Hadi Elzayn

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http://www.math.upenn.edu/~hads

EDUCATION

The University of Pennsylvania	**Philadelphia, PA**
Ph.D. in Applied Mathematics and Computational Science	08/2016-2021 (expected)
M.A. in Applied Mathematics and Computational Science	08/2018

- **Advisor:** Michael Kearns
- **Selected Coursework:** Advanced Machine Learning, Algorithms, Graduate Analysis I (Complex and Real Analysis), Graduate Analysis II (Real and Functional Analysis), Probability Theory, Stochastic Processes, Numerical Linear Algebra, Computational Learning Theory, Game Theory, Adaptive Data Analysis, Deep Learning, Market Design

Columbia University	**New York, NY**
Bachelor of Arts: Double Major in Mathematics and Economics	05/2013

- **GPA:** 3.8 / 4.0; *Cum Laude*
- **Economics Departmental Honors**
- **Jonathan Throne Kopit Memorial Prize in Logic and Rhetoric**
- **Selected Coursework:** Graduate Microeconomics, Advanced Econometrics, Advanced Macroeconomics, Linear Algebra, Analysis and Optimization, Real Analysis I-II, Planar Lattice Models, Data Structures and Algorithms in C

PEER-REVIEWED PUBLICATIONS

The Effect of Competition and Regulation on Error Inequality in Data-Driven Markets	**ACM FAT* 2020**
(Oral presentation and best poster award at NeuRIPS 2019 AI for Social Good Workshop)	
Elzayn, Fish	
Equilibrium Characterization for Data Acquisition Games	**IJCAI 2019**
Dong, Elzayn, Jabbari, Kearns, Schutzman	
The Price of Privacy in the Keynesian Beauty Contest	**EC 2019**
Elzayn, Schutzman	
Hidden Information, Teamwork, and Prediction in Trick-Taking Card Games (extended abstract)	**RLDM 2019**
Elzayn, Fereydounian, Hayhoe, Kumar	
Fair Algorithms for Learning in Allocation Problems	**ACM FAT* 2019**
Elzayn, Jabbari, Jung, Kearns, Neel, Roth, Schutzman	
Heart waiting-list implications of increased ventricular assistive device transplant use as bridge to transplant: a national database analysis (abstract)	**STS 2019**
Han, Elzayn, Atluri	
Long-term impacts of reducing pulmonary vascular resistance with VAD therapy in bridge-to-transplant patients (abstract)	**ASAIO 2017**
Han, Kanade, Chung, Chen, Elzayn, Gaffey, Rame, Acker, Atluri	

TEACHING EXPERIENCE

NETS 412: Algorithmic Game Theory	**University of Pennsylvania**
Teaching Assistant for Bo Waggoner	Spring 2018
AMCS 602: Algebraic Techniques I	**University of Pennsylvania**
Grader for Zhenfu Wang	Fall 2017

PROFESSIONAL SERVICE

AAAI Conference on Artificial Intelligence	**New York, NY**
Reviewer	2020
Conference on Neural Information Processing Systems	**Vancouver, BC**
Reviewer (top 5%)	2019
International Conference on Machine Learning	**Long Beach, CA**
Reviewer	2019
ACM Conference on Economics and Computation	**Ithaca, NY**
Reviewer	2018

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PUBLICATION TALKS

The Effect of Competition and Regulation on Error Inequality in Data-Driven Markets	**Vancouver, BC**
NeuRIPS AI for Social Good Workshop 2019	12/14/2019
The Price of Privacy in the Keynesian Beauty Contest	**Phoenix, AZ**
ACM EC 2019	*06/27/19*

PROFESSIONAL DEVELOPMENT

ACM FAT* Doctoral Consortium	**Atlanta, GA**
Attendee	2019
EC Algorithmic Game Theory Mentoring Workshop	**Ithaca, NY**
Attendee	2018

PEDAGOGICAL TALKS

Fast Rates in Statistical and Online Learning	**Philadelphia, PA**
Advanced Machine Learning	11/20/18
Deep Dive: Theory for Generative Adversarial Networks	**Philadelphia, PA**
Deep Learning Seminar	09/25/18

RESEARCH PROJECTS – BRIEF SUMMARIES

The Effect of Competition and Regulation on Error Inequality in Data-Driven Markets   **ACM FAT* 2020**

Elzayn, Fish

We create a stylized framework to study intrinsic economic incentives that create error inequality in data-driven markets. Using learning theory, we abstract the process of developing machine-learning models into the choice of data investment required to achieve a given worst-case error rate. Then, we model the interaction between firms and consumers using industrial organization theory. We find that a monopolist will underinvest in data collection for minority groups, and that introducing competition does not eliminate this tendency under all but the most extreme models of competition. We then show how to formalize two notions of regulation - relative error inequality and absolute error-bounds – and show that these can change the incentives of firms, albeit at a quantifiable cost (to the firm and potentially majority group) we call the price of fairness. Our work suggests that mitigating fairness concerns may require policy-driven solutions, not only technological ones.

