NWO/STAR/PWN

17th Winter School on Mathematical Finance

Special topics:

Extreme risks

Algorithmic and high-frequency trading

January 22–24, 2018
Congrescentrum De Werelt, Lunteren

Sponsored by NWO, STAR, PWN, and FWO

NWO/STAR/PWN
Winter School on Mathematical Finance

In recent years, the mathematical theory associated with financial risk management and the pricing of contingent claims has been a highly active field of research. The area has established itself as one of the most vigorously growing branches of applied mathematics. Model-based analysis of contracts and portfolios has become a standard in the finance industry, and the number of academic institutions offering curricula in financial mathematics has increased rapidly. In this context, the winter school on Mathematical Finance that will take place on January 22–24, 2018 in Lunteren aims at providing a meeting place for participants both from industry and from academia. The program provides ample opportunity for discussion.

The special topics of the 17th winter school are *Extreme risks*, and *Algorithmic and high-frequency trading*. These are the subjects of minicourses that will be taught by two distinguished speakers: Professor Emmanuel Gobet (Ecole Polytechnique, Palaiseau) and Professor Sebastian Jaimungal (University of Toronto). Additionally there will be three one-hour lectures by Professors Beatrice Acciaio (London School of Economics), Giulia Di Nunno (University of Oslo) and Martino Grasselli (Pôle Universitaire Léonard de Vinci, Paris La Defense and University of Padua). Thirty-minute lectures on recent research work in the Netherlands will be presented by Ki Wai Chau (CWI), Andrea Fontanari (TU Delft and CWI), Jitze Hooijsma (UvA) and Rob Sperna Weiland (UvA).

Auspices and sponsoring

The Winter School takes place under the auspices of the mathematics cluster STAR and of PWN. The stochastics groups of the mathematics departments of the universities in The Netherlands cooperate in STAR. PWN (Platform Wiskunde Nederland) is a national organization that aims to strengthen the position of mathematics in The Netherlands in all its aspects. The winter school is supported financially by STAR, PWN, by the Netherlands Organization for Scientific Research (NWO) and by the Research Foundation - Flanders (FWO). Administrative assistance is provided by the Korteweg–De Vries Institute for Mathematics of the Universiteit van Amsterdam.

The FWO WOG research network Stochastic Modelling with Applications in Financial Markets has made available a limited number of grants of € 250 each for young researchers (PhD students and postdocs) to be used as a reduction on the registration fee for the winter school. Priority will be given to grant applicants whose supervisor is a member of the network, but others are invited to apply as well. Applications for the grant can be sent by email to both Michel Vellekoop and Peter Spreij (make sure that both are addressed). Applications are required to contain a brief motivation describing why the grant should be beneficial to the research of the applicant, a brief motivation describing why the applicant has a specific need for the grant, a (link to a) CV of the applicant and the name of her/his principal supervisor. The deadline for applications is November 20, 2017.

Organizers

The winter school is organized by:

Michel Vellekoop (Faculty Economics and Business, Universiteit van Amsterdam; tel. +31 20 5254210, e-mail `m.h.vellekoop@uva.nl`)

Peter Spreij (Korteweg–De Vries Institute for Mathematics, Universiteit van Amsterdam and IMAPP, Radboud University; tel. +31 20 5256070, e-mail `spreij@uva.nl`).

Program outline

The program starts with registration and coffee on Monday, January 22, from 10:30 to 11:30, and ends on Wednesday, January 24, at 16:00. The following events are planned:

Minicourses

Emmanuel Gobet
Nested extreme risks in finance: regression Monte-Carlo, MCMC, stochastic algorithms

Sebastian Jaimungal
Algorithmic and high-frequency trading

Special invited lectures

Beatrice Acciaio
Non-anticipative optimal transport: a powerful tool in stochastic optimization

Giulia Di Nunno
Fully dynamic risk-indifference pricing and no-good-deal bounds

Martino Grasselli
Quantization meets Fourier: a new technology for pricing options

Short contributions

Ki Wai Chau
Stochastic grid bundling method for backward stochastic differential equations

Andrea Fontanari
Urn modelling of joint mortality and its impact on annuity contracts

Jitze Hooijsma
Long or short: how to optimally invest in variance swaps?

