MATRIX program "Mathematics of Risk – 2022",

31 Oct – 11 Nov 2022, Creswick, Australia

Abstracts of lectures and talks at mini-Symposiums

Lectures

C1. Generalized Integral Transforms in Mathematical Finance.
9am – 11.am, Tuesday 8/11
Dmitri Muravey (WorldQuant, global quantitative asset management firm)

Abstract: *The lecture aims to present new methods and approaches to solve various initial-boundary value problems for partial differential equations with moving boundaries. Such problems often appear in mathematical finance when pricing barrier and American options, finding the hitting time probability distribution for some stochastic processes, etc. The methods we discuss in this talk belong to a class of integral transforms. However, they are not classical transforms used in science. Instead, they are broad generalizations of their classical counterparts.*

*The lecture is based on the monograph "Generalized Integral Transforms in Mathematical Finance", **World Scientific**, 2021,*
(https://doi.org/10.1142/12147), by (authors): Andrey Itkin (*New York University, USA*), Alexander Lipton (*Hebrew University of Jerusalem, Israel*), Dmitry Muravey (*Moscow State University, Russia*)

C2. Mathematical Modelling of the Term Structure of Interest Rates – From Fundamentals to a Post-LIBOR World
Tuesday 1/11, Thursday 3/11, all at 9.00-11am; Friday 4/11, 9.00-10am
Prof Erik Schlogl (Prof of Quantitative Finance, University of Technology Sydney**)**

Abstract: *This five-hour lecture sequence covers arbitrage-free modelling of stochastic interest rates. It begins with mathematical definitions of the financial objects which are modelled, and then introduces the basic concepts of interest rate term structure modelling. Subsequently, the Heath/Jarrow/Morton framework for continuous-time arbitrage-free interest rate term structure models is presented, and key instances of specific stochastic dynamics are discussed. Now-standard extensions then allow the possibility of default to be incorporated into the model. Going beyond standard theory, the phenomenon of interest rate basis spreads (also known as the "multicurve term structures") observed in the markets leads to modelling of refinancing (or "roll-over") risk, allowing this phenomenon to be incorporated into interest models in a consistent manner.*

C3. Machine Learning algorithms in signal processing and Finance (7 hours).
I.Guo, J.Hinz, G.Moustakides

Dr Ivan Guo (Monash University)
11am – 1pm on Tuesday 1/11, 11am – 12pm Thursday 3/11

Title: Machine Learning algorithms in Finance

Abstract: *Machine learning has gained tremendous popularity in recent years due to increased availability of computational power and found applications in numerous fields, including mathematical sciences. In this lecture we will examine their recent applications in financial mathematics, with a focus on neural networks and their variants. In essence, neural networks are used as universal and tractable approximators for solution functions in a wide range of problems, from simple regressions to complex stochastic optimal controls. They are also particularly useful in high-dimensional numerical settings, such as for non-linear partial differential equations and backward stochastic differential equations, where classical grid-based or regression-based methods encounter the curse of dimensionality. Applications examined include option pricing and hedging, model calibration, martingale optimal transport and portfolio optimisation.*

Dr Jury Hinz (National Australian Bank, Sydney)
12pm -1pm on Thursday 3/11

Title: Reinforcement Learning

Abstract: *Reinforcement Learning encompasses a class of machine learning problems with emphasis on direct interaction with the environment. In this framework, there is no supervision, and usually no complete model of the environment. Instead, the interaction is formulated as a sequential decision-making process using states, actions, and rewards for taking actions. Thereby, uncertainty and nondeterminism and the existence of explicit goals are essential. In this talk, we present some aspects of the theory of Reinforcement Learning and elaborate on its applications*

George Moustakides ((Professor, Department of Electrical & Computer Engineering, University of Patras, Greece)

