

Conference on Mathematical Modelling of Risk and
Contiguous Topics
MATRIX programme on the Mathematics of Risk

November 27 – December 1, 2017

Held at the MATRIX research institute, Creswick campus of the University of Melbourne

Supported by
MATRIX, ACEMS, AMSI and
the School of Mathematical Sciences at Monash University

Conference on Mathematical Modelling of Risk and Contiguous Topics

MATRIX programme on the Mathematics of Risk

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Monday 27 November 2017

9:50 – 10:00	Welcome	THEATRE
10:00 – 10:50	Zbigniew Palmowski	Invited Talk (p19) THEATRE <i>Ruin probabilities: exact and asymptotic results</i>
10:50 – 11:40	Yuri Kabanov	Invited Talk (p12) THEATRE <i>Ruin probabilities with investments in a risky asset with the price given by a geometric Lévy process</i>
11:40 – 12:10	Coffee Break	
12:10 – 13:00	Takashi Shibata	Invited Talk (p21) THEATRE <i>Financing and investment strategies under information asymmetry</i>
13:00 – 14:30	Lunch	
14:30 – 15:20	Peter Straka	Invited Talk (p23) THEATRE <i>Extremes of events with heavy-tailed inter-arrival times</i>
15:20 – 16:10	Marie Kratz	Invited Talk (p14) THEATRE <i>On Risk Aggregation</i>
16:10 – 16:40	Coffee Break	
16:40 – 17:30	Daniel Dufresne	Invited Talk (p11) THEATRE <i>More properties of Asian options</i>

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Tuesday 28 November 2017

10:00 – 10:50	Martin Larsson	Invited Talk (p16)	THEATRE
<i>Affine Volterra processes and models for rough volatility</i>			
10:50 – 11:40	Katsumasa Nishide	Invited Talk (p18)	THEATRE
<i>Default Contagion and Systemic Risk in the Presence of Credit Default Swaps</i>			
11:40 – 12:10	Coffee Break		
12:10 – 13:00	Boris Buchmann	Invited Talk (p9)	THEATRE
<i>Weak Subordination of Multivariate Levy Processes</i>			
13:00 – 14:30	Lunch		
14:30 – 15:20	Kyoko Yagi	Invited Talk (p27)	THEATRE
<i>A Dynamic Model of Tender and Exchange Offer</i>			
15:20 – 16:10	Libo Li	Invited Talk (p17)	THEATRE
<i>Supermartingales associated with finite honest times</i>			
16:10 – 16:40	Coffee Break		
16:40 – 17:30	Jie Xiong	Invited Talk (p26)	THEATRE
<i>Stochastic Maximum Principle under Probability Distortion</i>			

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Wednesday 29 November 2017

10:00 – 10:50	Gregoire Loeper	Invited Talk (p7)	THEATRE
<i>An overview of Risk in the Finance Industry and some current hot topics – Part 1</i>			
10:50 – 11:40	Mark Aarons	Invited Talk (p7)	THEATRE
<i>An overview of Risk in the Finance Industry and some current hot topics – Part 2</i>			
11:40 – 12:10	Coffee Break		
12:10 – 13:00	Marie Kratz	Invited Talk (p15)	THEATRE
<i>Analyzing and Managing the New Risk Landscape in Insurance Industry: perspectives and challenges for academics</i>			
13:00 – 14:30	Lunch		

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Thursday 30 November 2017

10:00 – 10:50	Thomas Taimre	Invited Talk (p24)	THEATRE
<i>Asymptotic Structure of Sums of Random Variables and Efficient Rare-event Estimation</i>			
10:50 – 11:40	Kazutoshi Yamazaki	Invited Talk (p28)	THEATRE
<i>On optimal periodic dividend strategies for Levy risk processes</i>			
11:40 – 12:10	Coffee Break		
12:10 – 13:00	Lioudmila Vostrikova	Invited Talk (p25)	THEATRE
<i>Ruin problem and identities in law for Levy type models</i>			
13:00 – 14:30	Lunch		
14:30 – 15:20	Yan Dolinsky	Invited Talk (p10)	THEATRE
<i>Market Delay and G-Expectations</i>			
15:20 – 16:10	Fima Klebaner	Invited Talk (p13)	THEATRE
<i>Bystander Effect in radiation of cancer and Risk of spread</i>			
16:10 – 16:40	Coffee Break		
16:40 – 17:30	Jun Sekine	Invited Talk (p20)	THEATRE
<i>Modeling state variable via randomized Markov bridge and conditional SDE</i>			

