**Workshop on Applied Mathematics**

June 6-8, 2016

Shandong University

**Workshop on Applied Mathematics**

June 6-8, 2016, Shandong University

**Sponsors**

School of Mathematics, Shandong University

Qilu Securities institute for financial studies, Shandong University

Joint Research Center on Financial Mathematics

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Prof. Wu Zhen, Shandong University

Dr. Yiu Ka Fai Cedric, The Hong Kong Polytechnic University

Dr. Yuan Xiaoming, Hong Kong Baptist University

**Venue**

Zhixin Building B1238, Shandong University, Jinan, Shandong

**Participants**

Bensoussan Alain, University of Texas at Dallas and City University of Hong Kong

Chen Zengjing, Shandong University

Hu Mingshang, Shandong University

Huang Jianhui James, The Hong Kong Polytechnic University

Huang Zongyuan, Shandong University

Ji Shaolin, Shandong University

Jia Guangyan, Shandong University

Li Xinpeng, Shandong University

Lin Lu, Shandong University

Luan Yihui, Shandong University

Nie Tianyang, Shandong University

Peng Shige, Shandong University

Shi Jingtao, Shandong University

Shi Yufeng, Shandong University

Wang Falei, Shandong University

Wang Hanchao, Shandong University

Wang Xin, Shandong University

Wei Gang, Shandong University

Wu Panyu, Shandong University

Wu Zhen, Shandong University

Xu Zuoquan, The Hong Kong Polytechnic University

Yiu Ka Fai Cedric, The Hong Kong Polytechnic University

Yu Xiang, The Hong Kong Polytechnic University

Zhang Guofeng, The Hong Kong Polytechnic University

Zhang Zaikun, The Hong Kong Polytechnic University

Zhao Weidong, Shandong University

Zhao Xingqiu, The Hong Kong Polytechnic University

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| **Tuesday, June 7, 2016** | | | |
| **Time** | **Schedule** | **Chair** | **Speaker** |
| 8:00-8:30 | Registration |  |  |
| 8:30-8:40 | Opening Speech | Peng Shige |  |
| 8:40-9:30 | Plenary Talk | Bensoussan Alain |
| 9:30-9:45 | **Coffee Break** | | |
| 9:45-10:15 | Invited Talk | Wu Zhen | Xu Zuoquan |
| 10:15-10:45 | Invited Talk | Zhang Guofeng |
| 10:45-11:00 | **Coffee Break** | | |
| 11:00-11:30 | Invited Talk | Lin Lu | Zhao Xingqiu |
| 11:30-12:00 | Invited Talk | Wang Hanchao |
| 12:00 | **Lunch** | | |
| 14:30-15:00 | Invited Talk | Zhao Weidong | Shi Jingtao |
| 15:00-15:30 | Invited Talk | Yu Xiang |
| 15:30-15:45 | **Coffee Break** | | |
| 15:45-16:15 | Invited Talk | Luan Yihui | Li Xinpeng |
| 16:15-16:45 | Invited Talk | Hu Mingshang |
| 16:45-17:00 | **Coffee Break** | | |
| 17:00-17:30 | Invited Talk | Ji Shaolin | Huang Jianhui James |
| 17:30-18:00 | Invited Talk | Nie Tianyang |
| 18:00 | **Banquet** | | |

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| **Wednesday, June 8, 2016** | | | |
| **Time** | **Schedule** | **Chair** | **Speaker** |
| 9:00-9:30 | Invited Talk | Shi Yufeng | Yiu Ka Fai Cedric |
| 9:30-10:00 | Invited Talk | Wang Falei |
| 10:00-10:30 | **Coffee Break** | | |
| 10:30-11:00 | Invited Talk | Jia Guangyan | Zhang Zaikun |
| 11:00-11:30 | Invited Talk | Wu Panyu |
| 11:30-12:00 | Discussion |  |  |
| 12:00 | **Lunch** | | |

**Remark**

Dinner of June 6: Buffet in Xueren Hotel

Banquet of June 7: Xueren Hotel

Coffee Break and Lunch: Zhixin Building B1135

**Abstracts of Talks**

**Title: Capital Accumulation and Real Options**

Bensoussan Alain

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Abstract: We study here the situation of a firm which exploits an external resource, and decides its investments at appropriate times, in the spirit of real options. However, we are interested in a sequence of projects, and not just a single one. Each project represents a substantial investment, with fixed cost and variable costs measuring the scale of the project. At the same time, the firm is growing and thus accumulates capital, which puts it each time in a more favorable position to exploit the external resource. The problem is to define the sequence of optimal stopping times to invest. We follow the methodology of impulse control, in which the value function is the solution of a Quasi Variational Inequality (QVI). We obtain new types of QVI, which we can solve in some particular cases.

