Workshop on computational finance

July 4, 2008
Shanghai Supercomputer Center

Organizers:
Thomas F. Coleman, Dean of Mathematics
University of Waterloo
tfcoleman@uwaterloo.ca

Jun Yuan, Deputy Director
Shanghai Supercomputer Centre
jyuan@ssc.net.cn

Hugh Couchman Scientific Director
Shared Hierarchical Academic Research Computing Network
couchman@mcmaster.ca

Co-sponsor: SHARCNET, SSC, MICROSOFT, Platform Computing

Overview
Computational finance is a cross-disciplinary field which relies on mathematical finance, numerical methods and computer simulation to make trading, hedging and investment decisions, as well as facilitating the risk management of these decisions. Practitioners aim to precisely determine the financial risk created by certain financial instruments.

The objective of this workshop is to discuss recent progress and challenges in the area of computational finance. The emphasis will be on practical problem solving involving novel algorithmic approaches to large-scale and time-sensitive problems as well as the modern use of technology: grid and cluster computing, high-end computers, and new computational finance environments. Financial areas of impact include: risk computations, portfolio optimization, credit risk analytics, asset-backed securities, hedging techniques, and high-frequency data problems.

Intended participants
The workshop is targeted to finance industry practitioners in China.

Confirmed speakers

Peter Forsyth – University of Waterloo
Yuying Li – University of Waterloo
David Li – Barclay's Capital
Qing Hou–Goldman Sachs
Mark Broadie – Columbia University
Dan Rosen – Dan Rosen & Associates
Liuren Wu – Baruch College, Bloomberg

Abstracts of the presentations

Mark Broadie - Simulation and Calibration of Stochastic Volatility and Jump Diffusion Option Pricing Models

- ✧ Strong empirical evidence against the Black-Scholes model
- ✧ Models beyond Black-Scholes
- ✧ Bias and variance in simulating stochastic volatility models
- ✧ Discretization methods
- ✧ Exact simulation using transform methods
- ✧ Calibration approaches and results

Peter Forsyth – Dynamic Hedging Under Jump Diffusion with Transaction Costs

Real assets do not follow Geometric Brownian Motion. It's important to consider jump diffusions from a risk management point of view. In order to hedge jumps, we need to construct a hedging portfolio containing the underlying asset and liquidly traded options. We devise a dynamic strategy, which minimizes jump risk and transaction costs. Simulation studies show that this strategy is effective at reducing jump risk, while not being too expensive. Theoretical analysis confirms the effectiveness of this strategy. Study also shows an optimal strategy for a hedge fund manager: maximize short term bonuses and let your investors suffer losses due to jumps.
In this talk, we consider the problem of hedging a contingent claim, where the underlying follows a jump diffusion process. The no-arbitrage value of the claim is given by the solution of a Partial Integro Differential Equation (PIDE), which in general must be solved numerically. By constructing a portfolio consisting of the underlying asset and a number of liquidly traded options, we devise a dynamic hedging strategy. At each hedge rebalance time, we minimize both the jump risk and the cost of buying/selling due to bid-ask spreads. Simulations of this strategy show that the standard deviation of the profit and loss of the hedging portfolio is greatly reduced compared to the standard hedging strategy. If time permits, some theoretical results concerning this strategy will also be presented. This is joint work with Shannon Kennedy and Ken Vetzal.

Qing Hou – Equity Derivatives Products: Structures and Pricing

Last few years have seen tremendous innovation in derivative products which has become popular for institutional as well as retail investors. We discuss, from a practitioner's viewpoint, the financial engineering process. We will highlight a few key products, hedging considerations, as well as challenges to modelling and pricing.

David Li abstract to follow

Yuying Li – Robust Portfolio Solutions to Mean-Variance Portfolio Selection

The Nobel prize winning work of the Markowitz portfolio selection method has difficulty performing in practice due to estimation errors in means and covariance matrix of asset returns. Recent min-max robust optimization methods promise new solutions to the old mean-variance portfolio solution problem. How well do the min-max robust optimal portfolios perform in practice? How should different robust optimization solutions be evaluated?

- ✧ In this talk, we will discuss

- ✧ impact of estimation error for optimal mean variance portfolio selection
- ✧ min-max robust optimization methods
- ✧ performance of min-max robust optimal portfolios in
  - sensitivity to data
  - efficiency in risk and return tradeoff
  - asset diversification
- ✧ a new CVaR robust mean variance optimal portfolio selection approach
- ✧ computationally efficient methods for CVaR optimizations

Dan Rosen -"Valuation and Risk Management of Credit Portfolios and Structured Credit Products"

- ✧ Introduction: credit risk, credit portfolios, credit derivatives
- ✧ General framework for credit portfolio models
- ✧ Factor models for credit risk
- ✧ Valuation models: synthetic CDOs, bespoke CDOs and cash structures
- ✧ Weighted Monte Carlo methods
- ✧ - Examples: ABX and cash CDOs
- ✧ - Measuring the risk of structured credit portfolios