Rob Sperna Weiland
Feedback between credit and liquidity risk in the US corporate bond market

Schedule of lectures

	Monday January 22	Tuesday January 23	Wednesday January 24
09:00 - 10:00		Gobet	Gobet
10:30 - 11:30		Gobet	Gobet
11:30 - 12:30	Gobet	Jaimungal	Jaimungal
14:00 - 15:00			Jaimungal
15:00 - 16:00	Jaimungal	Jaimungal	Grasselli
16:00 - 17:00	Acciaio	Di Nunno	
17:30 - 18:00	Chau	Hooijsma	
18:00 - 18:30	Sperna Weiland	Fontanari	

Venue

The winter school will take place at Congrescentrum De Werelt, Westhofflaan 2, Lunteren, tel. +31-(0)318-484641, fax +31-(0)318-482924. Located in the heart of the Veluwe forest, De Werelt is one of the top accommodations in the Netherlands in terms of attractiveness of surroundings. Access by car or by public transportation is easy. By train, the village of Lunteren can be reached in twenty minutes from Amersfoort, and in ten minutes from Ede-Wageningen. It takes about fifteen minutes to walk from the railway station in Lunteren to the conference center (see directions below). If you come by car, ANWB signs in Lunteren will guide you to the venue. It is also possible to take a taxi from the taxi stand at railway station Ede-Wageningen. To get a taxi in Lunteren, call +31-(0)318-484555. For further details please see `www.congrescentrum.com` (under De Werelt Lunteren and Route).

Directions from the railway station: leaving the station, turn right across the pebble-covered parking lot. Turn left into the forest (Boslaan). At the crossroads, turn right into Molenweg. The first turn left is Westhofflaan.

Abstracts

Mini-course on Extreme risks

Emmanuel Gobet (Ecole Polytechnique, Palaiseau)

Nested extreme risks in finance: regression Monte-Carlo, MCMC, stochastic algorithms

Under the impulse of the Basel committee, frequently updated risk management methodologies are implemented in banks with the concern of better analyzing and managing financial risks of different types. One needs to deal with distribution tails of complex risks, model uncertainty is also a concern, and the analysis can be quite intricate when moreover, one has to handle in advance with risks in the future (involving nested computations). In this short lecture, I will expose the most usual numerical methods that are used in this area. In particular I will present how stochastic algorithms, regression Monte-Carlo, MCMC and uncertainty quantification tools can help in solving these issues. First I will briefly expose the basics of these methods, give the main convergence and accuracy results that are available according to the simulation parameters, and then I will show how to apply them on the problems at hand. Illustrations with numerical examples will be provided.

Mini-course on Algorithmic trading

Sebastian Jaimungal (University of Toronto)

Algorithmic and high-frequency trading

This mini course focuses on how to formulate and solve various mathematical and statistical problems arising in algorithmic trading. We will look at high-frequency data, how market participants behave, investigate stochastic control problems related trade execution, high-frequency market-making, and statistical arbitrage. We will see how to solve those problems using the principles of dynamic programming, as well as how one can use machine learning techniques (including classification and reinforcement learning) to assist in building "model-free" strategies. Time permitting, we will also touch on mean-field games to account for the actions of multiple optimizing agents.

The mini-course will cover the following topics: Bayes and multi-class logistic classification, reinforcement learning, continuous time dynamic programming and Hamilton-Jacobi-Bellman Equations, limit order books, optimal execution, statistical arbitrage, incorporating order-flow, latent factors, and multiple agents through mean-field games.

Special invited lectures

Beatrice Acciaio (London School of Economics)

Non-anticipative optimal transport: a powerful tool in stochastic optimization

I will introduce a class of mass transports which are suitable to tackle stochastic optimization problems in a dynamic setting. I will give an overview of the optimization problems that we are able to analyze by means of this new tool so far: McKean-Vlasov control problems, Nash/Pareto equilibrium problems, utility maximization, optimal

stopping, and semimartingale preservation. The talk is based on several works, joint with J. Backhoff, R. Carmona, P. Wang, and A. Zalashko.

Giulia Di Nunno (University of Oslo)

Fully dynamic risk-indifference pricing and no-good-deal bounds

In an incomplete market with no a priori assumption on the underlying price dynamics, we focus on the problem of derivative pricing from the seller's perspective.

