



COLUMBIA ENGINEERING

The Fu Foundation School of Engineering and Applied Science

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CENTER FOR DIGITAL FINANCE  
AND TECHNOLOGIES

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ANNUAL SUMMIT

Friday, December 1, 2023  
Columbia University in the City of New York



# COLUMBIA ENGINEERING

The Fu Foundation School of Engineering and Applied Science

## Center for Digital Finance and Technologies Annual Summit

**Friday, December 1 2023 | 8:30AM - 3:30PM**

Columbia Engineering Innovation Hub, Tang Family Hall,  
2276 12th Avenue, Floor 2, New York, NY

### Participants



**Austin Adams**

*Researcher, Uniswap Labs*  
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Austin is a researcher on the protocols team at Uniswap Labs, where he focuses on mechanism design and economic incentives on the Uniswap Protocol.

**A Primer on Uniswap v4 core**

We present Uniswap v4, the next generation of automated market makers for Ethereum-based blockchains. Uniswap v4 iterates on the learnings from Uniswap v3, which has itself transacted \$1.7T to date without any hacks and is essential infrastructure for decentralized finance. The focus of Uniswap v4 is on customization, gas optimizations, and integrator experience.

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**Eric Alston, J.D.**

*Scholar in Residence: Finance Division, University of Colorado-Boulder*  
[eric.alston@colorado.edu](mailto:eric.alston@colorado.edu)



University of Colorado  
Boulder

Eric Alston is a Scholar in Residence in the Finance Division and the Faculty Director of the Hernando de Soto Capital Markets Program at the University of Colorado Boulder. Eric's research and teaching is centered in the fields of law and economics and institutional and organizational analysis, which he applies to research questions in the development of rights along frontiers, the design and implementation of constitutions, and digital governance challenges with an emphasis on cryptocurrencies and blockchain networks. Eric also consults with numerous cryptocurrency networks and DAOs on their specific governance design challenges.

**Lauren Berta**

*Product Manager - CBDC Platforms, Ripple*  
*lberta@ripple.com*

Since the start of my career I have been passionate about secure payments for retailers. I started at CitiGroup owning products focused on real-time liquidity for the bank's wholesale customers. During my time there, I participated in the development program of Citi's tokenization initiatives and strategy involving CBDCs. I have been a member of the Ripple CBDC Product team for about a year, focusing on our Issuer and Operator platforms, and working with customers on curating their issuance workflows. I graduated from the University of Miami with a degree in Economics and Computer Science, and have begun my Master's in Product Management at the University of Maryland in the last few months.

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**Agostino Capponi, PhD**

*Associate Professor; Director of the Center for Digital Finance and Technologies, Columbia Engineering*  
*ac3827@columbia.edu*

Agostino Capponi is an Associate Professor in the IEOR Department at Columbia University, and the founding director of the Center for Digital Finance and Technologies. His research interests are in financial technology, market microstructure, and economic networks. Agostino's research has been recognized with the 2018 NSF CAREER award, and with the JP Morgan AI Research Faculty award. Agostino is a fellow of the crypto and blockchain economics research forum, and an academic fellow of Alibaba's Luohan academy. He serves as an editor of Management Science in the Finance Department, co-editor of Mathematics and Financial Economics, and area editor of Operations Research Letters.

**Subir Chatterjee, MS, MBA**

Founder, President & CEO Fi-Tek, LLC; Chairman & CEO, Rocket® Solutions, LLC; Chairman & CEO, First State Trust Company  
[schatterjee@fi-tek.com](mailto:schatterjee@fi-tek.com)

Subir has over 35 years of experience in the US financial services industry, predominantly in founding and running Fintech companies, and in business consulting, product management, and technology with global financial institutions. Before founding Fi-Tek in 1997, he held key management positions at Chase Manhattan (JPMorgan Chase) and Bankers Trust (Deutsche Bank). His business experience includes Strategic Consulting, Institutional Trust, Wealth Management, Investment Operations, Global Custody, Private and International Banking. Subir is a graduate of Syracuse University, with a Masters in Operations Research, and an MBA in Finance. He has a B.E. in Mechanical Engineering from IIT in India.

