme with reduced variance that can be applied for the multi-level Monte Carlo simulation is presented. Finally, its performance in the case of option valuation is considered. As an example, improvements for Lipschitz and non-smooth payoff functions can be attained by the proposed scheme.

Tuesday 14 February 2012, 11:00 – 11:30, The Law Theatre G04

Hit-and-run for numerical integration

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Special session: Explicit Error Bounds for Markov Chain Monte Carlo p.60

The goal is to compute

$$S(f, \rho) = \frac{\int_D f(y)\rho(y)\,\mathrm{d}y}{\int_D \rho(y)\,\mathrm{d}y},$$

where $\rho > 0$ is a log-concave function and $D \subset \mathbb{R}^d$ is a convex body. Sampling with respect to the desired distribution, say π_ρ, is in general not possible. The hit-and-run algorithm provides a Markov chain which can be used to approximate π_ρ. Under suitable assumptions on the density one has explicit convergence estimates of the Markov chain. These estimates, for example of the L_2-spectral gap, are used to get error bounds for Markov chain Monte Carlo methods to approximate $S(f, \rho)$.

Thursday 16 February 2012, 14:50 – 15:20, CATS Room 101

Combining exploration and exploitation strategies in adaptive MCMC

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Special session: Adaptive MCMC: Theory, Algorithms, and Applications p.54

For complex high-dimensional target distributions, Markov chain Monte Carlo methods often require significant expertise and tuning. Adaptive MCMC methods address this by attempting to perform online learning from the sample history. We describe some theoretical results on mixing times of several adaptive strategies, and show that they can be classified by their effect on the convergence behavior. We show that a hybrid algorithm using two distinct methods of adaptation dramatically outperforms either individually.

Tuesday 14 February 2012, 10:00 – 10:30, CATS Theatre G23

Model-based 3D simulation of tomographic image data, with applications to virtual materials design

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

Mathematical models from stochastic geometry can greatly facilitate the quantitative analysis of morphological microstructures of materials used, e.g., in lithium-ion batteries, fuel cells, and polymer solar cells. Not only do they provide a quantitative description of complex microstructures in existing materials, but they also offer the opportunity to construct new virtual morphologies with improved physical properties, using model-based computer simulations. The latter can be achieved by modifying the model parameters and combining the stochastic microstructure models with numerical transport models. In this talk, we present a new approach to stochastic simulation of 3D images, which show complex microstructures reconstructed from electron or synchrotron tomography. Using a multiscale approach, it is possible to decompose complex microstructures into several (less complex) components. In particular, a macroscale component is determined by morphological smoothing, which can be represented by unions of overlapping spheres. This leads to an enormous reduction of complexity and allows us to model the macroscale component by random marked point processes, which is one of the most fundamental classes of models in stochastic geometry.

Wednesday 15 February 2012, 11:30 – 12:00, CATS Theatre G02

QMC convergence analysis for stochastic and parametric operator equations in infinite dimension

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Coauthor(s): Frances Y. Kuo, Ian H. Sloan

Special session: Multilevel Monte Carlo Methods p.65

We analyse the convergence rate of QMC approximations of operator equations

$$A(\omega)u(\omega) = f(\omega)\ .$$

Here, $A(\omega)$ denotes a random family of operators which depends on the random variable ω through a possibly countable family of random variables $\{Y_j(\omega)\}_{j\geq 1}$, i.e $A(\omega) = B(y_1, y_2, ...)|_{y_j=Y_j(\omega)}$, for example through a Karhunen-Loève expansion. Then we have $u(\omega) = v(y_1, y_2, ...)_{y_j=Y_j(\omega)}$.

The key are regularity results for the parametric solution $v(y)$ where $y = (y_1, y_2, ...)$ in weighted RKHS. We give sufficient conditions on the operator $B(y)$ in order for QMC approximations by randomly shifted lattice rules of first and higher statistical moments of the solution to converge at rate $O(N^{-1+\delta})$ (with N denoting the number of QMC points). Examples include elliptic, parabolic as well as certain hyperbolic problems.

We investigate the additional discretization error by multilevel Finite Element approximations, in dependence on the QMC rule. We compare with best N-term convergence rate bounds by generalized polynomial chaos approximations. We indicate extensions of our analysis to certain classes of nonlinear problems, as well as multilevel versions of the algorithms.

Monday 13 February 2012, 15:00 – 15:30, CATS Theatre G23

Application of Monte Carlo methods in charged particle optics

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Multiplication of the charged particles is a complicated stochastic process, which is usually simulated by the use of Monte Carlo (MC) methods. However, it is quite problematic to perform some investigations and optimizations using only MC simulations. A computational method for simulation of stochastic processes of an electron multiplication in microchannel amplifier is developed. The method is based on 3D Monte Carlo (MC) simulations and theorems about serial and parallel amplification stages proposed here. Splitting a stochastic process into a number of different stages, enables a contribution of each stage to the entire process to be easily investigated. The method preserves all advantages of the MC simulations which are used only once for one simple stage. The use of the theorems allows conducting any further investigations and optimizations without additional MC simulations. The method provides high calculation accuracy with minimal cost of computations. The mean gain and the variance of the amplitude distribution at the output of the amplifier are predicted. Here, the method is used to show how the input ratio of the signal to the noise is transforming to the output one, and how different multiplication stages contribute to the noise factor of the system. Also, the effect of a spread in the incidence coordinates of the input electrons on the noise characteristics of the multiplier is investigated.

