# Biased Programmers? Or Biased Training Data? A Field Experiment about Algorithmic Bias

Bo Cowgill and Fabrizio Dell'Acqua
Columbia Business School

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## 1 Overview

Why does "algorithmic bias" occur? Several high-profile cases allege algorithmic bias in criminal sentencing (Angwin et al., 2016), lending (Tan et al., 2017), recruiting (Lambrecht and Tucker, 2016), hiring (Ajunwa et al., 2016) and ad targeting (Datta et al., 2015) – raising policy questions about transparency, interpretability and bias. Scholars have proposed various plausible reasons, but almost no literature has measured the underlying cause of this discrimination.

Our research aims to address this gap using a field experiment in the setting of a machine learning prediction contest.[1] We are already in active conversation with several companies in this space willing to work with us, and may also be able to operate such a contest independently.

Our contest will be designed experimentally to allow us to measure the two most frequently cited reasons for algorithmic bias. The first possible reason ("biased programmers") alleges that the high-tech workforce at machine learning companies discriminates. Most engineers in the technology sector are white or Asian men.

These engineers may not be deliberately biased, but their approach to developing an algorithm may be influenced by their life experiences. For example, they may pay less attention to variables in the training data that are correlated with underserved demographics. Or they may look at particular training examples, measures of accuracy, or empirical applications of their algorithm that could bias the algorithm during development.[2]

The second theory is "biased training data" (Mullainathan and Obermeyer, 2017; Cowgill, 2017). Most machine learning applications are developed using historical data about outcomes. Such data may reflect historical biases about who is more (or less) likely to be labeled a criminal, or to be considered a future engineer or candidate for a high-paying job.

[1] For example, Kaggle, TopCoder, CorrelationOne, DrivenData, HackerRank, Halite, etc.

[2] One alleged example of this may have taken place in 2015, when Google released a photos product that offensively mislabeled African Americans (Forbes.com, 2015). Had Google's product developers had been more diverse, perhaps the problem would have been avoided.

"Biased training data" may particularly come from sample selection problems. Suppose a bank wants to use machine learning to predict who will repay loans. If their historical dataset contains few loans to ethnic minorities, these algorithms may accidentally sustain, or even exacerbate, historically biased lending decisions.

Our field experiment aims to measure the sizes of these contributors so their contributions can be directly compared on a common scale. Knowing the relative sizes of these biases will give practitioners practical guidance about combating it. If the dominant problem is "biased programmers," then the solution is to invest in diversifying the high-tech workforce and possibly training programmers to counteract subconscious biases.

Alternatively: If the problem is "biased training data," the solution is to seek out higher quality data, and to invest in developing and teaching technical methods to model and adjust for biases. There is very little research quantifying or comparing these contributing factors.

## 2 Experimental Design

In our experiment, we will recruit programmers into a data science competition. For our research design, we will need to recruit a diverse group of engineers. As participants register, they will receive a training dataset to utilize in predicting an outcome. The outcome will be related to an event that historically exhibited bias against a particular group.[3]

Subjects will be randomly assigned to one of two different conditions. In the first condition, engineers will receive unbiased training data. We will develop or obtain a training dataset for these programmers that is free of sample-selection bias – one where we have example outcomes for training on a truly representative group. This will permit these programmers to utilize unbiased training data in their algorithms.

In the second condition, participants receive similar dataset as above. However, this dataset will contain realistic sample-selection bias. For example: It will contain performance data only for job candidates who were hired in a demographically unbalanced way (in line with historical patterns). This second group will face similar incentives to develop the most accurate predictive algorithm using the training data.

These two groups will then enter a competition in which prizes and bonuses are awarded according to accuracy of predictions.[4] Rewards will be given according to how accurately each programmer labels a set of new observations.

The new observations used for testing would be drawn from a representative distribution containing members of minority and majority groups. Even if programmers were given training data

[3] We have several ideas about exactly what setting, but have not settled on a final decision. The programmers may be asked to predict (for example) who will get a job interview, who will be arrested or found guilty at trial, or who will score well on a particular measure of ability.