Lecture on Friday 4/11, 11am – 1pm

Title: Machine learning methods for statistical decision making

Abstract: *Well-known problems as classification and decision making employ schemes which are commonly modeled using parametric functions (as neural networks). On the other hand there exists a long standing classical theory in Statistical Signal Processing for Detection and Hypothesis Testing offering optimum decision making mechanisms based on likelihood ratio functions, requiring knowledge of probability densities for each data-class/hypothesis. In this presentation our main objective is to bring together these two seemingly unrelated approaches. Specifically we replace the requirement of knowledge of probability densities in the classical approach with the more realistic assumption that there are representative data from each data-class. Since from classical analysis we have that likelihood ratios are the key elements for optimum decision making we will develop purely data-driven solutions by providing neural network based estimates of these functions. To achieve this goal we must define suitable optimization problems that will be employed for the training of the corresponding networks. The main purpose of this talk is to offer a simple and unified approach for defining proper optimization problems with guarantees that their solution indeed offers efficient approximations of the unknown likelihood ratio functions. Our idea is applied to a number of well-known detection problems where, with simulations we compare popular training algorithms with respect to their decision making capability.*

Tutorial on Tuesday 8/11, 12pm – 1pm

Title: Machine learning for signal processing

Abstract: *We briefly present the problems of detection and parameter estimation and the corresponding optimum solutions offered by classical statistical signal processing theory. We then discuss the major drawbacks of these approaches basically due to the need for knowing exactly the statistical behavior of the data (availability of probability densities). The next step involves replacing the knowledge of probability densities with the more realistic assumption of having representative (training) data. Under this new setup we discuss appropriate formulations of the two problems (detection and estimation) that guarantee consistency with the long standing optimum theoretical solutions.*

C4. Functional limit theorems for financial markets with long-range dependence
Friday 4/11 10.00-11.00
Konstiantyn Ralchenko
(Professor, Taras Shevchenko National University of Kyiv, Ukraine)

Abstract: *We consider functional limit theorems adapted to the case when the limit process has no semimartingale structure and apply them to the financial markets involving long memory into asset prices themselves. The examples are: fractional Brownian motion and Riemann-Liouville fBm. Application to fBm gives rise to some interesting conjectures related to the covariance matrix.*

Mini-Symposium S1. Change-point analysis and analysis of structural changes

Monday 7/11, 9.00am to 7pm

Organisers: A.Novikov, A.Tartakovsky

Morning session 7/11

Chairman: Artem Prokhorov

9.00 – 9.55 Alexander Tartakovsky

(IMS Fellow AGT StatConsult, President, Los Angeles, California, USA)

Title: Quickest and Reliable Changepoint Detection and Identification in General Stochastic Models: Recent Results, Applications and Future Challenges

Abstract: *Modern information systems generate large volumes of data with anomalies that occur at unknown points in time and have to be detected and classified quickly with low false alarm rates. My talk consists of four parts. In the first part, I will focus on the asymptotic theory of quickest joint detection and identification of changes in multiple data streams with general non-i.i.d. stochastic models for efficient Big Data analysis. Nearly optimal pointwise and minimax joint detection-identification strategies are proposed and analyzed when the rates of false alarms and misidentification are low. The general theory is illustrated for Markov models. In the second part, I will consider the reliable change detection problem with possible transient changes of a finite duration for i.i.d. data models. Using optimal stopping theory, it is possible to find an optimal maximin change detection procedure that maximizes the probability of detection in the worst possible situation for the given probability of a false alarm. Several convenient for practice detection procedures are compared with the optimal procedure, including the popular Finite Moving Average procedure. In the third part, I will discuss several challenging applications such as quick detection and isolation of anomalies associated with COVID, the appearance of nearEarth space objects, and target track management. Finally, in the fourth part, certain open problems and future challenges are discussed.*

9.55 – 10.50 George Moustakides

(Professor, Department of Electrical & Computer Engineering, University of Patras, Greece)

