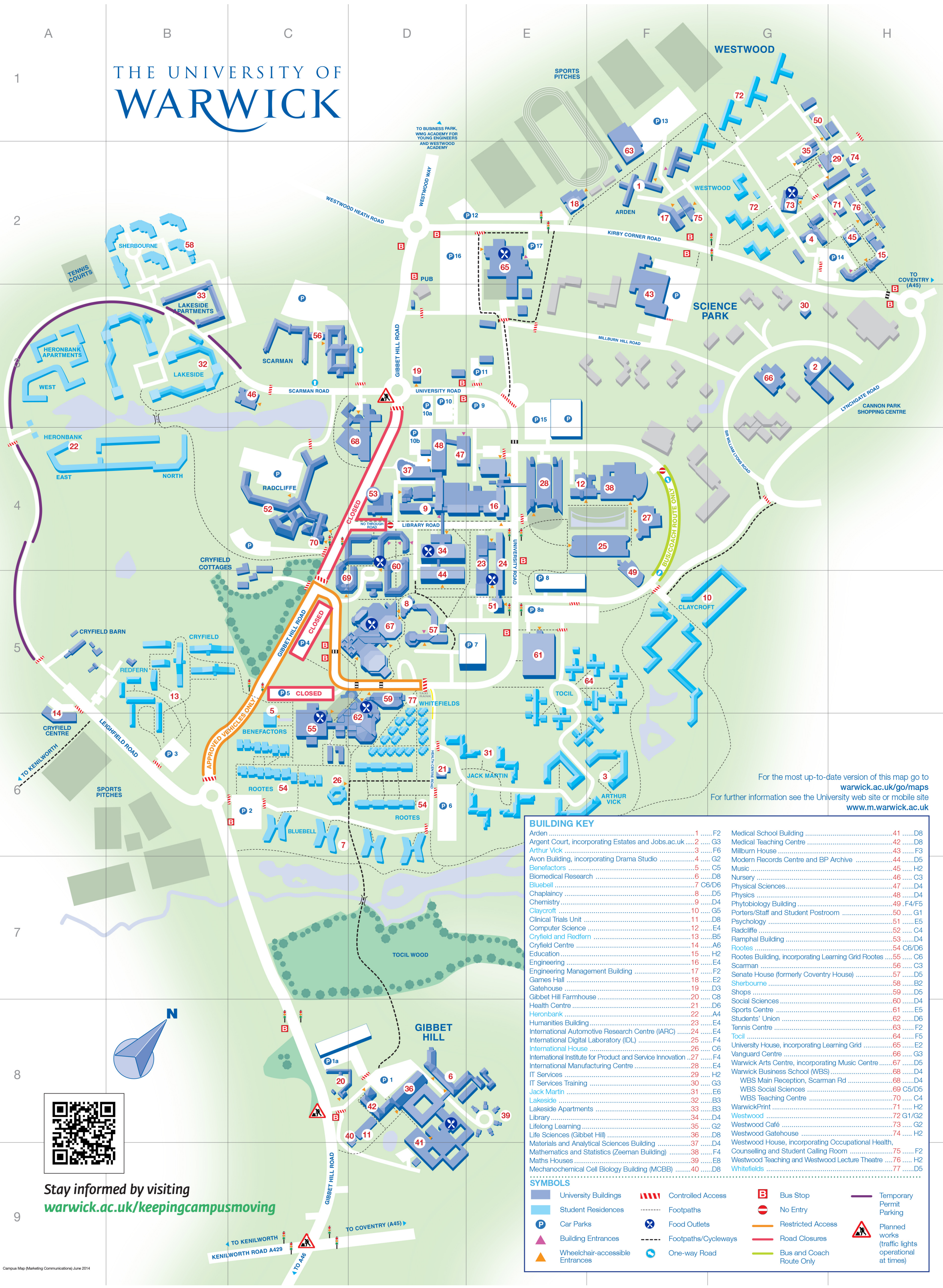
Computational Methods for Jump Processes

7th of July 2014 (lunch time) – 9th of July (afternoon)

Contents

THE UNIVERSITY OF WARWICK



For the most up-to-date version of this map go to **warwick.ac.uk/go/maps**
For further information see the University web site or mobile site **www.m.warwick.ac.uk**