[4] Although we refer to our setting as a "programming contest," we will design incentives to avoid the risk-seeking behavior that contests and tournaments may encourage (Rosen, 1988) by rewarding coders per unit of accuracy. Our team has prior empirical and theoretical research about tournament incentives (Cowgill, 2016), particularly in the setting of software engineering.

with sample selection issues, they would be evaluated using a sample without selection bias.[5]

With this experiment, we can assess how badly the problem of biased training data influenced performance of the algorithms in a setting with real-world machine learning practitioners.

In addition, we aim to measure how much the characteristics of the programmers influence their predictions. As previously stated, we need for the participants in the study to be diverse, so that we can measure the relationship between an engineers' demographics and their algorithms' accuracy. The premise of the "biased programmers" hypothesis (and of its policy solutions) is that different demographic groups differ in their attention to variables correlated with historically underrepresented demographics. In particular, minority programmers may build more accurate and socially-conscious algorithms because of the salience of bias in the programers' lives.

We will then compare the prediction and performance differences between coders with biased data (and without) and between those from typical high-tech demographics (and otherwise). By measuring accuracy for different types of predictions on a common scale – by engineers with whose input data demographics may vary – we can measure the relative contributions of biased programmers and biased data.[6]

By generating data through the contest described above, we would provide some of the first insights into the underlying sources of algorithmic bias. In particular, we could quantify and compare the sources of two plausibly large reasons for algorithmic discrimination. We believe the growing community of researchers studying algorithmic discrimination will be interested in our results – no matter which way they go.

## Budget

- Because this topic is related to the high-tech workforce and the application of novel digital technology to economic decisions, we are applying for multiple NBER small grants (Innovation, Entrepreneurship and Digitization). We understand if our proposal is a better fit for some some of these awards more than others.
- Our budget is larger than the NBER small grant, and thus we are seeking additional outside funding.
- All funds will be used for one of two expenses:
  - Prizes or bonuses to our research subjects (the programmers in a contest). The bulk of expenses will go towards this. We have estimates below.
  - Research assistance from an undergraduate or graduate student in administering the contest and cleaning the data.

[5] We feel that this is how many real-world applications work: Models trained using unrepresentative datasets (sometimes "datasets of convenience") are often deployed in practice on a larger population. For example, the hiring algorithm in Hoffman et al. (2017) was based on training data on employees only, but was applied to make assessments about all job applicants, including ones very different than the firms' historical set of employees. Cowgill (2017) contains a theory model about when and why this may (or may not) create problems.

[6] We are also considering adding a condition in which programmers receive some training or reminder about possible algorithmic bias.

- If we do not reach our full fundraising goals, research assistance will be cut.

| Budget Request | Estimate |
|---|---|
| Bonuses and Prizes for Programmers<br>100 programmers x two arms x $100 average per person accuracy bonus | $20,000.00 |
| Undergraduate or Graduate Student Research Assistance | $3,000.00 |
| Total | $23,000.00 |

## Research Team

Do not hesitate to contact us if we can answer your questions about our proposal. Our CVs are attached to the end of this document.


| **Bo Cowgill, Assistant Professor** | **Fabrizio Dell'Acqua, PhD student** |
|---|---|
| Columbia Business School | Columbia Business School |
| CBS Directory | CBS Directory |
| http://bocowgill.org/ | fdellacqua21@gsb.columbia.edu |
| bo.cowgill@gsb.columbia.edu | (646) 575 2510 |
| (650) 492-8252 | |

## References


**Ajunwa, Ifeoma, Sorelle Friedler, Carlos E Scheidegger, and Suresh Venkatasubramanian**, "Hiring by algorithm: predicting and preventing disparate impact," 2016.

**Angwin, Julia, Jeff Larson, Surya Mattu, and Lauren Kirchner**, "Machine bias: There's software used across the country to predict future criminals. and it's biased against blacks," *ProPublica, May*, 2016, *23*.

**Cowgill, Bo**, "Competition and Productivity in Employee Promotion Contests," 2016.

_ , "Automating Judgement and Decisionmaking: Theory and Evidence from Résumé Screening," *Working paper*, 2017.

**Datta, Amit, Michael Carl Tschantz, and Anupam Datta**, "Automated experiments on ad privacy settings," *Proceedings on Privacy Enhancing Technologies*, 2015, *2015* (1), 92–112.