**Product space for two processes with independent increments under nonlinear expectations**

Hu Mingshang

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Abstract: In this paper, we consider the product space for two processes with independent increments under nonlinear expectations. By introducing a discretization method, we construct a nonlinear expectation under which the given two processes can be seen as a new process with independent increments.

**Linear-Quadratic Mean-Field Games with Input Constraints**

Huang Jianhui James

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Abstract: We study the linear-quadratic mean-field games in which the input is subject to constraints characterized by some convex-cone. The consistency condition is established by the monotonicity condition of projection operator and some mean-field type forward-backward stochastic differential equation. The approximate Nash equilibrium is also verified.

**Title: Risk, uncertainty and arbitrage**

Li Xinpeng

Shandong University

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Abstract: We discuss the notions of risk and uncertainty in the financial market following Knight (1921). Empirical research of Chinese and French option markets will support our theoretical results.

**Title: A BSDE approach to fair bilateral pricing under funding costs and collateralization**

Nie Tianyang

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Abstract: Bielecki and Rutkowski (2015) introduced and studied a generic non-linear market model, which includes several risky assets, multiple funding accounts and margin accounts. In this talk, we examine the pricing and hedging of contract both from the perspective of the hedger and the counterparty with arbitrary initial endowments. We derive inequalities for unilateral prices and we study the range of fair bilateral prices and we study the positive homogeneity and monotonicity of unilateral prices with respect to the initial endowments. We also extend the results to the case of an endogenous margin account depending on the contract’s value for the hedger and/or the counterparty by using the backward stochastic viability property. Our results generalized in several respects the option pricing results from Bergman, Mercurio and Piterbarg, respectively, by considering contracts with cash stream flows and allowing for idiosyncratic funding costs for risky assets.

This talk is based on joint works with Prof. Marek Rutkowski (University of Sydney, Australia).

**Title: Connection between MP and DPP for Stochastic Recursive Optimal Control Problems: Viscosity Solution Framework in General Case**

Shi Jingtao

Shandong University

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Abstract: This talk deals with a stochastic recursive optimal control problem, where the diffusion coefficient depends on the control variable and the control domain is not necessarily convex. We focus on the connection between the general maximum principle and the dynamic programming principle for such control problem without the assumption that the value is smooth enough, the set inclusions among the sub- and super-jets of the value function and the first-order and second-order adjoint processes as well as the generalized Hamiltonian function are established. Moreover, by comparing this results with the ones in Yong and Zhou [Stochastic Controls: Hamiltonian Systems and HJB Equations, Springer-Verlag, New York, 1999], it is natural to obtain the first-order and second-order adjoint equations of Hu [Diret method on stochastic maximum principle for optimization with recursive utilities, arXiv:1507.03567v1 [math.OC], 13 Jul. 2015]. (Joint work with Dr. Tianyang Nie and Prof. Zhen Wu.)

**Title: Stochastic optimal control with infinite horizon and Hamilton- Jacobi-Bellman equations in the G-expectation framework**

Wang falei

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Abstract: The present paper considers a stochastic optimal control problem, in which the cost function is defined through a backward stochastic differential equation with infinite horizon driven by G-Brownian motion. Then we study the regularities of the value function and establish the dynamic programming principle. Moreover, we prove that the value function is the uniqueness viscosity solution of the related HJB equation.

**Title: Weak convergence to stochastic integrals for econometric applications**

Wang Hanchao

Shandong University

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Abstract: In cointegration model, endogeneity and nonlinearity play major roles and complicate the limit theory. In this talk, we explore weak convergence limit theory to overcome endogeneity and nonlinearity, and obtain some weak convergence theorems on stochastic integrals. An nonlinear extension of FM regression is used to illustrate practical application of our results.

**Title: Strong laws of large numbers for non-additive probabilities**

Wu Panyu

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Abstract: In this talk, we give the strong laws of large numbers for non-additive probabilities with the notion of independence for random variables under upper expectations. These results are natural extensions of the classical Kolmogorov’s strong law of large numbers to the case where the probability is no longer additive.