BUILDING KEY

Arden	1	F2
Argent Court, incorporating Estates and Jobs.ac.uk	2	G3
Arthur Vick	3	F6
Avon Building, incorporating Drama Studio	4	G2
Benefactors	5	C5
Biomedical Research	6	D8
Bluebell	7	C6/D6
Chaplaincy	8	D5
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Claycroft	10	G5
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International Digital Laboratory (IDL)	25	F4
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Warwick Arts Centre, incorporating Music Centre	67	D5
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WBS Main Reception, Scarman Rd	68	D4
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WBS Teaching Centre	70	C4
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Westwood Gatehouse	74	H2
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Westwood Teaching and Westwood Lecture Theatre	76	H2
Whitefields	77	D5

SYMBOLS

- University Buildings
- Student Residences
- Car Parks
- Building Entrances
- Wheelchair-accessible Entrances
- Controlled Access
- Footpaths
- Food Outlets
- Footpaths/Cycleways
- One-way Road
- Bus Stop
- No Entry
- Restricted Access
- Road Closures
- Bus and Coach Route Only
- Temporary Permit Parking
- Planned works (traffic lights operational at times)

Stay informed by visiting
warwick.ac.uk/keepingcampusmoving

Campus Map (Marketing Communications) June 2014

Administrative Details

Workshop Registration

Registration on Wednesday will take place in the lobby of the Mathematics & Statistics Building (Map Key 38), between 12.30 am and 2 pm.

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/`

Around campus and the surrounding area in Coventry there have recently been a number of road works and traffic. Here is a link which is updated on a regular basis based on information given from the Coventry Council `http://www.warwickconferences.com/delegates/delegates-conference-park`

Accommodation

Accommodation is on campus in either the Arden House (Map Key 1) or Conference Park (Arthur Vick /Map Key 3/ or Bluebell /Map Key 7/). Arden House operates on hotel-like basis, go there directly to check in. Participants staying in Bluebell or Arthur Vick will collect their keys from Conference Reception which is currently situated in the Atrium of the Student Union Building (Map Key 62). For standard accommodation arrangements check in is Monday 7th July after 15:00, check out is Wednesday 9th July before 9:30 am. If you plan to arrive after 22.45, please contact Conference Reception to arrange late key collection (wcpreception@warwick.ac.uk).

Car Parking

Car parking is included and delegates are invited to park in either CP7, 8, 8a or 15. If parked in either 7 or 15 they will need to take the blue token at the barrier and have it validated in either the Conference Reception or at the information desk on the ground floor of the Rootes Building (Map Key 55).

Internet Access

Campus: Wireless access is most easily available via eduroam — `http://www.eduroam.org/` — which is supported across most of the Warwick campus (but not at the time of writing in all the accommodation buildings). Speak to one of the organisers for details of other options.

Accommodation: *Wired* internet access is available in all bedrooms. Details of how to log onto the system will be displayed in each individual bedroom, but participants will need to bring their own Ethernet cable. Ethernet cables can be purchased from Costcutter on campus (Map Key 59).

Start.Warwick

The Start.Warwick app, available for iPads, iPhones and Android devices from `http://www2.warwick.ac.uk/insite/news/intnews2/start_warwick_app`, provides useful information on travel and an interactive map of the campus amongst other things.

Facilities

Supermarkets:	Costcutter (Map Key 59)
	Tesco (Map Grid Reference H4)
Food & Drink:	Dirty Duck (Map Key 62)
	Xananas (Map Key 59)
	Le Gusta (Map Key 67)
	Terrace Bar (Map Key 62)
	Varsity (Map Grid Reference D3)
Coffee Shops:	Curiositea (Map Key 62)
	Costa (Map Key 55)
	Arts Centre (Map Key 67)
Cinema:	Map Key 67
Theatre:	Map Key 67
Sports Centre:	Map Key 61
Health Centre:	Map Key 21
Pharmacy:	Map Key 62

Help, Information & Telephone Numbers

Department

Department of Statistics
University of Warwick
Gibbet Hill Road
Coventry
CV4 7AL

Telephone:	024 7657 4812
Fax:	024 7652 4532
Map Key:	**38**

Emergency Numbers

Emergency:	Internal - 22222; External - 024 7652 2222
Security:	Internal - 22083; External - 024 7652 2083
Organiser:	Internal - 50920; External - 02476 150920 (Krys Latuszynski)

Transport

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

Timetable

All activities will take place in the Mathematics & Statistics Building (Map Key 38), with talks in room MS.04 (signposted from lobby), unless otherwise stated.