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Friday 1 December 2017

10:00 – 10:50	Mikhail Zhitlukhin	Invited Talk (p29)	THEATRE
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A sequential hypothesis test for the drift of a fractional Brownian motion

10:50 – 11:40	Peter Spreij	Invited Talk (p22)	THEATRE
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Nonparametric Bayesian estimation of a Hölder continuous diffusion coefficient

11:40 – 12:10	Coffee Break		
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12:10 – 13:00	Konstantin Borovkov	Invited Talk (p8)	THEATRE
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The exact asymptotics of the large deviation probabilities in the multivariate boundary crossing problem

13:00 – 14:30	Lunch		
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Location

The meeting will be held at the University of Melbourne's Creswick campus, 129km west of Melbourne.



Workshop Dinner

The Workshop Dinner will be held on Thursday 30 November from 7:00PM till about 10:00PM at the **Farmers Arms Hotel**, 31 Albert St, Creswick.



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Mark Aarons & Gregoire Loeper

An overview of Risk in the Finance Industry and some current hot topics

Wednesday, 10:00-11:40

Invited Talk

THEATRE

We will start with a top-down overview of risk across the Finance industry: different types of risk, how it's managed, who owns it, and where some interesting mathematical problems might be found. The aim is to give pointers for interesting research both within and beyond existing research horizons. We will then cover some current "hot topics" including KVA, computational issues in XVA, hedging exotic derivatives and model risk in systematic trading.

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Konstantin Borovkov

The exact asymptotics of the large deviation probabilities in the multivariate boundary crossing problem

Friday, 12:10-13:00

Invited Talk

THEATRE

For a multivariate random walk with i.i.d. jumps satisfying the Cramér moment condition and having mean vector with at least one negative component, we derive the exact asymptotics of the probability of ever hitting the positive orthant that is being translated to infinity along a fixed vector with positive components. This problem is motivated by and extends results from a paper by F. Avram et al. (2008) on a two-dimensional risk process. Our approach combines the large deviation techniques from a recent series of papers by A. Borovkov and A. Mogulskii with new auxiliary constructions, which enable us to extend their results on hitting remote sets with smooth boundaries to the case of boundaries with a "corner" at the "most probable hitting point". [Joint work with Yuqing Pan.]

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Boris Buchmann

Weak Subordination of Multivariate Levy Processes

Tuesday, 12:10-13:00

Invited Talk

THEATRE

Subordinating a multivariate Levy process, the subordinate, with a univariate subordinator gives rise to a pathwise construction of a new Levy process, provided the subordinator and the subordinate are independent processes. The variance-gamma model in finance was generated accordingly from a Brownian motion and a gamma process. Alternatively, multivariate subordination can be used to create L'evy processes, but this requires the subordinate to have independent components.

In this talk, we show that there exists another operation acting on pairs (T, X) of Levy processes which creates a Levy process $X \odot T$. Here, T is a subordinator, but X is an arbitrary Levy process with possibly dependent components. We show that this method is an extension of both univariate and multivariate subordination and provide two applications.

We illustrate our methods giving a weak formulation of the variance--gamma process that exhibits a wider range of dependence than using traditional subordination. Also, the variance generalised gamma convolution class of Levy processes formed by subordinating Brownian motion with Thorin subordinators is further extended using weak subordination.

This joint work with Kevin Lu and Dilip B. Madan.

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Yan Dolinsky

Market Delay and G-Expectations

Thursday, 14:30-15:20

Invited Talk

THEATRE

We study super-replication of contingent claims in markets with delay. This can be viewed as a stochastic target problem with delayed filtration. First, we establish a duality result for this setup. Our second result says that the scaling limit of super-replication prices for binomial models with a fixed number moments of delay is equal to the G-expectation with volatility uncertainty interval which we compute explicitly.

