Second Stanford Conference in Quantitative Finance: Algorithmic Trading

November 12 & 13, 2010
Jordan Hall Auditorium,
Stanford University

An event organized by
The Financial Mathematics Program
and Financial Modeling Forum
Algorithmic trading is an exciting new area in quantitative finance. The interdisciplinary nature of the subject, involving computer science, statistics, engineering and information systems, economics and finance, mathematical modeling and optimization, fits well with Stanford University's Financial Mathematics Program, whose core faculty come from these disciplines and whose students also have broad interests and diverse backgrounds.

Because this is a new area that does not have an established body of knowledge to be presented in courses (although the Financial Mathematics Program has just introduced one such course), we are organizing a conference, for our alumni and also for other interested professionals, to present some current research and innovations in high-frequency econometrics and finance, institutional constraints and market microstructure, quantitative strategies and other topics in algorithmic trading. Our invited speakers are from different disciplines, and from both academia and industry. The program also features a tutorial that gives an overview of this exciting new area.

Conf. Organizing Committee
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Agenda

Friday, November 12

Session Chair: Kay Giesecke

1:30pm - 1:35pm Welcome and Opening Remarks

1:35pm - 2:25pm High-Frequency Trading: Old Wine in New Bottles?
Jeremy Evnine, Evnine & Associates

2:25pm - 3:15pm High-Frequency Trading: Some Research Problems
George Papanicolaou, Nick West, Thomas Callaghan,
Anca Vacarescu, Lijia Wang and Tzu-Wei Yang,
Stanford University

3:15pm - 3:30pm Coffee Break

3:30pm - 5:00pm Algorithmic Trading and Quantitative Strategies: A Tutorial
Raja Velu, Syracuse University and Stanford University
Second Stanford Conference in Quantitative Finance: Algorithmic Trading

Agenda

Saturday, November 13

Session Chairs: Tze Leung Lai and Peter Glynn

9:00am - 9:50am
Approaching the Chinese A-share Market from Quantitative Investing and Absolute Return Perspectives
Zhifeng Zhang, Bosera Funds

9:50am - 10:40am
Forecasting Prices Using Level-1 Quotes in the Presence of Hidden Liquidity
Marco Avellaneda, New York University

10:40am - 11:00am
Coffee Break

11:00am - 11:50am
Blind Portfolio Auctions
Benjamin Van Roy, Stanford University

11:50am - 12:40pm
High-Frequency Trading: A Practitioner's Perspective
Brad Banks, Athena Capital Research

12:40pm - 2:00pm
Complimentary Boxed Lunch
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Agenda

Saturday, November 13

Session Chairs: Bala Rajaratnam and Peter Hansen

2:00pm - 2:50pm  The Use of High-Frequency Data in Financial Econometrics: Some Recent Developments
                 Peter Hansen, Stanford University

2:50pm - 3:40pm  High-Frequency Market and Limit Order Dynamics: Modeling and Adaptive Execution Strategies
                 Tze Leung Lai, Dirk Ormoneit, Howard Shek and Viktor Spivakovsky, Stanford University

3:40pm - 4:00pm  Coffee Break

4:00pm - 4:50pm  The Cost of Latency
                 Ciamac Moallemi, Columbia University

4:50pm - 5:40pm  Factor Models and Expected Utility Maximization for Active Portfolio Management
                 Gerd Infanger, Stanford University

5:40pm - 5:45pm  Closing Remarks
Abstracts

High-Frequency Trading: Old Wine in New Bottles?

While much concern has been expressed about the effect of HF traders in markets, the scaling of time is not likely to be a relevant factor in market behavior. It may be spuriously correlated with algorithmic trading and violating the rules of the market place. A look at some of the side effects of HF trading.

High-Frequency Trading: Some Research Problems

Four research problems that are in their final stages of completion by our group are presented. The first comes from an algorithmic trading problem and involves a study of the top eigenvalue of large time-dependent random matrices. The second is on the effect of high-frequency trading on price volatility. The third is on filtering and parameter estimation. The last one is a comparative study of market-neutral algorithmic trading over different time periods in the last two decades.

Algorithmic Trading and Quantitative Strategies: A Tutorial

This tutorial will provide an introduction to common financial trading strategies based on methods of statistical arbitrage. Topics include momentum strategies, pairs trading and methods of technical analysis. On the high-frequency side, models of order book dynamics and order placement and dynamic trade planning with feedback will be discussed. Emphasis is on developing and automating the models that reflect the market and behavioral patterns. The tutorial will be balanced between theory and practice with sufficient theory to understand practical applications. Although the methodologies could be applied to various financial markets, our material will focus on stock and equity markets. This tutorial will benefit practitioners from both buy-side and sell-side as well as academics who want to engage in cutting-edge research. Lecture notes, along with the description of illustrative examples/programs, will be made available to participants.

