

November 9–10, 2021

Artificial Intelligence in Consumer Finance

Defining and Insuring Fairness

FEDERAL RESERVE BANK
PHILADELPHIA

FEDERAL RESERVE BANK
of CLEVELAND

A virtual conference co-organized by the Federal Reserve Bank of Cleveland and the
Consumer Finance Institute of the Federal Reserve Bank of Philadelphia



The Federal Reserve Bank of Cleveland and the Consumer Finance Institute of the Federal Reserve Bank of Philadelphia are hosting Artificial Intelligence in Consumer Finance: Defining and Insuring Fairness, a virtual conference on the application of artificial intelligence in consumer finance.

This conference takes place on two consecutive afternoons on November 9–10 for participants from the academic, industry, and the supervisory communities.

We have assembled a stellar group of presenters and panelists on the cutting edge of researching fairness in artificial intelligence (AI) in the fields of computer science, econometrics, economics, law, and regulatory policy analysis. Our rigorous and robust conversations are designed to help define what are fair outcomes, both in the context of recent advances in computer science and in practical application under the law. Specifically, we explore how algorithms can be evaluated and assessed as fair in the pricing of and access to consumer lending and payments.

Conference Organizers

AUJ	HJI	WWE	PLD
1,822	20,349	890	6,350
(+35)	(+588)	(+68)	(+288)
MBC	LJH	MJB	PON
3,605	9,542	2,609	7,654
(+210)	(+128)	(+35)	(+169)
YBV	DMN	MMJ	BT
3,204	5,211	7,100	7,130
(+33)	(+156)	(+60)	(+156)
MBB	WFF	HJM	DLI
3,320	712	134	2,022
(+120)	(+12)	(+3)	(+15)

Robert M. Hunt, Ph.D.

Senior Vice President
Consumer Finance Institute
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Ben Craig, Ph.D.

Economic and Policy Advisor
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Conference Planner

Nicole Rizzo

The views expressed at the conference are those of the keynoters, speakers, and moderators and do not necessarily reflect those of anyone else in the Federal Reserve Banks or the Federal Reserve System.

Tuesday, November 9

Day 1: Defining and Verifying Algorithmic Fairness

The first day will focus on the technical problems of incorporating fairness into an algorithmic decision, providing humanly understandable explanations for algorithmic decisions and other recent advances in our understanding of fairness in algorithms.

1:00 p.m.–1:15 p.m.

Opening Remarks: Patrick T. Harker, President and CEO, Federal Reserve Bank of Philadelphia

1:15 p.m.–2:45 p.m.

Session 1: Algorithmic Fairness, Causality, and Interpretability

We focus on programming fairness into the routine from the first and consider foundational and theoretical works in the fair machine learning literature, emphasizing the role of structure in the training phase of the algorithm.

Moderator: Minchul Shin, Federal Reserve Bank of Philadelphia

Panelists: Cynthia Rudin, Duke University
Michael Kearns, University of Pennsylvania
Niki Kilbertus, Helmholtz AI

2:45 p.m.–3:00 p.m.

Break

3:00 p.m.–4:45 p.m.

Session 2: Practical Challenges to Recent Advances in Machine Learning

We explore how ideas can be implemented consistently with fair lending and other consumer protection law. The main tension is between the theoretical optimum of an algorithm and the second-best solution that is permissible, given the constraints of legal and regulatory institutions and the realities of the marketplace.

Moderator: Jeanne Rentzelas, Federal Reserve Bank of Philadelphia

Panelists: Talia Gillis, Columbia Law School
Jenn Wortman Vaughan, Microsoft Research
Doaa Abu-Elyounes, Harvard Law School

Wednesday, November 10

Day 2: The Past as Prologue

On the second day, we focus on past lessons learned from applying previous generations of statistical tools to understand some of the problems and opportunities in applying fair lending and other consumer protection laws to new technologies and approaches.

1:00 p.m.–1:15 p.m.

Opening Remarks: Loretta J. Mester, President and CEO, Federal Reserve Bank of Cleveland

1:15 p.m.–2:45 p.m.

Session 3: Possible Discrimination and Its Uncertain Mechanisms

We focus on the role of structural approaches to evaluating discrimination in markets. In the past, we have needed this approach to reveal the mechanisms through which discrimination works and how effective our regulatory approaches have been in mitigating discrimination.