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Daniel Dufresne

More properties of Asian options

Monday, 16:40-17:30

Invited Talk

THEATRE

New methods are presented to accelerate the pricing of Asian options. "Downsizing" refers to employing a smaller number of lognormals than there are averaging time points. "Upsizing" is an approximation based on a larger number of lognormals; in our case using the continuous average, which has an infinite number of averaging time points. The advantage of upsizing is that explicit formulas exist for the density, distribution function and expected payoffs. Upsizing requires some new results on the integral of geometric Brownian motion.

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Yuri Kabanov

Ruin probabilities with investments in a risky asset with the price given by a geometric Lévy process

Monday, 10:50-11:40

Invited Talk

THEATRE

We consider a model describing the evolution of capital of a venture company selling innovations and investing its reserve into a risky asset with the price given by a geometric Lvy process. We find the exact asymptotic of the ruin probabilities. Under some natural conditions it decays as a power function. The rate of decay is a positive root of equation determined by characteristics of the price process. When the price follows a gBm the results are reduced to those of our previous works where we used the method of ODEs assuming exponentially distributed jumps. Our proofs are based on the theory of distributional equations, in particular, on a recent result by Guivarc'h and Le Page.

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Fima Klebaner

Bystander Effect in radiation of cancer and Risk of spread

Thursday, 15:20-16:10

Invited Talk

THEATRE

A novel model for radiation effect on cancer cells allows to assess risk of cancer spread.

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Marie Kratz

On Risk Aggregation

Monday, 15:20-16:10

Invited Talk

THEATRE

We study the local behavior of (extreme) quantiles of the sum of heavy-tailed random variables, to infer on risk aggregation, and thus on the behavior of diversification benefit. Looking at the literature, asymptotic (for high threshold) results have been obtained when assuming (asymptotic) independence and second order regularly varying conditions on the variables. Other asymptotic results have been obtained in the dependent case when considering specific copula structures.

Our contribution is to investigate on one hand, the non-asymptotic case (i.e. for any threshold), providing analytical results on the risk aggregation for copula models that are used in practice and comparing them with results obtained via Monte-Carlo (MC) method. Indeed, most models rely in practice heavily on Monte Carlo (MC) simulations. Given their complexity, the convergence of the MC algorithm is difficult to prove mathematically. To circumvent this problem and nevertheless explore the conditions of convergence, we suggest an analytical approach.

On the other hand, when looking at extreme quantiles, we assume a multivariate second order regular variation condition on the vectors and provide asymptotic risk concentration results. We show that many models used in practice come under the purview of such an assumption and provide a few examples. Moreover this ties up related results available in the literature under a broad umbrella.

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Marie Kratz

*Analyzing and Managing the New Risk Landscape in Insurance Industry:
perspectives and challenges for academics*

Wednesday, 12:10-13:00

Invited Talk

THEATRE

We will analyze the change of paradigm in the insurance industry:

- From cash flow management to risk management (various performance measures);
- Risk models and their use in companies (problem with dependence modelling and calibration, Economic Scenario Generators);
- Changes in the organization (role of CRO and Actuaries);
- Difficulty with the economic valuation of long-term liabilities;
- Emerging risks;

and discuss the challenges for researchers to help the industry face this new risk landscape.

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Martin Larsson

Affine Volterra processes and models for rough volatility

Tuesday, 10:00-10:50

Invited Talk

THEATRE

Motivated by recent advances in rough volatility modeling, we introduce affine Volterra processes, defined as solutions of certain stochastic convolution equations with affine coefficients. Classical affine diffusions constitute a special case, but affine Volterra processes are neither semimartingales, nor Markov processes in general. Nonetheless, their Fourier-Laplace functionals admit exponential-affine representations in terms of solutions of associated deterministic integral equations, extending the well-known Riccati equations for classical affine diffusions. Our findings generalize and simplify recent results in the literature on rough volatility.