Monday 7th July

Time	Speaker	Title	Pg
12:45	Registration	Maths & Stats main lobby	-
13:00	Lunch	Maths & Stats main lobby	-
14:30	**Denis Belomestny**	**Multilevel path simulation for weak approximation schemes: myth or reality**	**7**
15:30	Coffee		-
16:00	**Gareth Roberts**	**Continous time importance sampling for jump diffusions with application to maximum likelihood parameter estimation**	**7**
17:00	**Poster Session**	Maths & Stats main lobby Posters by: István Barra 12 Catalin Cantia 13 Andrea Cremaschi 14 Catherine Daveloose 15 Jim Griffin 16 Sylvain Le Corff 16 Filippo Macaluso 17 Tommaso Paletta 18 Murray Pollock 19 Enrico Scalas 20 Illia Simonov 21 Jakob Söhl 22 Wei Wei 23	**12**

Tuesday 8th July

Time	Speaker	Title	Pg
9:00	**Arturo Kohatsu-Higa**	**The parametrix method for jump sde's**	**7**
10:00	Coffee		**-**
10:30	**Zhiyi Chi**	**Random sampling for infinitely divisible distributions and Lévy processes**	**8**
11:30	Coffee		**-**
12:00	**Per Mykland**	**Assessment of Uncertainty in High Frequency Data: The Observed Asymptotic Variance**	**9**
13:00	Lunch	Maths & Stats main lobby	**-**
14:30	**Yacine Aït-Sahalia**	**High Frequency Traders: Taking Advantage of Speed**	**10**
15:30	Coffee		**-**
16:00	**Almut Veraart**	**Trawl processes and applications**	**10**
19:00	**Dinner**	**The Courtyard, Scarman House (Map Key 56)**	**-**

Wednesday 9th July

Time	Speaker	Title	Pg
9:00	**Jean Jacod**	**Backward differential equations driven by a point process: an elementary approach**	**11**
10:00	Coffee		**-**
10:30	**Matija Vidmar**	**Markov chain approximations to scale functions of Lévy processes**	**11**
11:30	Coffee		**-**
12:00	**Noufel Frikha**	**Multilevel stochastic approximation algorithms**	**11**
13:00	Lunch	Maths & Stats main lobby	**-**

Talk Abstracts

Multilevel path simulation for weak approximation schemes: myth or reality

Denis Belomestny
UNIVERSITÄT DUISBURG-ESSEN

In this paper we discuss the possibility of using multilevel Monte Carlo (MLMC) methods for weak approximation schemes in jump diffusion models. It turns out that by means of a simple coupling between consecutive time discretisation levels one can achieve the same complexity gain as under the presence of a strong convergence. We exemplify this general idea in the case of weak Euler and Milstein schemes, and prove that the complexity of the corresponding "weak" MLMC estimates are of order $\varepsilon^{-2}\log^2(\varepsilon)$ and ε^{-2} respectively. Thus, we propose a new simple approach how to achieve the complexity ε^{-2} without time-consuming Levy area simulation. The numerical performance of the new "weak" MLMC methods is illustrated by several numerical examples.

Continous time importance sampling for jump diffusions with application to maximum likelihood parameter estimation

Gareth Roberts, Paul Fearnhead, Krys Latuszynski, Sylvain Le Corff, Giorgos Sermaidis
University of Warwick, University of Lancaster, University of Warwick, Université Paris-Sud, University of Lancaster

In the talk I will present a novel algorithm for sampling multidimensional irreducible jump diffusions that, unlike methods based on time discretisation, is unbiased. The algorithm can be used as a building block for maximum likelihood parameter estimation. The approach is illustrated by numerical examples on financial models like the Merton or double-jump model where its efficiency is compared to methods based on the standard Euler discretisation and Multilevel Monte Carlo.

The parametrix method for jump sde's

Arturo Kohatsu-Higa
Ritsumeikan University and JST-CREST

In this talk we will introduce the parametrix method for stochastic differential equations and explain how to obtain stochastic representations. In particular, we will discuss some of these representations for jump sde's.

Random sampling for infinitely divisible distributions and Lévy processes

Zhiyi Chi
Department of Statistics, University of Connecticut

The talk has three related parts. The first part concerns exact sampling of infinitely divisible (i.d.) distributions. Most i.d. distributions specified via their Lévy densities have no closed-form expressions, making them difficult to sample. We show that for a rather wide range of i.d. distributions with finite variation, this difficulty can be overcome by utilizing an integral series expansion of their probability densities and rejection sampling.

The second part concerns approximate sampling of i.d. distributions. In order to achieve small approximation error, the idea is to find an approximating distribution that has several consecutive cumulants, starting from the first one, that are equal to those of the original distribution. The proposed non-Normal small jump approximation combines compound Poisson, Gamma, and Normal distributions. Its parameters are easy to fix, and its sampling has the same order of complexity as its well-known Normal counterpart.