Approaching the Chinese A-share Market from Quantitative Investing and Absolute Return Perspectives

This is a brief summary of our experience in the Chinese A-share market. The presentation contains four parts: investors, the characteristics of the secondary market, our main competitors, and our investment framework. It is intended to provide some realistic information on our (perhaps not representative for others) current status of quantitative investment and our absolute return business. Some comparison between the Chinese market and the US market, including comparison of investment frameworks, will be made along the way. The usage and the limitation of high-frequency trading strategy will also be briefly discussed.
Abstracts

Forecasting Prices Using Level-1 Quotes in the Presence of Hidden Liquidity

Bid and ask sizes at the top of the order book provide information on short-term price moves. Drawing from classical descriptions of the order book in terms of queues and order-arrival rates (Smith et al, 2003), we consider a diffusion model for the evolution of the best bid/ask queues. We compute the probability that the next price move is upward, conditional on the best bid/ask sizes and an additional parameter, the hidden liquidity of the market. We provide closed-form solutions for the probability in some important special cases. The model can be useful, among other things, to rank trading venues in terms of the information content of their quotes and to estimate the hidden liquidity in a market based on high-frequency data. We illustrate the approach with an empirical study of a few liquid stocks using quotes from various exchanges.

Blind Portfolio Auctions

A significant portion of the traded volume of equities involves sales by institutional investors to brokers through blind portfolio auctions. Such transactions typically take the form of a first-price sealed-bid auction in which the seller engages a few potential brokers and provides limited information about the portfolio being sold. Uncertainty about the portfolio contents reduces bids, effectively increasing the transaction cost paid by the seller. We consider the use of a trusted intermediary or equivalent cryptographic protocol to reduce transaction costs. In particular, we propose a mechanism through which each party provides relevant private information to an intermediary who ultimately reveals only the portfolio contents and price paid, and only to the seller and winning bidder. Through analysis of a game-theoretic model, we demonstrate substantial potential benefits to sellers. For example, under reasonable assumptions a seller can reduce expected transaction costs by more than 10%.

High-Frequency Trading: A Practitioner's Perspective

A perspective on issues related to high-frequency trading as seen by the head of a high-frequency proprietary trading firm. Topics to be discussed include an overview of high-frequency trading strategies, costs and benefits of HFT, the importance (or lack thereof) of speed, regulatory changes, risk management in a HFT firm, and the expansion of HFT to additional asset classes and geographies.
The Use of High-Frequency Data in Financial Econometrics: Some Recent Developments

Harnessing high-frequency financial data has led to substantial improvements in our understanding of financial volatility. Under ideal circumstances, volatility is measured almost perfectly from high-frequency prices. However, a range of empirical issues arise in practice, because market microstructure effects cause the observed price process to be at odds with standard no-arbitrage conditions. We discuss some of these empirical issues and examine how successful volatility estimators have dealt with them. We also discuss applications where high-frequency based estimators have proven to be highly beneficial. The latter includes option pricing and modeling the dynamic properties of volatility with a new class of GARCH models, called Realized GARCH models.

High-Frequency Market and Limit Order Dynamics: Modeling and Adaptive Execution Strategies

After a brief overview of typical intraday limit order book characteristics at stock exchanges, we introduce a modeling approach that uses marked point processes. We then review the literature on execution strategies and describe some recent research on execution strategies involving both market orders and limit orders. In particular, we introduce a new approach that uses counting process modeling, stochastic adaptive control, and analysis of expected cost of limit order versus that of market data. Some high-frequency data are used to illustrate and motivate the methodology.

The Cost of Latency

Electronic markets have experienced dramatic improvements in latency, or the delay between a trading decision and the resulting trade execution. A model that allows for the quantitative valuation of latency is presented, together with a closed-form expression for the cost of frictions created by latency, in terms of well-known parameters of the underlying traded asset. It is also shown empirically that the cost of latency has grown in recent years.

Factor Models and Expected Utility Maximization for Active Portfolio Management

It is common practice in large-scale portfolio optimization to employ factor models (fundamental, economic, and/or statistical) of asset returns to construct a covariance matrix of asset returns and then use mean-variance optimization for trading-off expected return versus risk for obtaining a suitable portfolio. Maximizing expected utility of wealth is a more general concept that is more useful in many situations. A method for solving expected utility-based large-scale portfolio optimization problems and an equilibrium model of asset returns based on a factor representation of asset returns and expected utility maximization will be presented.
Marco Avellaneda is Professor of Mathematics and Director of the Division of Financial Mathematics at the Courant Institute of Mathematical Sciences, New York University. He is also founding partner of Finance Concepts SARL, and was head of volatility arbitrage of Capital Fund Management SA in 2004-05. His research interests include mathematical finance, econometrics of financial markets, risk management, mathematical physics, turbulence, and partial differential equations. He received his PhD in mathematics from University of Minnesota in 1985, and is Risk Magazine's Quant of the Year in 2010.

