Retrospective Monte Carlo Workshop
7th – 8th July 2016

Organising Committee: J Blanchet (Columbia), F Gonçalves (UFMG), K Łatuszyński (Warwick), M Pollock (Warwick), G Roberts (Warwick).

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CENTRAL CAMPUS
Cryfield Sports Pavilion
Scarman
Radcliffe
Warwick Business School (WBS)
Gatehouse
Ramphal
Social Sciences
Physics
Physical Sciences
Chemistry
Sciences
IARC
Engineering
Library
Modern Records Centre
Chaplaincy
Arts Centre
Bus Interchange
Rootes Building
Students' Union
ATM
Senate House
Humanities
Psychology
IMC
Computer Science
Mathematics
Zeeman
IIPSI
IDL
Sports Centre
Health Centre
Jack Martin
Tocil
Arthur Vick
Claycroft
Bluebell
Rootes
University House
Tennis Centre
Games Hall
Arden
EMB
Millburn House
Argent Court
WESTWOOD WAY
GIBBET HILL ROAD
SCARMAN ROAD
UNIVERSITY ROAD
LIBRARY ROAD
LEIGHFIELD ROAD
SERVICE ROAD ONLY
HEALTH CENTRE ROAD
KIRBY CORNER ROAD
MILLBURN HILL ROAD
SIR WILLIAM LYONS ROAD
LYNCHGATE ROAD
A45, M42 M5, M6 BIRMINGHAM
M6, M6 M1 LONDON
A46, M40 WARWICK, KENILWORTH, LEAMINGTON SPA
KEY TO SYMBOLS
Accommodation
Bus stop
Construction zones
Information totem
Male, female, disabled
Male, female, disabled (inc. baby change)
Pay & display parking
Multi-storey pay & display parking
Pay & display parking (Without accessibility parking)
Shopping on campus
Sustrans cycle route
Taxi rank

1 Administrative Details

1.1 Conference Webpages

- `http://www.warwick.ac.uk/rmc2016`
- **Programme:** `http://www.warwick.ac.uk/rmc2016/programme/`
- **Abstracts:** `http://www.warwick.ac.uk/rmc2016/abstracts/`
- **(Online) Administrative Details:** `http://www.warwick.ac.uk/rmc2016/admin/`

1.2 Registration and Venue

- **Registration:** 9am-9.25am, Thursday 7th July, Mathematics and Statistics Building, Lobby.
- **Talks:** Mathematics and Statistics Building, [MS.04].
- **Poster Session & Wine Reception:** 4.30pm-6.30pm, Thursday 7th July, Mathematics and Statistics Building, Lobby.
- **Breakfast (Participants with on-campus accommodation only):** 7.30am-9am, Rootes Social Building.
- **Lunch (Thursday and Friday):** 12pm-1.30pm, Mathematics and Statistics Building, Statistics Common Room.
- **Dinner (Wednesday / Thursday):** 7.30pm, Rootes Social Building (Rootes Restaurant).
- **Conference Dinner (Thursday):** 7.30pm, Rootes Social Building (Radcliffe private dining room).

1.3 Getting Here

- Information on getting to the University of Warwick from Coventry, as well as from other directions locally and further afield, can be found at `http://www.warwick.ac.uk/about/visiting/`
- Further details can be found in the appendices.

1.4 Accommodation

- Accommodation is in en-suite rooms on campus in Bluebell residences. Keys can be collected from the Conference Reception in the Student Union Atrium. All rooms have linen and toiletries. Kitchen facilities are available although meals are provided throughout the workshop. Rooms will be available after 15:00 for check in. All bedrooms must be vacated by 9:30am on the day of departure.
- Further details can be found in the appendices.

1.5 Internet Access

- **Campus:** Wireless access is most easily available via eduroam — `http://www.eduroam.org/` — which is supported across most of the Warwick campus. Speak to one of the organisers for details of other options.
- **Accommodation:** Wireless access is available, ask for log-in details whenever you check-in to your accommodation.