The last part briefly discusses exact sampling of first passage event of Lévy processes with finite variation. The idea is to embed a process into a "carrier" process whose first passage event can be sampled exactly and then extract the part belonging to the former from the data sampled for the carrier.

Assessment of Uncertainty in High Frequency Data: The Observed Asymptotic Variance

Per Mykland, Lan Zhang
The University of Chicago, University of Illinois at Chicago

High frequency inference has generated a wave of research interest among econometricians and practitioners, as indicated from the increasing number of estimators based on intra-day data. However, we also witness a scarcity of methodology to assess the uncertainty – standard error– of the estimator. The root of the problem is that whether with or without the presence of microstructure, standard errors rely on estimating the asymptotic variance (AVAR), and often this asymptotic variance involves substantially more complex quantities than the original parameter to be estimated.
Standard errors are important: they are used both to assess th precision of estimators in the form of confidence intervals, to create "feasible statistics" for testing, and also when building forecasting models based on, say, daily estimates.
The contribution of this paper is to provide an alternative and general solution to this problem, which we call *Observed Asymptotic Variance*. It is a general nonparametric method for assessing asymptotic variance (AVAR), and it provides consistent estimators of AVAR for a broad class of integrated parameters $\Theta = \int \theta_t dt$. The spot parameter process θ can be a general semimartingale, with continuous and jump components. The construction and the analysis of $\widehat{AVAR}(\hat{\Theta})$ work well in the presence of microstructure noise, and when the observation times are irregular or asynchronous in the multivariate case. The edge effect – phasing in and phasing out the information on the boundary of the data interval – of any relevant estimator is also analyzed and treated rigorously.
As part of the theoretical development, the paper shows how to feasibly disentangle the effect from estimation error $\hat{\Theta} - \Theta$ and the variation in the parameter θ alone. For the latter, we obtain a consistent estimator of the quadratic variation (QV) of the parameter to be estimated, for example, the QV of the leverage effect.
The methodology is valid for a wide variety of estimators, including the standard ones for variance and covariance, and also for estimators, such as, of leverage effects, high frequency betas, and semi-variance.

High Frequency Traders: Taking Advantage of Speed*

Yacine Aït-Sahalia†
Department of Economics
Bendheim Center for Finance
Princeton University
and NBER

Mehmet Saglam‡
Department of Finance
Carl H. Lindner College of Business
University of Cincinnati

First Version: September 2013
This Version: May 15, 2014

Abstract

We propose a model of dynamic trading where a strategic high frequency trader receives an imperfect signal about the future order flow, and exploits his speed advantage to act as a market maker. We determine the provision of liquidity, order cancellations, and impact on low frequency traders. The model predicts that volatility leads high frequency traders to reduce their provision of liquidity. Next, we analyze the problem when the high frequency trader competes with another market maker. Finally, we provide the first formal, model-based analysis of the impact of various policies designed to regulate high frequency trading.

Keywords: High Frequency Trading, Market Making, Liquidity, Order Cancellations, Competition for Order Flow, Tobin Tax, Order Resting Time, Order Cancellation Tax.
JEL Classification: G10.

Trawl processes and applications

Almut Veraart , Ole E. Barndorff-Nielsen, Asger Lunde and Neil Shephard
Imperial College London, Aarhus, Aarhus, Harvard

We introduce a new continuous-time modelling framework for modelling serially correlated count and integer-valued data based on so-called trawl processes. Such processes are stationary and infinitely divisible. We analyse the key probabilistic properties of such processes and discuss simulation methods and inference within the new modelling framework. Finally, we apply the modelling framework to high-frequency financial data.

Backward differential equations driven by a point process: an elementary approach

Jean Jacod
(joint with Fulvia Confortola and Marco Fuhrman)

We consider a BSDE driven by a point process, or a multivariate point process, on a finite time interval. If the point process has a bounded number of points, we show that the problem reduces to recursively solving a finite number of ordinary differential equations, and no probability is involved. When the number of points is unbounded (e.g. for a Poisson point process), the problem is slightly more complex, in the sense that it involves *a priori* estimates. But this approach allows us to construct an $\mathbf{L}^1$ theory, instead of the usual $\mathbf{L}^2$ theory. This also provide a new method for numerically solving such a BSDE.

If time permits, I will also show how this can be applied to a control problem driven by a point process.