**How can AI enable financial advisors to provide custom solution to next generation of wealth owners with scale?**

Today's financial advisors face a daunting challenge – how to better engage with the new generation of wealth owners – almost 60 trillion dollars will change hands from baby boomers to next generation. Most likely the new owners will change advisors – they will not stay with their parents advisors. The advisors need to leverage technology to show how they are state of the art – and not what their parents experienced. One of the ways for the advisors to show this would be the leverage AI to provide more custom solution by better understanding their “new” clients. AI can help advisors to understand the individual needs of their clients and formulate strategies which can enhance their user experience. This will require a lot of data and thru AI leverage this data to connect the dots to create new solutions.

**Ramsey El-Fakir**

CIO, Fi-Tek, LLC  
[relfakir@fi-tek.com](mailto:relfakir@fi-tek.com)

Ramsey is the Chief Information Officer at Fi-Tek. Before being associated with Fi-Tek in 1998, he managed the crude oil swap and cap book for Chase Investment Bank in London, also worked for Bear Stearns in NY in their Fixed Income Group. Since 2006, Ramsey has been CIO for Fi-Tek, responsible for the development and management of Fi-Tek's Wealth Management Solutions, creation of the managed hosting infrastructure for SaaS delivery, and defining current and future systems architecture strategy. Ramsey received his MBA from Cornell University's Johnson Graduate School of Management, and his BS in Engineering, Magna Cum Laude, from Missouri University of Science and Technology.



# Morgan Stanley

**Sahil Garg, PhD**

*VP: Department of ML Research, Morgan Stanley*  
*Sahil.Garg@morganstanley.com*

Garg is a senior research scientist in the department of machine learning research at Morgan Stanley. He obtained his PhD in Computer Science from the University of Southern California, and post doctorate in the department of Psychiatry from Icahn School of Medicine. He is passionate about problem driven research to solve real world problems. In his recent works, he has contributed to various aspects of machine learning in finance such as out-of-distribution detection, continual learning, generative sampling, uncertainty estimation.

**Robust OOD Detection for Continual Learning via Dual Divergence Estimation**

Detecting out-of-distribution (OOD) samples is a problem of practical importance for a reliable use of deep neural networks (DNNs) in production settings. We propose a principled yet simple approach of (empirically) estimating KL-Divergence, in its dual form, for a given test set w.r.t. a known set of in-distribution (ID) samples in order to quantify the contribution of each test sample individually towards the divergence measure and accordingly detect it as OOD vs ID. Our approach is compute-efficient and enjoys strong theoretical guarantees. For ImageNet dataset as the ID benchmark, we evaluate the proposed OOD detector on several test datasets, and observe drastically and consistently lower false positive rates w.r.t. all the competitive methods. Moreover, I will present results from the latest evaluation of our approach for continual learning settings where the ID dataset is itself noisy and available only in batches throughout the lifetime of a DNN model. Time permitting, I will brief on my recent contributions to the emerging field of information theoretic deep learning for applications such as generative sampling, uncertainty estimation, continual learning, etc.



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**Vineet Goyal, PhD**

*Associate Professor of Industrial Engineering and Operations Research, Columbia University*  
*vg2277@columbia.edu*

Vineet Goyal is Associate Professor in the Industrial Engineering and Operations Research Department at Columbia University where he joined in 2010. He received his Bachelor's degree in Computer Science from Indian Institute of Technology, Delhi in 2003 and his Ph.D. in Algorithms, Combinatorics and Optimization (ACO) from Carnegie Mellon University in 2008. Before coming to Columbia, he spent two years as a Postdoctoral Associate at the Operations Research Center at MIT. He is interested in the design of efficient and robust data-driven algorithms for large scale dynamic optimization problems with applications in revenue management and healthcare. He received the 2021 INFORMS Revenue Management and Pricing Section prize and 2019 MSOM Society Best Paper in Operations Research Prize. His research has been supported by grants from NSF, DARPA and the industry including the NSF CAREER Award and faculty research awards from Google, IBM, Adobe and Amazon.