Tuesday 14 February 2012, 14:30 – 15:00, CATS Theatre G02

Quasi-Monte Carlo methods for applications in statistics

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We examine the problem of using quasi-Monte Carlo methods for a class of applications in statistics. Such applications lead to evaluating high dimensional integrals over unbounded regions which are usually transformed to equivalent integrals over the unit cube. It is known that for integrals over the unit cube, quasi-Monte Carlo methods in general, and lattice rules in particular, can then be used to obtain the optimal convergence order. There is also a rich theory illustrating that the convergence rate is independent of the dimension by suitably choosing a weighted space of functions.

Our approach is different in the sense that we are aiming to find the optimal weights that lead to the desired integration error for a particular problem and analyse how available theory on randomly shifted lattice rules can be used. The talk will present some preliminary results in this direction.

Friday 17 February 2012, 10:30 – 11:00, CATS Theatre G23

Spatial modelling in small area estimation via the cross-entropy method

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

Estimation of population characteristics for sub-national domains or smaller regions can be considered one of the important issues of statistical surveys. In particular, geographically defined domains such as regions, states, districts and local government areas may be of interest. One of general methods in small area estimation (SAE) is the use of linear mixed models with area specific random effects to account for between areas variation beyond that explained by auxiliary variables included in the fixed part of the model. In order to use spatial auxiliary information in SAE, it is reasonable to assume that either the area or the individual random effects (defined, for example, by a contiguity criterion) are correlated, with the correlation decaying to zero as the distance between these areas increases. In this talk, we consider the Cross-Entropy method to spatial modelling in small area estimation using Monte Carlo simulation to find a contiguity matrix that maximizes some measure of spatial association between areas/units. Estimation of the mean squared error of the resulting small area estimators is discussed. The properties of the estimators are evaluated by applying them to the results of farm surveys that have been conducted by the Australian Bureau of Agricultural and Resource Economics.

Monday 13 February 2012, 15:00 – 15:30, CATS Room 101

Bayesian methods for analyzing metabolic models

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A standard way of modeling metabolism in different organs involve large dynamical systems with kinetic parameters that are hard or impossible to measure and need to be inferred on indirectly from eclectic data, such as concentration measurement from plasma, biopsies or magnetic resonance spectroscopy. In addition, scattered pieces of information concerning the time constants or saturation levels of selected reaction fluxes and transport rates are available. While Bayesian methods with MCMC strategies seem to be the optimal tools for inferring on the model parameters, the practical implementation is non-trivial due to the stiffness of the ODE systems, the large number of unknowns and the difficulty of quantifying some of the information that is qualitative in nature. In this talk, we review the recent progress is applying the MCMC methods in analyzing the metabolic networks and the associated kinetic models.

Tuesday 14 February 2012, 16:30 – 17:00, CATS Room 101

Bayesian inference for a generalized class of Heston models

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Special session: Monte Carlo Based Inference for Diffusions p.63

In this talk, we define a more general form of the Heston model proposed in Heston (1993); the Heston model is a stochastic volatility (SV) model for the log-price of a stock or the short term interest rate with a stochastic variance. Our generalized class of Heston models allows the volatility of the volatility process and the correlation between the log-stock price returns and the variance shocks (the so-called "leverage effect") to be state dependent. We apply our generalized Heston model to a S&P 500, VIX bivariate dataset. We utilize and justify two relatively new MCMC methods which allow for Bayesian inference in our class of models. The first method, defined in Golightly and Wilkinson (2008), relies on re-parametrization techniques. The second method, applied in Stramer and Bognar (2011), avoids the need for re-parametrization techniques; this method was first described in Beaumont (2003) and was generalized in Andrieu and Roberts (2009).

Monday 13 February 2012, 10:00 – 10:30, CATS Theatre G23

Bayesian MCMC analysis using Python

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Special session: Fast Computational Methods for Large Scale Bayesian Inference p.61

We discuss three related Python libraries that are useful for Bayesian analysis. Firstly, PyMCMC, which is a Python library for the analysis of generic MCMC problems. Second, the PyMCMC standard models library, which is contains an easy Python interface to optimised code for a range of standard models. In particular, the library includes generalised linear models, linear mixed models, generalised linear mixed models and mixture models. Third, PySSM a Python module for the analysis of state space models will be discussed. PySSM, includes many algorithms for the analysis of state space models and combined with PyMCMC, can be used for the Bayesian analysis of state space models. We illustrate Bayesian analysis using our Python libraries with several examples.

Monday 13 February 2012, 11:30 – 12:00, CATS Theatre G23

Variational Bayesian approximation method for inference in item response models

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Special session: Fast Computational Methods for Large Scale Bayesian Inference p.61

Bayesian approach has been increasing its popularity in the psychometrics field especially in Item Response Model (IRT) because the full Bayesian estimation can overcome the inconsistency problem in parameter estimations unlike likelihood approach. However, in its MCMC implementation, it is computationally intensive, often lacks reliable convergence criteria and requires appropriate choice of the priors. To overcome these difficulties, we focus on the Variational Bayes (VB) approximation. It approximates the posterior by using simpler tractable density, to reduce the computational intensity of MCMC and yet delivers reasonable accuracy of estimation. The advantages of VB include less computational time, availability of a lower bound on the marginal likelihood to check convergence and a reasonable accuracy of the estimates of item parameters. We outline the VB method for inference in the two-parameter IRT model. We also discuss multifactor extensions of the method. We demonstrate its good convergence by monotonically increasing the value of the lower bound during the iteration process which makes the convergence check very easy. VBs item parameter estimators perform well and even better than Bayesian estimators in smaller sample sizes and when non-informative prior on the item parameters is applied. For informative priors, VB and Bayesian estimation are comparable when small to moderate samples are used but VB uses much less computing time.