1.6 Facilities - See Map

- **Supermarket, Food and Drink Outlets:** `http://www.warwickretail.com`
- **Arts Centre:** `http://www.warwickartscentre.co.uk`
- **Sports Centre:** `http://www.warwick.ac.uk/sport/`
- **Health Centre:** `http://www.uwhc.org.uk`
- **Pharmacy:** Students Union Atrium

2 Help, Information & Telephone Numbers

2.1 Department

- **Address:** Department of Statistics, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL
- **Telephone:** 024 7652 4553
- **Fax:** 024 7652 4532
- **Webpage:** `http://www.warwick.ac.uk/stats`

2.2 Emergency Numbers

- **Emergency:** Internal - 22222; External - 024 7652 2222
- **Security:** Internal - 22083; External - 024 7652 2083
- **Organiser:** Internal - 73436; External - 024 7617 3436 (Murray Pollock)

2.3 Transport

- **Swift Taxis (Coventry):** 024 7676 7676
- **Trinity Street Taxis:** 024 7699 9999
- **National Rail Enquiries:** 08457 484 950

3 Timetable

All activities will take place in the Mathematics & Statistics Building, with talks in room MS.04 (signposted from lobby), unless otherwise stated.

3.1 Wednesday 6th July

Time	Speaker	Title	Pg
19:30	**Dinner**	**Rootes Social Building (Rootes Restaurant)**	**-**

3.2 Thursday 7th July

Time	Speaker	Title	Pg
07:30	**Breakfast**	**Rootes Social Building (Rootes Restaurant)**	**-**
09:00	**Registration**	**-**	**-**
09:25	**Welcome**	**Welcome: Gareth Roberts (Warwick)**	**-**
09:30	Sergios Agapiou	Unbiased Estimation and Exact Simulation for Bayesian Inverse Problems	7
10:30	**Coffee Break**	**-**	**-**
11:00	Chang-han Rhee	Unbiased Multilevel Monte Carlo	10
12:00	**Lunch**	**-**	**-**
13:30	**Coffee Break**	**-**	**-**
14:00	Hongsheng Dai	Monte Carlo method for conflation of probability distributions	8
15:00	**Coffee Break**	**-**	**-**
15:30	Flavio Gonçalves	Infinite-dimensional unbiased MCMC for exact inference in SDE driven models	9
16:30	**Poster Session**	**Wine and light refreshments will be provided**	**-**
18:30	**Finish**	**-**	**-**
19:30	**Dinner**	**Rootes Social Building (Rootes Restaurant)**	**-**

3.3 Friday 8th July

Time	Speaker	Title	Pg
07:30	**Breakfast**	**Rootes Social Building (Rootes Restaurant)**	**-**
09:30	Gareth Roberts	The Zig-Zag	10
10:30	**Coffee Break**	**-**	**-**
11:00	Mark Huber	A Bernoulli Factory using the Fundamental Theorem of Perfect Simulation	10
12:00	**Lunch**	**-**	**-**
13:30	**Coffee Break**	**-**	**-**
14:00	Jing Dong	ϵ–strong simulation for multidimensional stochastic differential equations via rough path analysis	9
15:00	**Coffee Break**	**-**	**-**
15:30	Jose Blanchet	Efficient Monte Carlo Methods for Spatial Extremes	8
16:30	**Coffee Break**	**-**	**-**
17:00	Peter Glynn	Randomized MLMC for Markov Chains	9
18:00	**Finish**	**-**	**-**
19:30	**Conference Dinner**	**Radcliffe, Radcliffe private dining room**	**-**

4 Talk Abstracts

Unbiased Estimation and Exact Simulation for Bayesian Inverse Problems

Sergios Agapiou
Cyprus

We will consider the problem of estimating expectations with respect to measures which are intractable in the sense that sampling them requires infinite cost. In particular we are interested in computing expectations with respect to the posterior distribution in the context of Bayesian PDE inverse problems. The standard approach in this context is to construct a Markov chain with limiting distribution the posterior measure and to use samples from this Markov chain to estimate posterior expectations, for example using the ergodic average. In this approach there are two forms of approximation, due to a) the discretization of the possibly infinite dimensional parameter and/or the discretization of the forward PDE in order to solve it numerically; b) the use of finite-time samples from the Markov chain which have not necessarily converged to the limiting posterior distribution. We will first discuss techniques for estimating posterior expectations unbiasedly, building on the recent work by Peter Glynn and Chang-han Rhee. Then, we will discuss techniques for drawing samples from the posterior without any error due to the discretization of the forward PDE solver.

