Conference on Probability with Applications to Finance and Insurance

December 19 – 21, 2005

T6, Meng Wah Complex

Organizing Committee:

Ngai Hang Chan, CUHK, Bingyi Jing, HKUST, Qiman Shao, HKUST
Hailiang Yang, HKU, Siu Pang Yung, HKU, Zukang Zheng, Fudan U

December 19
Monday

09:00 – 09:15 *Welcoming Address and Introductory Remarks*
Ngaiming Mok, Director, HKU Institute of Mathematical Research

Chair: **Ngaiming Mok**, The University of Hong Kong

09:15 – 09:55 **Peter Hall**, *Australia National University*
Labour Market Modelling and Hypothesis Testing for Functional Data

09:55 – 10:35 **Zhiliang Ying,** *Columbia University*
Statistical Modeling of Jump Diffusion Processes with Application to Valuation of CDO

10:35 – 10:55 *Coffee Break*

Chair: **Shiqing Ling**, Hong Kong University of Science and Technology

10:55 – 11:35 **Lei Guo**, Chinese Academy of Sciences, Beijing
Feedback and Uncertainty: Some Fundamental Limitations

11:35 – 12:15 **Ming Gao Gu**, Chinese University of Hong Kong
Models for Ranking Data with Application to Horse Racing

12:15 – 14:15 *Lunch Break*

Chair: **Siu Pang Yung**, The University of Hong Kong

14:15 – 14:55 **Louis H. Y. Chen,** National University of Singapore
Poisson Process Approximation via Compound Poisson Approximation

14:55 – 15:35 **Bernard Bercu**, Universite Paul Sabatier
Exponential Inequalities for Self-normalized Martingales

15:35 – 15:55 *Coffee Break*

Chair: **Hangji Shang**, Fudan University

15:55 – 16:35 **Yi-Ching Yao**, Academia Sinica, Taiwan
Corrected Random Walk Approximations for Brownian Optimal Stopping Problems with an Application to American Put Option

16:35 – 17:15 **Zhengyan Lin**, Zhejiang University
Asymptotic Properties of Robust Regression Estimation for Stationary Processes

December 20
Tuesday

Chair: **Wai K. Li**, The University of Hong Kong

09:00 – 09:40 **Hans U. Gerber**, University of Lausanne and the University of Hong Kong
On Optimal Dividends

09:40 – 10:20 **Kai W. Ng**, The University of Hong Kong
A Journey from the Inverse Bayes Formula to a Dependence Index

10:20 – 10:40 *Coffee Break*

Chair: **Yeh Lam**, The University of Hong Kong

10:40 – 11:20 **Cun-Hui Zhang**, Rutgers University
Nonlinear Renewal Theory and Expected Sample Size of Rank SPRT

11:20 – 12:00 **Hock Peng Chan**, National University of Singapore
Efficient Importance Sampling and Sequential Monte Carlo Methods for Computing Probabilities in Complex Statistical Models

12:00 – 14:00 *Lunch Break*

Chair: **Man K. Siu**, The University of Hong Kong

14:00 – 14:40 **Wenbo Li**, University of Delaware
The First Exit Time of Unbounded Domain

14:40 – 15:20 **Tiefeng Jiang**, University of Minnesota
Spectral Measure of Large Hankel, Markov and Toeplitz Matrices

15:20 – 15:40 *Coffee Break*

Chair: **Kin Lam**, Hong Kong Baptist University

15:40 – 16:20 **Qi-Man Shao**, Hong Kong University of Science and Technology and University of Oregon
Limit Theorems for Permutation Empirical Processes with Applications to Change Point Analysis

16:20 – 17:00 **Xinsheng Zhang**, Fudan University
Stochastic Comparisons of Order Statistics from Weibull Distributions and Gamma Distributions

December 21
Wednesday

Chair: **Hailiang Yang**, The University of Hong Kong

09:00 – 09:40 **Sai Wan Elias Shiu**, University of Iowa and the University of Hong Kong
Dynamic Protection with Optimal Withdrawal - Part II

09:40 – 10:20 **Lancelot James**, Hong Kong University of Science and Technology
A Class of Continuous Time General Hyperbolic Student Skew Stochastic Volatility Models

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10:20 – 10:40 *Coffee Break*

Chair: **Samuel Wong**, Chinese University of Hong Kong

10:40 – 11:20 **Victor H. de la Pena**, Columbia University
From Decoupling to Copulas and the Road in Between