Moderator: David Lynch, Board of Governors

Panelists: Alexander D'Amour, Google Research
Jann Spiess, Stanford University
Matt Kusner, University College London

2:45 p.m.–3:00 p.m.

Break

3:00 p.m.–3:30 p.m.

Keynote: Robert Avery, Federal Housing Finance Agency

3:30 p.m.–5:00 p.m.

Session 4: Statistical Lessons in Identifying Fairness

In our final session, we focus on lessons learned from the statistical examination of fair lending rules: patterns in the data and patterns we would like to see in machine learning practice. What has worked and what has not?

Moderator: Dionissi Aliprantis, Federal Reserve Bank of Cleveland

Panelists: Marsha Courchane, Charles River Associates
Gregorio Caetano, University of Georgia
Dean Knox, University of Pennsylvania

5:00 p.m.–5:15 p.m.

Closing Remarks: Ben Craig, Federal Reserve Bank of Cleveland

Keynote Speakers

2021

Robert Avery

Project Director, Federal Housing Finance Agency

Robert Avery is the project director of the National Mortgage Database at the Federal Housing Finance Agency (FHFA). He heads an interagency effort at the FHFA, which developed and maintains the most comprehensive loan-level residential mortgage database in the U.S. to better serve supervisory and policy concerns. Since 2013, the project team has also fielded a quarterly survey of new mortgagees, which is released annually as a public use database.

Avery joined the FHFA after retiring from the Board of Governors of the Federal Reserve System in fall 2012. Previously, he had held positions as a professor at Cornell University and as an assistant professor at Carnegie Mellon University. His work at the Federal Reserve focused on supervisory issues related to community affairs and bank supervision, including the Federal Reserve's *Congressional Report on Disparate Impact in Credit Scoring* and revisions to the Community Reinvestment Act in 2005. He was also one of the founders of the triennial *Survey of Consumer Finances* and designed the loan sampling systems used for the Federal Reserve's examinations of small bank safety and soundness and for large syndicated loans. Avery has a Ph.D. from the University of Wisconsin and a B.A. from the University of Pennsylvania.

Patrick T. Harker

President and Chief Executive Officer
Federal Reserve Bank of Philadelphia

Patrick T. Harker took office on July 1, 2015, as the 11th president and chief executive officer of the Federal Reserve Bank of Philadelphia. He was reappointed for his second five-year term effective March 1, 2021. In this role, Harker participates on the Federal Open Market Committee, which formulates the nation's monetary policy.

Before taking office at the Philadelphia Fed, Harker was the 26th president of the University of Delaware. He was also a professor of business administration at the university's Alfred Lerner College of Business and Economics and a professor of civil and environmental engineering at the College of Engineering. Before joining the University of Delaware in 2007, Harker was dean and Reliance Professor of Management and Private Enterprise at the Wharton School of the University of Pennsylvania. Prior to being appointed dean in 2000, Harker was the Wharton School's interim dean and deputy dean as well as the chair of its Operations and Information Management Department. He has published/edited nine books and more than 100 professional articles. From 1996 to 1999, he served as editor-in-chief of the journal *Operations Research*. In 2012, Harker was named a fellow of the Institute for *Operations Research* and the Management Sciences (INFORMS) and a charter fellow of the National Academy of Inventors.

Keynote Speakers

2021

Harker is a board member of both the Chamber of Commerce for Greater Philadelphia and its Select Greater Philadelphia Council. He is also a board member at the Science Center in Philadelphia. Harker has a Ph.D. in civil and urban engineering, an M.A. in economics, and an M.S.E. and B.S.E. in civil engineering, all from the University of Pennsylvania.

Loretta J. Mester

**President and Chief Executive Officer
Federal Reserve Bank of Cleveland**

Loretta J. Mester is president and chief executive officer of the Federal Reserve Bank of Cleveland. In this role, she participates in the formulation of U.S. monetary policy and oversees 1,000 employees in Cleveland, Cincinnati, and Pittsburgh, who conduct economic research, supervise banking institutions, and provide payment services to commercial banks and the U.S. government. She became president and chief executive officer in June 2014.

