

# Hadi Elzayn

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<https://hzelzayn.github.io/>

## EDUCATION

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<b>Stanford University</b> <i>Postdoctoral Fellowship in Machine Learning and Public Policy</i>	<b>Stanford, CA</b> 01/2021-03/22
<b>The University of Pennsylvania</b> <i>Ph.D. in Applied Mathematics and Computational Science</i> <i>M.A. in Applied Mathematics and Computational Science</i> <b>Dissertation:</b> <i>Essays on Algorithms, Markets, and Society</i> <b>Advisor:</b> Michael Kearns Benjamin Franklin Fellowship	<b>Philadelphia, PA</b> 12/2020 08/2018
<b>Columbia University</b> <i>Bachelor of Arts: Double Major in Mathematics and Economics</i> Economics Departmental Honors; <i>Cum Laude</i> , Jonathan Throne Kopit Memorial Prize in Logic and Rhetoric	<b>New York, NY</b> 05/2013

## RESEARCH INTERESTS

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Algorithmic fairness + public policy; machine learning; algorithmic game theory

## MANUSCRIPTS & CONFERENCE PRESENTATIONS - SOCIAL SCIENCE

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<b>Measuring and Mitigating Racial Disparities in Tax Audits</b> Elzayn, Smith, Ramesh, Hertz, Fisher, Ho, Goldin	Reject & Resubmit: <i>Quarterly Journal of Economics</i>
<b>Measuring and Mitigating Racial Disparities in Tax Audits</b> National Bureau of Economics Research - Public Economics Meeting Elzayn, Smith, Ramesh, Hertz, Fisher, Ho, Goldin	<b>NBER, Cambridge, MA</b> 10/2022
<b>How Fair is the Mortgage Market? Adapting Fair Machine Learning for Real-world Systems</b> <i>INFORMS 2020, Machine Learning and Markets session</i> Elzayn, Freyaldenhoven, Shin	<b>Virtual</b> 11/2020

## PEER-REVIEWED PUBLICATIONS AND PRESENTATIONS - COMPUTER SCIENCE

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<b>Algorithmic Fairness and Vertical Equity: Income Fairness with Tax Audit Models</b> <i>Association for Computing Machinery's Fairness, Accountability, and Transparency</i> Black, Elzayn, Chouldechova, Goldin, Ho	2022
<b>Equilibria in Auctions with Ad Types</b> <i>Association for Computing Machinery's TheWebConf</i> Elzayn, Colini-Baldeschi, Lan, and Schrijvers	2022
<b>Algorithms and Learning for Fair Portfolio Design</b> <i>Association for Computing Machinery's Economics and Computation</i> Diana, Dick, Elzayn, Kearns, Schutzman, Sharif-Malvajerdi, Roth, Ziani	2021
<b>Differentially Private Call Auctions and Market Impact</b> <i>Association for Computing Machinery's Economics and Computation</i> Diana, Elzayn, Kearns, Roth, Sharif-Malvajerdi, Ziani	2020
<b>The Effect of Competition and Regulation on Error Inequality in Data-Driven Markets</b> <i>Association for Computing Machinery's Fairness, Accountability, and Transparency</i> <i>Association for Computing Machinery's Economics and Computation (oral presentation)</i> <i>Neural and Information Processing Systems AI For Social Good Workshop (best poster)</i> Elzayn, Fish	2020

<b>Equilibrium Characterization for Data Acquisition Games</b> <i>International Joint Conference on Artificial Intelligence</i> Dong, <b>Elzayn</b> , Jabbari, Kearns, Schutzman	2019
<b>Price of Privacy in the Keynesian Beauty Contest</b> <i>Association for Computing Machinery's Economics and Computation</i> <b>Elzayn</b> , Schutzman	2019
<b>Hidden Information, Teamwork, and Prediction in Trick-Taking Card Games</b> (extended abstract) <i>Reinforcement Learning and Decision-Making</i> <b>Elzayn</b> , Fereydounian, Hayhoe, Kumar	2019
<b>Fair Algorithms for Learning in Allocation Problems</b> <i>Association for Computing Machinery's Fairness, Accountability, and Transparency</i> <b>Elzayn</b> , Jabbari, Jung, Kearns, Neel, Roth, Schutzman	2019