11:20 – 12:00 **Bing-Yi Jing**, Hong Kong University of Science and Technology
Saddlepoint Approximations for Studentized Compound Poisson Sum

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12:00 – 14:00 *Lunch Break*

Chair: **Tiong-Wee Lim**, National University of Singapore

14:00 – 14:40 **Yue Kuen Kwok**, Hong Kong University of Science and Technology
Credit Contagion Models with Interacting Intensities

14:40 – 15:20 **Qiying Wang**, University of Sydney
Cramer-Type Large Deviations for Samples from a Finite Population

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15:20 – 15:40 *Coffee Break*

Chair: **Wing K. Fung**, The University of Hong Kong

15:40 – 16:20 **Zhidong Bai**, Northeast Normal University in China and National University of Singapore
Making Markowitz's Portfolio Principle Practically Useful

16:20 – 17:00 **Hailiang Yang**, The University of Hong Kong
Optimal Investment for Insurer with Jump-Diffusion Risk Process

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17:00 – 17:20 ***Closing***

Abstracts

Zhidong Bai, Northeast Normal University in China and NUS

Making Markowitz's Portfolio Principle Practically Useful

The Markowitz mean-variance optimization procedure is highly appreciated as a theoretic result in the literature. However, it has been demonstrated to be less applicable in practice due to its serious departure of its estimated optimal portfolio allocation from its theoretic counterpart, this is attributed to the huge measurement errors. In this paper, applying the large dimensional data analysis, we first explain theoretically that this phenomenon is natural when the number of assets is large. In addition, we prove theoretically that the estimated optimal return is always larger than the theoretical value when the number of assets is large. To circumvent this problem, we employ the large dimensional random matrix theory again to develop a bootstrap method to correct the overprediction and to reduce the measurement error. Our simulation results show that the bootstrap correction method can significantly improve the accuracy of the estimation. (This paper reports a joint work with Huixia Liu and Wing-Keung Wong)

Bernard Bercu, Universite Paul Sabatier

Exponential inequalities for self-normalized martingales

We propose exponential inequalities for self-normalized martingales similar to those recently established by De la Pena. Statistical applications on the least square estimator of the parameter of a stable autoregressive process are also provided.

Hock Peng Chan, NUS

Efficient importance sampling and sequential Monte Carlo methods for computing probabilites in complex statistical models

Large deviation theory has provided important clues for the choice of importance sampling measures, as described in Bucklew's (1990) monograph. However, Glasserman and Wang (1997) have provided examples in which importance sampling measures that are consistent with large deviations can perform much worse than direct Monte Carlo. We first address this problem by using certain mixtures of these importance sampling measures and showing that they are asymptotically optimal. We then develop sequential Monte Carlo methods to implement them

in multidimensional and Markov-dependent settings. Applications to queueing theory, time series, sequential analysis and multiple testing are given. (This paper reports a joint work with Tze Leung Lai)

Louis H.Y. Chen, NUS

Poisson Process Approximatiom via Compound Poisson Approximation

Poisson process approximation has been successfully developed by Barbour, Brown, Xia and others since 1988. The key idea is to convert the Stein equation into one involving the generator of an immigration-death process, solve it in terms of the process and then obtain sharp bounds on the solution and its smoothness using coupling. This approach is known as the probabilistic approach of Barbour.

In this talk, we regard a Poisson process as a compound Poisson random variable taking values in a semi-group which is generated by Dirac measures on a carrier space. From this viewpoint, Poisson process approximation can be treated as compound Poisson approximation. We discuss two approaches to this approximation, the direct approach which works well for certain special cases and an analytic approach (as opposed to the probabilistic approach of Barbour) for the general setting. (This paper reports a joint work with K.P. Choi)

Victor H. de la Pena, Statistics, Columbia University

From Decoupling to Copulas and the Road in Between

In this talk I show how the study of decoupling leads naturally to the use of copulas. In particular, I will introduce a central limit theorem for dependent variables based on 1) a new copula characterization 2) sharp decoupling inequalities and 3) the use of multivariate measures of dependence. Copula functions are joint distributions of uniform random variables. They provide a nice modelling tool that permits the separation of the dependence of a joint density into a dependence function (copula) and the marginal densities. (This paper reports a joint work with R. Ibragimov and Sh. Sharakhmetov)

Hans-Ulrich Gerber, U of Lausanne and HKU

On Optimal Dividends

According to Bruno De Finetti, a company pays dividends to the stockholders in order to

maximize the expectation of the discounted dividends before possible ruin. In the talk sveral versions and appications of this problem are explained.