The first part on unbiased estimation is work done in collaboration with Gareth Roberts (Warwick) and Sebastian Vollmer (Oxford) (arXiv:1411.7713), while the second part on exact estimation is ongoing work in collaboration with Gareth Roberts and Andrew Stuart (Warwick).

Efficient Monte Carlo Methods for Spatial Extremes

Jose Blanchet
Columbia

Many applications, including modeling extreme weather events, naturally call for extrapolation techniques of extremes with spatial dependence. To preserve the standard univariate extreme value theory, it is natural to consider random fields, $\{M(t) : t \in T\}$ (T may represent a geographical region), satisfying, as their definition, a max-stable property. That is, if $\{M_i(\cdot)\}_{i=1}^n$ are iid copies of $M(\cdot)$ then there is a sequence of functions $\{a_n(t), b_n(t)\}$ satisfying the equality in distribution $M(\cdot) = \max_{i=1}^n (M_i(\cdot) - a_n(\cdot))/b_n(\cdot)$. It turns out that if $M(\cdot)$ is a max-stable random field then (after applying a simple transformation) $M(\cdot)$ must admit a representation of the form

$$M(t) = \max_{n=1}^{\infty}\{-\log(A_n) + X_n(t)\},$$

where A_n is the n-th arrival of a Poisson process and $X_n(\cdot)$ is an iid sequence of random fields (typically Gaussian) independent of the A_ns. The goal of this talk is to discuss efficient Monte Carlo techniques for max-stable random fields. In particular, we study the following questions:
a) Is it possible to simulate $\{M(t_1), ...M(t_d)\}$ exactly (i.e. without bias)?
b) Can exact simulation be performed optimally as d grows to infinity?
c) Can conditional simulation also be done efficiently and without bias?
We share surprising good news in response to these questions using ideas borrowed from recent exact simulation algorithms, rare-event simulation, and multilevel Monte Carlo. (This is joint work with Z. Liu, T. Dieker, and T. Mikosch.)

Monte Carlo method for conflation of probability distributions

Hongsheng Dai
Essex

This presentation will cover a new rejection sampling algorithms, which could potentially be applied Bayesian group decision problems and meta-analysis. The idea depends on a decomposition of the target distribution to a product of two simple distributions. If independent realisations are generated from each of the two simple distributions, then they can be combined into a single realisation in a certain way, which is exactly from the target distribution. The presentation will also discuss the possibility of using random series to improve the efficiency of the algorithm.

ϵ-strong simulation for multidimensional stochastic differential equations via rough path analysis

Jing Dong
Northwestern

Consider a multidimensional diffusion process, X. Let $\epsilon > 0$ be a deterministic user defined tolerance error parameter. We develop a systematic way to construct a probability space, supporting both X and a fully simulatable piecewise constant process X_ϵ, such that X_ϵ is within epsilon distance from X under the uniform metric on compact time intervals with probability one, Our construction requires a detailed study of continuity estimates of the Ito map using Lyons' theory of rough paths. We approximate the underlying Brownian paths, jointly with the Levy areas, with a deterministic error bound in the underlying rough path metric.

Infinite-dimensional unbiased MCMC for exact inference in SDE driven models

Flavio Gonçalves
UFMG

Exact methodologies for analytically intractable infinite-dimensional problems have been an area of intensive investigation in the last few years. In particular, models including continuous time stochastic processes which are the solution of some given stochastic differential equation (SDE). The most promising solutions rely on novel simulation techniques, in special, retrospective Monte Carlo ones. In this talk, I describe a novel general methodology do deal with inference problems for SDE driven models in an exact setup. It consists of an infinite-dimensional pseudo-marginal MCMC with Barker's steps. Retrospective sampling and Bernoulli factories play an important role in this context. I will then discuss its implementation for two families of models: jump-diffusions and diffusion-driven Cox processes.