Her areas of research expertise and interest include the organizational structure and productive efficiency of financial institutions, financial intermediation and regulation, agency problems in credit markets, credit card pricing, central bank governance, and inflation. Mester has published numerous articles in refereed academic and professional journals on a variety of topics, including economics, central banking, and financial issues. In addition, she is a Management Committee member of the *International Journal of Central Banking* and coeditor of the *Journal of Financial Services Research*; she is also an associate editor of several other academic journals.

Prior to being named president and chief executive officer of the Cleveland Fed, Mester had been executive vice president and director of research at the Federal Reserve Bank of Philadelphia, where she was the chief policy advisor, attended meetings of the Federal Open Market Committee, and oversaw the economists and analysts in the Research Department, as well as professionals in the Financial Statistics Department and the Payments Cards Center. She joined the Federal Reserve Bank of Philadelphia in 1985 as an economist, becoming senior vice president and director of research in 2000, and executive vice president and director of research in 2010.

Mester is an adjunct professor of finance at the Wharton School of the University of Pennsylvania and is a fellow at the Wharton Financial Institutions Center. She has also taught in the undergraduate finance and M.B.A. programs at Wharton and in the Ph.D. program in finance at New York University. In addition, Mester is a director of the Greater Cleveland Partnership, a trustee of the Cleveland Clinic, a trustee of the Musical Arts Association (Cleveland Orchestra), a director of the Council for Economic Education, a founding director of the Financial Intermediation Research Society, and a member of the advisory board of the Financial Intermediation Network of European Studies. She is also a member of the American Economic Association, the American Finance Association, the Econometric Society, and the Financial Management Association International. Mester has a Ph.D. and an M.A. in economics from Princeton University, where she was a National Science Foundation fellow, and a B.A. (summa cum laude) in mathematics and economics from Barnard College of Columbia University.

Doaa Abu-Elyounes

Researcher, Harvard Law School

Doaa Abu-Elyounes works at the United Nations Educational, Scientific and Cultural Organization (UNESCO) on the ethics of artificial intelligence. In addition, she is an affiliated researcher at the Berkman Klein Center for Internet and Society at Harvard University and a postdoctoral researcher at the École Normale Supérieure in Paris. Her research highlights algorithmic governance and the different ways to regulate artificial intelligence.

Abu-Elyounes focuses on algorithms deployed in the public sector and examines how general principles such as fairness, transparency, and accountability can be interpreted in the context of the policy domain in which they are implemented. She has extensive experience working on public policy at the national and international levels. Prior to UNESCO, she consulted the Organisation for Economic Co-operation and Development (OECD) on artificial intelligence regulation and was involved in shaping its work. Previously, she worked at the Supreme Court of Israel as a law clerk and at the Israeli Ministry of Justice as an advisor to the Director General of the Ministry. Abu-Elyounes has a Ph.D. from Harvard Law School.

Dionissi Aliprantis

Assistant Vice President and Senior Research Economist
Federal Reserve Bank of Cleveland

Dionissi Aliprantis is an assistant vice president, senior research economist, and director of the Program on Economic Inclusion at the Federal Reserve Bank of Cleveland. His research is focused on human capital formation, racial inequality, and neighborhood effects. He is also a codirector of Greater Than Math and recently completed a math textbook for grades 7–12. He has a Ph.D. in economics from the University of Pennsylvania and bachelor's degrees in mathematics, economics, and Spanish from Indiana University.

Gregorio Caetano

Assistant Professor of Economics, University of Georgia

Gregorio Caetano is an assistant professor of economics at the University of Georgia. His research interests are social interactions, urban economics, local public economics, education, labor economics, and applied econometrics. Caetano has a Ph.D. in economics from the University of California, Berkeley; an M.A. in economics from Fundação Getúlio Vargas (FGV-RJ); and a B.A. in economics from Universidade Federal do Rio Grande do Sul.

Presenters and Moderators

2021

Marsha J. Courchane

Vice President and Practice Leader of Financial Economics Practice
Charles River Associates

Marsha J. Courchane is vice president and practice leader of the Financial Economics Practice at Charles River Associates and a leading expert in mortgage and consumer lending. She engages in research, consulting, and litigation support for mortgage markets, discrimination in lending, consumer credit, credit scoring, credit risk, and redlining issues. She has published in academic journals, including the *Journal of Economics and Business*, *Housing Policy Debate*, *Journal of Housing Research*, *Journal of Real Estate Finance and Economics*, *Property Management*, *International Real Estate Review*, and *Real Estate Economics*. She is a member of Counselors in Real Estate and a fellow of the Weimer School of Advanced Studies in Real Estate and Land Economics.