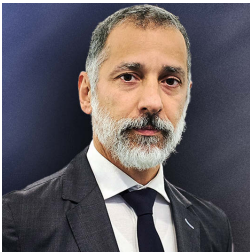


**GLOBALRISK**  
INSTITUTE

**Victoria Guo, MA, CFA, FRM**

*Interim Managing Director: Research, Global Risk Institute in Financial Services*  
vguo@globalriskinstitute.org

Victoria Guo is the Interim Managing Director, Research at the Global Risk Institute in Financial Services (GRI). In her role, she collaborates with members to develop research strategies that aim to create economic value for all stakeholders. Bringing over a decade of experience in treasury and risk management in the financial services industry, Victoria has previously assumed a number of management roles at Scotiabank. Her responsibilities encompassed overseeing risk within capital markets and treasury activities, including the critical assessment of liquidity risk management through stress-testing and enterprise recovery and resolution planning across Scotiabank's diverse businesses. Additionally, Victoria is the co-regional Director of PRMIA (Professional Risk Managers' International Association) Toronto Chapter. She is the Chair of the regional steering committee, guiding the formulation of the chapter's development strategies and setting organizational priorities. Victoria holds a Master's degree in Economics from the University of Toronto, a Bachelor's degree in Financial Engineering from Shanghai Jiao Tong University and is a CFA and FRM charter holder.



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**Ali Hirs, PhD**

*Professor; Director of Center for AI in Business Analytics & Financial Technology; Director of Financial Engineering Program, Columbia University*  
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Ali Hirs is a Professor at Columbia University. He is also CSO at ASK2.ai and MP at Sauma Capital, LLC. Previously Ali was a Partner at Caspian Capital Management, LLC and has worked in a variety of quantitative positions. Ali was also a Fellow at Courant Institute of NYU. Ali is the author of "Computational Methods in Finance," co-author of "An Introduction to Mathematics of Financial Derivatives," and editor-in-chief of the Journal of Investment Strategies. He is a frequent speaker at academic and practitioner conferences. Ali received his Ph.D. in Applied Mathematics from University of Maryland at College Park under the supervision of Professors Elman and Madan.

## AI Advancements in Asset Management

As of 2025, global assets under management are projected to reach an estimated \$145 trillion. This vast pool of assets encompasses a diverse spectrum of liquidity, tradability, and intricate nuances. These assets span various durations, traded on exchanges or negotiated privately, involve multiple currencies, exhibit distinct trading frequencies and holding periods, adhere to varying protocols, and are subject to evolving regulatory frameworks. This complexity generates a vast and ever-evolving repository of information. The application of artificial intelligence (AI) in the realm of asset management has emerged as a transformative force. It enables the simultaneous analysis of heterogeneous datasets, diverse models, multiple viewpoints, interactive visuals, and more. AI empowers practitioners to continuously evaluate historical performance and predict future outcomes at every stage of the investment life cycle, guided by well-defined or suggested objective functions. However, implementing AI in the context of nonstationary financial markets demands a nuanced approach that goes beyond the simplistic notion of 'data in, miracles out.' It necessitates meticulous tuning, ongoing enhancements, and, at times, a fundamental reevaluation of methodologies. In this context, our aim is to delve deeper and present a selection of proposed advancements in harnessing AI techniques across various asset management processes. By exploring these advancements, we seek to illuminate the evolving landscape of AI-powered asset management and its potential to navigate the complexities of global financial markets.

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### Gur Huberman, PhD

*Robert G. Kirby Professor of Behavioral Finance, Columbia Business School*  
[gh16@columbia.edu](mailto:gh16@columbia.edu)

Gur Huberman is the Robert G. Kirby Professor of Behavioral Finance at Columbia Business School where he has taught since 1989. Prior to that, he taught at Tel Aviv University and at the University of Chicago. Between 1993 and 1995 he was Vice President at JP Morgan Investment Management responsible for research on quantitative equity trading. In that capacity, he also helped develop tax aware strategies for the private bank. He earned his Ph.D. (with distinction) in operations research from Yale in 1980 and his B.Sc. (cum laude) in mathematics from Tel Aviv University in 1975. Professor Huberman's published work is widely read and cited, and covers a broad range in finance and economics. He contributed to the theory of equilibrium return-risk tradeoff, to the theory of contracts, to the study of individual's portfolio selection, especially in the context of retirement savings to the theory of liquidity and trading, and to Behavior Finance. More recently he has turned his attention to FinTech and cryptocurrencies.