Wednesday 15 February 2012, 11:00 – 11:30, CATS Theatre G02

Multi-level Monte Carlo finite volume methods for nonlinear systems of stochastic conservation laws in multi-dimensions

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Special session: Multilevel Monte Carlo Methods p.65

We extend the Multi-Level Monte Carlo (MLMC) algorithm in order to quantify uncertainty in the solutions of multi-dimensional hyperbolic systems of conservation laws with uncertain initial data and sources. The algorithm together with the novel load balancing procedure is presented and the scalability on the massively parallel hardware is verified. A new code ALSVID-UQ is described and applied to simulate uncertain solutions of the Euler equations, ideal magnetohydrodynamics (MHD) equations and shallow water equations. Numerical experiments showing the robustness, efficiency and scalability of the proposed algorithm are presented.

Wednesday 15 February 2012, 11:30 – 12:00, CATS Theatre G23

General construction of irreversible kernel in Markov chain Monte Carlo

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Special session: Recent Advances in MCMC p.71

The Markov chain Monte Carlo (MCMC) method is a powerful tool especially for systems with multiple degrees of freedom. For the method to work effectively, we must consider following three key matters: the choice of ensemble, the selection of candidate states, and the optimization of transition kernel. We will focus on the third issue in this talk. For the construction of transition kernel, the Metropolis-Hastings (MH) algorithm or the Gibbs sampler is widely used in practical simulations. However, these conventional methods are not optimal. Since the invention by Metropolis and the co-workers in 1953, the MCMC method has evolved within the paradigm of the detailed balance, namely reversibility. The detailed balance is, however, not necessary condition. Instead of solving usual algebraic equations of the detailed balance, we rewrite the conditions as a geometric allocation problem. As the result, it becomes always possible to find not only a reversible solution but also an irreversible kernel with minimized rejection rate. For continuous variables, we present an another update algorithm that breaks the reversibility by using a periodic shift for the cumulative conditional distribution, instead of the Gibbs sampler. When such a direct variable generation is not available, the MH algorithm is used in most cases, where the rejection can be a serious bottleneck. Applying our rejection-minimized algorithms, we can reduce the rate significantly. We emphasize that our algorithms are the first versatile methods that is free from the reversibility and should replace the conventional update procedures in the all MCMC simulations.

Tuesday 14 February 2012, 10:30 – 11:00, CATS Theatre G02

Efficient multilevel Monte Carlo simulations of non-linear financial SDEs without a need of simulating levy areas

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Special session: Multilevel Monte Carlo Methods p.65

Using a simple Monte Carlo method with a numerical discretization with first order weak convergence, to achieve a root-mean-square error of $O(\epsilon)$ would require $O(\epsilon^{-3})$ computational complexity. Recently, Giles [Giles, 2008] introduced a Multilevel Monte Carlo (MLMC) estimator, which enables a reduction of this computational cost to $O(\epsilon^{-2})$. In order to achieve this superior property of the MLMC estimator, the numerical discretization of a SDEs under consideration requires certain convergence properties, namely that the numerical approximation strongly converge to the solution of the SDEs with order 1. This carries some difficulties. First of all, it is well known that it impossible to obtain an order of convergence higher than 0.5 without a good approximation of the Levy areas (which are very expensive to simulate) [Cameron, 1980]. Second, convergence and stability of numerical methods are well understood for SDEs with Lipschitz continuous coefficients, whereas most financial SDEs violates these conditions. Our work addresses both of these issues, giving a customized analysis of the most widely used numerical methods. In this work we generalize the current theory of strong numerical approximations for some highly non-linear multidimensional SDEs. We also construct a new MLMC estimator that enables us to avoid simulation of Levy areas without affecting the required computational cost of order $O(\epsilon^{-2})$.

Wednesday 15 February 2012, 10:00 – 10:30, The Law Theatre G04

Good, low degree, rank-1 lattice rules in high dimensions

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

An s-dimensional rank-1 lattice rule is defined by an s-dimensional vector $\mathbf{x}$, and an integer N. In this talk we present a new approach to finding good high dimensional rank-1 lattice rules. In the general case we set up a huge search. To limit the search we break it into two steps. First finding a potential good $\mathbf{x}$, and then only for these potentially good $\mathbf{x}$ we proceed to find the best possible N. Our quality measure will be the enhanced trigonometric degree, δ.

It turns out that for $\delta = 5$ the first step, that of finding potentially good vectors, is closely related to that of finding good Golomb rulers. Using the rich literature on algorithms for finding good Golomb rulers we can easily compute good vectors of dimension $s \leq 50000$. A conjecture by Erdös that the length, l, of a Golomb ruler with s marks is bounded such that $l < s^2$ is computational verified for $s < 65000$. A simple corollary of this is that there do exist rank-1 lattice rules with $\delta = 5$ satisfying $N < 4s^2$, and that our algorithm will find them. Thus the computational cost of these rules are of same order as the established lower bound.