Title: Metrics and optimum tests in sequential detection of changes

Abstract: *The problem of rapid detection of changes in the statistical behavior of an observed data sequence, finds application in a plethora of scientific fields. Anomaly detection, detection of attacks, quality control, detection of seismic wave onset time, epidemic detection, portfolio monitoring, health monitoring of structures, fraud detection, spectrum monitoring, router failure detection in networks, are only a few examples where quickest (sequential) change detection can be adopted to mathematically formulate the corresponding application problem. In the first part of the presentation we recall the notion of a stopping time which is the mathematical entity we employ for implementing a sequential detector. We continue with an effort to understand the various change imposing mechanisms that exist in nature and we provide a high-level model for their probabilistic description. This in turn allows for the definition of suitable performance measures and related optimization problems which, when solved, give rise to optimum detection strategies. In the second part of the presentation, we make an overview of the most popular metrics encountered in the literature along with their optimum detectors and discuss their applicability to real problems. In the end, we very briefly tackle the change detection problem under a purely data-driven setup where knowledge of probability densities is replaced by the availability of training data and discuss possibilities for its solution.*

11.20 – 12.15 Alexander Semenov

(Visiting Professor, University of Sydney and University of Florida)

Title: Change Point Detection in Time Series Using Mixed Integer Programming

Abstract: *We use recent advances in mixed integer optimization (MIO) methods to develop a framework for identification and estimation of structural breaks in time series. The framework requires a transformation of the classical structural break detection problem into an Mixed Integer Quadratic Programming problem. MIO is capable of finding optimal solutions to this problem using a well-known optimization solver. The framework allows to determine the unknown number of structural breaks. In addition to that, we demonstrate how to accommodate a specific required number of structural breaks, or a minimal required number of breaks. We demonstrate the effectiveness of our approach through extensive numerical experiments on synthetic and real-world data. We examine optimal and sub-optimal solutions of the problem, and the effect of tuning the parameters. We show how to choose the tuning parameters and compare our results with established econometric methods.*
This is a joint work with A. Prokhorov and A. Skrobotov.

12.15 – 13.10 Vladimir Dragalin (Zoom presentation)

(Vice-President, Scientific Fellow and Global Head of Quantitative Sciences, Johnson and Johnson, Philadelphia, USA)

Title: Model-based Adaptive Designs for Dose-ranging Studies

Abstract: *In this presentation, I will focus on adaptive designs in dose-ranging studies -- the exploratory phase of the drug development process designed and carried out to establish drug efficacy and dose response relationships. A failure to identify the correct dose or detect important dose-limiting toxicities, or a reliance on a surrogate endpoint that ultimately behaves differently than the endpoint required for a Phase III confirmatory trial, can lead to a failure in Phase III. In part based on these concerns, there has been increasing interest in, and utilization of, adaptive approaches for the design and analysis of Phase II trials. These designs directly address the goals of the exploratory phase trial with respect to identification of dose to carry forward in the confirmatory phase, estimation of likelihood of success in confirmatory trial, and efficient early stopping for efficacy or for futility. A critical component of these designs is the dose-response model for efficacy and/or safety endpoints that captures prior information about the form and location of the clinically important dose response relationship. The optimal experimental design framework, with available doses as design region and response variables following a mathematical model of dose-response relationship, provides enough structure to address the objectives of the dose-ranging studies. The focus is on choosing the dose levels and the patient allocation per dose in some optimal way to enhance the process of estimating the unknown parameters of the model. The challenge is that the optimal design for non-linear models depends on unknown parameters. The solution is adaptive design – running the experiment sequentially. Initial design is chosen, and preliminary parameter estimates are obtained. Then, the next stage doses are selected from the available range of doses that satisfy the efficacy and toxicity constraints and provide the maximal improvement of the design with respect to the selected criterion of optimality and current parameter estimates. The next available cohort of patients is allocated to these doses. The estimates of unknown parameters are refined given these additional observations. These design-estimation steps are repeated until an early stopping decision is achieved, or the maximum number of patients is enrolled.*

Adaptive designs employ frequent interim analyses of all accumulated data (and, possibly, external trial data) to determine whether pre-planned design modifications will be 'triggered'. Interim analyses partition the trial into multiple stages, each trial stage's characteristics (number of treatment arms, number of patients to be enrolled, their allocation between arms, stage duration, etc.) defined by the preceding interim analysis results. The ability to sequentially examine available data to determine whether trial modifications are necessary and, when indicated, implement pre-defined design changes gives adaptive design its strength and flexibility. I will also provide an overview of available adaptive designs appropriate for drug development at different level: trial, program, and portfolio, including platform, umbrella, and basket designs.

