The AMSS-Poly U Joint Workshop on Computational and Applied Mathematics

December 7-8, 2009 in Beijing, China

Conference Schedule

Conference Site: 110 Room, Morningside Center of Mathematics
（晨兴数学中心，110 报告厅）

Monday Dec. 7

8:30 Opening Ceremony

Chair: Yuan Yaxiang

08:40-09:25 Qi Liqun (Poly U)

09:25-10:10 Cao Daomin (AMSS)

10:10-10:30 Break. Coffee/Tea

Chair: Cao Daomin

10:30-11:15 Kwong Man Kam (Poly U)

11:15-12:00 Yang Xiaoguang (AMSS)

12:00-14:00 LUNCH

5th 6th Room, Fourth floor, Wuke Hotel Restaurant
物科餐厅四层 5-6 号房间

Chair: Yang Xiaoguang

14:10-14:55 Xu Zhiqiang (AMSS)

14:55-15:40 Cedric K. F. Yiu (Poly U)

15:40-16:00 Break. Coffee/Tea

Chair: Xu Zhiqiang

16:00-16:45 Sun Liuquan (AMSS)

16:45-17:30 Philip S. C. Yam (Poly U)

Tuesday Dec. 8

Chair: Yuan Li

08:40-09:25 Chen Xiaojun (Poly U)

09:25-10:10 Yan Ningning (AMSS)

10:10-10:30 Break. Coffee/Tea

Chair: Yan Ningning

10:30-11:15 Lin Yanping (Poly U)

11:15-12:00 Yuan Li (AMSS)

12:00-14:00 LUNCH

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Chair: Sun Liuquan

14:10-14:55 Zhao Xinqiu (Poly U)

14:55-15:40 Song Yongsheng (AMSS)

15:40-16:00 Break. Coffee/Tea

Chair: Dai Yuhong

16:00-16:45 Li Xun (Poly U)

16:45-17:30 Zhang Dixin (AMSS)

Minimizing a Multi-Variate Homogeneous Polynomial over the Sphere

Qi Liqun

Abstract

The minimization problem of a multi-variate homogeneous polynomial over the sphere has applications in optimal control, signal processing, quantum physics and magnetic resonance imaging. This problem is NP-hard with respect to its dimension. When the dimension is small or all the coefficients are non-negative, better results can be obtained. In this talk, we review complexity, algorithms and applications of this problem.

A free boundary problem arising in plasma physics

Cao Daomin

Abstract

In the talk the speaker will talk about a free boundary problem arising from plasma physics. Previous results on the existence of ground state, multiplicity and asymptotic behaviour of plasma set when some parameter is large will be presented. A new result on the existence of solutions in a joint work with Peng Shuangjie and Yan Shusen will be explained.

Existence of Traveling Waves for a Delayed Fisher Equation

Kwong Man Kam

Abstract

The Fisher equation $u_t = u_{xx} + u(1-u)$ has many applications in population dynamics, and has been extensively studied. It is well-known that there exist monotone traveling waves of the form $u(x,t) = \phi(x - ct)$ for all wave speed $|c| \geq 2$. For more realistic biological models, time delays and nonlocal effects have been introduced into the equation. In one form of the modified equation $u_t = u_{xx} + u(x,t-\tau)(1-u(x,t))$, the delay appears in the first factor of the nonlinear reaction term. The associated dynamical system satisfies the so-called quasi-monotonicity property and the existence of traveling waves can be established using a general theory first developed by Schaaf (1987). In another form of the modified equation $u_t = u_{xx} + u(x,t)(1-u(x,t-\tau))$ the system is no longer quasi-monotonic and existing approaches are only able to give partial results. Wu and Zou (2001) showed that given $|c| \geq 2$, traveling waves exist provided that τ is sufficiently small.

In a recent joint work with C. Ou, we used a different approach, by solving an initial value problem (instead of the the conventional approach of solving a boundary value problem), to give a complete characterization of the delay for which a traveling wave exists. The question for more general nonlinear reaction term is still open.

Vector Games

Yang Xiaoguang

Abstract

We introduce a family of coalitional succinct games, which is referred to as the vector games. Intuitively, a vector game is defined as a coalitional game where each player can be completely described by a vector with fixed dimensions (to describe the game, several external parameters are still possibly needed), each of which stands for a kind of resource or ability that the player possesses. We focus on the simple vector games, i.e. vector games whose coalition values are either 1 or zero, and find that every simple vector game can be specified by a vector aggregation rule and a vector comparison rule. To turn the coalitional game into a noncooperative one, where varieties of equilibria and corresponding efficiency problems can be studied, we only have to fix a payoff allocation rule and a social welfare function. Since there are many natural and simple ways for each of the above rules or function, quite a few new models and new problems are brought out. Analogous to the three field notation of Graham et al. in the field of scheduling theory, we propose a four field notation to represent every specific vector game, which we hope may accelerate the potential research in this new area.