### Who pays for products/services supported by a blockchain?

Fifteen years after Nakamoto posted his sensational paper, BTC's market cap is above \$700B, and the aggregate cryptocurrencies market cap is twice that much. Traditional money has been flowing from the traditional economy into crypto (i) to pay engineers, marketing people, lawyers etc. to develop the crypto financial system and to (ii) speculate. How much money has been flowing from the traditional into the crypto economy to purchase goods & services? How much will be flowing in that direction? What are the implications of the answers to these questions?



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## Garud Iyengar, PhD

*Tang Professor of Industrial Engineering and Operations Research and Senior Vice Dean for Research and Academic Programs, Columbia University*  
 gi10@columbia.edu

Garud Iyengar is the Tang Professor of Operations at Columbia Engineering. He received his B. Tech. in Electrical Engineering from IIT Kanpur, and an MS and PhD in Electrical Engineering from Stanford University. His research interests are broadly in control, machine learning and optimization. His published works span a diverse range of fields, including information theory, applied mathematics, operations research, economics and financing engineering. His current projects focus on the areas of large-scale power systems and supply chains, causal inference, and modeling of cellular processes. He was elected an INFORMS Fellow in 2018. He was the Chair of the Department of Industrial Engineering and Operations Research from 2013-19, and the Associate Director for Research at the Columbia Data Science Institute from 2017-19. He has been an Amazon Scholar since 2019. He is currently the Senior Vice Dean for Research and Academic Programs at Columbia Engineering.



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## Ruizhe Jia

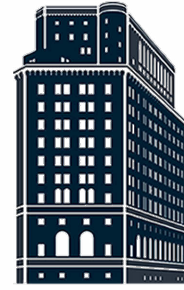
*PhD Student, Columbia University*  
 rj2536@columbia.edu

Ruizhe Jia, currently in the fifth year of a Ph.D. program in Industrial Engineering and Operations Research at Columbia University, is under the guidance of Prof. Agostino Capponi. Their research delves into decentralized finance (DeFi) platforms, focusing on the operational aspects of emerging technologies like distributed ledgers, smart contracts, and the Internet of Things (IoT). Ruizhe Jia's work has significantly contributed to the design of pricing mechanisms for goods traded on decentralized platforms and has offered insights into measuring and mitigating Maximal Extractable Value (MEV), a key concern in the field of DeFi.

### **Maximal Extractable Value and Allocative Inefficiencies in Public Blockchains**

We argue that the transparent observability of pending transactions in public distributed ledgers leads to suboptimal allocation of blockspace. We show that augmenting these ledgers with private transaction submission pools can reduce allocative inefficiencies and raise welfare. While full adoption of private pools is socially desirable, it limits validators' rent extraction from frontrunning opportunities, referred to as maximal extractable value, and thus is not sustainable in equilibrium. Our empirical analysis reveals that despite the implementation of Flashbot private pools, frontrunning attacks continue, leading to an estimated transfer of USD 100 million from victim users to validators and frontrunners.





FEDERAL RESERVE BANK of NEW YORK

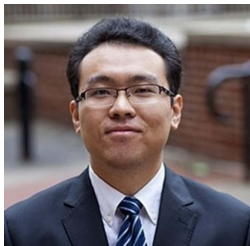
**Michael Junho Lee, PhD**

*Financial Economist, Federal Reserve Bank of New York  
michaeljunholee@gmail.com*

Michael Lee is a financial economist in the Research Group at the Federal Reserve Bank of New York. His interests are broadly in financial intermediation, financial markets, and corporate finance. Recently, his work explores issues at the intersection of technology and finance, including digital assets, the design and safeguarding of financial and information networks, the economics and regulation of data, and financial market design. Michael joined the NY Fed in 2016 after completing his Ph.D. in finance from the Wharton School at the University of Pennsylvania.