Liuren Wu – Computational Challenges in Estimating Option Pricing Models

- ✧ The current state of the art in option pricing theory: A review
  - Capture return innovation distribution using Levy processes
  - Capture the stochastic variation of the innovation distribution using stochastic time changes
- ✧ Design economically sensible option pricing models
  - Identify the sources of economic shocks
  - Measure the time variation of the financial responses
- ✧ Estimate option pricing models for different purposes
  - Static versus dynamic consistency
  - Fast recalibration of simpler models for options market making
  - Dynamically consistent estimation of option pricing models for long-term statistical arbitrage
- ✧ Computational challenges in estimating option pricing models
  - Fast Fourier transform (FFT) and fractional FFT: Trade-offs between speed, accuracy, and robustness.
  - Unscented Kalman filtering and particle filtering: The sequential procedure for extracting risk states
  - Monte Carlo simulation: Determine exotic derivative values and hedging ratios.
  - Embedding Monte Carlo simulation into model estimation: Models for the next generation

Brief biography of speakers

Mark Broadie is the Carson Family Professor of Business at Columbia University. His research focuses on problems in the pricing of derivative securities, risk management, and portfolio optimization. His paper with Boyle and Glasserman "Recent advances in simulation for security pricing" was honored as a landmark paper in the four decades of the Winter Simulation Conference. He is editor-in-chief of the *Journal of Computational Finance* and serves as associate editor for *Operations Research*, *Finance and Stochastics* and *Computational Management Science*.

Peter Forsyth is a Professor in the David R. Cheriton School of Computer Science at the University of Waterloo, and is also currently the Scientific Director of the Institute for Quantitative Finance and Insurance. Previously, he was the Director of the Institute for Computer Research, and also served as the Associate Director of the School of Computer Science Prior to joining Waterloo in 1987, he was a Senior

Simulation Scientist with the Computer Modelling Group (1979-1985) and was also President of Dynamic Reservoir Systems (1985-87). Peter's research interests include pricing and hedging of exotic options, and numerical solution of optimal stochastic control problems.

Qing Hou is a senior equity derivatives structurer for Goldman Sachs, based in Hong Kong. His work focuses on creating innovative investment solutions for institutional, corporate, retail and high-net-worth clients using equity as well as other asset classes. Prior to joining Goldman Sachs, Qing worked in JP Morgan's derivative research department covering equity, rate-fixed and credit risk, based in New York, London and Hong Kong. Qing obtained his Ph.D. degree in physics from University of Illinois at Urbana-Champain and B.S. degree from University of Science and Technology of China.

David Li is Head of Quantitative Analytics in the Credit Derivatives Group at Barclays Capital in New York. He leads Barclays Capital quantitative development efforts to support the global credit derivative trading business. He has achieved broad recognition in the industry for his groundbreaking work on pricing portfolio credit derivatives, such as CDOs, using copula functions. David has previously worked at Citigroup, AXA Financial, The RiskMetrics Group and CIBC. David has a PhD degree in statistics from the University of Waterloo, and Master's degrees in economics, finance and actuarial science. He is an associate of the Society of Actuaries and an Associate Editor of the North American Actuarial Journal.

Yuying Li is a Professor in the David R. Cheriton School of Computer Science at the University of Waterloo. She received her PhD in Computer Science from the University of Waterloo, Canada, in 1988. She is the recipient of the 1993 first prize of Leslie Fox Prize in numerical analysis held at Oxford, England. Her main research interests include computational finance and computational optimization. She has published more than twenty papers in the refereed journals in finance as well as optimization. In addition, she has taught many courses at Cornell University, including computational finance and scientific computing.

Dan Rosen
Dr. Dan Rosen is the President of R2 Financial Technologies and acts as an advisor to institutions in Europe, North America, and Latin America on derivatives valuation, risk management, economic and regulatory capital. He is a research fellow at the Fields Institute for Research in Mathematical Sciences and an adjunct professor at the University of Toronto's Mathematical Finance program. Up to July 2005, Dr. Rosen had a successful ten-year career at Algorithmics Inc., where he held senior management roles in strategy and business development, research and financial engineering, and products. Dr. Rosen lectures extensively around the world on financial engineering, enterprise risk and capital management, credit risk and market risk, and has authored numerous papers. He is a member of advisory Boards for the Fields Institute, Fitch, IAFE, and is the regional director in Toronto of PRMIA. He holds a Ph.D.from the University of Toronto.

Liuren Wu is an associate professor of economics and finance at Zicklin School of Business, Baruch College, City University of New York. Before he joined Zicklin in 2003, he was an assistant professor at Fordham University. Liuren's major research interests include option pricing, credit risk and term structure modeling, market microstructure, and general asset pricing. During the past six years, Liuren has published over 20 articles, many of them in top finance journals such as the Journal of Finance, the Journal of Financial Economics, and the Journal of Financial and Quantitative Analysis. Liuren has worked extensively as a consultant in the finance industry, including Bloomberg, Morgan Stanley, and several fixed income and equity hedge funds and options market makers. As a consultant, he has developed statistical arbitrage strategies, risk management procedures, and quantitative models for pricing fixed income and derivative securities.