**Hoffman, Mitchell, Lisa B Kahn, and Danielle Li**, "Discretion in hiring," *The Quarterly Journal of Economics*, 2017, *133* (2), 765–800.

**Lambrecht, Anja and Catherine E Tucker**, "Algorithmic Bias? An Empirical Study into Apparent Gender-Based Discrimination in the Display of STEM Career Ads," 2016.

**Mullainathan, Sendhil and Ziad Obermeyer**, "Does Machine Learning Automate Moral Hazard and Error?," *American Economic Review*, 2017, *107* (5), 476–480.

**Rosen, Sherwin**, "Promotions, elections and other contests," *Journal of Institutional and Theoretical Economics (JITE)/Zeitschrift für die gesamte Staatswissenschaft*, 1988, *144* (1), 73–90.

**Tan, Sarah, Rich Caruana, Giles Hooker, and Yin Lou**, "Detecting Bias in Black-Box Models Using Transparent Model Distillation," *arXiv preprint arXiv:1710.06169*, 2017.

# Bo Cowgill

Columbia Business School, New York, NY
http://bocowgill.org, bo.cowgill@columbia.edu

## Academic Affiliations

**Columbia University, Graduate School of Business**. Assistant Professor, 2016-present.
**Center for Economic Studies + Ifo Institute (CESifo)**. Research affiliate, 2017-present. Economics of Digitization Area.
**Data Science Institute**, Columbia University. Research affiliate in Computational Social Science, Cybersecurity areas. 2018-present.
**J. Robert Beyster Fellowship** (Fall 2015). New York City, NY.

## Education

**University of California, Berkeley**, Berkeley, CA, USA
PhD, Business and Public Policy, Haas School of Business. 2015.
MS, Business Administration (Business and Public Policy). 2011.
*Committee*: John Morgan (Chair), Noam Yuchtman, Stefano DellaVigna, David Card.

**Stanford University**, Palo Alto, CA, USA
MS, Statistics 2007-2009 (unfinished). Employer sponsored (Google).
BA, Public Policy, 2004. Undergraduate Senate Chair (elected), Byrd Scholar.

## Publications

"Corporate Prediction Markets: Evidence from Google, Ford, and Firm X," *Review of Economic Studies*, Volume 82, Issue 4, October 2015, 1309-1341. Extended abstract in *EC'14* (with Eric Zitzewitz).

"The Value of Hiring Through Employee Referrals," *Quarterly Journal of Economics*, Volume 130, Issue 2, May 2015, 805-839 (with Stephen Burks, Mitch Hoffman and Michael Housman).

"Television Advertising and Online Search," *Management Science*. Volume 60 Issue 1, January 2014, pp. 56-73 (with Mingyu Joo, Kenneth C. Wilbur and Yi Zhu).

## Working Papers

"Using Prediction Markets to Track Information Flows," with Justin Wolfers and Eric Zitzewitz.

"Mood Swings at Work: Stock Price Movements, Effort and Decision Making," with Eric Zitzewitz.

"The US-Canada Border Effect: Evidence from Online Commerce" and "Worldwide Gravity in Online Commerce." (with Cosmina Dorobantu).

"Competition and Productivity in Employee Promotion Contests."

"Does online trade live up to the promise of a borderless world? Evidence from the EU Digital Single Market."With Cosmina Dorobantu and Bertin Martens.

"Bias and Productivity in Humans and Algorithms: Theory and Evidence from Résumé Screening."Formerly titled, "The Labor Market Effects of Hiring through Machine Learning." *Draft available by email.*

"Do Incentive Stock Options Incent? Evidence from a Natural Experiment in Employee Options Pricing," with Eric Zitzewitz.

"Algorithmic Bias: A Counterfactual Perspective," with Catherine Tucker. December 2017.

"From Russia, with Labor: The Effect of the Ruble Collapse on the Market for Software Engineering," with John Horton. Dec 2017.

"Competition and Specificity in Market Design: Evidence from Geotargeted Advertising." (with Cosmina Dorobantu) *Draft available by email.*

"Agency and Homophily: Evidence from Recruiting Software Engineers." with Dan Wang.

"The Value of an Additional Job Offer: Field Experimental Evidence."