Markov chain approximations to scale functions of Lévy processess

Matija Vidmar, Aleksandar Mijatović and Saul Jacka
University of Warwick, Imperial College London, University of Warwick

We introduce a general algorithm for the computation of the scale functions of a spectrally negative Lévy process X, based on a natural weak approximation of X via upwards skip-free continuous-time Markov chains with stationary independent increments. The algorithm consists of evaluating a finite linear recursion with, what are nonnegative, coefficients given explicitly in terms of the Lévy triplet of X. Thus it is easy to implement and numerically stable. Our main result establishes sharp rates of convergence of this algorithm providing an explicit link between the semimartingale characteristics of X and its scale functions, not unlike the one-dimensional Itô diffusion setting, where scale functions are expressed in terms of certain integrals of the coefficients of the governing SDE.

Multilevel stochastic approximation algorithms

Noufel Frikha
Université Paris-Diderot (Paris 7)

During this presentation we study multi-level stochastic approximation algorithm. Our aim is to extend the scope of the multi-level Monte Carlo method recently introduced by Giles (Giles 2008) to the framework of stochastic optimization by means of stochastic approximation algorithm. We first introduce and study a two-level method, also referred as statistical romberg stochastic approximation algorithm. Then, its extension to multi-level is proposed. We prove a central limit theorem for both methods and describe the possible optimal choices of step size sequence. Numerical results confirm the theoretical analysis and show a significant reduction in the initial computational cost. If time permits I will present how the principle of Richardson-Romberg extrapolation method can be applied to stochastic optimization.

Poster Abstracts

Dynamic Negative Binomial Difference Model for High Frequency Returns

István Barra, Siem Jan Koopman
VU University Amsterdam

We introduce the dynamic ΔNB model for financial tick by tick data. Our model explicitly takes into account the discreteness of the observed prices, fat tails of tick returns and the intraday pattern of volatility. We propose a Markov Chain Monte Carlo estimation procedure, which takes advantage of the auxiliary mixture representation of the ΔNB distribution.

Estimation of Tail Dependence Sensitivities by Pathwise Derivative Methods

C. Cantia, R. Tunaru

January 31, 2014

Abstract

In the recent literature, a multitude of multidimensional stochastic models has been proposed for multivariate modelling in finance. Some of the applications of such models are: multi-asset derivative pricing, credit derivatives modelling and risk management of portfolios. Most of these models are part of the class of Levy processes which have been shown to have a representation that involve a jump component. For the multidimensional models these jump terms become very important in modelling the dependence between the unidimensional components and especially the dependence between extreme events. Often, the presence of jumps and of complicated dependence structure make these models so complex that their probabilistic characteristics are not easy to investigate analytically. One such characteristic is the dependence in the tails of the finite dimensional distribution at some time T of the multidimensional process. Following the direction set by a series of papers on "quantile sensitivity estimation" and "probability sensitivity estimation" by L.J. Hong and G. Liu (2009), we propose four different parameter sensitivity estimators of tail dependence and intermediate tail dependence coefficients. Such estimators have the purpose of quantifying the change of the tail dependence intensity driven by changes in the parameters of the multidimensional process. These estimators are developed in the context of pathwise derivative methodology and imply performing simulations of the process in order to compute such sensitivities. The asymptotic properties of the estimators are analysed and proven. We conclude the article with an application, where we use the above estimators to investigate the dependence in the tails of the finite dimensional distributions of some recently proposed multidimensional Levy processes and compare their tail dependence profile. The implications for multi-asset derivatives pricing and risk management are discussed from the perspective of flexibility of the model as well as model risk, implied by choosing a multidimensional model that doesn't represent well the dependence between events in the tails.

Bayesian inference for integer-valued Lévy processes with non-Gaussian Ornstein-Uhlenbeck subordinator

Andrea Cremaschi
University of Kent

Financial time series are usually modelled as continuous, often involving geometric Brownian motion with drift, leverage and possibly jump components. An alternative modelling approach allows financial observations to take discrete values, multiples of a fixed quantity, the ticksize, the monetary value associated with a single change during the asset evolution. This approach is particularly suitable when dealing with samples collected at irregularly spaced time points, such as high-frequency data, exhibiting diverse trading operations in a few seconds. The class of integer-valued Lévy processes is used to model the observations, yielding desirable flexibility in the choice of the marginal distribution for a fixed time interval. Time deformation is used to allow for stochastic volatility and is modelled as a non-Gaussian Ornstein-Uhlenbeck process (which is driven by a purely non-Gaussian Lévy process). In particular, the relationship between the class of infinitely divisible distributions and Lévy processes is exploited to perform posterior computations. Bayesian inference is performed on applications to real stock market indices.