**Title: Investment model with intractable claims**

Xu Zuoquan

The Hong Kong Polytechnic University

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Abstract: We will present a Markowitz mean-variance models with intractable claim involved in the terminal wealth. The term “intractable claim” refers to claims (rewards or losses) that are irrelevant to the underlying market. The payoffs of such claims cannot be predicted or hedged based on the underlying financial market even if the information of the financial market is increasingly available to the investor over time. The target of the investor is to minimize the variance in the worst scenario over all the possible realizations of the underlying intractable claim. Because of the time in consistent nature of the problem, both the standard penalization approach and the duality method used to tackle robust stochastic control problems fail for these models. Instead, the quantile formulation and martingale approaches are adopted to tackle the problems and closed-form solutions are derived. The properties of the mean-variance frontiers will also be discussed.

The presentation is based on joint works with Danlin Hou (The Hong Kong Polytechnic University) and Xun Yu Zhou (Columbia University and University of Oxford).

**Title: Optimization with engineering and financial applications**

Yiu K.F.C.

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Abstract: Optimization has been an essential tools for many practical problems, including engineering and financial applications. In this talk, we will discuss some advances in optimal design of filters, as well as broadband beamforming system. We review on various approaches and discuss some of the performance issues. Different optimization models will be considered. In particular, we found that the geometric configuration of the array is important for the accuracy of the designs.

In financial risk management, optimization is applied extensively for portfolio selection. Here, we consider the risk-constrained portfolio selection problems arising from an ordinary investor or an insurer who can invest her surplus into financial market. The goal is to maximize the expected utility of terminal wealth. We will examine a few scenarios with different stochastic processes and discuss how to solve the resulting HJB equation. Furthermore, we will investigate the impacts of the risk constraint on the optimal strategies.

**Title: On the Market Viability under Proportional Transaction Costs**

Yu Xiang

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Abstract: This project studies the market viability with proportional transaction costs. Instead of requiring the existence of strictly consistent price systems (SCPS) as in the literature, we show that strictly consistent local martingale systems (SCLMS) can successfully serve as the dual elements such that the market viability can be verified. We introduce two weaker notions of no arbitrage conditions on market models named no unbounded profit with bounded risk (NUPBR) and no local arbitrage with bounded portfolios (NLABP). In particular, we show that the NUPBR and NLABP conditions in the robust sense for the smaller bid-ask spreads is the equivalent characterization of the existence of SCLMS for general market models. We also discuss the implications for the utility maximization problem.

**Title: Continuous-time multi-photon filtering**

Zhang Guofeng

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Abstract: In this talk we discuss filtering for an arbitrary open quantum system driven by a light wavepacket in a continuous-mode multi-photon state. A continuous-mode multi-photon state is a state of a travelling wavepacket that contains a definite number of photons and is characterised by a temporal (or spectral) profile. After the interaction with the system, the output light is measured by means of homodyne detection or photodetection. Filters for both cases are derived in this paper. As illustrated by an example --- a two-level atom driven by a continuous-mode two-photon state, multi-photon filters can reveal interesting optical phenomena absent in either the single-photon filter case or the continuous-mode Fock state case.

**Title: A Subspace Decomposition Framework for Nonlinear Optimization**

Zhang Zaikun

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Abstract: We present a parallel subspace decomposition framework for nonlinear optimization, which can be regarded as an extension of the domain decomposition method for PDEs. A feature of the framework is that it incorporates the restricted additive Schwarz methodology into the synchronization phase of the algorithm. We establish the global convergence and worst case iteration complexity of the framework, and illustrate how this framework can be applied to design parallel algorithms for optimization problems with or without derivatives.

This is a joint work with S. Gratton (IRIT/ENSEEIHT/INPT, France) and L. N. Vicente (University of Coimbra, Portugal).

**Title: Sieve Estimation of Cox Models with Latent Structures**

Zhao Xingqiu

The Hong Kong Polytechnic University,

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Abstract: In this talk we considers sieve estimation of Cox models with unknown structures based on right censored data, which often occur in survival studies. For the problem, we propose a semiparametric pursuit method to simultaneously identify and estimate linear and nonlinear covariate effects on the log hazards function through a penalized group selection method with folded concave penalties. Both the parametric and nonparametric estimators are consistent, and the parametric estimator is asymptotically normal. To compute the proposed estimators, we develop a modified blockwise majorization descent algorithm that is easy to implement and has a fast convergence rate. Both simulation studies and real data analysis results indicate that the proposed method works well.

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