**Perspectives on Central Bank Digital Currencies**

Central banks around the world are actively exploring and developing central bank digital currencies (CBDCs). What are CBDCs, and why do they matter? We explore these questions in the broader context of the evolving payment landscape, and discuss key design considerations and challenges.

**Fengpei Li**

*Machine Learning Researcher; Vice President, Morgan Stanley  
fengpei.li@morganstanley.com*

Fengpei Li graduated with a Ph.D in IEOR at Columbia University. He received his B.S. degree in mathematics from UCSD. His research focuses on uncertainty quantification, optimization and quantitative finance.

# Morgan Stanley

**Yiming Ma, PhD**

*Associate Professor of Business, Columbia Business School*  
*ym2701@gsb.columbia.edu*

Yiming Ma is an Associate Professor in the Finance Division at Columbia Business School. She received her Ph.D. from the Stanford Graduate School of Business and a B.A. from Yale University. Her research examines the evolving landscape of financial intermediation, where non-banks are increasingly engaged in liquidity transformation alongside commercial banks. Her recent work examines the implications of this trend on asset prices, financial stability, and monetary policy transmission. Her findings have been published in leading academic journals and cited by the Financial Times, the International Monetary Fund, the Securities and Exchange Commission, and the Federal Reserve.

**Stablecoin Runs and the Centralization of Arbitrage**

We analyze the run risk of USD-backed stablecoins. Stablecoin issuers hold a portfolio of US dollar assets, while promising to redeem stablecoins for \$1 with arbitrageurs on the primary market. Although arbitrage helps to stabilize the secondary market price at \$1, we find that the largest stablecoin issuer, USDT, only trades with 6 authorized arbitrageurs in a given month. We show that issuers actively constrain arbitrage because more efficient arbitrage amplifies the risk of panic runs by reducing investors' price impact from selling stablecoins in secondary markets. Our estimated model predicts a sizable run risk for the largest two USD stablecoins, Tether (USDT) and Circle (USDC). These stablecoin runs could disrupt important USD markets for bank deposits and Treasuries. Finally, we show that run risk could be reduced by imposing redemption fees or issuing dividends to investors.

**Omid Malekan**

*Adjunct Professor, Columbia Business School*  
*om44@columbia.edu*

Omid Malekan is the Explainer-in-Chief of blockchain technology. He's the author of *Re-Architecting Trust: The Curse of History and the Crypto Cure for Money, Markets, and Platforms* and *The Story of the Blockchain: A Beginner's Guide to the Technology That Nobody Understands*. He's an adjunct professor at Columbia Business School and helps people and companies engage with digital assets.

**Gerard McDonald, PhD**

*Managing Director: Head of Research, Global Risk Institute*  
[gmcDonald@globalriskinstitute.org](mailto:gmcDonald@globalriskinstitute.org)

Gerard McDonald has over 20 years of experience in risk management, strategy, regulatory change and transformational management. Gerard is currently Managing Director, Head of Research at the Global Risk Institute, Gerard retired from BMO Financial Group in 2022, where he was Head, Risk and Compliance, responsible for BMO's Canadian Personal & Business Banking businesses. Gerard joined BMO in 2005, in the Office of Strategic Management, and his roles included Chief Risk Officer, Wealth Management and Head, Capital Management. Gerard was at McKinsey & Company (2001-2005), where he led and participated in advisory engagements in North America and Europe for clients in financial services. Gerard holds a Ph.D. in Economics from Yale University, and an M.A. in Economics from the New School for Social Research.

**Brett Mollin**

*Technical Partner Director: Central Banks, Ripple*  
[brett@ripple.com](mailto:brett@ripple.com)

Brett has been implementing enterprise software solutions in highly secure and critical environments for 20 years, starting with the nuclear power industry and currently focused on Central Bank Digital Currency (CBDC). Since 2015 Brett has been assisting with implementation of Ripple blockchain technology solutions at commercial banks around the world, and is currently the technical lead for Ripple's central bank pilots.

