Western Conference in Mathematical Finance

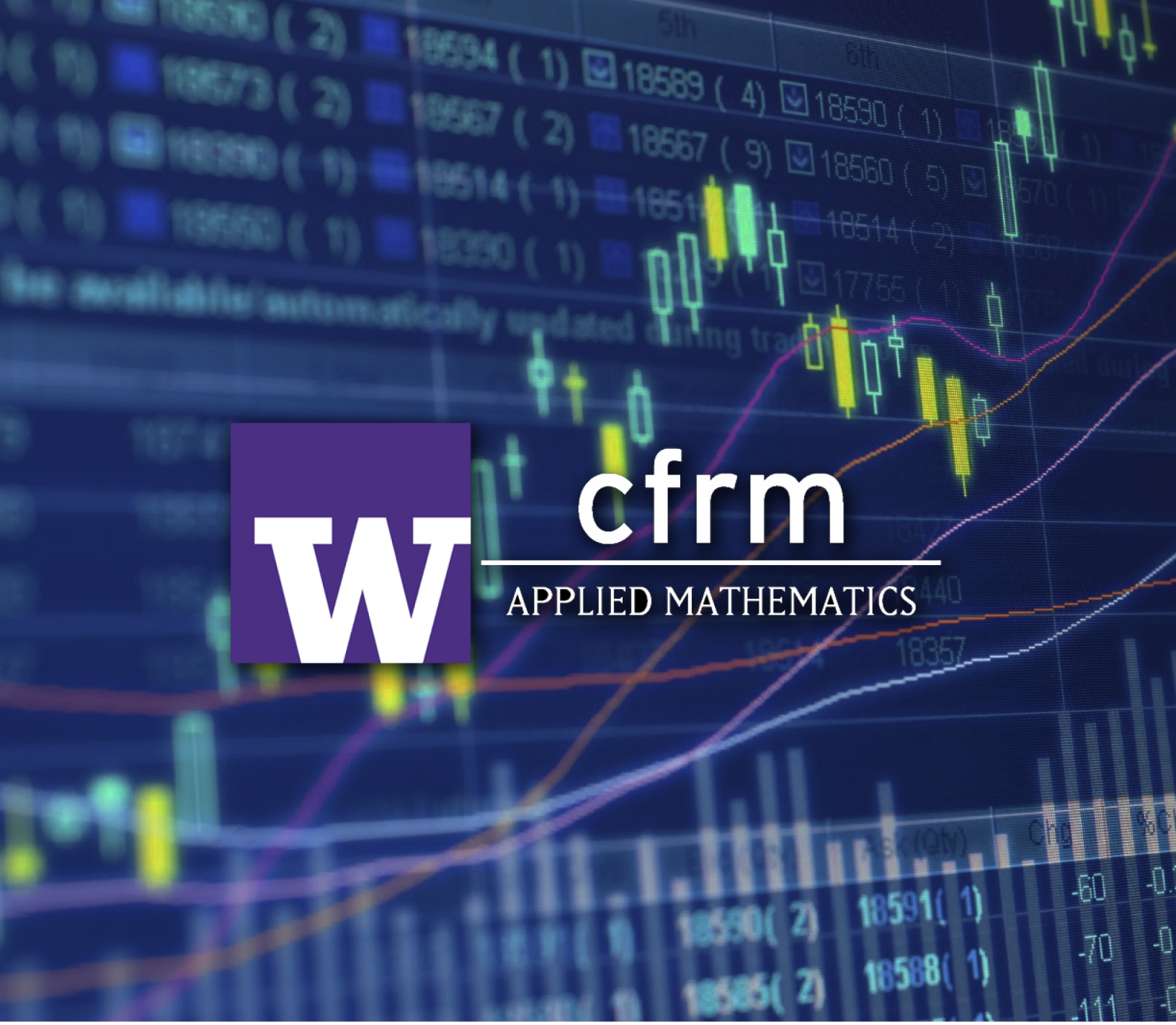
2017 Agenda and Speaker Abstracts

Generously supported by the National Science Foundation

Organized by the UW Department of Applied Mathematics

APPLIED MATHEMATICS
UNIVERSITY of WASHINGTON

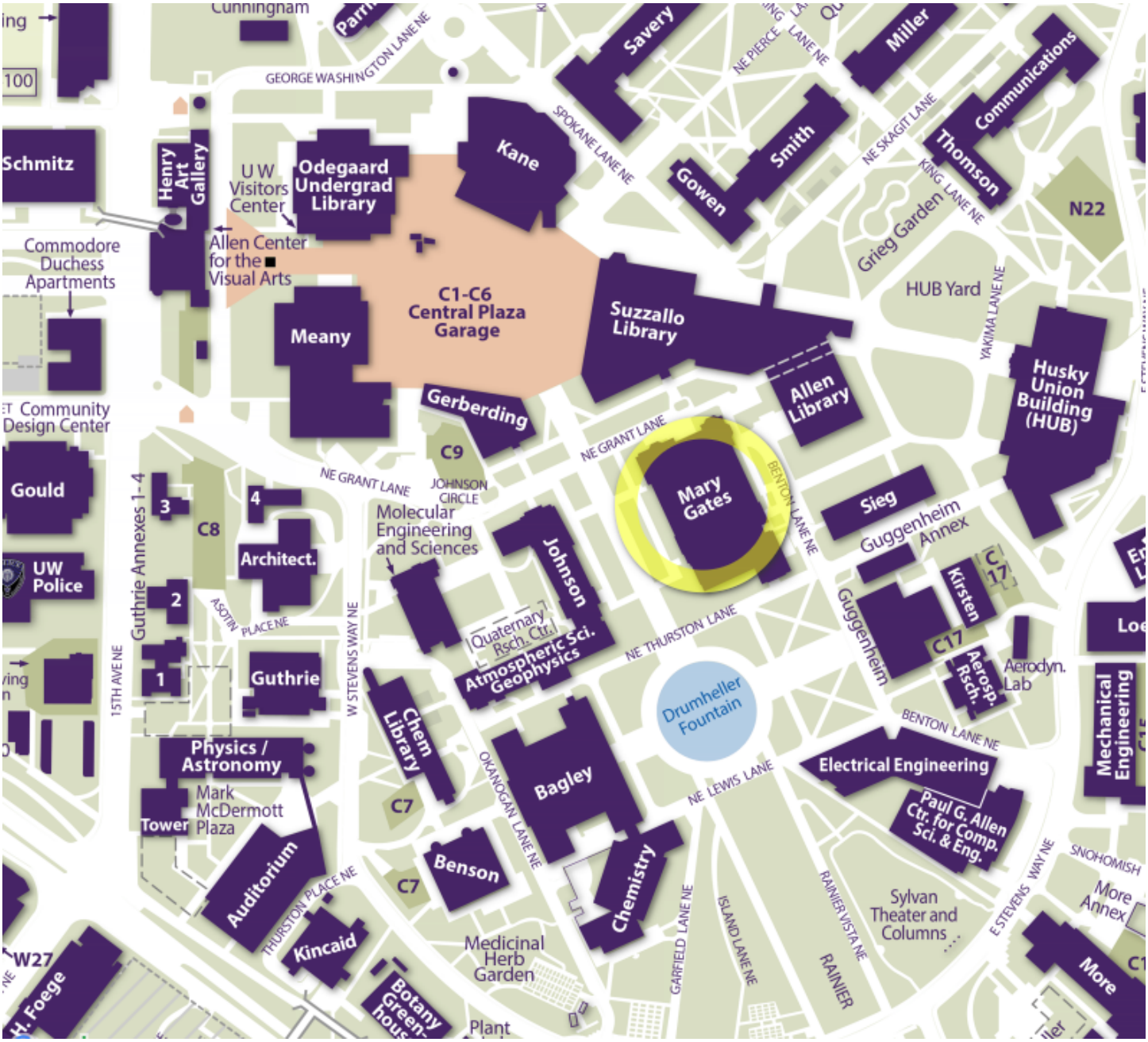
And further supported by Applied Math's CFRM program



computational finance & RISK MANAGEMENT

WCMF Location

MARY GATES HALL (MGH) 231



Friday, March 24, 2017 **Website**: http://depts.washington.edu/amath/wcmf/

- 8:30 - 9:00 Registration and Breakfast. Welcoming Remarks at 8:50.

- 9:00 - 9:45
  Speaker: Daniel Lacker
  Title: Mean field game limits, fluctuations, and large deviations

- 9:45 - 10:30
  Speaker: Thaleia Zariphopoulou
  Title: Mean-field and n-agent games for optimal investment under relative performance criteria

- 10:30 - 11:00 Coffee Break

- 11:00 - 11:45
  Speaker: Marcus Pelger
  Title: Estimating Latent Asset Pricing Factors from Large-Dimensional Data

- 11:45 - 12:30
  Speaker: Rohini Kumar
  Title: Portfolio optimization in a short time horizon

- 12:30 - 2:00 Lunch (on your own)

- 2:00 - 2:45
  Speaker: Xin Guo
  Title: Mean-Field games of singular controls, with application