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Libo Li

Supermartingales associated with finite honest times

Tuesday, 15:20-16:10

Invited Talk

THEATRE

We derive under full generality some representations for the additive and multiplicative decomposition of supermartingales associated with a finite honest time, in particular the Azema supermartingale, in terms of optional supermartingales with continuous supremum. Furthermore, if we assume that the honest time avoids all stopping times then one can retrieve the additive and multiplicative representation of the Azema supermartingale obtained in Nikeghbali and Yor, Kardaras and Acciaio and Irina. The mains tools for this study are the stochastic calculus for ladlag processes developed by Gal'chuk and finer properties of honest times from the theory of enlargement of filtration.

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Katsumasa Nishide

Default Contagion and Systemic Risk in the Presence of Credit Default Swaps

Tuesday, 10:50-11:40

Invited Talk

THEATRE

We consider a clearing system of an interbank market in the case in which cross-trading of credit default swaps among banks is present, and we investigate the effect of credit default swaps on market stability. The existence and uniqueness of a clearing payment vector is proved under the assumption of the fictitious default algorithm with financial covenants, which reflects technical defaults often observed in actual financial markets. Some numerical results are presented to show that, in contrast to the previous literature, a complete network does not necessarily imply the most stable market when credit default swaps are introduced.

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Zbigniew Palmowski

Ruin probabilities: exact and asymptotic results

Monday, 10:00-10:50

Invited Talk

THEATRE

Ruin theory concerns the study of stochastic processes that represent the time evolution of the surplus of an insurance company. The initial goal of early researchers of the field, Lundberg (1903) and Cramér (1930), was to determine the probability for the surplus to become negative. In those pioneer works, the authors showed that the ruin probability decreases exponentially fast to zero with initial reserve tending to infinity when the net profit condition is satisfied and claim sizes are light-tailed. During lecture we will explain when and why we can observe this phenomenon. We will also discuss the complimentary heavy-tailed case and explain what is the most likely way of getting ruined in this case. During the lectures we will show as well how to identify the exact expressions for (ultimate and finite time) ruin probabilities, or for more general so-called Gerber-Shiu functions. The main tool will be based on theory of ordinary differential equations and the Picard-Lefévre formula. We will demonstrate main techniques and results related with the exact and asymptotics of the ruin probabilities: ordinary differential equations for the Gerber-Shiu function, ballot theorem, Pollaczek-Khinchin formula, Lundberg bounds, change of measure, Wiener-Hopf factorization, principle of one big jump and theory of scale functions of Lévy processes. Finally, we will present some extensive statistical and numerical results and simulation methods of the ruin probability as well as the risk process itself.

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Jun Sekine

Modeling state variable via randomized Markov bridge and conditional SDE

Thursday, 16:40-17:30

Invited Talk

THEATRE

Inspired by the information-based asset pricing models by Brody, Hughston and Macrina (2007), we introduce the filtering problem and its solution associated with a randomized Markov bridge. When the underlying Markov process is given by the solution to a Brownian SDE, the solution is described by using a conditional stochastic differential equation (CSDE), introduced by Baudoin (2002). We present a skew-normal diffusion model as an analytically tractable example. Further, we are interested in a stochastic interpolation problem, where multiple marginal distributions of the solution to an SDE are conditioned. The talk is based on collaborations with Camilo Garcia Trillo and Andrea Macrina (University College London).

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Takashi Shibata

Financing and investment strategies under information asymmetry

Monday, 12:10-13:00

Invited Talk

THEATRE

We examine the interaction between the financing and investment decisions of a firm under information asymmetry between well-informed managers and less-informed investors. We show that information asymmetry delays corporate investment and decreases the amount of debt issuance to finance the cost of investment. When the level of information asymmetry is sufficient high, the firm prefers the all-equity financing to the debt-equity financing. This is joint work with Michi Nishihara.