S1. Afternoon session 7/11

Chairman: Alex Tartakovsky

15.00 – 15.35 Cheng-Der Fuh (Zoom presentation)

(Professor, Zhejiang University City College, China)

Title: Credit Risk Propagation in Structural-Form Models

Abstract: *Existing empirical studies on correlated defaults have shown that the default of a firm impacts other firms; however, this impact has yet to be theoretically validated and quantified, especially under a structural-form model with more than two firms, and with multiple firms that are all likely to default with almost equal weight. To fill the gap, this paper studies how the firm value processes interact with each other in the presence of correlated* *defaults as well as a large number of firms. To this end, a new renewal theory is developed. The results show that even under a simple one-factor model, the idiosyncratic moments of the defaulted firm transfer to other firms at the time of default, causing a propagation in credit risk. Furthermore, we can quantify this propagation via asymptotic theory, which provides a multiname distance-to-default type risk measure for a system of firms. The results potentially constitute a new method in studying contagion and other correlated default effects and therefore provide new measurements in credit risk management. Numerical and empirical studies are presented to illustrate our claim.*

15.35 – 16.10 Michael Baron (Zoom presentation)

(Professor and Chair, Department of Mathematics and Statistics, American University, USA)

Title: Bayesian Approach to Sequential Change-Point Detection in Multivariate Time Series

Abstract: *Bayesian change-point detection problem is studied in the following general setting. A multidimensional stochastic process is observed; some or all of its components may experience changes in distribution, simultaneously or not. The loss function penalizes for false alarms and detection delays, and the penalty increases with each missed changepoint. Also, the prior distribution is available, and for practical purposes, it does not necessarily have a simple standard form. For wide classes of stochastic processes, with or without nuisance parameters and practically any joint prior distribution of change-points, asymptotically pointwise optimal (APO) rules are obtained, translating the classical concept of Bickel and Yahav to the sequential change-point detection. These APO rules are attractive because of their simple analytic form, weak assumptions, wide applicability, and straightforward computation. An application to a multidimensional autoregressive time series is shown.*

Break 16.10 – 16.25

16.25 – 17.00 Yajun Mei (Zoom presentation)

(Professor, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology, USA)

Title: Bandit Sequential Change-Point Detection

Abstract: *Bandit sequential change-point detection problem occurs in many real-world problems such as battery-powered sensor networks or biosurveillance, where there are sampling control contraints and one might only be able to observe or analyze parts of potential multi- or high- dimensional data due to the limited capacity in data acquisition, transmission and processing. In such a scenario, one needs to decide how to smartly observe which local components or features of streaming data at each and every time, and then uses the observed incomplete data to quickly raise an alarm once a change has occurred subject to the false alarm constraint. In this talk, we present our latest research that applies some well-known sampling strategies from multi-armed bandit problems to develop efficient sequential change-point detection algorithms under the sampling control: one is Robbins' win-stay, lose-switch policy that leads to asymptotically optimal algorithm when monitoring low-dimensional data, and the other is Thompson sampling policy that yields efficient scalable schemes for online monitoring high-dimensional data. Numerical simulations and case studies will be presented to demonstrate the usefulness of our proposed algorithms, and future potential research directions will also be discussed.*

17.00 – 17.35 Georgios Fellouris (Zoom presentation)

(Professor, Department of Statistics, University of Illinois at Urbana-Champaign, USA)

Title: Sequential Change Diagnosis

Abstract: *We will consider the problem of sequential change diagnosis, where observations are obtained on-line, an abrupt change occurs in their distribution, and the goal is to quickly detect the change and accurately identify the post-change distribution, while controlling the false alarm rate. We will highlight a drawback of many algorithms that have been proposed for this problem, the implicit use of pre-change data for determining the post-change distribution. We will propose a recursive algorithm that resolves this issue without the use of tuning parameters and without sacrificing control of the worst-case delay in Lorden's sense. A novel method will also be proposed for the design and evaluation of sequential change diagnosis algorithms. (This is joint work with Austin Warner from the University of Illinois, Urbana-Champaign).*