The error bound of PCM quantization

Xu Zhiqiang

Abstract

In signal processing, coding and transmitting, a signal is first decomposed using some suitably chosen atoms. In the digital domain, a quantization is performed for transmission storage, coding and other purpose. But quantizations inevitably induce errors. It is important that we understand how the errors behave and have a good estimate of these errors. In this talk, we will introduce the PCM quantization and sigma-delta quantization. Using the tools from number theory and probability, we will give the error bound of PCM scheme. Moreover, we will introduce some research problems in this area.

Optimal Portfolios with a VaR constraint

Cedric K. F. Yiu

Abstract

In market risk management, it is widely accepted that Value-at-Risk (VaR) is a useful summary measure of market risks and an option to be used by regulators and large banks to set the requirement on capital reserves. In order to fulfill the requirement, a portfolio must be able to control the level of VaR. If the expected utility of wealth or consumption is maximized over a certain period of time without considering risks, the optimal allocation to the risky asset might violate the VaR restriction at some points and fall short of the regulatory requirement.

In this article, we impose the VaR as a dynamic constraint to the optimal portfolio problem. At each instant, the VaR is estimated and is applied to influence the investment decision. The optimal portfolio problem is formulated as a constrained maximization of the expected utility, with the constraint being the VaR level. Dynamic programming is applied to reduce the whole problem to solving the Hamilton-Jacobi-Bellman equation coupled with the VaR constraint, and the method of Lagrange multiplier is then applied to handle the constraint. A numerical method is proposed to solve the problem. By applying the VaR constraint continuously over time, we find that investments in risky assets are reduced whenever the VaR constraint becomes active.

A class of Box-Cox transformation models for recurrent event data

Sun Liuquan

Abstract

In this article, we propose a class of Box-Cox transformation models for recurrent event data, which includes the proportional means models as special cases. The new model offers great flexibility in formulating the effects of covariates on the mean functions of counting processes while leaving the stochastic structure completely unspecified. For the inference on the proposed models, we apply a profile pseudo-partial likelihood method to estimate the model parameters via estimating equation approaches and establish large sample properties of the estimators and examine its performance in moderate-sized samples through simulation studies. In addition, some graphical and numerical procedures are presented for model checking. An example of application on a set of multiple-infection data taken from a clinic study on chronic granulomatous disease (CGD) is also illustrated.

Callable Stock Loans and Beyond

Phillip S. C. Yam, S. P. Yung and W. Zhou

Abstract

A stock loan is a loan in which the borrower, who owns one share of a stock, obtains a loan from the lender with the stock as a collateral. In their work, Xia and Zhou (2007) provided the first quantitative analysis of stock loans under the Black-Scholes framework and determined the fair price charged by the lender for providing such a service.

In this talk, I shall consider the pricing issue of stock loans with a callable feature that lender can call back the loan at any time before maturity; upon calling the loan, lender has the right to enforce the borrower either to immediately redeem the stock by paying back the loan at a reduced amount or surrender his share of stock. Financial products with such a feature are commonly traded under the name: Callable REPO. Explicit solution together with range of loan-to-value ratio for marketable REPOs will be illustrated in infinite time horizon setting; while for the finite time counterpart, a couple of integral equations characterizing the two exercising boundaries will be shown.

On the other hand, in a recent work of Kunita and Seko (2007), they attempted to identify the exercising region of game call options (with δ-penalty) with finite time to maturity. In this talk, I shall also illustrate a complete solution to the same problem which is in contrast to their expected results; indeed, by applying similar method, we had shown the non-trival nature of the pair of exercising boundaries of the corresponding optimal stopping game (Dynkin's game).

Computational Existence Proofs for Spherical *t*-Designs

Chen Xiaojun

Abstract

Spherical *t*-designs provide quadrature rules for the sphere which are exact for polynomials up to degree *t*. In this paper, we propose a computational algorithm based on interval arithmetic which, for given *t*, upon successful completion will have proved the existence of a *t*-design with $(t+1)^2$ nodes and will have computed narrow interval enclosures which are known to contain these nodes with mathematical certainty. Since there is no theoretical result which proves the existence of a *t*-design with $(t + 1)^2$ nodes for arbitrary *t*, our method contributes to the theory because it was tested successfully for $t = 1, 2, \ldots, 100$, i.e., for all *t* considered so far. The *t*-design is usually not unique; our method aims at finding a well-conditioned one. The method relies on computing an interval enclosure for the zero of a highly nonlinear system of dimension $(t+1)^2$. We therefore develop several special approaches which allow us to use interval arithmetic efficiently in this particular situation. The computations were all done using the MATLAB toolbox INTLAB.