Wednesday 15 February 2012, 10:00 – 10:30, CATS Theatre G02

Multilevel Monte Carlo for highly heterogeneous media

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Special session: Multilevel Monte Carlo Methods p.65

The quantification of uncertainty in groundwater flow plays a central role in the safety assessment of radioactive waste disposal and of CO2 capture and storage underground. Stochastic modelling of data uncertainties in the rock permeabilities lead to elliptic PDEs with random coefficients. Typical models used for the random coefficients, such as lognormal random fields with exponential covariance, are unbounded and have only limited spatial regularity, making practical computations very expensive and the rigorous numerical analysis challenging.

To overcome the slow convergence of conventional Monte Carlo methods, we employ and analyse a multilevel Monte Carlo (MLMC) method, based on a hierarchy of spatial levels/grids. We will demonstrate on a typical model problem the significant gains with respect to conventional Monte Carlo that are possible with this new approach, leading (in the best case) to an asymptotic computational cost that is proportional to the cost of solving one deterministic PDE to the same accuracy.

We further improve the performance of the MLMC estimator by using level dependent representations of the random coefficient. This can be achieved, for example, by a level dependent truncation of the Karhunen-Loève expansion. We show practically and theoretically how smoother approximations of the coefficient on the coarse levels lead to a further reduction in the total computational cost, and can make even very rough problems computationally feasible.

Wednesday 15 February 2012, 14:30 – 15:00, CATS Theatre G23

Scaling analysis of MCMC methods

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Metropolis-Hastings methods form a widely used class of MCMC methods for sampling from complex probability distributions. We will discuss the Random Walk and Langevin algorithms and establish scaling limits in different asymptotic regimes. Scaling limits of MCMC methods provide a useful theoretical tool for studying efficiency of such algorithms. In particular they lead directly to precise estimates of the number of steps required to explore the target distribution. To date, such results have only been proved for relatively simple target measures, severely limiting their applicability to real applications. In this talk, we will present recent results on the scaling limits of MCMC methods for two class of naturally occurring target measures: probability distribution concentrated on low dimensional manifolds and high/infinite dimensional measures.

Thursday 16 February 2012, 10:30 – 11:00, CATS Theatre G02

Option pricing by simulation of fuzzy-random variables

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Special session: Computational Finance p.58

The option pricing model performance crucially depends on the ability to estimate all necessary input parameters successfully. Within the standard models of Black-Scholes type, the most important parameter is volatility. Since it is often very difficult to obtain a single number an alternative can be to apply interval approach or more generalized fuzzy-stochastic approach. In this paper recent knowledge of fuzzy numbers and their approximation is utilized in order to suggest fuzzy-MC simulation approach to option price modeling in terms of fuzzy-random variables. In particular, we suggest to replace a crisp volatility parameter in the standard market model (ie. Black-Scholes type) by a fuzzy random variable, which can be easily evaluated by Monte Carlo simulation. Application possibilities are shown on illustrative examples. In particular, we evaluate the model for various input data and option types. We also suggest more complex models based on fuzzy-random variables.

Wednesday 15 February 2012, 15:00 – 15:30, CATS Room 163

Inference of seasonal long-memory time series with measurement error

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In this talk we consider the estimation of Seasonal Autoregressive Fractionally Integrated Moving Average (SARFIMA) models in the presence of additional measurement error by maximizing the Whittle likelihood. We show that the spectral maximum Whittle likelihood estimator is asymptotically normal, and study its finite-sample properties through simulation. We illustrate by simulation that ignoring measurement errors may result in incorrect inference. Hence, it is pertinent to test for the presence of measurement error, which we do by developing a likelihood ratio (LR) test within the framework of Whittle likelihood. We derive the non-standard asymptotic null distribution of this LR test. Finite sample properties of the LR test both under the null and the alternative are examined by simulations. The efficacy of the proposed approach is illustrated by a real-life example.

Wednesday 15 February 2012, 10:30 – 11:00, CATS Theatre G02

Towards efficient simulations of groundwater flow problems in random media

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Special session: Multilevel Monte Carlo Methods p.65

The efficient quantification of uncertainties in the simulation of subsurface flows plays an important role in many applications, e.g., radioactive waste disposal. The coefficients in such problems are highly uncertain, rough and oscillatory, resulting in very computing-intensive simulations that reach the limits of all existing methods even on the largest supercomputers. To overcome these limits we employ multilevel Monte Carlo (MLMC), a novel variance reduction technique.

We study model elliptic problems of single phase flow in random media described by correlated lognormal distributions. To be useful for realistic groundwater flow problems, it is desirable to study 3D models and to use mass-conservative discretisation schemes. In contrast to other applications of MLMC, the computations on the finest level will in this case dominate the overall cost. We use circulant embedding methods to efficiently generate coefficient realisations and algebraic multigrid techniques with aggressive coarsening to solve the arising sparse linear systems.