Brad Banks co-founded Athena Capital Research in June 2003. He is responsible for overall management and growth of the company, in addition to overseeing research, development, and risk management of investment strategies. He was previously a Managing Director at Tower Research Capital, a highly successful early pioneer in automated electronic trading. He has 10 years of industry experience covering operations, personnel, and portfolio management, as well as development of quantitative trading strategies. Brad received SB and MEng degrees in computer science from the Massachusetts Institute of Technology in 1999. His graduate thesis research focused on the extraction of patterns from large data sets through statistical and machine learning techniques.

Jeremy Evnine founded Evnine & Associates (EvA), a quantitative hedge fund, in 1992 and has served as CEO and Head of Research since the firm's inception. Prior to founding EvA, Jeremy was Head of Research for six years at Wells Fargo Investment Advisors (WFIA, now BlackRock) where he was a pioneer in the development of WFIA's derivative strategies and also successfully managed $13bn in portfolio insurance strategies through Black Monday. Jeremy began his career in finance in 1980 as an early employee at BARRA where he developed BARRA's options risk and valuation system. He earned his PhD in Operations Research and Finance at UC Berkeley in 1984, an MSc in Pure Mathematics at the Hebrew University of Jerusalem and a BSc in Mathematics at Manchester University. He has published articles on option pricing and tactical asset allocation and is recognized as an expert in quantitative investment both domestically and abroad.

Peter Hansen is Assistant Professor of Economics at Stanford University. He holds a MSc in Mathematics and Economics from University of Copenhagen and a PhD in Economics from University of California, San Diego. Before joining the Department of Economics at Stanford University in 2004, he was Assistant Professor of Economics at Brown University (2000-04). His is the inventor of the Test for Superior Predictability; the co-inventor of the Model Confidence Set and Realized Kernel Estimator; and he is the discoverer of the Winner's Curse of Econometric Models. He has co-authored the book Workbook on Cointegration, published by Oxford University Press in 1998 and he has published research articles on cointegration, forecasting, and financial volatility. He is associate editor for the Journal of Applied Econometrics, a research fellow of the Center for Research in Econometric Analysis of Time Series, and the Volatility Institute at NYU, Stern. His research has been supported by grants from the Danish Research Council and the Salomon Research Grant. His current research is concerned with the estimation of financial volatility using high-frequency data, the theory behind the winner's curse of econometric models, and the development of GARCH models that utilize realized measures of volatility.
Gerd Infanger is Consulting Professor of Management Science and Engineering (formerly Operations Research) at Stanford University and CEO of Infanger Investment Technology, LLC. Infanger received his Master's degrees in electrical engineering and economics at Graz University of Technology in 1983 and his PhD with high honors in energy economics and operations research in 1986 at Vienna University of Technology, where he stayed on the faculty and received tenure as an Associate Professor in 1993. At the beginning of 1989, he came to visit the Department of Operations Research at Stanford, collaborating with George B. Dantzig in the field of optimization under uncertainty. Since then, Infanger's research has concentrated on the development of theory, algorithms and software for solving large-scale optimization problems under uncertainty. In 1998, based on his proprietary quantitative methods of equity performance prediction, he founded Infanger Investment Technology, LLC, with the goal to provide state-of-the-art quantitative investment advisory services and software offerings to institutional investors. The firm currently advised over 250 million dollars in assets in various global tactical asset allocation funds and American and European equity funds. He published the book Planning Under Uncertainty --- Solving Large-Scale Stochastic Programs and edited Stochastic Programming --- The State of the Art, in Honor of George B. Dantzig, as well as several book chapters including a recent chapter about dynamic portfolio strategies in Handbook of Asset and Liability Management and many papers on operations research, mathematical programming, and quantitative finance. He is the principal author of DECIS, a software system for solving large-scale stochastic programs, IITPortfTM, a large-scale portfolio optimization system, and WealthiORTM a web-based software system for dynamic asset allocation. His current research focuses on optimization under uncertainty, including stochastic and dynamic programming, particularly as applied to portfolio optimization and asset allocation, as well as other quantitative aspects of asset management.