"The Impact of Algorithms on Judicial Discretion: Evidence from Regression Discontinuities."

## Work In Progress

"Market Design for Job Assignments: Theory and Evidence from Tech Workers." With Rem Koning. "Centralized Internal Labor Markets: A Field Experiment Matching Managers and Workers in Vietnam." (with Zoe Cullen)

"Online Labor Markets and Spatial Labor Misallocation Developing Economies: A Field Experiment in Virtual Migration." (with Zoe Cullen, Sam Bazzi and Rizki Siregar) and "The Value of Online Jobs in Developing Countries: Evidence from a Field Experiment." (with Natalie Carlson)

"Launching Two-Sided Markets." (with John Morgan)

"Biased Programmers? Or Biased Data? A Field Experiment in Algorithmic Discrimination." (with Fabrizio Dell'Acqua)

"Labor Market Segregation: Employers' Preferences? Or Workers'?"

"MBA Admissions, Clustering and Values: A Machine Learning Approach" with Paul Ingram and Yoojin Choi.

## Awards, Fellowships and Grants

**Kauffman Junior Faculty Fellowship in Entrepreneurship Research**. 2017. Competitive research award for junior faculty in innovation and/or entrepreneurship.

**CESifo Prize** in Economics of Digitization ("Distinguished Affiliate"). 2017. For a young research economist for the scientific originality, policy relevance and quality of exposition.

**J-PAL Southeast Asia IRF Grant Award**. 2017. Grant for field experiment about digital jobs in developing economies.

**Chazen Institute Faculty Research Grant Award**. 2017.

**W.E. Upjohn Institute 2016 Early Career Research Grant**. 2016. Competitive research award for early career faculty in labor economics and public policy.

**Kauffman Dissertation Fellowship** (2012-2013). Competitive research award for PhD students studying innovation and/or entrepreneurship.

**J. Robert Beyster Fellowship** (2014-2015). Competitive award for scholars studying management, innovation, technology and employee ownership.

**John D. C. Little Award** (2015), given annually to the best marketing-related paper published in *Management Science* or *Marketing Science*.

**Winner, Ronald H. Coase Dissertation Award**, 2016. Society for Institutional & Organizational Economics (SIOE).

**Winner, Best Paper**, Workshop on Information Systems and Economics (WISE). 2016.

**Frank M. Bass Dissertation Paper Award Finalist** (one of three, 2015), given annually to the best marketing paper derived from a Ph.D. thesis published in *Management Science* or *Marketing Science*.

**Wiley Blackwell Award for Outstanding Dissertation Research in Business Policy and Strategy Finalist**, 2016. One of six. Academy of Management, Business Policy and Strategy Division (BPS).

**Technology in Management Best Dissertation Award Finalist**, 2016. One of four. Academy of Management, Technology in Management Division (TIM).

**INFORMS TIMES Best Dissertation Award Finalist**, 2017. One of five. INFORMS, Technology, Innovation Management and Entrepreneurship Section (TIMES).

**Society for Business Ethics Best Dissertation Award Finalist**, 2016. One of three.

**European Commission, Joint Research Centre**. Appointment and Grant. Independent Expert for the EU's Digital Agenda. For research about cross-border ecommerce. With Cosmina Dorobantu, 2013.

**IARPA Research Award: IARPA-BAA-10-05** (2011-2012): PhD supported by grant from US intelligence research agency supporting research about forecasting and information aggregation. RA for winning team ("The Good Judgement Project") in US Government forecasting competition.

**Berkeley Graduate Fellowships**: Full PhD tuition, stipend and travel support.

## Invited Academic Presentations

**2018** (inc. planned/invited): Stanford Conference on Hiring, NBER Summer Institute (Personnel), Behavioral Decision Research in Management (BDRM, 3×), AOM (Strategy, Careers), 14th Annual Smith Entrepreneurship Research Conference (Maryland), Harvard Gender and Technology Conference, Microsoft Research, Yahoo! Research.