Randomized MLMC for Markov Chains

Peter Glynn
Stanford

Multi-level Monte Carlo (MLMC) algorithms have been extensively applied in recent years to obtain schemes that often converge at faster rates than corresponding traditional Monte Carlo methods. In this talk, we shall discuss a randomized method introduced in joint work with Chang-han Rhee, and then describe a stratified alternative estimator. Our principal focus in the talk will be on applications to equilibrium computations for Markov chains. computing value functions, spectral densities, and sensitivity estimates, and covers joint work with Rhee and Zeyu Zheng.

A Bernoulli Factory using the Fundamental Theorem of Perfect Simulation

Mark Huber
Claremont-McKenna

Given a sequence of iid coin flips with unknown probability p of heads, a Bernoulli factory builds a single coin whose probability of heads is $f(p)$. This problem has a twenty year history, with applications in perfect simulation for regenerative MCMC and diffusions. When $f(p)$ is analytic, Yuval and Peres showed that the problem can be reduced to a Bernoulli factory for $2p$. Here a probabilistic recursive approach is used for functions of the form $f(p) = Cp$, which gives an algorithm that runs in an expected number of flips that is provably within a constant factor of the best possible. This notion of probabilistic recursion forms the basis of many perfect simulation methods, and the Fundamental Theorem of Perfect Simulation presented here gives a simple criterion for the correctness of such algorithms

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Unbiased Multilevel Monte Carlo

Chang-Han Rhee
CWI Amsterdam

Monte Carlo simulation is a powerful computational tool when the quantity of ones interest can be written as an expectation of a random object. Often, however, such a random object is difficult to generate from its exact distribution, and only approximations are available. The errors from such approximations can lead to slower convergence rates and less reliable error estimates. To address such difficulties, [1] proposes a simple yet effective and broadly applicable idea, and studies the implications of the idea in SDE context. In this talk, we will review the general theory developed in [1] and discuss its close connection to the standard (biased) multilevel Monte Carlo methods. We will then discuss the application of the idea to rare event simulation of stochastic recurrence equations.

[1] C.-H. Rhee and P. W. Glynn Unbiased estimation with square root convergence for SDE models. Operations Research, 63(5):10261043, 2015.

The Zig-Zag

Gareth Roberts
Warwick

This is a new continuous-time non-reversible MCMC method. It has been known for some time that non-reversible MCMC methods sometimes have potentially large advantages over reversible ones. The difficulty has always been to construct them in a way which is practically possible. The zig-zag is one of an emerging collection of ideas motivated by this problem.

Delegate Joining Instructions
Warwick Conferences Conference Park

We are delighted that you will be joining us at the University of Warwick. Please bring these instructions with you as you will find them useful whilst you are on campus.

Getting to campus and car parking:

- The Conference Park is situated on the **Central Campus** of the University of Warwick located on the outskirts of Coventry with good transport links
- Download further information from the website at www.warwickconferences.com following the link 'how to find us'
- A further link can be found for any relevant traffic information at http://www.warwickconferences.com/delegates/delegates-conference-park. The Conference Park is the name given to the facilities provided by Warwick Conferences on the **Central** University campus
- Complimentary car parking is available for conference delegates in any of the **Central** campus non-barriered car parks (shared use)
- Your Event Organiser will send you the link to our car parking permit website where you can register, download and print your permit which is to be displayed in your vehicle
- Accessible parking spaces are available in all car parks
- Please inform your Event Organiser if you require an accessible parking space close to your accommodation (blue badge holders only)

Accommodation:

- Please check with your Event Organiser which type of accommodation has been reserved for your event

Conference Reception:

- Located within the Atrium of the Student Union building
- Our Reception team are available to answer any queries between 07:00 – 23:00
- A left luggage store is available in Conference Reception

Bedroom Keys:

- You will be provided with a key or key card which will access your room and entry door to the residence
- On the day of departure, keys can be left at Conference Reception (in the Students Union building), Rootes Restaurant (in Rootes Building) or one of the boxes situated in the entrance halls of each residence

Bedroom check in/out:

- Bedroom keys will be available from 15:00 to 22:45 at Conference Reception
- If you plan to arrive after 22.45, please contact Conference Reception to arrange late key collection wcpreception@warwick.ac.uk or 02476 528910
- Rooms need to be vacated by 09:30 on your day of departure. Luggage and belongings should be removed by that time
- Please inform Conference Reception on arrival, of any difficulties you may have in the unlikely event of an evacuation from your accommodation

Wi-Fi access across Central campus:

- Conference Park delegates can access the "Warwick Guest" Wi-Fi network around campus and within their accommodation. Ask at Conference Reception or any member of the team for assistance if required

Food and Drink:

- All meals are provided in Rootes Restaurant located on the first floor of Rootes Building for all delegates (unless your programme indicates otherwise)
- The restaurant offers breakfast, lunch and dinner including a range of hot and cold drinks
- Please have with you your conference badge or room key to gain access to the restaurant
- Please inform your Event Organiser if you have a specific food allergy or a lifestyle dietary requirement (for example: vegan, vegetarian, halal or Kosher)
- Bar facilities are located on the first floor of Rootes Building and is the ideal place to network and relax after a day's session. There are alternative bars in Warwick Arts Centre and Students Union building (check opening times locally)

Shops, Banks and Cafés on Central campus:

- The campus has a range of facilities available to all delegates, for information and opening times please see the website: http://www.warwickretail.com
- Warwick Arts Centre cinema offers discounted cinema ticket prices, which can be purchased from the box office. Proof of delegate status is required

Chaplaincy:

- Catholic mass takes place in the Chaplaincy on central campus on Sundays throughout the year at 12:30 and conference visitors are welcome to join the service.
- Muslims wishing to pray can request access via Conference Reception for the Islamic Prayer Halls on Central campus.

Sports facilities:

- Guests have free unlimited access to Warwick Sport's premium leisure facilities on campus.
- Opening hours are 07:00 to 21:30 (Monday to Friday) and 08:15 to 19:30 (Saturday and Sunday)
- 25metre swimming pool and sauna
- State of the art gym
- Running track
- Other sports facilities that can be used but at additional charge are:
    - Tennis Centre with 4 indoor and 4 outdoor courts
    - Climbing Centre with 14m high walls and a bouldering room
    - Sports halls for basketball, 5-a-side football, netball or volleyball
    - Outdoor astro or grass pitches for football, rugby or cricket
- You will be required to show your bedroom key or delegate badge to access the facilities
- Lockers are available and require a £1 coin
- Towel hire is available at a minimal charge
- To make a booking or for further information
  Call the Sport Centre Reception on 23011 from any internal phone or 024 76523011 externally; email warwicksport@warwick.ac.uk website www.warwick.ac.uk/sport

For more information: You can also refer to our Frequently Asked Questions document (FAQ's) which can be obtained from our website: http: //www.warwickconferences.com/delegates/delegates-conference-park

WARWICK CONFERENCES

Frequently Asked Questions
Warwick Conferences Conference Park

Where is the University of Warwick?
- Four miles from Coventry City centre at the hub of the central motorway network

What is the Conference Park?
- The name given to the facilities provided by Warwick Conferences on the main University campus
- Once you arrive on campus please look out for the Warwick Conferences signage to direct you to the car parks and conference venues

Where is the nearest Mainline Rail Station?
- Coventry Intercity station is only four miles from the University

Is there a taxi rank on campus?
- Taxis are available on Health Centre Road opposite Warwick Arts Centre at most times of the day. Alternatively you can contact Conference Reception on 02476 528910 for more information and relevant phone numbers