17.35 – 18.10 Travis Monk (Dr., University of Western Sydney)

Title: Spiking neurones are changepoint detectors

Abstract: *Spiking neurones are perfect devices to implement a changepoint detection (CPD) algorithm. They compare their membrane potential to a threshold, and generate a spike when they cross. Their membrane potential depends on excitatory or inhibitory inputs from other neurones. Therefore spiking neurones can implement some form of an online CPD algorithm that detects changes in their inputs. We will illustrate this implementation by showing how a simple model of a neurone can implement CPD on Poisson-distributed inputs. So a simple, single neurone can assert when the rate of its input spikes has changed, e.g. when its afferents suddenly start spiking faster. CPD offers natural probabilistic interpretations of neural membrane potentials, thresholds, and output spikes. If spiking neurones are implementing some online CPD algorithm, then their electrophysiology must be related to the spiking statistics of its afferents. We will demonstrate this relationship for spiking neurones in the barn owl auditory pathway. More generally, it might be possible to derive the electrophysiology of spiking neurones directly from principles of probability theory and a well-posed CPD problem.*

18.10 – 18.45 Anton Skorobotov (Dr., RANEPA and Saint-Petersburg University, Russia)

Title: On the asymptotic behaviour of the bubble dates estimators

Abstract: *In this study, we extend the three-regime bubble model of Pang et al. (2021) to allow the forth regime followed by the unit root process after recovery. We provide the asymptotic and finite sample justification of the consistency of the collapse date estimator in the two-regime AR(1) model. The consistency allows us to split the sample before and after the date of collapse and to consider the estimation of the date of exuberation and date of recovery separately. We have also found that the limiting behavior of the recovery date varies depending on the extent of explosiveness and recovering.*

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Mini-Symposium S2a. Recent Advances in Stochastic Modelling in Finance and Economics

Monday 31/10, 9.30am to 7pm

Organisers: A.Novikov

S2a. Morning session 31/10

Chairman: Konstantin Borovkov

9.30 – 10.15 Masaaki Fukasawa

(Professor, Osaka University, Japan)

Title: A multivariate cumulant recursion formula with application to Hawkes processes

Abstract: *The signature cumulants is a formal series of tensors with graded structure that stores all the important statistics of the underlying path. When it is projected to the symmetric tensor algebra, it coincides with the multivariate cumulant generating function. In this paper, we obtain an explicit formula for the n-th multivariate conditional cumulants of the multivariate Hawkes processes, through the use of recursive formula for the symmetrized signature cumulants. The expression takes a simple form of an integral of a deterministic kernel, multiplied by the (forward) Hawkes intensity. The deterministic kernel can be computed recursively and deterministically, provided that we have the knowledge of the Bell polynomials in advance. This essentially allows us to bypass all the stochastic procedures usually required for the computation of the conditional expectations, and compute all the cumulants only in deterministic setting.*

This is a joint work with Tassa Thaksakronwong.

10.15 – 11.00 Peter Spreij

(Professor, Universiteit van Amsterdam, Korteweg-de Vries Institute for Mathematics)

Title: Nonparametric Bayesian volatility estimation for gamma-driven stochastic differential equations

Abstract: *We study a nonparametric Bayesian approach to estimation of the volatility function of a stochastic differential equation (SDE) driven by a gamma process. The volatility function is assumed to be positive and piecewise constant or Hölder continuous. We first show that the SDE admits a weak solution under a simple growth condition, which is unique in law. In the statistical problem, the volatility function is always modelled a priori as piecewise constant on a partition of the real line, and we specify a gamma prior on its coefficients. This leads to a straightforward procedure for posterior inference. We show that the contraction rate of the posterior distribution is root n (sample size) for piecewise constant volatility and depends on the Hölder exponent in the other case.*

Joint work with Denis Belomestny, Shota Gugushvili, Moritz Schauer.