**2017**: MIT (Org Econ), NBER Labor Studies (Cambridge, MA), Wharton (Operations, Information and Decisions), MIT (Sloan/IDE), OECD & IZA Joint Workshop on Labor Productivity and the Digital Economy, CESifo (Area Conference on the Economics of Digitization), American Economic Association (AEA) Annual Meetings (Chicago), Organization Science Winter Conference (Utah), Winter Strategy Conference (Utah), Columbia Business School, Rutgers (Economics), Society of Labor Economists (SOLE) Annual Meetings, University of Chicago Crime Lab, Marketing Science Conference (UCLA), INFORMS' Advances in Decision Analysis Conference, City University of New York (Econ. Seminar), INFORMS Annual Conference (Houston), HBS (Innovations and Institutions Conference, 10/2017), REER Conference (Georgia Tech), NSF Conference on Trustworthy Algorithms (Arlington, VA). Declined for scheduling reasons: Amazon Computational Social Science Routable (10/2017, Seattle, WA), Microsoft Research, Yahoo Research!, UC Irvine, Cornell, Temple.

**2016**: NBER Economics of Digitization (Stanford), NBER Summer Institute (Labor/Personnel), Harvard EconCS (Economics and Computer Science) Seminar, Summer Institute in Competitive Strategy (Berkeley/Haas), Tinbergen Institute, Universidad Carlos III de Madrid, NYU/Stern Creativity and Innovation Seminar (3/2016), Kauffman Emerging Scholars Conference, Collective Intelligence 2016 Conference (plenary speaker), Stanford (CASBS), Academy of Management Annual Conference (Best Dissertation Presentations, TIM and BPS), Wharton People and Organizations (Plenary, 9/2016), University of Chicago (Advances in Field Experiments, 9/2016), NYU Information Systems Seminar (11/2016), HBS (Innovations and Institutions Conference, 10/2016), Workshop on Information Systems and Economics (WISE, 12/2016), Google Quantitative Analyst Summit (3/2016). Declined for scheduling reasons: Economics of Strategy Workshop (NYU/Stern, 6/2016), IC2S2 (2nd Annual International Conference on Computational Social Science).

**2015**: Kellogg (MEDS), University of Michigan (Econ), Harvard Business School (NOM), London School of Economics (Management), Harvard Business School (TOM), 2015 Empirical Management Conference (Stanford), Harvard Business School (Innovations and Institutions Conference, 11/2015), Kauffman/UToronto/FSU Workshop on Experimental Economics and Entrepreneurship, UT Austin (Economics), WUSTL Olin (Econ), Georgia Tech Scheller (Strategy), Wharton People and Organizations (Plenary, 10/2015), Vanderbilt (Strategic Management). Declined for scheduling reasons: University College London (Management), University of Virginia (Darden), Valve Software, Square, Stanford/Berkeley Doctoral Student Conference.

**2014**: Columbia Business School, The Fifteenth ACM Conference on Economics and Computation (*EC'14*), Emory (Goizueta ISOM), Kauffman Emerging Scholars (10/2014), Academy of Management Annual Meeting (8/2014), INFORMS Annual Meeting: Empirical Market Design Session (11/2014), Collective Intelligence 2014, Wharton People and Organizations (Plenary, 10/2014), eLance/oDesk Research Seminar (5/2014), Consortium on Competitiveness and Cooperation ("CCC") Doctoral Conference (4/2014), Beyster Symposium 2014, Berkeley Innovation Seminar (4/2014), All California Labor Economics Conference (poster, 10/2014).

**2013**: NBER Market Design Working Group (10/2013), Wharton People and Organizations Conference (Breakout 9/2013), *Computation in California*, (Ken Judd's Summer meeting of computational economists at Stanford, 7/2013), *EC'13* (6/2013), Berkeley Psych/Econ Non-Lunch (9/2013).

**Earlier**: Kauffman Foundation conference on Information Markets (11/2007), Google Faculty Summit (2007), Conference on Auctions, Market Mechanisms and Their Applications (AMMA, 2008), Center for Collective Intelligence (CCI) Seminar, Massachusetts Institutes of Technology (2008), Collective Intelligence FooCamp (Google Headquarters, Mountain View, 2008).