- 2:45 - 3:30
  Speaker: Andrey Sarantsev
  Title: A Model of Systemic Risk

- 3:30 - 4:00 Coffee Break

- 4:00 - 4:30
  Speaker: Ruimeng Hu
  Title: Optimal Portfolio under Fractional Stochastic Environment

- 4:30 - 5:00
  Speaker: Ruoxuan Xiong
  Title: State-Varying Factor Models of Large Dimension

- 5:00 - 5:30
  Speaker: Cong Wu
  Title: Controlled McKean-Vlasov Equations and Related Master Equations

Saturday, March 25, 2017 **UW NetID**: event0891, **Password**: ZzUo=DpEe=FgYu

- 8:30 - 9:00 Breakfast

- 9:00 - 9:45
  Speaker: Jean-Pierre Fouque
  Title: Systemic risk and stochastic games with delay

- 9:45 - 10:30
  Speaker: Zachary Feinstein
  Title: Financial contagion with multiple illiquid assets

- 10:30 - 11:00 Coffee Break

- 11:00 - 11:45
  Speaker: Jaksa Cvitanic
  Title: Asset pricing under optimal contracts

- 11:45 - 12:30
  Speaker: Leonard Wong
  Title: Cover's universal portfolio and stochastic portfolio theory

- 12:30 - 2:00 Lunch (on your own)

- 2:00 - 2:45
  Speaker: Jianfeng Zhang
  Title: A Martingale Approach for Fractional Brownian Motions

- 2:45 - 3:30
  Speaker: Mykhaylo Shkolnikov
  Title: A predictor of systemic risk and particle systems interacting through hitting times

- 3:30 - 4:00 Coffee Break

- 4:00 - 4:30
  Speaker: Haoran Wang
  Title: Optimal liquidation with market parameter shift: a forward approach

- 4:30 - 5:00
  Speaker: Weston Barger
  Title: Approximate pricing of Barrier claims in a local-stochastic volatility setting

- 5:00 - 5:30
  Speaker: Joon Seok Lee
  Title: Mean field games with bounded velocity

- 5:30 - 6:00 Panel Discussion: Future Trends and Open Problems

Abstracts (listed in order of the order of speaking)

Speaker: Daniel Lacker
Title: Mean field game limits, fluctuations, and large deviations
Abstract: A mean field game (MFG) is a stochastic differential game with a continuum of players, describing the limit as n tends to infinity of Nash equilibria of certain n-player games, in which agents interact symmetrically through the empirical measure of their state processes. One way to understand a mean field game is through its "master equation," an infinite-dimensional PDE for the value function. A solution of this equation can be used, for instance, to construct a solution of the original mean field game or to prove convergence of n-player equilibria to the MFG. This talk shows how to use a sufficiently smooth solution to answer several open questions about the limit theory for MFGs. In particular, we derive for the first time a central limit theorem and a large deviations principle for the n-player empirical measure (in equilibrium). The key idea is to use the master equation to quantitatively relate the n-player equilibrium to a McKean-Vlasov system of interacting diffusions.

Speaker: Thaleia Zariphopoulou
Title: Mean-field and n-agent games for optimal investment under relative performance criteria
Abstract: I will discuss optimal portfolio management of a population of investors who trade, in a common horizon $[0, T]$ and log-normal markets, aiming at maximizing their expected utility but are also concerned about their relative performance. I will present the n-agent and mean field game for both CARA and CRRA risk preferences, construct the equilibria explicitly and provide conditions for their existence and uniqueness. (joint work with D. Lacker)

Speaker: Marcus Pelger
Title: Estimating Latent Asset Pricing Factors from Large-Dimensional Data
Abstract: We develop an estimator for latent factors in a large-dimensional panel of financial data that can explain expected excess returns. Statistical factor analysis based on Principal Component Analysis (PCA) has problems identifying factors with a small variance that are important for asset pricing. Our estimator searches for factors with a high Sharpe-ratio that can explain both the expected return and covariance structure. We derive the statistical properties of the new estimator based on new results from random matrix theory and show that our estimator can find asset-pricing factors, which cannot be detected with PCA, even if a large amount of data is available. Applying the approach to portfolio and stock data we find factors with Sharpe-ratios more than twice as large as those based on conventional PCA. Our factors accommodate a large set of anomalies better than notable four- and five-factor alternative models.

Speaker: Rohini Kumar
Title: Portfolio optimization in a short time horizon
Abstract: We find a closed-form formula for a portfolio under which the expected utility is close to optimal when the time horizon is small. The optimal expected terminal utility is obtained by constructing sub- and supersolutions of the "marginal Hamilton-Jacobi-Bellman" equation associated with the portfolio optimization problem and applying a comparison principle. The results hold for general strictly increasing, concave utility functions that behave asymptotically like power functions.