Finally, in the context of (mass-conservative) mixed finite element (FE) discretisations, we provide a rigorous mathematical analysis of the MLMC complexity. This work is an extension of the work presented by A. Teckentrup for standard nodal FEs. As in the standard case, the analysis is non-trivial due to the limited spatial regularity and the unboundedness of the employed lognormal random fields.

This talk will be presented jointly with M. Park (University of Nottingham).

Tuesday 14 February 2012, 11:30 – 12:00, The Law Theatre G04

Tight mixing bounds at the Potts transition point for single-bond dynamics on the torus

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Special session: Explicit Error Bounds for Markov Chain Monte Carlo p.60

In this talk, we present upper and lower bounds on the mixing time of the single-bond dynamics on the discrete d-dimensional torus of side length L at the Potts transition temperature that are exponential in L^{d-1}, complementing a result of Borgs, Chayes and Tetali.

For this we prove that, if G is an arbitrary graph, $p \in (0,1)$ and $q \in \mathbb{N}$, then

$$\lambda(P_{\mathrm{SW}}) \;\geq\; \lambda(P_{\mathrm{SB}}),$$

where $\lambda(\cdot)$ denotes the spectral gap and P_{SW} (resp. P_{SB}) denotes the transition matrix of the Swendsen-Wang (resp. single-bond) dynamics.

The upper bound uses a result of Ge and Stefankovic and a bound on the linear-width of the d-dimensional torus.

Wednesday 15 February 2012, 15:00 – 15:30, CATS Theatre G23

On a dimension independent lower bound of the Wasserstein spectral gap for Metropolis-Hastings algorithms with Ornstein-Uhlenbeck proposal

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Our main intention is to study the problem of sampling high dimensional target measures. We focus on those that arise from approximating infinite dimensional measures that have a density with respect to a Gaussian reference measure. We consider the Metropolis-Hasting algorithm that adds an accept-reject-mechanism to a Markov-Chain proposal in order to have the target measure as an ergodic invariant measure, where we focus attention on cases where the proposal is either a random walk with covariance equal to that of the reference measure, or an Ornstein-Uhlenbeck proposal for which the reference measure is invariant. The resulting algorithms are called RWM and P-RWM respectively.

Previous results in terms of scaling and diffusion limits suggested that under certain conditions the P-RWM has a convergence rate that is independent of the dimension, whilst the RWM method has undesirable dimension-dependent behaviour. Our contribution is that we give an example for the latter case and prove a uniformly lower bound on the Wasserstein spectral gap for Metropolis-Hastings algorithms with an Ornstein-Uhlenbeck proposal that is independent of the dimension for a large class of target measures. This is true under mild conditions on the growth of the local Lipschitz constant of the log-density and its growth at infinity. Moreover, we are able to derive a law of large numbers and a central limit theorem for locally Lipschitz functions in this case.

Tuesday 14 February 2012, 11:30 – 12:00, CATS Theatre G02

Adaptive multilevel Monte Carlo simulation of Ito SDEs

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Special session: Multilevel Monte Carlo Methods p.65

We consider the numerical approximation of expected values of functionals of solutions to Ito Stochastic Ordinary Differential Equations (SDE). This problem has many applications in physics and finance, such as pricing financial contracts in the Black-Scholes model. The multilevel Monte Carlo method (MLMC), introduced in the context of forward Euler time stepping for Ito SDEs by M. Giles, significantly improves the complexity of numerical methods for accurately approximating such expected values. This talk presents a generalisation of MLMC to adaptive time stepping algorithms.

The adaptive MLMC method uses a hierarchy of non uniform time discretisations, generated by adaptive algorithms based on a posteriori error expansions. Adaptive time stepping is advantageous in cases where constant step size has decreased convergence rate due to lower regularity. By combining adaptivity and MLMC the same computational gain can be achieved, relative to single level adaptive method, as is obtained when MLMC is introduced in regular problems without adaptivity. We show examples from mathematical finance which exhibit savings in the computational cost to achieve an accuracy of $O(TOL)$, from $O(TOL^3)$ using the single level adaptive method to $O(TOL^{-1}\log(TOL))^2$ using the multilevel adaptive method; for these examples computational cost of a single level uniform method grows even faster than (TOL^3).

Tuesday 14 February 2012, 16:30 – 17:00, CATS Theatre G02

Linear tensor product problems in (anti-) symmetric Hilbert spaces

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Special session: Tractability of Multivariate Problems p.74

We investigate the complexity of linear problems $S_d \colon H_d \to G_d$ defined on d-fold tensor products of Hilbert spaces with an additional (anti-) symmetry property. Therefore, we restrict S_d to the subspaces of (*anti-*) *symmetric* functions $f \colon D^d \to \mathbb{R}$ in H_d. That is, we claim

$$f(x) = f(\pi(x)), \quad \text{or} \quad f(x) = (-1)^{|\pi|} \cdot f(\pi(x)),$$

respectively, for all $x \in D^d$ and every permutation π on a certain subset of coordinates. We show that this essentially new kind of a priori knowledge allows us to vanquish the curse of dimensionality which we are often faced with while dealing with problems defined on *unweighted* spaces. For this purpose, we characterize (strong) polynomial tractability in the terms of the squared singular values $\lambda = (\lambda_j)_{j\in\mathbb{N}}$ of the univariate operator S_1 and the amount of (anti-) symmetry conditions. In particular, the fully *symmetric* problem is strongly polynomial tractable w.r.t. the absolute error criterion iff $\lambda \in \ell_\tau$ for some $\tau > 0$ and either $\lambda_1 < 1$ or $\lambda_1 = 1 > \lambda_2$. Furthermore, the problem is strongly polynomially tractable w.r.t. the normalized error criterion iff $\lambda \in \ell_\tau$ and $\lambda_1 > \lambda_2$. Moreover, we show that the fully *antisymmetric* problem is strongly polynomial tractable w.r.t. the absolute error criterion iff $\lambda \in \ell_\tau$.