Courchane was the executive vice president of the American Real Estate and Urban Economics Association (2008–2019). She has also held positions at Freddie Mac, the Office of the Comptroller of the Currency, and at various universities, including the University of Victoria, Canterbury University, the University of British Columbia, and North Carolina State University. She has a Ph.D. and an M.A. in economics from Northwestern University.

Ben Craig

Economic and Policy Advisor, Federal Reserve Bank of Cleveland

Ben Craig is an economic and policy advisor in the Research Department at the Federal Reserve Bank of Cleveland. He specializes in the economics of networks, banking, and finance, with an emphasis on empirical structural modeling. Before joining the Bank in 1994, Craig was an assistant professor of economics at Indiana University. He also taught at Washington State University, Stanford University, and the University of Konstanz in Germany. He was a visiting scholar at the Bundesbank in Germany in 2001, 2007–2008, and 2012–2014. Craig has a Ph.D. from Stanford University and a B.A. (with honors) from Harvard University.

Alexander D'Amour

Senior Scientist, Google Research

Alexander D'Amour is a senior research scientist at Google Research. His research is focused on the intersection of causality and machine learning, highlighting how we can use machine learning to more effectively answer causal questions and how we can use concepts from causal inference to make machine learning more robust, fair, and trustworthy. D'Amour has also worked in a number of application areas, including sports analytics, marketing, and epidemiology. Prior to joining Google, he was a visiting assistant professor in the Department of Statistics at the University of California, Berkeley. He has a Ph.D. from Harvard University's Department of Statistics.

Talia Gillis

Associate Professor, Columbia Law School

Talia Gillis is an associate professor at Columbia Law School and an affiliate of Columbia University's Data Science Institute, studying the law and economics of consumer markets. She is interested in household financial behavior and how consumer welfare is shaped by technological and legal changes. In her research, she has studied the impact of regulatory tools, such as financial disclosures and fiduciary duties on consumer welfare. She also uses insights from psychology to empirically study the way households manage their financial ebbs and flows. Some of her recent work considers how artificial intelligence, and consumer fintech more broadly, is affecting consumers and raises distributional concerns. Gillis has a Ph.D. from Harvard Law School and is completing a Ph.D. in business economics at Harvard University.

Robert M. Hunt

Associate Director
Consumer Finance Institute, and Senior Vice President
Federal Reserve Bank of Philadelphia

Robert (Bob) M. Hunt is senior vice president and associate director of the Bank's Consumer Finance Institute (CFI), which studies the credit and payment markets to understand how they affect consumers and the economy. His research within the CFI focuses on gaps in our understanding of consumer credit and payments. By filling in those holes, his research — and that of his colleagues — can make important contributions to the literature and inform important policy decisions.

Hunt conducts research on consumer payments, consumer finance, and the economics of innovation. His work includes studies of payment cards, adoption of new payment technologies, antitrust issues in consumer payment networks, identity theft, regulation of credit cards, mortgage default, consumer credit reporting, credit counseling organizations, and the collections industry. He has published papers covering economic geography and intellectual property.

Hunt joined the Bank in 1998. Prior to that, he worked for the U.S. Congressional Budget Office and began his career as an industry risk analyst for Bank One, Indianapolis. He has a Ph.D. in economics from the University of Pennsylvania and a bachelor's degree in political science and economics from Butler University.

Michael Kearns

Professor and National Center Chair
Department of Computer and Information Science
University of Pennsylvania

Michael Kearns is a professor in the Computer and Information Science Department at the University of Pennsylvania and is the National Center Chair. He also has secondary appointments in the Economics Department and in the departments of Statistics and Operations, Information, and Decisions in the Wharton School of the University of Pennsylvania. Kearns is the founding director of the Warren Center for Network and Data Sciences and the faculty founder and former director of Penn Engineering's Networked and Social Systems Engineering Program. He is also a faculty affiliate in Penn's Applied Math and Computational Science graduate program and was codirector of Penn's interdisciplinary Institute for Research in Cognitive Science until 2006.