Minggao Gu, Statistics,CUHK

Models for Ranking Data with Application to Horse Racing

Because of broad spectrum of applications, ranking data has been an interesting area of research for almost all of last century. In this talk, we use horse racing data as an example to introduce some interesting problems of ranking data, such as partially ranked data, selecting the error distributions, model selection and prediction, variance modeling, correlation modeling and cluster modeling. For computation, MCMC techniques were used in the Bayesian setting (Yu, 2000). The stochastic approximation methods (Gu and Zhu, 2001) can be applied in the classical setting. The methodologies are applied to the Hong Kong Jockey Club horse racing data for illustrations.

Lei Guo, Academy of Mathematics and Systems Science, Chinese Academy of Sciences

Feedback and Uncertainty: Some Fundamental Limitations

Modeling plays an important role in controller design, but uncertainties always exist in any modeling, which are usually dealt with by feedback in control systems. Thus, two natural and fundamental questions are: How much uncertainty can be dealt with by feedback? What are the limitations of feedback in dealing with uncertainties? Answers to these questions will help us to understand the necessary amount of model information needed for feedback control design. In this talk, we will try to answer these questions for several simple and basic classes of discrete-time nonlinear dynamical systems with parametric or nonparametric uncertainties, and will present some "critical values" and "impossibility theorems" on the capability of feedback in dealing with uncertainties.

Peter Hall, ANU

Labour Market Modelling and Hypothesis Testing For Functional Data

Motivated by a labour-market modelling problem arising in economics, we develop methods for testing the null hypothesis that a particular sample of random functions comes from a specific, parametrically defined distribution of random functions. The true values of the parameters, under the null hypothesis, are not known and have to be estimated from the data. Methodology

for implementing the test, involving Monte Carlo techniques for computing the test statistic, and bootstrap algorithms for calibration, are suggested. The proposed method does not rely on statistical dimension reduction or smoothing. (This paper reports a joint work with Federico A. Bugni, Joel L. Horowitz and George R. Neumann)

Lancelot James, ISMT, HKUST

A class of continuous time general hyperbolic student skew stochastic volatility models

It is well known that Gaussian models used to model the return of asset prices does not fit well with what is observed empirically. In the past few years there has been considerable investigations of possible alternatives to the Gaussion based framework. One major innovation has been the idea of time changing the Gaussian process by functionals of a Levy process. An example is the use of positive Ornstein-Uhlenbeck type processes. This has enjoyed some level of success in terms of option pricing but creates a new problem in terms of statistical estimation. Here we describe a class of models where we replace Brownian motion component by Student t-proceses of arbitrary order (subject otherwise to the same type of time changing mechanisms). In addition to the modelling advantages delivered by this class it, as we shall discuss, also allows one to conduct likelihood based statistical analysis more easily. This is a joint work with John Lau.

Tiefeng Jiang, School of Statistics, University of Minnesota

Spectral Measure of Large Hankel, Markov and Toeplitz Matrices

We study the limiting spectral measure of large symmetric random matrices. This includes the asymptotic behavior of properly scaled eigenvalues of Hankel, Markov and Toeplitz matrices. This solves three unsolved random matrix problems. It is a joint work with W. Bryc and A. Dembo.

Bing-Yi Jing, Mathematics, HKUST

Saddlepoint approximations for studentized compound Poisson sum

Saddlepoint approximations for studentized compound Poisson sum are derived without any moment conditions. The bootstrap approximation to the studentized compound Poisson sum is also considered. (Joint work with Helmers and Zhou)

Yue Kuen Kwok, Mathematics, HKUST,

Credit contagion models with interacting intensities

In credit contagion models using the interacting intensities approach, the default intensity of one firm receives an upward jump upon the occurrence of default events of the other firms. In this talk, the general Markovian formulation of the credit contagion model will be discussed. The derivation of the joint distribution of the default times of obligors in the portfolio using Markov chain techniques will be presented. The valuation of credit default swap subject to counterparty risk is considered, in particular, the impact of settlement risk and replacement cost on the swap rate will be explored.