Thursday 16 February 2012, 10:30 – 11:00, The Law Theatre G04

Asymptotic behavior of average L_p-discrepancies

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Special session: Small Ball Problems, Discrepancy, and Metric Entropy p.72

We analyse the limit behavior of the average L_p-B-discrepancy for arbitrary $0 < p < \infty$ if the number of sample points n tends to infinity. This generalizes a result of Steinerberger who investigated the L_p-star discrepancy and the extreme L_p-discrepancy. The L_p-B-discrepancy involves several types of discrepancy functions studied in the literature, for example L_p-star discrepancy, extreme, anchored and periodic L_p-discrepancies.

To prove our result we use probabilistic methods, in particular the central limit theorem, characteristic functions and the dominated convergence theorem. Furthermore we employ symmetrization techniques to obtain estimates for arbitrary p.

Friday 17 February 2012, 10:00 – 10:30, CATS Theatre G23

Prediction of catastrophes in spatio-temporal settings

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Special session: Monte Carlo Methods for Spatial Stochastic Modeling p.64

The predicting of rare events, such as high level up-crossings, for spatio-temporal processes plays an important role in the analysis of the occurrence and impact of potential catastrophes in, for example, environmental settings. It is clearly desirable that a system which predicts these events does so with high probability, but with few false alarms. In this paper, an optimal alarm system in space over time is introduced and studied in detail. These results generalize those obtained by de Maré (1980) and Lindgren (1980, 1985) for stationary stochastic processes evolving in continuous time and are applied here to stationary Gaussian random fields.

De Maré, J., (1980) Optimal prediction of catastrophes with applications to Gaussian processes, *Ann. Probab.*, **8**, 841-850.

Lindgren, G., (1980) Model processes in nonlinear prediction with application to detection and alarm, *Ann. Probab.*, **8**, 775-792.

Lindgren, G., (1985) Optimal Prediction of Level Crossings in Gaussian Processes and Sequences, *Ann. Probab.*, **13**, Number 3, 804-824.

Tuesday 14 February 2012, 17:30 – 18:00, CATS Theatre G23

A survey on recursive nonlinear pseudorandom number generators

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Special session: Measures of Pseudorandomness p.62

This survey collects recent results on recursive nonlinear pseudorandom number generators. We mention upper bounds on additive character sums which imply uniform distribution results in terms of discrepancy bounds. Moreover, we present lower bounds on the linear complexity profile and closely related lattice tests and thus results on the suitability in cryptography.

Thursday 16 February 2012, 16:20 – 16:50, CATS Theatre G02

Computing star discrepancies via a refined threshold accepting heuristic

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Special session: Theoretical and Computational Aspects of Discrepancy p.73

In many applications it is of interest to measure the quality of certain sets by calculating their star discrepancy, e.g., to test whether successive pseudo random numbers are statistically independent, or whether given sample sets are suitable for multivariate numerical integration of certain classes of integrands.

The problem of calculating the star discrepancy of arbitrary point sets exactly is an NP-hard problem. Furthermore, it was proven recently that it is also a $W[1]$-hard problem with respect to the dimension. So it is not very surprising that all known algorithms for calculating the star discrepancy or approximating it up to a user-specified error exhibit running times exponential in the dimension.

We present a new algorithm for estimating the star discrepancy of arbitrary point sets. Similar to the algorithm of Winker and Fang, it is based on the optimization algorithm threshold accepting. Our improvements include a non-uniform sampling strategy, which is more suited for higher-dimensional inputs and additionally takes into account the topological characteristics of given point sets, and rounding steps, which transform axis-parallel boxes, on which the discrepancy is to be tested, into critical test boxes.

Our randomized algorithm computes the exact discrepancy frequently in all cases where this can be checked. Most importantly, in higher dimension the new method behaves clearly better than all previously known methods.

Friday 17 February 2012, 11:30 – 12:00, The Law Theatre G04

Spherical designs and quasi-Monte Carlo methods for the sphere

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Special session: Point Sets and Sequences for Quasi-Monte Carlo p.68

A spherical t-design is a set of N points on the unit sphere such that the equal weight cubature rule is exact for all spherical polynomials of degrees at most t. As such they can be regarded as a quasi-Monte Carlo rule for the sphere. Most attention has been focussed on the minimum numbers of points N needed for a spherical design on $\mathbb{S}^d \subset \mathbb{R}^{d+1}$. This talk will focus on the low dimensional case of $d = 2$, and spherical t designs with $N = t^2/2 + O(t)$ points, and their geometrical properties, such as mesh norm, separation, (spherical cap) discrepancy, worst case error and energy.