Some Finite Element Schemes for State-constrained Optimal Control Problems

Yan Ningning

Abstract

In this talk, we discuss the numerical methods for the optimal control problems with point-wise state constraints. The traditional approaches often need to deal with the delta-singularity in the dual equation, which causes many difficulties in its theoretical analysis and numerical approximation. In our new approaches we reformulate the state-constrained optimal control as a constrained minimization problems only involving the state, whose optimality condition is characterized by a fourth order elliptic variational inequality. Moreover, the fourth order elliptic variational inequality can be rewritten to a system of variational inequalities with mixed form involving the state and control (but without costate). Based on above results, the direct numerical algorithms (nonconforming finite element approximation and mixed finite element approximation) are proposed for the inequalities. The error estimates of the finite element approximation and mixed finite element approximation are derived. The adaptive finite element mesh refinement is discussed based on a posteriori error estimates. Numerical experiments are presented to illustrate the effectiveness of the new approaches.

A biosensor modeling and its analysis

Lin Yanping

Abstract

In this talk we present a mathematical modelling of an optical biosensor, which uses optical principles qualitatively to convert chemical and biochemical concentrations into electrical signals. For realistic applications, we propose the biosensor model in 3D. In particular, we present existence and uniqueness results based on Maximum Principle and weak solution arguments. Our theoretical approach is explicitly presented since it is simple and directly applicable to the numerical methods. These ideas are later applied to systems and to the numerical analysis of the approximate discretized problems. It should be noted that without one dimensional symmetry, the equations can not be decoupled in order to reduce the problem to a single equation. We also show the long time monotonic convergence to the steady state.

An Improved Real Ghost Fluid Method and Its Implementation on Moving Meshes

Yuan Li

Abstract

We study some issues encountered when using the Real Ghost Fluid Method (RGFM) for simulation of two-dimensional compressible multi-medium flows governed by stiff gas equation of state. Original RGFM chooses grid-point flow states on each side of the interface as the initial condition for Riemann problem, and this may cause nonphysical oscillations. By replacing the point-wise states with interpolated states, we eliminate the numerical oscillations successfully. Furthermore, we combine the RGFM with an adaptive moving mesh method and propose a new technique to avoid grid points from crossing the interface during the mesh redistribution. Some computational results show that our improvement is effective.

Semiparametric regression analysis of panel count data with informative observation times

Zhao Xinqiu

Abstract

This talk discusses regression analysis of panel count data that arise naturally when recurrent events are considered. For the analysis of panel count data, most of the existing methods have assumed that observation times are independent of recurrent events completely or given covariates, which may not be true in practice. We propose a joint modeling approach that uses an unobserved random variable and a completely unspecified link function to characterize the correlations between the response variable and the observation times. For inference about regression parameters, estimating equation approaches are developed without involving any estimation for latent variables and the asymptotic properties of the resulting estimators are established. The performance of the proposed estimation procedures are evaluated by means of Monte Carlo simulations and a data set from a bladder tumor study is analyzed as an illustrative example.

Some properties on G-evaluation and its applications to G-martingale decomposition

Song Yongsheng

Abstract

In this article, a sublinear expectation induced by G-expectation is introduced, which is called G-evaluation for convenience. As an application, it shows that any bounded G-martingale has the martingale decomposition theorem. Furthermore, we show that any symmetric G-martingale has martingale representation theorem. Also, we shall introduce an stopping time technique.

Selling Financial Assets at the Best Time

Li Xun and Wu Zhenyu

Abstract

A primary decision-making problem in financial investment practice is to determine the best time to sell an asset. This project aims to solve such a problem for a class of general continuous-time asset price processes where the objective is to sell at a price closest to the highest possible price over a given investment horizon. The problem is formulated as an optimal stopping problem, although it is non-standard in the sense that the maximum price involved is not adapted to the information generated over time. By delicate stochastic analysis the problem is expected to be converted to a standard optimal stopping one involving adapted processes. Moreover, different from the probabilistic approach in the literature which is ad-hoc and works for relatively simple price processes, this project develops a general approach, mainly employing the partial differential equation technique, to cope with the difficulty arising from the general price processes. The results derived from the optimal selling problems will also be applied to a wealth management problem involving decisions of both a fund manager and a client.

A General LIBOR Market Model with Default Risk

Zhang Dixin

Abstract

The Market Model of the term structure of interest rates are extended to a defaultable setting in which the default is introduced in the intensity-based framework. With the help of default intensity a new default-free bond market is constructed which is closely related to the former default-able one. Some connections between these two markets are discussed, such as arbitrage free conditions, hedging strategies and change of numeraires. A new credit spread process S is introduced and the backward SDEs which S should satisfy are derived. At the end we will give closed-form pricing formulas for CDS and CDS options under forward risk-neutral measures.