Computation of conditional expectations in Lévy and jump-diffusion setting

Applied to pricing and hedging of financial products

Catherine Daveloose[1], Asma Khedher[2], and Michèle Vanmaele[1]

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[2]Technische Universität München, Lehrstuhl für Finanzmathematik, Parkring 11-13, 85748 Garching, Germany

[1,2]Catherine.Daveloose@UGent.be, Asma.Khedher@cma.uio.no, Michele.Vanmaele@UGent.be

January 2014

Abstract Conditional expectations play an important role in the pricing and hedging of financial derivatives. There exist several methods to compute and rewrite conditional expectations in markets modeled by Brownian motions, see e.g. Fournié et al. (1999, 2001). In this paper, we consider markets driven by Lévy and jump-diffusion processes. We express the conditional expectation in terms of expectations without conditioning, but involving some weights. For this we apply two approaches: the conditional density method and the Malliavin derivative. The weights can be optimized in minimal variance sense and a localization technique will be used to obtain acceptable convergence in numerical applications, where we focus on American options. In certain examples, Monte Carlo simulations will improve remarkably by using these representations.

Keywords Conditional expectation, Monte Carlo methods, Conditional density method, Malliavin calculus, Pricing, Lévy processes, American option, Reduction of variance

References

E. Fournié, J.M. Lasry, J. Lébucheux, P.L. Lions, and N. Touzi. Applications of Malliavin calculus to Monte Carlo methods in finance. *Finance and Stochastics*, 3: 391–412, 1999.

E. Fournié, J.M. Lasry, J. Lébucheux, and P.L. Lions. Applications of Malliavin calculus to Monte Carlo methods in finance. II. *Finance and Stochastics*, 5:201–236, 2001.

A Bayesian model of jumps in financial time series

Jim Griffin
University of Kent

It is commonly accepted that financial time series are prone to both jumps in the price process and jumps in volatility. Disentangling the jump part of the price price from the part with continuous sample paths is challenging. Realized measures which use intra-day data offer one useful approach to this problem with the jumps estimated as the difference between realized volatility and the bi-power variation. Naive application of this method can lead to negative estimates of jumps due to the noise in the estimates. I will look at a Bayesian approach to this problem which models the price process as the sum of a Brownian semimartingale and a jump process. The stochastic volatility process is assumed to follow an infinite superposition of non-Gaussian Ornstein-Uhlenbeck processes which allows jumps in the volatility. Inference is made using observed returns, realized volatility and bi-power variation. The method will be illustrated using applications to stock index data.

Continuous-time importance sampling for Jump difusions

Sylvain Le Corff, Krys Latuszynski, Gareth O. Roberts
Université Paris-Sud, University of Warwick, University of Warwick

The aim of this poster is to introduce a new algorithm to sample from continuous-time jump diffusions and to estimate expectations of functionals of such diffusions. Simulation and inference for jump diffusions are challenging tasks due to the intractability of some basic quantities related to diffusions such as transition probabilities. A common approach is to use a discretization scheme (*e.g.* Euler or Milstein schemes) to obtain independent draws approximately distributed as the target process. However, every discretization procedure introduces a systematic bias which vanishes only when the number of discretization steps grows to infinity.
In this contribution, we introduce a new algorithm to compute unbiased estimates of expectations of functionals of jump diffusions which can be used under weak assumptions. This Jump Continuous Importance Sampling (JCIS) algorithm draws weighted skeletons using an importance sampling mechanism recently introduced for diffusion processes. In this case, the sampled paths are not distributed as the diffusion process but the weighted samples can be used to produce unbiased Monte Carlo estimates. The JCIS algorithm is compared to several other algorithms (Euler scheme with thinned jumps, Multilevel Monte Carlo path simulation, Jump Exact algorithm) using different models (Merton model, Sinus model, Double Jump model).

How to Sample From a Distribution When Only the Characteristic Function is Known.