**Enhancing Cross Border Payments with CBDC**

CBDC's are commonly seen as a means to enhance cross border payments. What are some specific cross border use cases and how can a CBDC make the process more efficient? CBDC cross border payments utilizing a blockchain distributed exchange will be demonstrated.

**Danielle Nelson**

*Program Manager; University Blockchain Research Initiative, Ripple*  
[dnelson@ripple.com](mailto:dnelson@ripple.com)

Danielle Nelson is a Program Manager for the University Blockchain Research Initiative (UBRI) program at Ripple. This partnership program funds a diverse portfolio of blockchain research, technical development, and innovation at over 50 universities around the world. Coming from a career in fintech, before joining Ripple, Danielle was a Program Manager for Diversity, Equity and Inclusion at NFT marketplace, OpenSea.

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**Mike Neuder**

*Research Engineer, Ethereum Foundation*  
[michael.neuder@ethereum.org](mailto:michael.neuder@ethereum.org)

Mike joined the Ethereum Foundation in March 2023 to work on consensus layer research. His main focus continues to be MEV markets and Proposer-Builder Separation, and he also writes on other related topics such as liquid staking tokens, censorship resistance, and validator balance mechanics.

**Why it's hard to enshrine Proposer-Builder Separation...**

We explore Proposer-Builder separation and what tools we have to reduce the negative externalities of MEV on Ethereum, while being pragmatic about the centralizing forces of specialization among consensus protocol participants.



# Morgan Stanley

**Yuriy Nevmyvaka**

*Managing Director of Machine Learning Research, Morgan Stanley*  
*Yuriy.Nevmyvaka@morganstanley.com*

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**Sveinn Olafsson, PhD**

*Assistant Professor, Stevens Institute of Technology*  
*solafsso@stevens.edu*

Sveinn Olafsson is an Assistant Professor in the School of Business at Stevens Institute of Technology. His research interests are Financial Engineering and Financial Technology.

**Model of the MEV supply chain under PBS**

We consider a model of the MEV supply chain under proposer-builder separation (PBS). We analyze the incentives of different network participants, and study the centralizing effects of exclusive order flow and the potential for vertical integration.

**Sujit Raman**

Chief Legal Officer, TRM Labs  
[sujit@trmlabs.com](mailto:sujit@trmlabs.com)

Sujit Raman is Chief Legal Officer at TRM Labs, the blockchain intelligence company. He was previously a partner at the international law firm Sidley Austin LLP. Mr. Raman joined the private sector after serving as an Associate Deputy Attorney General in the U.S. Department of Justice, where he assisted the Attorney General and Deputy Attorney General in their supervision of the nation's cyber-related criminal and national security investigations and prosecutions, and helped oversee the Department's cyber-related policy development, including its crypto enforcement strategy. He is a graduate of Harvard College, Harvard Law School, and the University of Bristol (UK), where he studied as a Marshall Scholar.



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**Tim Rougharden, PhD**

Assistant Professor, Columbia Engineering & a16z  
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Tim Rougharden is Head of Research for a16z crypto, leading a team focused on advancing the science and technology of the future of the Internet through fundamental research breakthroughs, the integration of research with practice, education, and open source software. He has served on the computer science faculty at Columbia (for 6 years) and Stanford (for 15 years). He works on the boundary of computer science and economics (aka algorithmic game theory), and is currently focused on research challenges in web3, including transaction fee mechanism design, permissionless consensus, token system design, and the theoretical foundations of DeFi.

**Transaction fee mechanism design in a post-MEV era**



# Morgan Stanley

**Anderson Schneider, PhD**

*Executive Director of Machine Learning Research, Morgan Stanley*  
*[sujit@trmlabs.com](mailto:sujit@trmlabs.com)*

Anderson is executive director of Morgan Stanley Machine Learning Research Department. He has joined Morgan Stanley in 2019. Anderson was previously an quant trader at Infinium Capital and Tower Research Capital, and a senior quantitative researcher at Graham Capital. Anderson has authored and co-authored conference and journal papers. He received his PhD in Economics from University of Minnesota.