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Peter Spreij

Nonparametric Bayesian estimation of a Hölder continuous diffusion coefficient

Friday, 10:50-11:40

Invited Talk

THEATRE

We consider a nonparametric Bayesian approach to estimate the diffusion coefficient of a stochastic differential equation given discrete time observations on its solution over a fixed time interval. As a prior on the diffusion coefficient, we employ a histogram-type prior with piecewise constant realisations on bins forming a partition of the time interval. We justify our approach by deriving the rate at which the corresponding posterior distribution asymptotically concentrates around the diffusion coefficient under which the data have been generated. For a specific choice of the prior based on the inverse gamma distribution, this posterior contraction rate turns out to be optimal for estimation of a Hölder-continuous diffusion coefficient with smoothness parameter $0 < \lambda \leq 1$. Our approach is straightforward to implement and leads to good practical results in a wide range of simulation examples. Finally, we apply our method on exchange rate data sets.

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Peter Straka

Extremes of events with heavy-tailed inter-arrival times

Monday, 14:30-15:20

Invited Talk

THEATRE

In the statistical physics literature, heavy-tailed inter-arrival times are said to be the main signature of "bursty" dynamics. Such dynamics have been observed for financial time series, earthquakes, solar flares and neuron voltage spikes.

This talk is concerned with the modelling of extremes of events when events follow such bursty dynamics. We assign i.i.d. magnitudes (marks) to the events in a heavy-tailed renewal process and apply the "Peaks Over Threshold" method from Extreme Value Theory. Leveraging geometric stability, it can be shown that the threshold exceedance times asymptotically form a "fractional Poisson process" with Mittag-Leffler inter-arrival times. Finally, we discuss methods for inference on the tail and scale parameters of the bursty dynamics.

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Thomas Taimre

*Asymptotic Structure of Sums of Random Variables and Efficient
Rare-event Estimation*

Thursday, 10:00-10:50

Invited Talk

THEATRE

We consider the problem of estimating the right-tail probability of a sum of random variables when the density of the sum is not known explicitly, but whose asymptotic behaviour is known. We embed this asymptotic structure into a simple and natural importance sampling estimator via a polar coordinate transformation, in which we consider the radial and angular components of the distribution separately. Although there has been a lot of work on the asymptotic behaviour of the sum, much less is known about the angular asymptotics. Here, we explore this asymptotic angular behaviour and discuss practical simulation considerations.

This is joint work with Patrick Laub.

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Lioudmila Vostrikova

Ruin problem and identities in law for Levy type models

Thursday, 12:10-13:00

Invited Talk

THEATRE

As known, the risk process $Y = (Y_t)_{t \geq 0}$ of an insurance company invested in the risk market is given by the equation

$$(1) \quad Y_t = y + X_t + \int_0^t Y_{s-} dR_s$$

where $y > 0$ is initial capital of the company, $X = (X_t)_{t \geq 0}$ a basic investment process and $R = (R_t)_{t \geq 0}$ is a return on investment generating process. We suppose that the processes $X = (X_t)_{t \geq 0}$ and $R = (R_t)_{t \geq 0}$ are independent processes both starting from zero, and such that the jumps $\Delta R_t = R_t - R_{t-}$ of the process R are strictly bigger than -1 . The process X is supposed to be Levy process and R is the process with independent increments (PII in short), being a semi-martingale.

As well known the equation (1) has a unique strong solution : for $t > 0$

$$(2) \quad Y_t = \mathcal{E}(R)_t \left(y + \int_0^t \frac{dX_s}{\mathcal{E}(R)_s} \right)$$

where $\mathcal{E}(R)$ is Dolan-Dade exponential. We will be interested by the study of the stopping time

$$(3) \quad \tau(y) = \inf\{t \geq 0 \mid Y_t \leq 0\}$$

corresponding to the ruin of the company, more precisely we will evaluate the probability of the ruin before time $T > 0$, $\mathbf{P}(\tau(y) \leq T)$, and also the ultimate ruin probability $\mathbf{P}(\tau(y) < \infty)$. Using the identity in law techniques we show that the behaviour of the ruin probability depend very much on the behaviour of the corresponding exponential functionals

$$I_T = \int_0^T \frac{ds}{\mathcal{E}(R)_s} = \int_0^T e^{-\hat{R}_s} ds \text{ and } I_\infty = \int_0^\infty e^{-\hat{R}_s} ds$$

respectively where $\hat{R}_s = \ln(\mathcal{E}(R)_s)$, $s \geq 0$, and also on the presence/absence of the Brownian part in the basic investment process X .