Break 11.00 – 11.20

11.20 – 12.05 Jiro Akahori

(Professor, Department of Mathematical Sciences, Ritsumeikan University, Japan)

Title: Some Thoughts on Diffusion Estimation

Abstract*:* *In the talk, I will present some of my recent research projects related to "Diffusion Estimation". I will discuss some shortcomings of new methods, occurring in both types of their applications, the theory and practice.*

12.05 – 12.40 Arturo Kohatsu-Higa

(Professor, Department of Mathematical Sciences, Ritsumeikan University, Japan)

Title: The risk of killing a diffusion

Abstract*: I will discuss the probabilistic representation of the derivative of a killed diffusion process. In fact, such representation depends on the reflected process and it has an expression using the solution of a linear stochastic differential equation.*

S2a. Afternoon session, 31/10

Chairman: Fima Klebaner

15.00 – 15.35 Anthony Brockwell (on Zoom)

(Wellhan Partners LLC, New York, USA)

Title: Fractional Growth Portfolio Investment

Abstract: *We review some fundamental concepts of investment from a mathematical perspective, concentrating specifically on fractional-Kelly portfolios, which allocate a fraction of wealth to a growth-optimal portfolio while the remainder collects (or pays) interest at a risk-free rate. We elucidate a coherent continuous-parameter time-series framework for analysis of these portfolios, explaining relationships between Sharpe ratios, growth rates, and leverage. We see how Kelly's criterion prescribes the same leverage as Markowitz mean-variance optimization. Furthermore, for fractional Kelly portfolios, we state a simple distributional relationship between portfolio Sharpe ratio, the fractional coefficient, and portfolio log-returns. These results provide critical insight into realistic expectations of growth for different classes of investors, from individuals to quantitative trading operations. We then illustrate application of the results by analyzing performance of various bond and equity mixes for an investor. We also demonstrate how the relationships can be exploited by a simple method-of-moments calculation to estimate portfolio Sharpe ratios and levels of risk deployment, given a fund's reported returns.*

15.35 – 16.10 Kazutoshi Yamazaki

(Dr., University of Queensland, Brisbane)

Title: A series expansion formula of the scale matrix with applications in change-point detection

Abstract*: We introduce a new Levy fluctuation theoretic method to analyze the cumulative sum (CUSUM) procedure in sequential change-point detection. When observations are phase-type distributed and the post-change distribution is given by exponential tilting of its pre-change distribution, the first passage analysis of the CUSUM statistic is reduced to that of a certain Markov additive process. We develop a novel series expansion formula of the scale matrix for Markov additive processes of finite activity, and apply it to derive exact expressions of the average run length, average detection delay, and false alarm probability under the CUSUM procedure.*
This is a joint work with Jevgenijs Ivanovs.

Break 16.10 – 16.25

Chairman: Kazutoshi Yamazaki

16.25 – 17.00 Peter Taylor

(Professor, the University of Melbourne)

Title: A continuous-time Markov chain model for the distribution of blockchain heights

Abstract*: TBA***

17.00 – 17.35 Ken Palmer

(Professor, Department of Mathematics, National Taiwan University, Taipei, Taiwan)

Title: Path independence of exotic options and convergence of binomial approximations

Abstract: *The analysis of the convergence of tree methods for pricing barrier and lookback options has been the subject of numerous publications aimed at describing, quantifying and improving the slow and oscillatory convergence in such methods. For barrier and lookback options, we find path-independent options whose price is exactly that of the original path-dependent option. The usual binomial models converge at a speed of order n^(-1/2) to the Black–Scholes price. Our new path-independent approach yields a convergence of order 1/n. Further, we derive a closed-form formula for the coefficient of 1/n in the expansion of the error of our path-independent pricing when the underlying is approximated by the Cox, Ross and Rubinstein (CRR) model. Using this, we obtain a corrected model with a convergence of order n^(-3/2) to the price of barrier and lookback options in the Black–Scholes model. Our results are supported and illustrated by numerical examples.*

17.35 – 18.20 Yuliya Mishura (Zoom presentation)