Tuesday 14 February 2012, 17:30 – 18:00, CATS Theatre G02

Rates of convergence and tractability for the approximation problem in various settings

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Special session: Tractability of Multivariate Problems p.74

In our recent paper with Erich Novak published in SAT, Vol. 6, pp. 1–23, 2011, we survey the optimal rates of convergence for the approximation problem in various settings which can be achieved by algorithms using arbitrary linear functionals or only function values. We extend this analysis by requiring different notions of tractability. We show that in the randomized and average case settings the results are the same as without requiring tractability. That is, the power of function values is the same as the power of arbitrary linear functionals. However, in the worst case setting the situation is quite different and the power of function values is not comparable to the power of arbitrary linear functionals.

Thursday 16 February 2012, 15:50 – 16:20, CATS Theatre G23

On the complexity of computing quadrature formulas for marginal distributions of SDEs

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Special session: Numerics for SDEs p.67

We study deterministic algorithms A for the constructive approximation of the marginal distribution $P_{X(T)}$ of the solution X of a scalar SDE at time T by a probability measure with finite support. Any such measure yields a quadrature formula for the expectations $Ef(X(T))$ of integrable functions $f : \mathbb{R} \to \mathbb{R}$, and the error of A is defined in the worst case sense with respect to a class of integrands f and a class of SDEs.

We provide almost sharp upper and lower bounds for the complexity of this problem with respect to either the size of the support of the approximating measure or the number of evaluations of the coefficients of the equations or the total computational cost.

Monday 13 February 2012, 11:30 – 12:00, CATS Theatre G02

Approximation of stochastic partial differential equations by a Kernel-based collocation method

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Special session: Computational SPDEs p.59

In this talk we present the theoretical framework needed to justify the use of a kernel-based collocation method (reproducing-kernel approach) to estimate the solution of high-dimensional stochastic partial differential equations. Using an implicit time stepping scheme, we transform stochastic parabolic equations into stochastic elliptic equations. Our main attention is concentrated on the numerical solution of the elliptic equations at each time step. The estimator of the solution of the elliptic equations is given as a linear combination of reproducing kernels derived from the differential and boundary operators of the PDE centered at collocation points to be chosen by the user. The random expansion coefficients are computed by solving a random system of linear equations. Numerical experiments demonstrate the feasibility of the method.

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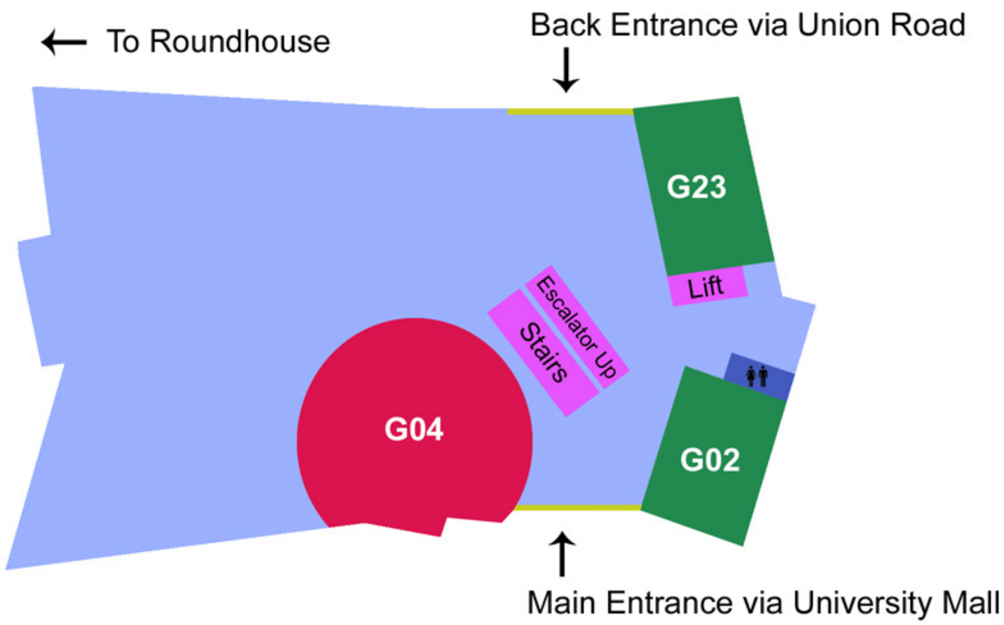
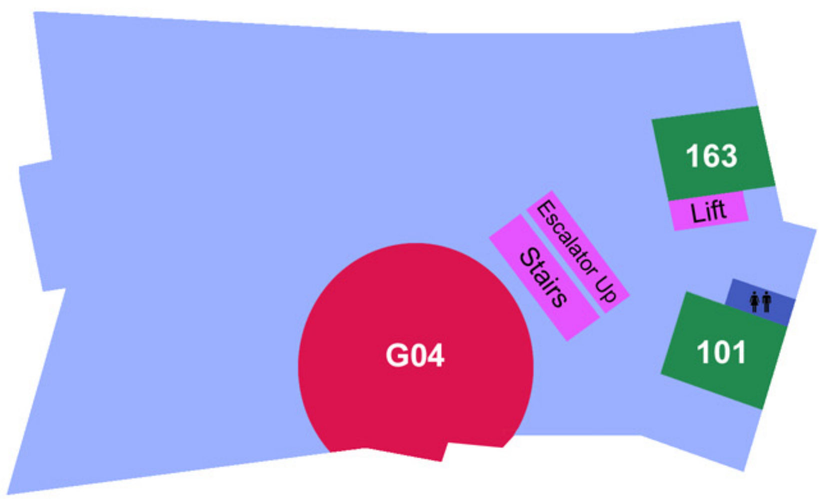
Conference Venue Schematic Map