The Price of Privacy in the Keynesian Beauty Contest   **SIGECOM EC 2019**

Elzayn, Schutzman

We extend the Keynesian Beauty Pageant (a classical coordination game) to incorporate privacy costs, which we formalize using the posterior variance of Bayesian opponents' inference of private signals. We characterize the unique symmetric linear Bayes-Nash equilibrium and calculate worst-case bounds on the price of privacy.

Fair Algorithms for Learning in Allocation Problems   **ACM FAT* 2019**

Elzayn, Jabbari, Jung, Kearns, Neel, Roth, Schutzman

We formulate a model of a setting in which an allocator wishes to allocate a fixed number of resources to groups with candidates/targets for the resource and non-candidate, and provide an appropriate, novel notion of allocative fairness. We give an algorithm that maximizes the allocator's objective function subject to fairness constraints in the case of known distributions; we also study learning in a repeated setting, and show worst-case impossibility results for 'natural' algorithms, but provide an algorithm (based on maximum likelihood estimation) with convergence guarantees under distributional assumptions. Applications include problems as diverse as loan allocation and predictive policing.

Equilibrium Characterization for Data Acquisition Games   **IJCAI 2019**

Dong, Elzayn, Jabbari, Kearns, Schutzman

We formulate a strategic model of data acquisition and model selection between competing firms that provide products based on machine learning algorithms. We show a reduction, via computational learning theory, to a simpler strategy space, and solve for pure and mixed strategy equilibria. We characterize the tension between consumer and firm welfare under the possible parameter regimes.

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Hidden Information, Teamwork, and Prediction in Trick-Taking Card Games   **RLDM 2019**
(extended abstract)
Elzayn, Fereydounian, Hayhoe, Kumar
We design and implement a deep reinforcement learning style algorithm to play a team-based, closed hand, trick-taking card game with betting (called *400* – similar to spades and contract bridge). We architect and implement a convolutional neural network to evaluate hand value, and implement an end-to-end training and testing process with the Keras library in Python to reach human-competitive performance through 100,000 games of self-play.

Learning and Optimizing for Long-Term Population Effects   **Manuscript**
Elzayn, Jabbari, Kearns, Roth
We use a Markov Decision Process framework to capture a stylized model of a credit market with population-level feedback loops. We design a learning algorithm and prove finite-sample convergence for a mixed stochastic/deterministic design. We characterize the optimal policy and value functions using the recursive structure of the model, and implement value iteration in Matlab to compute the optimal policy.

WORK EXPERIENCE

Microsoft Research   **Montreal, QC**
Research Intern   06/2019-2019
- Combined learning theory with industrial organization to model data-driven markets and to characterize group-wise error inequality and firms profits under competition and regulation

Two Sigma Investments   **Philadelphia, PA**
Consultant   02/2019-05/2019
- Created new feature set predictive of residual returns from SEC data, used econometric techniques to test for statistical and economic significance, and calculated financial metrics on strategy

TGG Group (The Greatest Good)   **Chicago, IL**
Associate, Senior Associate   09/2013-04/2016
- Used quasi-experiment and differences-in-differences framework to estimate price elasticity of demand for financial advising. Created sampling and two-stage regression process to overcome computational constraints on large dataset and estimate fixed effects. Identified evidence of gaming behavior induced by discontinuous marginal incentives (with Steve Levitt)
- 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 large credit card acquirer. Designed randomized control trial protocol (with Chad Syverson)
- Designed and implemented a negotiation framework using Final Offer Arbitration on behalf of a large insurance company to credibly signal a best offer and avoid costly litigation (with Max Bazerman)
- Created decision aids to reduce random variation ("noise") in claims evaluation and premium-setting and analyzed efficacy through results of randomized control trial (with Daniel Kahneman)

TGG Group (The Greatest Good)   **Chicago, IL**
Summer Associate   06/2012-08/2012
- Built linear regression model trained on SEC filings to identify firms likely committing accounting fraud

STARTUP EXPERIENCE

StaffMeal   **Chicago, IL**
Co-Founder   10/2015-06/2016
- Founded company to connect up-and-coming chefs from fine/unique dining scene in Chicago to customers throwing in-home dinner parties
- Executed multiple contracts for positive profits and managed implementation of MVP software product, chef approval, menu testing, inventory purchase, and in-home events

AskZuma   **Chicago, IL**
CEO   10/2015-08/2016

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- Built proof-of-concept in python and managed team of programmers implementing product – a web/mobile app paired with white-glove service to help users avoid getting ripped off in their car repairs
- Grew estimate base from zero estimates to 30K monthly via organic growth and users from zero to several thousand
- Managed relationships with data suppliers and automotive companies, trained adjusters in customer handling process, oversaw branding development and marketing

SKILLS

Programming Languages: R, Python, SQL, JavaScript,
Tools, Packages, and Applications: Matlab, Stata, SAS, LaTeX, HTML, CSS, jQuery, D3, MS Office Suite
Languages: English (native), Arabic (intermediate), Spanish (proficient), French (intermediate)

MISCELLANEOUS

Citadel Datathon: 2nd Place finish 2019 East Coast Regional

INTERESTS

Fencing, Muay Thai, Mountaineering, Oud