(Professor, Department of Probability Theory, Statistics and Actuarial Mathematics, Taras Shevchenko National University of Kyiv, Ukraine)

Title: Approximations of financial models with memory and stochastic volatility

Abstract: *We consider two approaches to the markets with memory: when the memory is inserted into stochastic volatility and when it is inserted into the prices themselves. In the first case we consider discrete-time approximations of option prices for possibly discontinuous payoffs, in the second case consider discrete-time approximations of option prices.*

18.20 – 19.05 Rustam Ibragimov (Zoom presentation)

(Professor, Imperial College Business School, UK)

Title: New Approaches to Robust Inference on Market (Non-)Efficiency, Volatility Clustering and Nonlinear Dependence

Abstract: *Many financial and economic variables, including financial returns, exhibit nonlinear dependence, heterogeneity and heavy-tailedness. These properties may make problematic the analysis of (non-) efficiency and volatility clustering in economic and financial markets using traditional approaches that appeal to asymptotic normality of sample autocorrelation functions of returns and their squares. This paper presents new approaches to deal with the above problems. We provide the results that motivate the use of measures of market (non-)efficiency and volatility clustering based on (small) powers of absolute returns and their signed versions. We further provide new approaches to robust inference on the measures in the case of general time series, including GARCH-type processes. The approaches are based on robust t−statistic methods (Ibragimov and Muller, 2010, 2016) and new results on their applicability in the problems considered. In the approaches, parameter estimates (e.g., estimates of measures of nonlinear dependence) are computed for groups of data, and the inference is based on t−statistics in the resulting group estimates. This results in valid robust inference under heterogeneity and dependence assumptions satisfied in real-world financial markets. Numerical results and empirical applications confirm the advantages and wide applicability of the proposed approaches.*

Joint work : Rasmus S. Pedersen (Department of Economics, University of Copenhagen) and Anton Skrobotov (RANEPA)

Thursday 10/11, 9.00am to 7pm

S2b. Morning session 10/11

Chairperson: Anna Aksamit

9.00 – 9.55 Eckhard Platen

(Professor, University of Technology Sydney, School of Mathematical and Physical Sciences, and Finance Discipline Group)

Title: Principles for the Long-term Modeling of Continuous Financial Markets

Abstract: *By assuming the existence of the growth optimal portfolio (GP) and the maximization of entropy, the paper derives seven principles for the longterm modeling of continuous financial markets: the laws of No-arbitrage, Action and Reaction, the Minimal Price, Inertia, Activity Equilibrium, Energy, and Zero Activity. They predict the dynamics of the GP in the denominations of basis security accounts as those of time-transformed squared Bessel processes of dimension four, the convergence of the average of their squared volatilities toward a common level, and gamma-distributed initial values of basis security accounts.*

9.55 – 10.55 Pavel Shevchenko

(Professor, Department of Actuarial Studies and Business Analytics, Macquarie University)

Title: Stochastic dynamic integrated climate-economy models

Abstract: *The classical dynamic integrated climate-economy (DICE) model has become the iconic typical reference point for the joint modelling of economic and climate systems, where all model state variables evolve over time deterministically. We reformulate and solve the DICE model as an optimal control dynamic programming problem with six state variables (related to the carbon concentration, temperature, and economic capital) evolving over time deterministically and affected by two controls (carbon emission mitigation rate and consumption). We then extend the model by adding stochastic shock variables to the economy and temperature, and solve the model under several scenarios as an optimal stochastic control problem.*

Break 10.50 – 11.20

11.20 – 12.15 Robert Elliott

(Professor, University of Calgary and Research Professor, University of South Australia)

Title: Conditional Coherent Risk Measures and Regime-Switching Conic Pricing

Abstract: *This paper introduces and represents conditional coherent risk measures as essential suprema of conditional expectations over a convex set of probability measures and as distorted expectations given a concave distortion function. A model is then developed for the bid and ask prices of a European type asset by a conic formulation. The price process is governed by a modified geometric Brownian motion whose drift and diffusion coefficients depend on a Markov chain. The bid and ask prices of a European type asset are then characterized using conic quantization.*