## SELECTED WORKS IN PROGRESS

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**Measuring and Mitigating Disparities in Machine Learned Models**  
**Elzayn**, Black, Vossler, Jo, Ho, Goldin

**Ecological Inference via Partial Identification**  
**Elzayn**, Goldin, Guage, Ho

**How Fair is the Mortgage Market? Adapting Fair Machine Learning for Real-world Systems**  
**Elzayn**, Freyaldenhoven, Shin

## PUBLIC ENGAGEMENT

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Selected Engagement for **Measuring and Mitigating Racial Disparities in Tax Audits** : [NYT](#) | [NPR Morning Edition](#) | [House Ways & Means](#) | [NPR 1A](#) | [USA Today](#) | [WWJ News Radio](#) | [Tax Notes](#) | [Axios](#) | [Slate Money](#) | [Mother Jones](#) | [The Hill](#) | [NPR Cincinnati Edition](#) | [Tax Chats podcast](#) | [ABC11 Raleigh-Durham](#) | [Senate Finance Committee](#) | [Warren Letter](#) | [Werfel Letter](#) | [Supreme Court](#)

[Radical ideas spread through social media. Are the algorithms to blame?](#) 2019  
*PBS Nova* – named interview

[Why Algorithms Need Ethics \(and How We Can Teach Them\)](#) 2019  
*University of Pennsylvania 60-second SLAM lecture*

## RESEARCH WORK EXPERIENCE

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**Meta Platforms** **Menlo Park, CA**  
*Research Scientist, Ads Fairness Team* 03/2022-present

- Designed/built novel product interacting with multiple Meta ad stack systems to ensure fair Targeting
- Scaled product to run on hundreds of thousands of ads daily and conducted comprehensive A/B testing
- Drove extensive research and implemented fairness metrics grounded on contemporary literature, fostering transparent and ethical ad practices
- Collaborated cross-functionally with legal, policy, and product marketing teams, aiding in the successful launch and realization of the project

*Systems and Infrastructure Software Engineering PhD Intern (joint with Core Data Science)* 06/2020-08/2020

- Designed and implemented new, more efficient real-time auction algorithms in production C++ codebase
- Designed and implemented auction system with multiple pricing and allocation algorithms for quick offline experimentation
- Formulated no-regret learning-based algorithms to study real-world equilibrium performance of various auction formats under realistic valuation distributions
- Investigated and determined limits on welfare and revenue for novel auction formats under general conditions, and Bayes-Nash equilibrium strategies for natural special cases.

- Characterized bounds on welfare and revenue under general conditions and Bayes-Nash equilibrium strategies for natural special cases for novel auction formats

### **Stanford University - RegLab**

*External Affiliate*

*Postdoctoral Fellow*

**Stanford, CA**

03/2022-present

01/2021-03/22

- Drove multiple research projects and managed teams from 2-6 researchers including post-docs, graduate students, research fellows, and external collaborators, resulting in publication at ACM FAccT and pre-print *Measuring and Mitigating Racial Disparities in Tax Audits* cited by policymakers, legislators, NGOs, and the Supreme Court
- Developed novel econometric method with rigorous mathematical theory combining race imputations with outcomes and obtain novel, credible bounds on disparity without ground truth protected class status
- Oversaw entire data analytics process across multiple projects including pre-processing, analysis, econometric modeling, and machine learning pipelines; personally authored majority of code and mentored graduate students and research fellows on best practices for data analytic work
- Conceived and constructed core data analytics components — spanning pre-processing, in-depth analysis, econometric modeling, and machine learning pipelines — which became the backbone for multiple projects. Oversaw team members building on initial efforts and mentored graduate students and research fellows on best practices for rigorous data analytic work

### **Federal Reserve Bank of Philadelphia**

*PhD Research Analyst*

**Philadelphia, PA**

02/2020-05/2020; 09/2020-03/22

- Combined advanced machine learning techniques with algorithmic fairness literature to measure fairness of the U.S. mortgage market as a whole according to a suite of metrics
- Managed data from millions of mortgage applications and repayment histories, including data cleaning, merging, and analysis. Constructed gradient-boosted decision tree models to predict default risk with highly accurate default rankings and calibration after accounting for macroeconomic trends
- Designed, simulated, and implemented machine-learning based strategy to collate multiple applications belonging to a single borrower from anonymized data, allowing for measurement of individual treatment
- Coauthored two working papers with Federal Reserve Bank economists