Wenbo Li, Mathematical Sciences, University of Delaware

The First Exit Time of Unbounded Domain

Consider the first exit time τ_D of a smooth domain D by d-dimensional Brownian motion. When D is unbounded, we provide an overview on the behavior of $P(\tau_D > t)$ as $t \to \infty$ and its various connections with its principle eigenvalue and small deviation probability. The emphasis is on ideas/tools and open problems.

Zhengyan Lin, Zhejiang U

Asymptotic Properties of Robust Regression Estimation for Stationary Processes.

A robust nonparametric regression estimation combining kernel methods and robust location estimation techniques is considered for a wide class of stationary processes. Consistency and asymptotic normality are established under mild conditions.

Kai W. Ng, Statistics and Actuarial Science, HKU

A Journey from the Inverse Bayes Formula to a Dependence Index

The study of dependence between risks is currently a very active area in actuarial science and insurance mathematics; e.g. see the comprehensive exposition by Denuit, Dhaene, Goovarers and Kaas, entitled "Actuarial Theory fro Dependent Risks – Measures, Orders and Models", Wiley & Sons, 2005, and the references therein. In statistics, measuring association or dependence between two variables has been a topic of interest too, as shown in Lehmann (1966), Esary, Proschan and Walkup (1967), Esary and Proschan (1972) and others, and reviewed in the book by Harry Joe, "Multivariate Models and Dependence Concepts", Chapman and Hall,

1997.

In this talk I shall report my joint work with Howell Tong, in which we quantify the information gained by an experiment due to the Bayesian operation from the prior to the posterior, with the aid of the Inverse Bayes Formula introduced by Ng (1995, 1997a, 1997b). Unexpectedly, the quantification leads to a measure of dependence between two (groups of) variables. The audiences are warned that the measure is so intuitively obvious that once presented with it, they (like the co-authors themselves) may well wonder why it had not been proposed in the literature before. Of course, the real challenge is in proving the dependence measure obtaining positivity when the variables are not independent. A Dependence Index is proposed to normalize the measure into the close unit interval [0, 1], which equals 0 if and only if the two variables are independent and equals 1 when one variable is a function of the other, such as one variable being the square of the other. Extension to a similar measure of mutual dependence of three or more (groups of) variables is still an open problem.

Qiman Shao, Mathematics, HKUST and U of Oregon

Limit Theorems for Permutation Empirical Processes with Applications to Change Point Analysis

Let $X_{1,n}, X_{2,n}, \ldots, X_{n,n}$ be i.i.d. random variables, and let $(R_1, R_2, \ldots, R_n)$ be a random permutation of $(1, 2, \ldots, n)$, independent of $\{X_{1,n}, X_{2,n}, \ldots, X_{n,n}\}$. Consider Permutation empirical process

$$\beta_n(x,t) = n^{-1/2} \sum_{1 \le i \le nt} (I\{X_{R_i,n} \le x\} - F_n(x)),$$

where $F_n(x) = \frac{1}{n} \sum_{1 \le i \le n} I\{X_{i,n} \le x\}$. We shall show that β_n can be approximated by a Gaussian process. The results are applied to simulate critical values for the functionals of sequential empirical processes used in change point analysis. This talk is based on a joint work with Lajos Horváth.

Elias Shiu, U of Iowa and HKU

Dynamic Protection with Optimal Withdrawal - Part II

In July 2002, Professor Lai organized a conference in which we presented the paper "Dynamic Protection with Optimal Withdrawal?". We received valuable feedbacks from conference participants, especially Professor Y.K. Kwok. This presentation reports the progress made since

then.

Qiying Wang, U of Sydney

Cramer-type large deviations for samples from a finite population

Cramer-type large deviations for means of samples from a finite population are established under weak conditions. The results are comparable to results for the so-called self-nomalized large deviation for independent random variables. Cramer-type large deviations for finite population Student t-statistics are also investigated. This talk is based on joint work with Dr Zhishui Hu and Professor John Robinson.

Hailiang Yang, The University of Hong Kong

Optimal Investment for Insurer with Jump-Diffusion Risk Process

In this talk, I will present optimal investment strategies of an insurance company. In the fist part, we assume that the insurance company receives premiums at a constant rate, the total claims are modeled by a compound Poisson process, and the insurance company can invest in the money market and in a risky asset such as stocks. The investment behaviour is investigated numerically for various claim size distributions. We also investigate the effects of changes in various factors, such as stock volatility, on optimal investment strategies and survival probability. In the second part, we study optimal investment policies of an insurer with jump-diffusion risk process. Under the assumptions that the risk process is compound Poisson process perturbed by a standard Brownian motion and the insurer can invest in the money market and in a risky asset, we obtain a close form expression of the optimal policy when the utility function is exponential. We also study the insurer's optimal policy for general objective function. In the case of minimizing ruin probability, numerical methods and numerical results are presented for various claim-size distributions.