We give the inequalities for the ruin probabilities, we precise the conditions in terms of the triplets of the processes for the ruin with probability 0, the conditions for exponential and polynomial decay of this probability as a function of the initial capital y and also the conditions giving the ruin with probability 1.

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Jie Xiong

Stochastic Maximum Principle under Probability Distortion

Tuesday, 16:40-17:30

Invited Talk

THEATRE

Within the framework of Kahneman and Tversky's cumulative prospective theory, this talk considers a continuous-time behavioral portfolio selection model, which includes both running and terminal terms in the objective functional. Despite the existence of S-shaped utility functions and probability distortions, a necessary condition for optimality is derived by stochastic maximum principle. Finally, the results are applied to various cases. This talk is based on a joint paper with Liang.

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Kyoko Yagi

A Dynamic Model of Tender and Exchange Offer

Tuesday, 14:30-15:20

Invited Talk

THEATRE

This paper proposes a two-step dynamic model of a tender/exchange offer and gives an investigation of optimal decisions for a hostile takeover. An acquisition of a public company is generally structured in one of two methods: a merger or a tender/exchange offer. A merger can be made on a friendly basis pursuant to the agreement that has been negotiated with the target board of directors, while a tender/exchange offer is often approached on a hostile basis avoiding an approval from the target managers. We often refer to mergers as one-step mergers and tender/exchange offers as two-step mergers. A one-step merger involves the filing of a proxy statement and a shareholder vote. A two-step merger first needs a bidder's direct proposition to the shareholder of a target firm to tender/exchange their shares. In a tender (or exchange) offer, target shareholders sell (or exchange) their share in which the consideration includes cash (or acquirer share). Following the bidders acquisition of a specified percentage of the target shares, the bidder can control the target firm without a shareholder vote and then have a right to merge the target firm. Several studies have been conducted on one-step mergers using real options settings. Yet little attention has been given to two-step mergers, i.e. tender/exchange offers. This paper develops a two-step dynamic model of a tender/exchange offer. We then show that acquirer can propose two types of optimal offering share for an exchange offer. The one is optimal for the existing shareholders of acquirer resulting in a hostile takeover, the other is Pareto optimal for bidder and targets shareholders in which the model degenerates into one-step friendly mergers. An optimal timing to start takeovers and related comparative statistics are compared between acquires that choose a one-step merger and a two-step merger.

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Kazutoshi Yamazaki

On optimal periodic dividend strategies for Levy risk processes

Thursday, 10:50-11:40

Invited Talk

THEATRE

We study the optimal dividend problem in the dual model where dividend payments can only be made at the jump times of an independent Poisson process. In this context, Avanzi et al. (2014) solved the case with spectrally positive Levy processes with i.i.d. hyperexponential jumps; they showed the optimality of a (periodic) barrier strategy where dividends are paid at dividend-decision times if and only if the surplus is above some level. In this talk, we generalize the results for a general spectrally positive Levy process and also for a spectrally negative Levy process with a completely monotone Levy density. The optimal strategies as well as the value functions are concisely written in terms of the scale function. (Joint work with K. Noba, J.L. Perez and K. Yano)

Conference on Mathematical Modelling of Risk and Contiguous Topics
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Mikhail Zhitlukhin

A sequential hypothesis test for the drift of a fractional Brownian motion

Friday, 10:00-10:50

Invited Talk

THEATRE

I'll consider a problem of sequentially testing the hypothesis about the sign of the drift of a fractional Brownian motion in a Bayesian setting. The main result shows that this problem can be reduced to an optimal stopping problem for a standard Brownian motion with a non-linear observation cost. I'll discuss a method how it can be solved, speak about qualitative properties of the solution, and show numerical results. This is a joint work with Alexey Muravlev from Steklov Institute.

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List of Participants

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