Tze Leung Lai is Professor of Statistics, and by courtesy, of Health Research and Policy in the School of Medicine at Stanford University. He is Director of the Financial Mathematics Program, Co-director of the Biostatistics Core of the Cancer Center, and is also a faculty member of the Institute of Computational and Mathematical Engineering. He received his PhD in mathematical statistics in 1971 from Columbia University, where he stayed on the faculty before moving to Stanford University in 1987. He won the COPSS (Committee of Presidents of Statistical Societies) Award in 1983 and the Abraham Wald Prize in Sequential Analysis in 2005. His research interests include financial modeling, quantitative trading strategies, risk management, sequential experimentation, time series, longitudinal and high-dimensional data analysis, econometrics, cancer biostatistics and clinical trials.

Ciamac C. Moallemi is an Assistant Professor in the Decision, Risk, and Operations Division of the Graduate School of Business at Columbia University, where he has been since 2007. He received SB degrees in Electrical Engineering & Computer Science and in Mathematics from the Massachusetts Institute of Technology (1996), and a Certificate of Advanced Study in Mathematics, with distinction (1997) from University of Cambridge. He received a PhD in Electrical Engineering from Stanford University (2007). Prior to his doctoral studies, he developed quantitative methods in a number of entrepreneurial ventures: as a partner in a $200 million fixed-income arbitrage hedge fund, as the director of scientific computing at an early-stage drug discovery start-up, and as the founder of a computer security software start-up. His interests are broadly at the intersection of probability and optimization theory, and in particular in the optimization and control of large-scale stochastic systems. Specific methodologies include approximate dynamic programming, message-passing algorithms, and machine learning; and application areas include financial engineering, service and communications networks, e-commerce, and data-mining. He is a member of the IEEE and INFORMS.
Speaker Biographies

**George Papanicolaou** is Robert Grimmett Professor of Mathematics at Stanford University. He is a member of the Steering Committee of the Financial Mathematics Program, of which he was the founding Director. He is also a faculty member of the Institute of Computational and Mathematical Engineering. He won the SIAM von Neumann Prize in 2006, the William Benter Prize in Applied Mathematics in 2010, and will be the Josiah Willard Gibbs Lecturer of the American Mathematical Society in 2011. He received his PhD in mathematics from the Courant Institute of Mathematical Sciences at New York University in 1969, and an Honorary DSc from University of Athens in 1987. His research interests include financial mathematics, asymptotic methods in stochastic analysis of complex models and data in financial markets, mathematical theory of multi-scale phenomena and waves and diffusions in inhomogeneous or random media, and scattering effects in imaging and communication systems.

**Benjamin Van Roy** is broadly interested in the formulation and analysis of mathematical models that address problems in information technology, business, and public policy. He is an Associate Professor of Management Science and Engineering, Electrical Engineering, and, by courtesy, Computer Science, at Stanford University. He has held visiting positions as the Wolfgang and Helga Gaul Visiting Professor at the University of Karlsruhe and as the Chin Sophonpanich Foundation Professor of Banking and Finance at Chulalongkorn University. He has been involved with several technology companies as a researcher, advisor, founder, or director. He received the SB (1993) in Computer Science and Engineering and the SM (1995) and PhD (1998) in Electrical Engineering and Computer Science, all from MIT. He is a member of INFORMS and IEEE. He has served on the editorial boards of *Discrete Event Dynamic Systems*, *Machine Learning*, *Mathematics of Operations Research*, and *Operations Research*.

**Raja Velu** is Irwin and Marjorie Guttag Professor of Managerial Statistics at Whitman School of Management, Syracuse University. He has held a visiting position in the Statistics department at Stanford since Fall 2005. He received his PhD in business statistics from University of Wisconsin-Madison. His research interests in statistics include multivariate methods, longitudinal and time series modeling, and exploratory data analysis. He is currently interested in applied areas such as scanner data modeling in marketing research, analysis of high frequency data in finance, and outcome research in health sciences. Professor Velu was a visiting researcher at Microsoft Search Labs and has worked as part of the Intelligent Information Systems Group at IBM-Almaden Lab, where he conducted cutting-edge research on data mining, and as part of the forecasting team at Yahoo!, he served as the technical architect for Forecasting in the Sponsored Search marketplace. Raja has published in *Biometrika* and *Journal of Econometrics*, among many others, and has a research monograph published by Springer. He is also involved in training and consulting for such leading companies as Saks Fifth Avenue and Time, Inc.

**Zhifeng Zhang** is Chief Investment Officer of Alternative Investments of Bosera Funds, Shenzhen, China. Before going to Shenzhen, he was head of quantitative research (credit) at Barclay’s Global Investments, and prior to that, was executive director and global head of the Credit Analytic Research Group at Morgan Stanley. He received his PhD in mathematics from the Courant Institute of Mathematical Sciences, New York University. During his postdoctoral years at Stanford from 1993-96, he published seminal papers on the matching pursuit algorithm, applications of wavelet analysis to foreign exchange rates and stock indices, and locally stationary processes.
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