Yi-Ching Yao, Academia Sinica

Corrected Random Walk Approximations for Brownian Optimal Stopping Problems with an Application to American Put Option

Corrected random walk approximations to continuous-time optimal stopping boundaries for Brownian motion, first introduced by Chernoff and Petkau, have provided powerful computational tools in option pricing and sequential analysis. A theory of these second-order ap-

proximations, recently developed by Lai, Yao and AitSahlia (2005) is reviewed, which is then applied, together with the work of Lamberton (2002), to derive a corrected approximation to the early exercise boundary for American put option.

Zhiliang Ying, Columbia University

*Statistical modeling of jump diffusion processes with application to valuation of CDO**

Time to default is fundamental to valuation of collaterized debt obligation, which is becoming increasingly popular in financial market. We propose a structural approach by incorporating underlying jump diffusion processes with embedded parameters. We show how such an approach can be used to model and derive multivariate default distributions. We then show how the results can be applied to valuation of CDO. This is a joint work with S. Kou and H. Xing, both of Columbia University.

Cun-Hui Zhang, Rutgers University

Nonlinear Renewal Theory And Expected Sample Size Of Rank SPRT

We provide a nonlinear renewal theorem for a perturbed random walk without assuming stochastic boundedness of the centered perturbation process. A second order expansion of the expectation of certain stopping times is obtained via the uniform integrability of the difference between linear and nonlinear stopping rules. The rank SPRT for the Lehmann alternative is investigated as a motivating example.

Xinsheng Zhang, Fudan University

Stochastic Comparisons of Order Statistics from Weibull Distributions and Gamma Distributions

In this talk, we will give some results on the stochastic comparisons of order statistics from Weibull distributions and Gamma distributions. Let $(X_1, X_2, ..., X_n)$ and $(X_1^*, X_2^*, ..., X_n^*)$ be independent Weibull random vectors with common shape parameter $\alpha(\alpha > 0)$ and scale parameters $(\lambda_1, \lambda_2, ..., \lambda_n)$, $(\lambda_1^*, \lambda_2^*, ..., \lambda_n^*)$, respectively. Let $\mathbf{X}_{()} = (X_{(1)}, X_{(2)}, ..., X_{(n)})$, $\mathbf{X}_{()}^* = (X_{(1)}^*, X_{(2)}^*, ..., X_{(n)}^*)$ be the order statistics of $(X_1, X_2, ..., X_n)$ and $(X_1^*, X_2^*, ..., X_n^*)$. Suppose that there exists a strictly monotone function f such that $(f(\lambda_1), f(\lambda_2), ..., f(\lambda_n)) \succeq_m (f(\lambda_1^*), f(\lambda_2^*), ..., f(\lambda_n^*))$. Under this assumption, it can be proved that if $f^{'}(x)f^{''}(x) \geq 0$, then $\mathbf{X}_{()} \geq_{st} \mathbf{X}_{()}^*$ and $X_{(1)} \geq_{lr} X_{(1)}^*$; if $f^{'}(x)f^{''}(x) \leq 0$, then $X_{(1)} \leq_{lr} X_{(1)}^*$; if $f^{'}(x)f^{''}(x) \leq$

0 and $| \ xf^{''}(x)| \ \leq \ |f^{'}(x)|$, then $X_{(n)} \ \geq_{st} \ X^*_{(n)}$. Furthermore, when $(X_1, X_2, ..., X_n)$ and $(X^*_1, X^*_2, ..., X^*_n)$ be independent Weibull random vectors with common scale parameter $\lambda(\lambda > 0)$ and shape parameters $(\alpha_1, \alpha_2, ..., \alpha_n)$, $(\alpha^*_1, \alpha^*_2, ..., \alpha^*_n)$ respectively, it can be shown that $X_{(1)} \leq_{st} X^*_{(1)}$ and $X_{(n)} \geq_{st} X^*_{(n)}$ provided that $(\alpha_1, \alpha_2, ..., \alpha_n) \succeq_m (\alpha^*_1, \alpha^*_2, ..., \alpha^*_n)$. Similar problems are discussed for Gamma distributions.