Kearns also has had a role at Amazon since June 2020, focusing on fairness and privacy in machine learning and related topics within Amazon Web Services. Previously, Kearns worked extensively in quantitative and algorithmic trading on Wall Street (including at Lehman Brothers, Bank of America, SAC Capital, and Morgan Stanley). He is a frequent advisor to technology

companies and venture capital firms and is involved in the seed-stage fund Founder Collective. He is a member of the Scientific Advisory Board of the Alan Turing Institute as well as the Market Surveillance Advisory Group of FINRA. Kearns is an elected member/fellow of the National Academy of Sciences, the American Academy of Arts and Sciences, the Association for Computing Machinery, the Association for the Advancement of Artificial Intelligence, and the Society for the Advancement of Economic Theory.

Niki Kilbertus

Group Leader and Technical University Munich Junior Fellow
Technical University of Munich

Niki Kilbertus is a research group leader at Helmholtz AI and a junior fellow at the Technical University Munich. His research centers on building reliable machine learning systems that impact the health and well-being of people, with a focus on understanding cause-effect relationships from observational data. Kilbertus has a Ph.D. from the University of Cambridge as a Cambridge-Tübingen Fellow in Machine Learning and master's degrees in mathematics and physics from the University of Regensburg, Germany.

Dean Knox

Computational Social Scientist and Assistant Professor
University of Pennsylvania

Dean Knox is a computational social scientist and an assistant professor in Operations, Information, and Decisions at the Wharton School of the University of Pennsylvania. His methodological work revolves around causal inference and audiovisual data analysis; his substantive work involves policing reform and accountability. Together with Jonathan Mummolo, he cofounded Research on Policing Reform and Accountability. Knox is also a statistical consultant for the Department of Justice Civil Rights Division, the American Civil Liberties Union, and the National Association for the Advancement of Colored People. Knox's research has appeared or is forthcoming in the following publications: *Science*, the *Proceedings of the National Academy of Sciences*, the *Journal of the American Statistical Association*, the *Journal of Machine Learning Research*, and the *American Political Science Review*.

Matt Kusner

Associate Professor, University College London

Matt Kusner is an associate professor in machine learning at University College London. His research focuses on designing simple machine learning models tailored to the constraints of a problem, particularly in causal inference, social justice, private learning, and molecular/materials design. Kusner was a part of the first cohort of research fellows at the Alan Turing Institute in London, UK's National Institute for Data Science and Artificial

Intelligence. His work received the Turner Dissertation Award for best computer science and engineering doctoral dissertation. Before joining University College London, he was an associate professor at the University of Oxford and tutorial fellow at Jesus College. He has a Ph.D. in computer science from Washington University in St. Louis.

Jeanne R. Rentezelas

Senior Vice President and General Counsel
Federal Reserve Bank of Philadelphia

Jeanne R. Rentezelas is senior vice president and general counsel, overseeing the Federal Reserve Bank of Philadelphia's Legal Department. She is also the Bank's ethics officer. Before joining the Bank on June 21, 2010, Rentezelas was counsel at the Federal Deposit Insurance Corporation (FDIC) in Washington, D.C. She actively participated in briefing FDIC Chairman Sheila Bair and represented the FDIC in federal interagency meetings, including serving on the Payment Fraud Working Group and President Barack Obama's Nondiscrimination Working Group.

Prior to joining the FDIC, Rentezelas was of counsel with Stradley Ronon Stevens & Young, LLP, in Cherry Hill, NJ, where she advised banks and other financial institutions on various financial regulatory matters. Before that, she was vice president and senior assistant counsel with Popular Financial Holdings, Inc. of Marlton, NJ. She was also an associate in the financial services department of the Philadelphia office of Blank Rome, LLP, and a law clerk to Federal Magistrate Judge M. Faith Angell. Rentezelas is a graduate of the Rutgers University School of Law and Cornell University.