Filippo Macaluso, [1] Antonietta Mira, [1] Paul Schneider [2]

[1] University of Lugano [2] University of Lugano and Swiss Finance Institute

Abstract

We develop a novel efficient simulation based procedure to sample from a multivariate distribution when only its characteristic function is known. To this aim we combine two strands of the statistical literature. The first one is concerned with the approximation of the density ratio of the original measure to an auxiliary measure in terms of orthonormal polynomial series in weighted $\mathcal{L}^2$ spaces developed in Filipović et al. (2013). The second strand investigates Markov Chain Monte Carlo (MCMC) and Importance Sampling (IS) schemes that use, when computing the Metropolis-Hastings (MH) acceptance probability or the importance weights, approximations of the true, unknown, target density. An unbiased estimator of the approximation density is introduced by means of the Russian Roulette tool from Girolami et al. (2013). The negativeness of the approximation density in the MCMC acceptance probability is overcome by employing results from Quantum Monte Carlo as in Lin et al. (2000). By our procedure we can simulate stochastic processes with infinity variation/activity jumps as in Wu (2011).

Keywords: Series approximation based methods, Monte Carlo Markov Chain, Importance Sampling, Jump Processes

References

Filipović, D., Mayerhofer, E., and Schneider, P. (2013). Transition density approximations for multivariate affine jump diffusion processes. *Journal of Econometrics*, 176(2):93–111.

Girolami, M., Lyne, A.-M., Strathmann, H., Simpson, D., and Atchade, Y. (2013). Playing russian roulette with intractable likelihoods. *arXiv preprint arXiv:1306.4032*.

Lin, L., Liu, K., and Sloan, J. (2000). A noisy monte carlo algorithm. *Physical Review D*, 61(7):074505.

Wu, L. (2011). Variance dynamics: Joint evidence from options and high-frequency returns. *Journal of Econometrics*, 160(1):280–287.

Pricing and hedging basket options with exact moment matching

Tommaso Paletta, Arturo Leccadito, Radu Tunaru

January 31, 2014

Basket options are contingent claims on a group of assets and are largely used to hedge away exposure to correlation or contagion risk, or for investment purposes. It is common to have options on groups of 10-15 assets and this causes several computational difficulties in the pricing and hedging of these contingent claims, since the probability density function is not known in closed-form. Several existing methods sacrifice the realism of the underlying price models to circumvent these difficulties. We provide a computational method to solve the problem of pricing and hedging these contingent claims under displaced multi-dimensional models with jumps.

Our paper describes a new methodology stemming out from a realistic underlying model and computational tractability. We assume that each asset follows the displaced lognormal process with jumps, a process capable of accommodating negative skewness, which is well known to characterize equities. Unlike most of the existing methods which assume the entire basket as a single asset, ours does not assume any dynamics of the entire basket but the only prerequisite is to be able to calculate the moments of the basket in closed form. Our method approximates the risk-neutral distribution of the basket price at maturity by the Hermite polynomial expansion that matches exactly its first m moments. Despite the more realistic model, the new method provides pricing semi-analytical formulae as well as formulae for the Greeks.

Finally, we propose a methodology to compare the performances of our pricing and hedging method with other existing methods in the literature. Through this methodology, we empirically show that the new method provides superior results not only with respect to pricing but also for hedging purposes.

Exact Simulation in a Nutshell.

Murray Pollock[*†], Adam M. Johansen[*], Gareth O. Roberts[*]

Abstract

In this talk we will discuss recent work extending methodology for simulating finite dimensional representations of jump diffusion sample paths over finite intervals, without discretisation error (*exactly*), in such a way that the sample path can be *restored* at any finite collection of time points. We demonstrate the efficacy of our approach by showing that with finite computation it is possible to determine whether or not sample paths cross various non-standard barriers.

Keywords: Adaptive Exact Algorithms; ϵ-Strong Simulation

A note on maximum statistic for a sequence of exceedances separated by random intervals and its applications

Enrico Scalas[1], *Andrea Giuseppe Vitali*[2]

1. Department of Mathematics, University of Sussex, Brighton, UK

2. Facultad de Ciencias Económicas y Empresariales, Euskal Herriko Unibertsitatea/Universidad del Paìs Vasco, Basque Country, Bilbao, Spain

Abstract

We consider a sequence of independent and identically distributed (i.i.d.) positive random variables with the meaning of jumps (for a pure jump model) or exceedances and separated by random times. It is assumed that random times are also i.i.d. and positive and they are independent from exceedances. This is a simple instance of marked point process.

We specialise the known formula for the cumulative distribution function of the maximum to the case of Mittag-Leffler distributed random times and we derive a generalisation of the Gumbel distribution.

We apply these ideas to absolute tick-by-tick log-returns in equity markets using a mixture of two exponential functions to describe the distribution of inter-trade duration and we present examples of hypothesis tests run on the statistics of the jump maximum. To this aim, we propose the following procedure:

1. Define a suitable data set that reproduces the normal behaviour of the data set under scrutiny (e.g the absolute log-returns for a given share).