12.15 – 13.10 Miryana Grigorova

(Dr., Department of Statistics, University of Warwick, UK)

Title: Game options in a non-linear incomplete market model with default

Abstract: TBA

S2b. Afternoon session 10/11

Chairperson: Miryana Grigorova

15.00 – 15.35 Anna Aksamit

(Dr., Anna Aksamit, School of Mathematics and Statistics, the University of Sydney)

Title: Information modelling: new type of filtration enlargement, representation property and applications

Abstract: In *this talk we will review the classical results about enlargement of filtration and present some new development with applications. The focus will be on conditions under which martingales in the reference filtration remain semimartingales in the large filtration, in which case, the canonical decomposition is of particular interest. We will then present enlargement of a reference filtration through the observation of a random time and a mark. Random time considered is such that its graph is included in the countable union of graphs of stopping times. Mark revealed at this random time is assumed to satisfy generalised Jacod's condition. Our relaxation of Jacod's condition accounts for the dynamic structure of the problem. Finally we will discuss stability of martingale representation property and further application.*
Talk is based on a joint work with Claudio Fontana.

15.35 – 16.10 Kei Noba (Dr., Institute of Statistical Mathematics, Japan)

Title: Optimality of classical or periodic barrier strategies for Lévy processes

Abstract: *We revisit the stochastic control problem in two cases with Lévy processes that minimize running and controlling costs. Existing studies have shown the optimality of classical or periodic barrier strategies when driven by Brownian motion or Lévy processes with one-sided jumps. Under the assumption that we can be controlled at any time or only at Poissonian dividend-decision times, we show the optimality of classical or periodic barrier strategies for a general class of Lévy processes.*

Break 16.10 - 16.25

Chairman: Kais Hamza (16.25 – 19.00)

16.25 – 17.00 Yuri Imamura (Dr., Kanazawa University, Japan)

Title: A Discrete Scheme of Static Hedging of Barrier Options

Abstract: *We consider a discrete scheme for static hedging of barrier options, by establishing a discrete version of the transform which Peter Carr and Sergey Nadtochiy (2013) introduced, for a general one-dimensional diffusion case. The transform describes the (put type) pay-off which balances at the barrier with a given (call-type) pay-off and hence the plain option with the former pay-off statically hedges a barrier option with the latter pay-off. In this talk we will construct the map for a class of Markov chains, which includes a discretization of Carr-Nadtochiy's correspondence, and also its multi-dimensional version.*

17.00 – 17.35 Yushi Hamaguchi (Dr., Osaka University, Japan)

Title: LQ control problems for stochastic Volterra integral equations

Abstract: *We study linear-quadratic (LQ) control problems for stochastic Volterra integral equations with singular and non-convolution type coefficients. The weighting matrices in the cost functional are not assumed to be non-negative definite. Inspired by the so-called forward variance approach in rough volatility model, we formulate a new framework of causal feedback strategies. The existence and uniqueness of the causal feedback optimal strategy are characterized by the corresponding Riccati--Volterra equation.*
This talk is based on joint works with Tianxiao Wang.

17.35 – 18.15 Mikhail Zhitlukhin (Zoom presentation) (Dr., Steklov Mathematical Institute, Moscow, Russia)

Title: Market strategies which are unbeatable by a small agent

Abstract: *We consider a model of a market which consists of a large agent (the market) and a small agent (an individual investor), who invest money in dividend paying stock. Stock prices are determined by the actions of the large agent, and the small agent is a price-taker. The goal of the work is to find a strategy of the large agent which does not allow a small agent to achieve long-term growth of wealth greater than that of the large agent. The motivation for studying this problem arises from the known empirical fact that it is not possible "to beat" the market in the long run. If one assumes that this fact is true, it can be used to describe long-term behavior of the market.*

18.15 – 18.55 Youri Kabanov (Zoom presentation)

(Professor, Lomonosov Moscow State University and Universit´e Bourgogne Franche-Comte)

Title: Old and recent results in the ruin theory

Abstract: TBA

18.55 - 19.05 *Concluding Remarks* (Alex Novikov, Kais Hamza)