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## COLUMBIA ENGINEERING

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**Jay Sethuraman, PhD**

*Professor of Industrial Engineering and Operations Research, Columbia University*  
*[js1353@columbia.edu](mailto:js1353@columbia.edu)*

Jay Sethuraman is a Professor of Industrial Engineering and Operations Research at Columbia University. He is currently the chair of the IEOR department. His research interests are in market design, discrete optimization and its applications, scheduling theory, and applied probability.

**Kevin Virgil**

CIO, Meta Impact Capital

kevin@metaimpact.capital

Kevin Virgil is a Partner and Chief Investment Officer of Meta Impact Capital, a venture capital fund that makes early-stage investments in web3, metaverse and digital asset technologies. He is also the co-founder and former CEO of Polysentry, a software company that provides AI-enabled data discovery solutions for government and commercial customers. Kevin has worked at several global investment banks in corporate finance and capital markets roles. He earned a B.S. from the United States Military Academy at West Point and an MBA from Emory University.

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**Junfeng Yang, PhD**

Professor of Computer Science, Columbia University

junfeng.yang@columbia.edu

Junfeng Yang is Professor of Computer Science, Member of the Data Science Institute, and co-Director of the Software Systems Lab at Columbia University. Yang's research centers on building reliable, secure, and fast software systems. Today's software systems are large, complex, and plagued with errors, some of which have caused critical system failures, breaches, and performance degradation. Yang has invented techniques, algorithms, and tools to analyze, test, debug, monitor, and optimize real-world software, including Android, Linux, production systems at Microsoft, machine learning systems, and self-driving platforms, benefiting hundreds of millions of users. His research has resulted in numerous vulnerability patches to real-world systems, practical adoption at the largest technology companies, and press coverage at Scientific American, The Atlantic, The Register, Communications of ACM, and other news outlets.

**SmartInv: Multimodal Learning for Smart Contract Invariant Inference**

Smart contract vulnerabilities have cost billions, yet traditional tools cannot detect more than 80% of these vulnerabilities because these "machine un-auditable" bugs arise from both transactional contexts and source code. I will present SmartInv, a multi-modal LLM-based smart contract invariant inference framework to automate the detection of "machine un-auditable" bugs. Our key insight is that the expected behavior of smart contracts, as specified by invariants, relies on understanding and reasoning across multimodal information, such as source code and natural language comments and documentation. SmartInv leverages a new prompting strategy we call Tier of Thought to reason across multiple modalities and ultimately generate invariants. It prevents LLM hallucination by validating the inferred invariants using formal verification. Evaluation on close to 90k real-world contracts shows that SmartInv is accurate and fast, and the invariants inferred detect numerous vulnerabilities that resulted in multi-million losses over the past 2.5 year, including 119 previously unknown vulnerabilities.





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## Shihao Yu, PhD

Postdoctoral Researcher, Columbia University  
sy3119@columbia.edu

I am a Postdoctoral Researcher at the Center for Digital Finance and Technologies of the Columbia University. My research is within asset pricing and market microstructure. In particular, I examine the impact of market (micro)structures on securities trading and clearing in aspects of market liquidity, price discovery, and systemic risk. I approach it through the lens of financial technology (FinTech) and by leveraging state-of-the-art econometric and machine learning models and big data analytics.

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## Brian Zi Qi Zhu

PhD Student, Columbia University  
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Brian is a 2nd-year Operations Research PhD student at Columbia advised by Professor Agostino Capponi. Brian's research interests are in the intersection of decentralized finance, market microstructure, and market design. Previously, Brian received a bachelor's degree in Economics and Mathematics from Yale University.