2. Fit the mixture of two exponentials for the inter-trade durations of your data set, using your favourite procedure (e.g. maximum likelihood).

3. Fit a distribution for the jumps of your data set, using your favourite procedure (e.g. maximum likelihood based on suitable assumptions).

4. Run your favourite test to detect anomalous jumps on another set of data (e.g. subsequent log-returns for the same share), using the above-fitted parameters. For instance, one could use a goodness-of-fit test to verify if the new data do obey the same distribution as the old data.

Illia Simonov (University of Leoben)

Infinity copulas

Dependence between two random variables is very well described by copulas introduced by Sklar. One can extend this dependence to n random variables. But what happens if we have infinity random variables? We will introduce and construct ∞-copulas and try to give some simulation techniques.

Definition 1 *Let E be a separable Hilbert space and a measure μ on $(E, \mathcal{B}(E))$. Let $\{e_n : n \in \mathbb{N}\}$ be a orthonormal basis. Then there exists a mapping*

$$C : l_\infty([0,1]) \to [0,1]$$

such that for any finite number $\{i_1, \dots, i_n\}$ of indices the finite dimensional copula

$$C_{i_1,\dots,i_n} : [0,1]^n \to [0,1]$$

of the probability measure μ_n on $(\mathbb{R}^n, \mathcal{B}(\mathbb{R}^n))$ given for $A = (A_1, A_2, \dots, A_n) \in \mathcal{B}(\mathbb{R}^n)$ by

$$\mu_n(A) = \mu\left(\{y \in E : \langle y \mid e_{i_1}\rangle \in A_1, \dots, \langle y \mid e_{i_n}\rangle \in A_n\}\right).$$

coincides with C, i.e. for any $x \in l_\infty([0,1])$, $x_j = 1$ for $j \neq i_1, \dots, i_n$, and $y = (x_{i_1}, x_{i_2}, \dots, x_{i_n})$

$$C(x) = C_{i_1,\dots,i_n}(y).$$

The result of this simulation gives the opportunity to solve SPDE with Lévy process in infinity dimensional case with given dependence on every dimension described by copula (Gaussian or Frank's).

Confidence sets in nonparametric calibration of exponential Lévy models

Jakob Söhl

We construct confidence intervals for the spectral calibration method of exponential Lévy models. In these models the log price of an asset is described by a Lévy process. The observations are given by prices of European put and call options with fixed maturity and different strike prices. Belomestny and Reiß (2006) introduced the spectral calibration method and showed that its estimators are minimax optimal. The method is designed for finite intensity Lévy process with absolutely continuous jump measures. First, the volatility, the drift and the intensity are estimated and then nonparametrically the jump density. The estimators are based on a cut–off scheme in the spectral domain.

We show that the estimators of the volatility, the drift and the intensity are asymptotically normally distributed. We also derive asymptotic normality for the pointwise estimation of the jump density at finitely many points and study the joint distribution of these estimators. The calibration of exponential Lévy models is a nonlinear inverse problem and our results cover both the mildly ill-posed case of volatility zero and the severely ill-posed case of positive volatility. Finally, the results on the asymptotic distribution of the estimators allow us to construct confidence intervals and confidence sets.

D. Belomestny, M. Reiß (2006) *Spectral calibration of exponential Lévy models*, Finance and Stochastics 10, 449–474.

J. Söhl (2014) *Confidence sets in nonparametric calibration of exponential Lévy models*, arXiv: 1202.6611. Finance and Stochastics, to appear.

A Jump Diffusion Model for Volatility and Duration

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Abstract

This paper puts forward a stochastic volatility and stochastic conditional duration with cojumps model to analyze returns and durations. In high frequency data, transactions are irregularly spaced, and the durations between transactions carry information about volatility as suggested by the market microstructure theory. Traditional measures of volatility do not utilize durations. We adopt a jump diffusion process to model the persistence of intraday volatility and conditional duration, and their interdependence. The jump component is disentangled from the continuous part of the price, volatility and conditional duration process. We utilize Markov Chain Monte Carlo algorithms for the inference on irregularly spaced multivariate process with jumps. The algorithm provides smoothed estimates of the latent variables such as spot volatility, jump times and jump sizes. We apply this model to IBM data and find meaningful relationship between volatility and conditional duration. Also, jumps play an important role in the total variation, but the jump variation is smaller than traditional measures that use returns sampled at lower frequency.

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