Speaker: Xin Guo
Title: Mean-Field games of singular controls, with application

Abstract: Theory of MFG has been developing rapidly, led by the pioneering works of Lasry and Lions (2007) and Huang, Malhame and Caines (2006). MFG is an elegant and analytically feasible framework to approximate the Nash equilibrium (equilibria) of the otherwise-notoriously-hard N player stochastic games. Most research on MFG, however, has been focused on regular controls where controls are absolutely continuous and optimal controlled processes are Lipschitz continuous. In practice, controls are not necessarily absolutely continuous and/or the control rate might be constrained. In this talk, we will present some recent progress of MFGs with singular controls, and discuss some models in systemic risk and (ir)reversible investment.

Speaker: Andrey Sarantsev
Title: A Model of Systemic Risk
Abstract: We introduce a new stochastic game model of systemic risk, in line with Carmona, Fouque, Sun "Mean Field Games and Systemic Risk". This new model has risk-averse banks borrowing from the government and each other, investing in risky assets, and paying taxes. The government influences their behavior by changing the discount rate, the tax rate, and the rate of interbank lending.

Speaker: Ruimeng Hu
Title: Optimal Portfolio under Fractional Stochastic Environment
Abstract: Rough stochastic volatility models have attracted a lot of attentions recently, in particular for the linear pricing problem. In this talk, we propose a novel martingale distortion method for the nonlinear asset allocation problem with power utility in a fractional stochastic environment (for all Hurst index $H \in (0, 1)$). In the classical Markovian case, the distortion transformation can linearize the nonlinear Hamilton-Jacobi-Bellman equation satisfied by the value function. Our method generalizes the distortion transformation to non-Markovian cases, and gives the value to the Merton problem in a probabilistic way. Starting from the value process, we rigorously establish a first order approximation of the value, where the return and volatility of the underlying asset are functions of a stationary slowly varying fractional Ornstein-Uhlenbeck process. We prove that this approximation can be also generated by a fixed zeroth order trading strategy, therefore this fixed strategy is asymptotically optimal in all admissible controls. Furthermore, we extend the discussion to general utility functions, and obtain the asymptotic optimality of this fixed strategy in a specific family of admissible strategies.

Speaker: Ruoxuan Xiong
Title: State-Varying Factor Models of Large Dimension
Abstract: This paper develops an inferential theory for state-varying factor models of large dimension. Unlike constant factor models, the loadings are general functions of some state-variables. We develop an estimator for the latent factors and state-varying loadings under a large cross section and large time dimension. Our estimator combines kernel regression with principal component analysis. We derive the rate of convergence and limiting normal distribution for the factors, loadings and common components. We also develop a statistical test for the constancy of factor loadings in different states. In an empirical study on U.S. equity and bond data, we find that the systematic factor structure is different in boom and recession times and in periods of high market volatility.

Speaker: Cong Wu
Title: Controlled McKean-Vlasov Equations and Related Master Equations
Abstract: The theory of mean field game has been rapidly growing since it has been introduced in 2006/2007. In my recent work with Prof. Jianfeng Zhang, we studied the so called mean field

control problem under weak formulation, which carries some additional interesting features than the classical version. We also proposed a proper definition of viscosity solution for the derived master equation.

Speaker: Jean-Pierre Fouque
Title: Systemic risk and stochastic games with delay
Abstract: We propose a model of inter-bank lending and borrowing which takes into account clearing debt obligations. The evolution of log-monetary reserves of N banks is described by coupled diffusions driven by controls with delay in their drifts. Banks are minimizing their finite-horizon objective functions which take into account a quadratic cost for lending or borrowing and a linear incentive to borrow if the reserve is low or lend if the reserve is high relative to the average capitalization of the system. As such, our problem is a linear-quadratic stochastic game with delay between N players. A unique open-loop Nash equilibrium is obtained using a system of fully coupled forward and advanced backward stochastic differential equations. We then describe how the delay affects liquidity and systemic risk characterized by a large number of defaults. We also derive a close-loop Nash equilibrium using an HJB approach to this stochastic game with delay and we analyze its mean field limit. Joint work with R. Carmona, M. Mousavi and L.H. Sun.