### **Microsoft Research**

*PhD Research Intern*

**Montreal, QC**

06/2019-09/2019

- Combined learning theory with industrial organization to model data-driven markets and to characterize group-wise error inequality as well as the effects of various models of competition and regulation on fairness outcomes and firm profits, resulting in publication at ACM FAT\*.
- Modeled feedback loops in customer subgroup retention and data collection in online learning settings, and developed algorithmic approaches to mitigate representation disparity

### **TGG Group (The Greatest Good)**

*Senior Associate, Associate*

**Chicago, IL**

09/2013-04/2016

- Developed sampling and two-stage regression procedure to overcome computational constraints and applied quasi-experimental differences-in-differences framework to estimate price elasticity of demand for Fortune-100 financial adviser. Identified evidence of gaming behavior induced by discontinuous marginal incentives via data forensic analysis
- Computed bootstrapped test statistics via random assignment of placebo treatments in order to mitigate effects of auto- and spatial correlation on standard errors and estimate price elasticity for Fortune-100 credit card acquirer. Designed randomized control trial protocol.
- Designed and implemented a negotiation framework using Final Offer Arbitration on behalf of Fortune-100 insurance company to credibly signal a best offer and avoid costly litigation, as part of estimated \$1B+ value project. Created decision aids to reduce random variation (“noise”) in claims evaluation and premium-setting and analyzed efficacy through results of randomized control trial

## **COLLABORATIONS IN OTHER DISCIPLINES**

**Heart transplant waiting list implications of increased ventricular assist device use as a bridge to transplant: a national analysis**

2021

*Artificial Organs*

**Elzayn, Duda, Acker, Patrick, Iyengar, Helmers, Birati, Atluri**

**Heart waiting-list implications of increased ventricular assistive device transplant use as bridge to transplant: a national database analysis** (abstract) 2019

*Society of Thoracic Surgeons*

Han, Elzayn, Atluri

**Long-term impacts of reducing pulmonary vascular resistance with VAD therapy in bridge-to-transplant patients** (abstract) 2017

*American Surgical Association IO*

Han, Kanade, Chung, Chen, Elzayn, Gaffey, Rame, Acker, Atluri

## INVITED PRESENTATIONS

**Measuring and Mitigating Racial Disparities in Tax Audits** Virtual

*UC Berkeley Opportunity Lab* (Race and the Tax Safety Net System) (scheduled) 12/2023