The Law Theatre G04 - *enter from both ground and first floors*
CATS Theatre G02 (The Gonski Levy Theatre)
CATS Theatre G23 (The Allens Arthur Robinson Theatre)
CATS Room 101 (The Arnold Block Leibler Room)
CATS Room 163 (The Kenneth Borda Room)

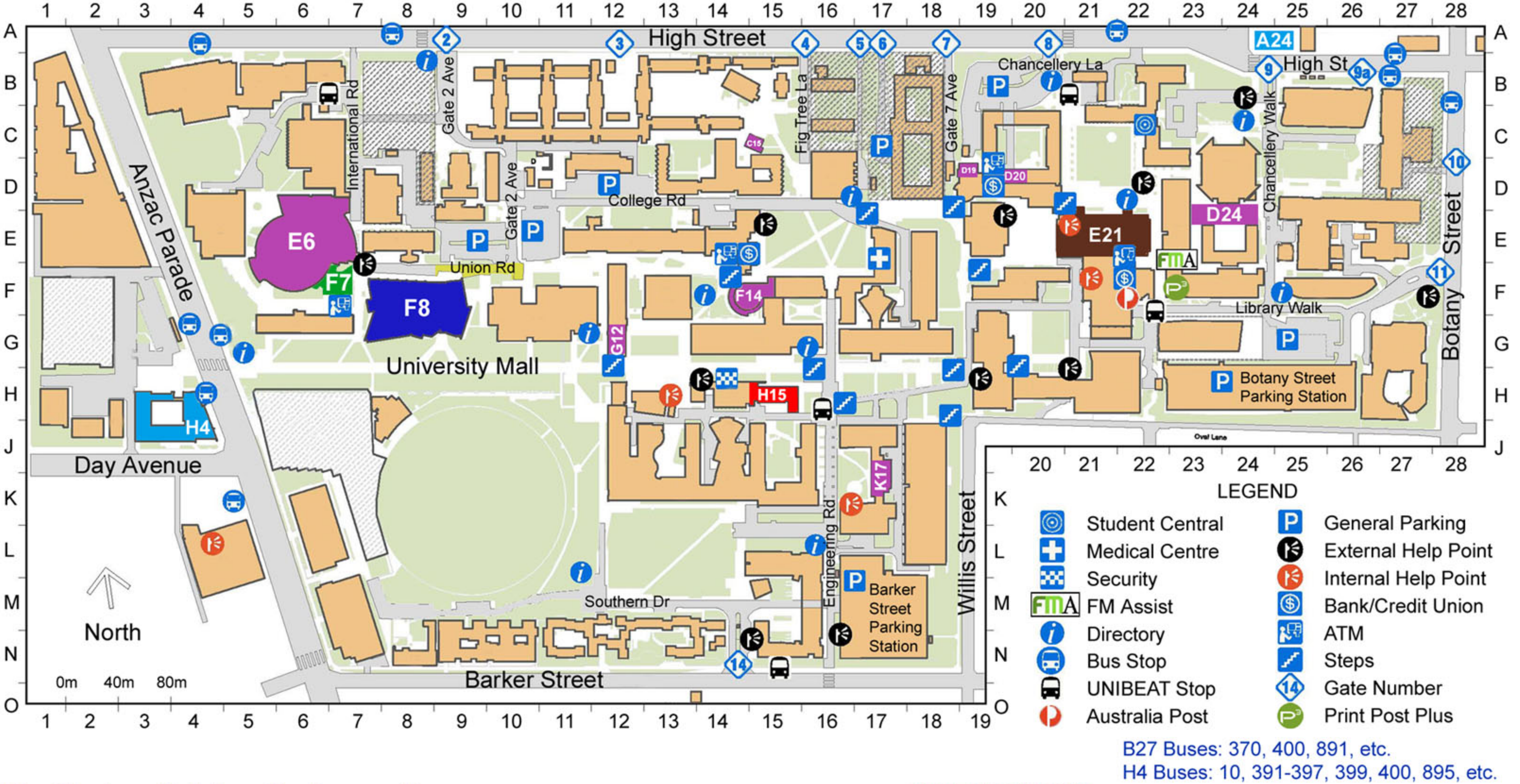
The Law Building: Ground Floor



The Law Building: First Floor



Campus Map



F8 The Law Building: Conference Venue

E6 Roundhouse (F7 Beergarden): Morning/Afternoon Tea and Welcome Reception

F9 Union Road: Bus Departure Point for Wednesday Excursion and Dinner

E21 UNSW Library

H15 Red Centre East Wing: School of Maths and Stats (Computer Lab M020)

H4 New College Village (NCV)

A24 High Street Apartments

WHERE TO EAT

E6 Roundhouse: Ivan's Fernery and UniBar

G12 JG's Cafe

F14 Quad Food Court

C15 The Whitehouse

K17 Coffee on Campus

D19 Bluestone Cafe

D20 Southern Wok

D24 Mathews Arcade Food Court

More Options Along Anzac Parade South of Barker Street