### **The Paradox of Just-in-Time Liquidity: More Providers Can Sometimes Mean Less Liquidity**

We study just-in-time (JIT) liquidity provision within blockchain-based decentralized exchanges (DEXs). In contrast to passive liquidity providers who deposit assets into liquidity pools before observing order flows, JIT providers take a more active approach. They monitor pending orders from public blockchain mempools and swiftly supply liquidity, only to withdraw it in the same block. Our game-theoretical analysis uncovers a paradoxical scenario: an increase in liquidity providers, rather than enhancing liquidity as expected, can inadvertently reduce it. At the heart of our investigation lies the adverse selection problem encountered by passive liquidity providers, stemming from the presence of informed arbitrageurs. Unlike passive liquidity providers, JIT providers have the advantage of analyzing the order flow prior to providing liquidity and block confirmation. We show that this second-mover advantage mitigates their adverse selection costs, potentially crowding out passive liquidity providers, particularly when order flows are not highly elastic to changes in pool liquidity. We show that these equilibrium effects lead to an overall reduction of pool liquidity and to an increased execution risk for liquidity demanders.



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## Agenda

8:30 AM - BREAKFAST

### OPENING REMARKS

9:00 AM - *Agostino Capponi & Garud Iyengar, Columbia Engineering*

### SESSION 1 - Decentralized Exchanges

9:20 AM - Introduction

*Shihao Yu, Columbia Engineering*

9:20 AM - Speaker 1A

*Austin Adams, Uniswap Labs*

“A Primer on Uniswap v4 core”

9:40 AM - Speaker 1B

*Brian Zi Qi Zhu, Columbia Engineering*

“The Paradox of Just-in-Time Liquidity: More Providers Can Sometimes Mean Less Liquidity”

### SESSION 2 - Blockchain Protocols, Fee, and Security

10:00 AM - Introduction

*Omid Malekan, Columbia Business School*

10:00 AM - Speaker 2A

*Tim Roughgarden, Columbia Engineering*

“Transaction fee mechanism design in a post-MEV era”

10:20 AM - Speaker 2B

*Junfeng Yang, Columbia Engineering*

“SmartInv: Multimodal Learning for Smart Contract Invariant Inference”

10:40 AM - Speaker 2C

*Gur Huberman, Columbia Business School*

“Who pays for products/services supported by a blockchain?”

11:00 AM - BREAK

### SESSION 3 - AI in Finance

11:15 AM - Introduction

*Agostino Capponi, Columbia Engineering*

11:15 AM - Speaker 3A

*Ali Hirsa, Columbia Engineering, ASK2.ai, Sauma Capital, LLC*

“AI Advancements in Asset Management”

11:35 AM - Speaker 3B

*Subir Chatterjee, Fi-Tek, LLC*

“How can AI enable financial advisors to provide custom solution to next generation of wealth owners with scale”

11:55 AM - Speaker 3C

*Sahil Garg, Morgan Stanley*

“Robust OOD Detection for Continual Learning via Dual Divergence Estimation”

12:15 PM - LUNCH

### SESSION 4 - Maximal Extractable Value

1:15 PM - Introduction

*Brett Mollin, Ripple*

1:15 PM - Speaker 4A

*Ruizhe Jia, Columbia Engineering*

“Maximal Extractable Value and Allocative Inefficiencies in Public Blockchains”

*(continued on next page)*



# COLUMBIA ENGINEERING

The Fu Foundation School of Engineering and Applied Science

## Agenda

1:35 PM - Speaker 4B

*Mike Neuder, Ethereum Foundation*

"Why it's hard to enshrine Proposer-Builder Separation..."

1:55 PM - Speaker 4C

*Sveinn Olafsson, Stevens Institute of Technology*

"Model of the MEV supply chain under PBS"

2:15 PM - BREAK

### SESSION 5 - Digital Currencies

2:30 PM - Introduction *Jay Sethuraman, Columbia Engineering*

2:30 PM - Speaker 5A

*Brett Mollin, Ripple*

"Enhancing Cross Border Payments with CBDC"

2:50 PM - Speaker 5B

*Yiming Ma, Columbia Business School*

"Stablecoin Runs and the Centralization of Arbitrage"

3:10 PM - Speaker 5C

*Michael Junho Lee, Federal Reserve Bank of NY*

"Perspectives on Central Bank Digital Currencies"

### CLOSING REMARKS

3:30 PM - *Agostino Capponi, Columbia Engineering*



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