*Congressional Budget Office* 04/2023

*Simons Theory of Computation 4 Fairness Seminar* 03/2023

*Government Accountability Office* 03/2023

*ABC Coalition* 03/2023

**Measuring and Mitigating Racial Disparities in Tax Audits** Cambridge, MA

*National Bureau of Economics Research - Public Economics Meeting* 10/2022

**Fair Algorithms for Learning and Allocation Problems** Virtual

*Facebook Fairness Group* 07/2020

**Differentially Private Call Auctions and Market Impact** Virtual

*Drexel University Theory Seminar* 07/2020

*Facebook Economics, Algorithms, and Optimization Group* 07/2020

**Fairness, Learning, and Economics** London, UK

*Cervest Earth* 01/2020

## INVITED CONFERENCES

**Simons Collaboration on the Theory of Algorithmic Fairness** 02/2024

*Annual Meeting (attendee)*

## PUBLICATION TALKS

**Differentially Private Call Auctions and Market Impact** Virtual

*ACM EC 2020* 07/2020

**The Effect of Competition and Regulation on Error Inequality in Data-Driven Markets** Barcelona, ES

*ACM FAT\* 2020* 01/2020

**The Effect of Competition and Regulation on Error Inequality in Data-Driven Markets** Vancouver, BC

*NeuRIPS AI for Social Good Workshop 2019* 12/2019

**The Price of Privacy in the Keynesian Beauty Contest** Phoenix, AZ

*ACM EC 2019* 06/2019

## PEDAGOGICAL TALKS

**Fast Rates in Statistical and Online Learning** Philadelphia, PA

*Advanced Machine Learning* 11/2018

**Deep Dive: Theory for Generative Adversarial Networks** Philadelphia, PA

*Deep Learning Seminar* 09/2018

## TEACHING AND MENTORING

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<b>Penn Mathematics – Undergraduate Directed Reading Program</b> <i>Mentor</i>	<b>University of Pennsylvania</b> Spring 2020
<b>NETS 412: Algorithmic Game Theory</b> <i>Teaching Assistant for Bo Waggoner</i>	<b>University of Pennsylvania</b> Spring 2018
<b>AMCS 602: Algebraic Techniques I</b> <i>Grader for Zhenfu Wang</i>	<b>University of Pennsylvania</b> Fall 2018
<b>ECON W3211: Intermediate Microeconomics</b> <i>Teaching Assistant for Susan Elmes</i>	<b>Columbia University</b> Fall 2012

## PROFESSIONAL SERVICE

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<b>ACM Conference on Economics and Computation</b> Program Committee	<b>Budapest, HU</b> 2021
<b>AAAI Conference on Artificial Intelligence</b> <i>Reviewer</i>	<b>Vancouver</b> 2021
<b>Machine Learning and Economic Policy Workshop at NeurIPS 2020</b> <i>Reviewer</i>	<b>Virtual</b> 2020
<b>ML Retrospectives, Surveys, and Meta-analyses Workshop at NeurIPS 2020</b> <i>Reviewer</i>	<b>Virtual</b> 2020
<b>Journal of Machine Learning Research</b> <i>Reviewer</i>	<b>Virtual</b> 2020
<b>Conference on Neural Information Processing Systems</b> <i>Reviewer</i>	<b>Virtual</b> 2020
<b>ACM EC Algorithmic Game Theory Mentoring Workshop</b> <i>Mentor</i>	<b>Virtual</b> 2020
<b>ACM Conference on Economics and Computation</b> <i>Subreviewer</i>	<b>Virtual</b> 2020
<b>International Conference on Machine Learning</b> <i>Reviewer (top 1/3 of reviewers)</i>	<b>Vancouver, BC</b> 2020
<b>ACM Conference on Economics and Computation</b> <i>Reviewer</i>	<b>Budapest, HU</b> 2020
<b>AAAI Conference on Artificial Intelligence</b> <i>Reviewer</i>	<b>New York, NY</b> 2020
<b>Conference on Neural Information Processing Systems</b> <i>Reviewer (top 5% of reviewers)</i>	<b>Vancouver, BC</b> 2019
<b>International Conference on Machine Learning</b>	<b>Long Beach, CA</b>

Reviewer

2019

ACM Conference on Economics and Computation

Ithaca, NY

Subreviewer

2018

## SKILLS

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**Programming Languages:** Python, R, SQL, JavaScript, C++

**Tools, Packages, and Applications:** Matlab, Stata, SAS, LaTeX, HTML, CSS, jQuery, D3, MS Office Suite

**Languages:** English (native), Arabic (intermediate), Spanish (proficient), French (intermediate)

## VOLUNTEER SERVICE

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**PA Democrats Victory 2020**

**Philadelphia, PA**

*Data munging*

10/2020

**Kayany Foundation Schools for Syrian Refugees**

**Bekaa Valley, LB**

*Teacher*

07/2016

## MISCELLANEOUS

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**Citadel Datathon:** 3<sup>rd</sup> Place team finish 2020 Summer Invitational

**Citadel AI Competition:** Participant Terminal Live 2020 Penn vs. Princeton

**Citadel Datathon:** 2<sup>nd</sup> Place team finish 2019 East Coast Regional

**American University of Beirut**

**Beirut, LB**

*CAMES Summer Language Institute, Intermediate Arabic*

08/2010

## INTERESTS

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Fencing, Mountaineering, Oud

## REFERENCES

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### **Jacob Goldin**

Richard M. Lipton Professor of Tax Law

University of Chicago

773-702-9494

[jsgoldin@uchicago.edu](mailto:jsgoldin@uchicago.edu)

### **Daniel E. Ho**

William Benjamin Scott and Luna M. Scott Professor of Law

Professor of Political Science

Stanford University

650-723-9560

[dho@law.stanford.edu](mailto:dho@law.stanford.edu)

### **Michael Kearns**

Professor of Computer Science

University of Pennsylvania

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