Speaker: Zach Feinstein
Title: Financial contagion with multiple illiquid assets
Abstract: In this talk we will consider an extension of the Eisenberg & Noe (2001) model of financial contagion to include fire sale externalities from multiple illiquid assets. By allowing for multiple illiquid assets, institutions may have a choice in how they delever in a fire sale. Mathematical results on existence and uniqueness of clearing payments and prices will be given. Special emphasis will be placed on a game theoretic equilibrium liquidation strategy.

Speaker: Jaksa Cvitanic
Title: Asset pricing under optimal contracts
Abstract: We consider the problem of finding equilibrium asset prices in a financial market in which a portfolio manager (Agent) invests on behalf of an investor (Principal), who compensates the managerwith an optimal contract. We extend a model from Buffa, Vayanos and Woolley (2014), BVW (2014), by allowing general contracts. In particular, the optimal contract rewards Agent for taking specific risk of individual assets and not only the systematic risk of the index by making use of the quadratic variation of the deviation of the portfolio return from the return optimal when investing only in the index. Similarly to BVW (2014), we find that the stocks in large supply have high risk premia, while the stocks in low supply have low risk premia, and this effect is stronger as agency friction increases. However, by using the risk-incentive optimal contract, the sensitivity of the price distortion to agency frictions is of an order of magnitude smaller compared to the price distortion in BVW (2014), where only contracts linear in portfolio value and the benchmark are allowed.

Speaker: Leonard Wong
Title: Cover's universal portfolio and stochastic portfolio theory
Abstract: How to invest in a robust and model-independent way? Cover's celebrated result states that a properly chosen "universal" portfolio achieves the long run yield of the best retrospectively chosen constant rebalanced portfolio. More recently, stochastic portfolio theory (SPT) introduces a family of state-dependent strategies that attempt to outperform the market portfolio. In this talk we present several theoretical results that connect the two approaches. We extend Cover's

model-free result to the setting of SPT and prove a pathwise large deviation principle. Moreover, if the stock market is driven by a stochastic model, we show under appropriate conditions that the universal portfolio achieves the same asymptotic growth rate as that of the log-optimal numeraire portfolio. This is partly joint work with Christa Cuchiero and Walter Schachermayer.

Speaker: Jianfeng Zhang
Title: A Martingale Approach for Fractional Brownian Motions
Abstract: Empirical studies show that the volatilities could be rough, which typically go beyond the semimartinagle framework and the fractional Brownian Motion (fBM) becomes a natural tool. Compared with BM, fBM has two features: (i) non-Markoivan; (ii) non-semimartingale (when the Hurst parameter $H < \frac{1}{2}$). We shall show that the recent development of path dependent PDEs provides a convenient tool to extend the standard literature of pricing/hedging derivatives to an fBM framework.

Speaker: Mykhaylo Shkolnikov
Title: A predictor of systemic risk and particle systems interacting through hitting times
Abstract: Abstract: We propose an interacting particle system model for the mutual exposures of banks. In the model banks may default, possibly triggering cascades of defaults of other banks. When the aggregate losses from default cascades become on the order of the whole banking system, we speak of a systemic event. The main results of the paper show that, when the number of banks is large, the relative asset value profile of banks that are close to failure can be used as a predictor of systemic events.

Speaker: Haoran Wang
Title: Optimal liquidation with market parameter shift: a forward approach
Abstract: Classical expected utility optimization is subject to both model and horizon commitment, whereas the forward approach allows for considerable more flexibility. In this talk, I will present an application of the forward approach to optimal liquidation with dynamically (forward in time) changing market parameters under CARA utility. Both single- and multiple-horizon forward problems are formulated and solved. In the same setting, I will also discuss the continuous-time forward, and present a convergence result to the continuous time zero-volatility case as the model reassessment period vanishes. This is joint with S. Nadotchiy and T. Zariphopoulou.

Speaker: Weston Barger
Title: Approximate pricing of European and Barrier claims in a local-stochastic volatility setting
Abstract: We derive asymptotic expansions for the prices of a variety of European and barrier-style claims in a general local-stochastic volatility setting. Our method combines Taylor series expansions of the diffusion coefficients with an expansion in the correlation parameter between the underlying asset and volatility process. Rigorous accuracy results are provided for European-style claims. For barrier-style claims, we include several numerical examples to illustrate the accuracy and versatility of our approximations.

Speaker: Joon Seok Lee
Title: Mean field games with bounded velocity
Abstract: We introduce a mean-field game framework with singular controls of bounded velocity. To solve this singular control problem with multiple agents, we derive the Kolmogorov forward equation for bounded velocity processes, which is a generalization of the mean field game with regular controls. Both single controls with a bounded velocity and singular controls with finite

variation will be analysed. Finally, we will present some applications to systemic risk and real options.