Can I travel by bus from Coventry Railway Station or Bus Station?
- The number 12 bus runs from Coventry Bus Station via Coventry Train Station to the University

If I have a minibus or high sided vehicle – where can these be parked?
- It would be advisable to let your Event Organiser know of your requirement for specific car parking, as the majority of University car parks are multi storey

I have a particular special dietary need – can you manage this?
- Please inform your event organiser if you have a specific food allergy or a lifestyle dietary requirement (for example: vegetarian, vegan, halal or Kosher)

Will we stay in halls of residence?
- All Conference Park accommodation is student style using either standard or en-suite rooms. Your Event Organiser will be able to advise the type of accommodation you have been allocated

Do any of the residences have lifts?
- Some residences do. If you have a particular requirement then please discuss with your Event Organiser

What electrical supply is available in the bedrooms?
- Electricity is supplied at 220/240v and 50 cycles AC. Adaptors are available to purchase in Rootes Grocery Store on Central campus

Are there any laundry facilities on campus?
- A launderette is situated between Rootes Building and Rootes residences, opening times are available from Conference Reception for self-service washing and drying
- All machines and driers are operated using a card payment system which can be purchased from the launderette at a cost of £10 (£2 for the card and £8 of available spend for use on machines or driers)
- Washing powder and softener is not provided. You can purchase this from Rootes Grocery Store on Central Campus
- A dry cleaning service is available in Rootes Grocery Store and the Chemist situated in the Student Union Atrium

Will I have access to a kitchen within my accommodation block?

- Each delegate will have access to a shared kitchen. Please note these areas will not contain any cooking equipment or utensils

If I have any lost property during my stay who do I contact?

- Contact Conference Reception on 02476 528910 who will be able to assist

Are religious services available on campus?

- A chaplaincy is available to all University visitors. Catholic mass takes place in the Chaplaincy on central campus on Sundays throughout the year at 12:30 and conference visitors are welcome to join the service.
- Muslims wishing to pray can request access via Conference Reception for the Islamic Prayer Halls on central campus.

Where can I access my emails?

- Conference Park delegates can access the Warwick Guest Wi-Fi network around campus and within their accommodation. Please ask at Conference Reception or any member of the team for assistance if required
- Computers are available at Conference Reception for guest use

If I am having mobility problems is there anything you can do to help?

- Mobility scooters are available for guests; please ask at Conference Reception for more information

What should I do if I feel unwell?

- Please contact Conference Reception on 02476 528910, who will ensure a message is given to your Event Organiser. We do not have a resident doctor available for conference delegates, but in the event you require a first aider, this can be done via our 24 hour Security Team on 02476 522083. Alternatively there is a Walk-In Medical Centre in Coventry – http://cityofcoventrynhshealthcarecentre.nhs.uk/

Is there anywhere on campus I can buy toiletries or get pharmacist advice?

- There is a pharmacy located in the Students Union Building and Rootes Grocery Store also sells a variety of items. These buildings are located next to Rootes Building

Are there any cash machines or banks on campus?

- There are branches of Barclays and Santander, both have cash machines in the Students Union Atrium (directly next to Rootes Building)
- There is also a cash machine outside Rootes Grocery Store

Where are the nearest shops to campus?

- There are a number of retail shops on campus; a grocery store, post office, pharmacy, bookshop and hairdressers
- Cannon Park Shopping Centre is within a ten minute walk and has a large supermarket and several smaller retail shops

What is there to do in the local area?

- Warwick Arts Centre is situated on Central campus and houses a cinema with reduced rates for Conference delegates
- You will find bikes for hire on site – a great way to see the local area. See the website for more information: http://www2.warwick.ac.uk/about/environment/transport/cycling/uni-cycles
- Coventry city centre is only four miles away and Warwick, Stratford Upon Avon and Leamington are nearby

What signage should I look out for on campus?

- University Signage – these are positioned around campus highlighting all Academic Buildings and social spaces – they are white rectangular blocks
- Warwick Conferences signage is in place around campus to highlight particular buildings used for Conference Events