Statistical Sciences
UNIVERSITY OF TORONTO

Graduate Student Seminars

April 7, 2016 at 3:10pm

Room 2106, Sidney Smith Hall

Refreshments will be provided

Tianyi Jia:

Title: Optimal Trading of Currency Triplets

Abstract: We develop the optimal trading strategy for our broker who has non-zero inventory in three currency pairs with different level of liquidity and would like to o ff-load all inventories with a given time schedule while accepting exogenous clients orders. The mid-exchange rate satisfies constraint to exclude the triangle arbitrage. Our broker is risk-neutral, inventory averse and would like to maximize the overall trading wealth denominated in her local currency. Unlike the case of liquidating individual asset separately, the appropriate form of inventory penalty should be consisted by both the square of individual inventory and their cross product. We propose an appropriate form of running inventory penalty by imposing ambiguity aversion on the drifts of mid-exchange rates. In our model, we can find the closed form solution for the value function and an optimal Markovian control of the stochastic control problem. Verification proofs are provided.

Zhenhua Lin

Title: Mixture Models and Densities for Functional Data

Abstract: We propose a novel perspective to represent infinite-dimensional functional data as mixtures, where each realization of the underlying stochastic process is represented by a finite number of basis functions. In the proposed mixture representation, the number of basis functions that constitutes the mixture may be arbitrarily large, where the number of included mixture components is specifically adapted for each random trajectory. We show that within this framework, a probability density can be well defined under mild regularity conditions, without the need for finite truncation or approximation, where genuine probability densities do not exist. This is due to the low small ball probabilities and as a consequence only approximate solutions to the density problem can be found in the usually considered L^2 space. Unlike traditional functional principal component analysis that uses a common number of components to represent all trajectories, individual trajectories possess a trajectory-specific dimension that may be treated as a latent random variable. We establish a notion of consistency for estimating the functional mixture density and introduce an algorithm for fitting the functional mixture model based on a modified expectation-maximization algorithm. Simulations confirm that in comparison to traditional functional principal component analysis the proposed mixture modeling achieves similar or better data recovery while using fewer components on average. The practical merits of functional mixture modeling are demonstrated in an analysis of egg-laying trajectories for medflies.

Wei Deng:

Title: A statistical algorithm for phantom clustering using PPCA

Abstract: In this paper we extend the idea of spectral clustering using probabilistic PCA (PPCA) to cluster panel data. The key challenge is to determine the true number of clusters. A number of solutions assume a factor analysis model when both the observation and a factor matrix are observed so that the loading matrix (W) can be estimated. However, when only the observations are available, we use a latent "phantom" random vector in place of the factors to account for the unknown cluster structure.

Within the wide-ranging assumption of small number of clusters relative to the sample size, a penalized form of the PPCA is implemented to directly maximize the number of clusters (p). We show theoretically that the penalized MLE p_0 is consistent for reasonable choices of the penalty parameter. This approach can be seen as a form of shrinkage estimation where the last N-p_0 singular values for the estimator of W are shrunk to zero. To summarize, our algorithm is three-step: 1) finding the penalized MLE p_0; 2) conditional on the number of phantom clusters p_0, the EM algorithm for PPCA produces an unbiased MLE W_0; 3) identifying cluster assignment from W_0 using an EM algorithm for multivariate normal mixture models.

We demonstrated with data from Google Domestic Trend searches (https://www.google.com/finance/domestic_trends) that clustering using penalized PPCA on over thousands of observations produce sensible results. Search terms that are assigned to the same cluster are conceptually consistent, and a visual inspection of the raw data overlaid confirms the shared similarity of trends over a 10-year period.

David Farahany

Title: Multifactor Foreign Exchange Modeling: Pricing and Calibration

Abstract: In this talk we discuss a new approach to foreign exchange (FX) modeling which accounts for stochastic interest rates and stochastic volatility. We introduce stochastic volatility into our FX rate by means of time changed Levy processes. Our time-changed model is able to incorporate stochastic interest rates while maintaining tractability. We then show how the model can price European options efficiently and also match observed implied volatility skews.

Evgeny Levi

Title: Gaussian Process Single Index for Conditional Copulas

Abstract: Parametric conditional copula models allow the copula parameters to vary with a set of covariates according to an unknown calibration function. In this project we develop a flexible Bayesian method to estimate the calibration function of a bivariate conditional copula. We construct a prior distribution over the set of smooth calibration functions using a sparse Gaussian process (GP) prior for the single index model (SIM). The estimation of parameters from the marginal distributions and the calibration function is done jointly via a Markov Chain Monte Carlo algorithm that is used to sample from the full posterior distribution. The choice of copula family is based on Deviance Information Criterion (DIC), Watanabe-Akaike Information Criterion (WAIC) and Cross-Validated Pseudo-Marginal Likelihood (CVML). The empirical study of the proposed method is performed via a series of simulations with Clayton, Frank and Gaussian copulas and using a real data example.

Xuancheng Huang

Mean-Field Game Strategies for a Major-Minor Agent Optimal Execution Problem

Abstract: We introduce, for the first time, a mean-field game framework for a multiple agent optimal execution problem with continuous trading. This modeling generalizes the classical single agent optimal liquidation problem to a setting with (i) a major agent who is liquidating a large portion of shares, and (ii) a number of minor agents (high-frequency traders (HFTs)) who detect and trade along with the liquidator. As in the classical framework, all agents are exposed to temporary price impact and attempt to balance their impact against price uncertainty. Unlike most other works, we account for the permanent price impact that order- flow from all agents have on the midprice and this induces a distinct cross interaction between major and minor agents. This formulation falls into the realm of stochastic dynamic game problems with mean-field couplings in the dynamics, and we analyze the problem using a mean-field game approach. We obtain a set of decentralized feedback trading strategies for the major and minor agents, and express the solution explicitly in terms of a deterministic fixed point problem. For a finite N population of HFTs, the set of major-minor agent mean- field game strategies is shown to have an ε_N-Nash equilibrium property where $\varepsilon_N \to 0$ as $N \to \infty$.

Luhui Gan

Liquidating Baskets of Co-moving Assets

Abstract: We show how to execute a basket consisting of a subset of co-moving assets and demonstrate how the information carried in other traded assets, which are not in the basket, improves execution performance. Market orders (MOs) from all participants, including the agent's orders to execute her basket, have permanent price impact on the assets, i.e. executions in a single asset affect prices of all assets. Furthermore, we assume the agent's MOs are executed at worse than midprices (by walking the LOB) through a temporary price impact. The execution problem is posed as an optimal stochastic control one and we reduce the dynamic programming equation to a system of coupled partial differential equations, which reduces to a coupled system of Riccati equations when other agents' order flow are deterministic. We use data of five stocks traded in the Nasdaq exchange to estimate the model parameters and use simulations to illustrate the performance of the strategy. As an example, the agent liquidates a portfolio consisting of shares in INTC and SMH. We show that including the information provided by three additional assets (FARO, NTAP, ORCL) considerably improves the strategy's performance -- for the portfolio we execute, it outperforms the multi-asset version of Almgren-Chriss by approximately 2 to 4 basis points per share.