We consider risk indifference pricing as an alternative to the classical utility indifference, so that the actual evaluations are done via risk measures. In addition we propose a fully-dynamic risk-indifference criteria, in which a whole family of risk measures is considered. This is based on the concept of fully-dynamic risk measure which extends the one of dynamic risk measure by adding the actual possibility of changing the risk perspectives over time. This entails an analysis on the questions of time-consistency in the risk and then the price evaluations. The framework proposed fits well the study of both short and long term investments. In this framework we study whether the risk indifference criterion actually provides a proper convex price system. We shall see that some conditions have to be fulfilled.

Then we consider the relationship of fully dynamic risk-indifference price with no-good-deal bounds. We recall that no-good-deal pricing guarantees that not only arbitrage opportunities are excluded, but also all deals that are 'too good to be true'. We shall provide necessary and sufficient conditions on the fully dynamic risk measure so that the corresponding risk-indifference prices satisfy the no-good-deal bounds. In this way no-good-deal bounds provide a way to select the risk measures to obtain a proper fully-dynamic risk-indifference price system.

The presentation is based on various joint works with Jocelyne Bion-Nadal.

Martino Grasselli (Pôle Universitaire Léonard de Vinci, Paris La Defense and University of Padua)

Quantization meets Fourier: a new technology for pricing options

In this paper we introduce a novel pricing methodology for a broad class of models for which the characteristic function of the log-asset price can be efficiently computed. The new method avoids the numerical integration required by the Fourier-based approaches and reveals to be fast and accurate, to the point that we can calibrate the models on real data. Our approach allows to price also American-style options, as it is possible to compute the transition probabilities for the underlying. This is accomplished through an efficient multinomial lattice discretization of the asset price based on a new quantization procedure which exploits the knowledge of the Fourier transform of the process at a given time. As a motivating example, we price an American Put option in a Tempered Stable model, with constitutes the first application of quantization to a pure jump process. (joint work with Giorgia Callegaro and Lucio Fiorin)

Short contributions

Ki Wai Chau (CWI)

Stochastic grid bundling method for backward stochastic differential equations

In this work, we aim to apply stochastic grid bundling method (SGBM) to numerically solve backward stochastic differential equations.

SGBM is an algorithm designed to solve a backward in time dynamic programming problem with initial application in pricing Bermudan options. It takes advantage of both regress later technique and the adaptive local partition approach in order to provide better numerical result.

In usual regression methods for backward in time problems, the target function values at the end of a time interval is regressed on some dependent variables measured at the beginning of the time interval, which creates a projection error. The dependent variable is regressed here on a set of basis functions at the end of the interval instead in a regress-later method, and the conditional expectation across the interval is then computed exactly for each basis function. By removing the projection error in the regression step, a regress-later method is capable of converging faster than a conventional method.

With the adaptive local partition approach, a partition of the function domain is generated depending on the simulated examples and regression is performed separately at each partition. Since the support is chosen so that they contain roughly the same number of samples and is non-overlapping, SGBM is easy to scale up and can facilitate the application of parallel computing to our algorithm.

Andrea Fontanari (TU Delft and CWI)

Urn modelling of joint mortality and its impact on annuity contracts

In this paper we propose a new modeling approach to joint (or depen- dent) mortality, that is to say the mortality risk in couples of individuals, whose lives and survivorships are likely to be interconnected. Differently from the other works in the literature about joint mortality, we propose a constructive approach based on a special class of combinatorial stochastic processes, i.e. reinforced urn processes, or RUP in acronym (Muliere et al., 2000). Exploiting the Bayesian update mechanism embedded in RUP, the new model has the ability of continuously learning from data, even when new observations become available at a later stage. Thanks to this, the model is able to improve its predictive power over time. If prior beliefs about the dependence structure and/or the marginal survivorships are present, these can be easily embedded in the model, by acting on the urn compositions. The use of RUP allows for the exploitation of many powerful results of Bayesian nonparametrics, for example, the beta-Stacy processes, a very flexible class of random distributions to model survival functions. Empirically, the new construction can be estimated via simulation-based techniques, like Markov Chain Monte Carlo. The modeling of dependent mortality is particularly interesting when we consider annuity contracts. An annuity is a contractual guarantee, issued by insurance companies, pension plans, etc., which offers promises of providing periodic income over the lifetime of individuals, after the payment of a lump sum premium. Using the well-known data of Frees et al. (2016), we discuss how the new model can be used in practice, also showing how the strong positive dependence between joint lives impacts on annuity values and, by extension, on similar products.