Cynthia Rudin

Professor of Computer Science, Electrical and Computer Engineering, Statistical Science, and Biostatistics and Bioinformatics, Duke University

Cynthia Rudin is a professor of computer science, electrical and computer engineering, statistical science, and biostatistics and bioinformatics at Duke University. In this role, she directs the Prediction Analysis Lab, with a main focus in interpretable machine learning. Previously, Rudin held positions at MIT, Columbia University, and New York University.

Rudin is the winner of the 2021 Squirrel AI Award for Artificial Intelligence for the Benefit of Humanity from the Association for the Advancement of Artificial Intelligence (AAAI). She is a three-time winner of the INFORMS Innovative Applications in Analytics Award, was named as one of the Top 40 Under 40 by Poets and Quants in 2015, and was named by Businessinsider.com as one of the 12 most impressive professors at MIT in 2015. She is a fellow of the American Statistical Association and a fellow of the Institute of Mathematical Statistics.

Rudin is past chair of both the INFORMS Data Mining Section and the Statistical Learning and Data Science Section of the American Statistical Association. She was also on committees for DARPA [Defense Advanced Research Projects Agency], the National Institute of Justice, AAAI, and ACM SIGKDD [Association for Computing Machinery's Special Interest Group on Knowledge

Discovery and Data Mining]. She was on three committees for the National Academies of Sciences, Engineering and Medicine, including the Committee on Applied and Theoretical Statistics, the Committee on Law and Justice, and the Committee on Analytic Research Foundations for the Next-Generation Electric Grid. She has given keynote/invited talks at several conferences including KDD, AISTATS [Artificial Intelligence and Statistics Conference], CODE, Machine Learning in Healthcare, Fairness, Accountability and Transparency in Machine Learning, and ECML-PKDD [European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases]. She has a Ph.D. from Princeton University and an undergraduate degree from the University at Buffalo.

Minchul Shin

Economic Advisor and Machine Learning Economist
Federal Reserve Bank of Philadelphia

Minchul Shin is an econometrician/data scientist with both theoretical and empirical interests. At the Bank, he has been developing new econometric, statistical, and machine learning tools that can be used in economic forecasting, macroeconomics, and urban economics. In addition, he helps develop and implement machine learning methods and applications for other areas of the Bank that are working on projects with big data and text data.

Shin is an associate editor of the *International Journal of Forecasting* and has published scholarly articles in economic and statistic journals, including the *Journal of Econometrics*, the *Journal of the American Statistical Association*, the *Review of Economics and Statistics*. Prior to joining the Bank, Minchul was an assistant professor of economics at the University of Illinois. He has a Ph.D. in economics from the University of Pennsylvania and master's and bachelor's degrees in economics from Sungkyunkwan University, Korea.

Jann Spiess

Assistant Professor
Operations, Information, and Technology Group
Stanford University

Jann Spiess is an assistant professor in the Operations, Information, and Technology Group at the Stanford Graduate School of Business. He works on integrating techniques and insights from machine learning into the econometric toolbox and is particularly interested in implications of machine learning for causal inference, policy, and regulation, and the role of human and machine decisions in replicable and robust inferences from big data. He previously was a postdoctoral researcher in economics at Microsoft Research New England. He has a Ph.D. in economics from Harvard University and has a background in public policy and mathematics.

Jenn Wortman Vaughan

Senior Principal Researcher, Microsoft Research

Jenn Wortman Vaughan is a senior principal researcher at Microsoft Research in New York City. Her research background is in machine learning and algorithmic economics. She is especially interested in the interaction between people and artificial intelligence and has often studied this interaction in the context of prediction markets and other crowdsourcing systems. She has recently turned her attention to human-centered approaches to transparency, interpretability, and fairness in machine learning as part of Microsoft Research's FATE group and cochair of Microsoft's Aether Working Group on Transparency.

Vaughan joined Microsoft Research in 2012 from the University of California, Los Angeles, where she was an assistant professor in the Computer Science Department. She is the recipient of Penn's 2009 Rubinoff dissertation award for innovative applications of computer technology, a National Science Foundation CAREER award, a Presidential Early Career Award for Scientists and Engineers, and several best paper awards. In addition, Vaughan is involved in providing support for women in computer science; most notably, she cofounded the Annual Workshop for Women in Machine Learning, which has been held each year since 2006. She has a Ph.D. from the University of Pennsylvania, and subsequently spent a year as a computing innovation fellow at Harvard.