E. Frees, J. Carriere, E. A. Valdez (1996). Annuity valuation with dependent mortality. The Journal of Risk and Insurance 63, 229–261.
E. Luciano, J. Spreeuw, E. Vigna (2008). Modelling stochastic mortality for dependent

lives. Insurance: Mathematics and Economics 43, 234–244.
P. Muliere, P. Secchi, S. Walker (2000). Urn schemes and reinforced ran- dom walks. Stochastic Processes and their Applications 88, 59–78.

Jitze Hooijsma (UvA)

Long or short: how to optimally invest in variance swaps?

The existing literature provides contradicting investment advice on the optimal investment mix for variance swaps. Some papers advocate a short-long variance swap strategy to hedge against volatility increases in the short run while benefiting from negative variance risk premia in the long run, while others prefer the opposite trading strategy.

In this paper, we develop a procedure to estimate multi-factor stochastic volatility models using both equity and variance swap data. We apply our estimation methodology to several canonical variance swap models and analyze their implications for optimal portfolio choice. Our analysis dissects the complex interplay of risk factors and risk premia which is crucial for optimal variance swap investment strategies.

Rob Sperna Weiland (UvA)

Feedback between credit and liquidity risk in the US corporate bond market

In this paper, we analyze the dynamic interactions between credit and liquidity risk and their impact on bond prices and risk. We propose a novel way of modeling credit-liquidity interactions by using mutually exciting processes and develop a corresponding Bayesian estimation procedure. We show, using US corporate bond transaction data, that there is evidence of feedback between credit and liquidity risk, that this feedback is asymmetric, and stronger for bonds with a low credit rating. Our model allows for a decomposition of bond yield spreads into pure credit, pure liquidity, credit-induced liquidity, and liquidity-induced credit components. We find that, on average, the credit-induced liquidity component accounts for about 8% (AAA/AA) to 17% (B and lower) of total yield spreads, but in the most distressed periods it accounts for over 40%. Our decomposition reveals that the widening of yield spreads during the financial crisis can mainly be attributed to a decrease in market liquidity, which, in turn, is for a substantial part caused by deteriorating credit conditions. Furthermore, we show that credit-liquidity interactions are responsible for a large part of Value-at-Risk bond capital requirements. Ignoring such interactions may result in a severe underestimation of required capital, especially for bonds with lower credit ratings.

Registration

To register for the winter school, please use the electronic registration form that is available at the web page of the winter school (see `https://staff.fnwi.uva.nl/p.j.c.spreij/winterschool/winterschool.html`). Alternatively, you may complete the registration form on the last page and return it to ms. E. Wallet, Korteweg–De Vries Institute for Mathematics, PO Box 94248, 1090GE Amsterdam.

The registration fee includes accommodation (single room) for the nights of January 22 and 23, all meals starting with lunch on Monday up to and including lunch on Wednesday, and tea and coffee during breaks. Payment can be made by transfer to IBAN account number: NL27 INGB 0007388994 of Winter School Amsterdam, Secretariaat Korteweg–De Vries Instituut, Amsterdam and (for international money transfers) BIC: INGBNL2A. The fee schedule is as follows:

	early registration (before December 1)	late registration (after December 1)
industry professional	€1195	€1350
full-time academic	€395	€445

Inquiries concerning fees for partial attendance may be directed to ms. Wallet at the address given below. Registration will be valid after full payment has been received. Refunds can be given only for cancellations received before January 1, 2018.

Accommodation at the venue is limited. Therefore, reservations will be treated on a first-come-first-served basis with priority for full arrangements. Participants who cannot be lodged at the venue will be accommodated in a hotel nearby. Transportation from the hotel to the venue and vice versa will be taken care of by the organization.

Further information

For further information regarding the scientific program, please contact one of the members of the organizing committee. For information concerning registration please contact:

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Lunteren, January 22–24, 2018

for online registration:
`https://staff.fnwi.uva.nl/p.j.c.spreij/winterschool/winterschool.html`

Registration Form

Last name: _____

First name: _____

Affiliation: _____

Address: _____

_____

_____

_____

Telephone: _____

Fax: _____

Email address: _____

Date: _____

Signature: _____

Please return the completed form *before January 1, 2018* to:

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Registration is valid only after full payment has been received following the fee schedule.