## Selective Institutes and Workshops

| | |
|---|---|
| 2017 | Russell Sage Foundation Summer Institute in Computational Social Science |
| 2016 | Summer Institute For Behavioral and Social Scientists: "Organizations and Their Effectiveness" Stanford Center for Advanced Study in the Behavioral Sciences (CASBS) |
| 2016 | Russell Sage Foundation Summer Institute in Social-Science Genomics (declined due to scheduling) |
| 2015 | Chicago Summer Institute on Field Experiments |
| 2015 | Kauffman/UToronto/FSU Workshop on Experimental Economics and Entrepreneurship |
| 2015 | NBER Economics of Digitization Tutorial |
| 2014 | Zurich Institute of Computational Economics |
| 2013 | Harvard Behavioral Science PhD Workshop |
| 2012 | NBER Entrepreneurship Research Summer Bootcamp |
| 2011 | University of Chicago Price Theory Summer Camp |

## Invited Discussant

The Mid-Year Fellows Workshop in Honor of Louis O. Kelso (January 2016).
*10th & 11th NYU-Columbia Doctoral Conference*. Moderator and discussant for human capital session (2016, 2017).
*Workshop on Information Systems and Economics*. December 2016.
*American Economic Association Meetings*. January 2017 (declined for scheduling reasons).
*NBER Summer Institute*. Economics of Digitization meeting. July 2017.
*NBER Summer Institute*. Entrepreneurship Bootcamp Alumni Panel. July 2017.

## Refereeing

*Management Science*, *European Economic Review*, *Journal of Labor Economics*, *Marketing Science*, *Journal of Law, Economics and Organization*, *The Economic Journal*, *Decision Analysis*, *17th ACM Conference on Economics and Computation ("*EC'16*")*, *Information Economics and Policy*, Google Faculty Research Awards, *Collective Intelligence'15* (Conference), *Global Environmental Change*.

## Session Organizing

- *ACM EC'13*. Session: "Econometrics for Computer Scientists."
- *AOM 2014*. Symposium: "Skills, Innovation and Mobility in Knowledge Workers."
- *Collective Intelligence '15*. Organizing Committee.
- *17th ACM Conference on Economics and Computation ("*EC'16*")*. Program Committee (2016).
- *Stanford Institute for Theoretical Economics 2014, Numerical Methods in Economics*. Offsite session at Google: "Ad auctions and quantum computing."
- *10th and 11th NYU-Columbia Doctoral Conference*. 2016, 2017. Moderator and discussant for human capital session.
- Professional Development Workshop (PWD) at Academy of Management (AOM) Annual Meeting, 2017 (Atlanta).
  - *Technology in Management (TIM) Doctoral Research Development Workshop.*
  - *Business Policy and Strategy (BPS) Doctoral Research Development Workshop.*

## Practitioner Talks

eLance/oDesk (5/2014), McKinsey Global Strategy Conference 2007 (Dubai), McKinsey Global Strategy Conference 2008 (Barcelona), US Defense Department, Highlands Forum (2008), National Intelligence Council Long-Term Strategic Analysis Workshop (2008). O'Reilly Money:Tech Conference (2008), O'Reilly ETech (2008), Beyster Symposium 2014, Google Faculty Summit (2007). Declined/rescheduled (2015): Valve Software, Square.

**Teaching**

*Strategy Formulation*, Columbia Business School EMBA/MBA/undergrad. Spring/Fall 2017.
*Technology Immersion*, Columbia Business School. Spring 2017.
*PhD Proseminar*, Columbia Business School. Fall 2017.
*Data and Decisions (MBA Statistics)*, Haas School of Business, UC Berkeley. GSI, Fall 2012.
*MBA Guest Lectures*: Northwestern/Kellogg (3/2010), Wharton/UPenn (4/2009), Stanford MS&E (2008), Stanford Stats (2007, 2008), MIT/Sloan (2007, 2008), Harvard Business School (2007, 2008), Columbia Technology Business MBA Student Group (2017).

**Other Writing**

"Good Bet: Can Markets Forecast Election Results?" With Cass Sunstein. The New Republic. November 21, 2006.

"McKinsey Quarterly: The promise of prediction markets" with Renee Dye, James Suroweicki, Todd Henderson and Todd Sverts. Second Quarter Edition, 2008.

"The Future of Work," with Ufuk Akcigit, Robert Seamans and Oren Ziv. *Kauffman Foundation State of the Field Series*, 2017.

**Outside Activities**

Consulting on information technology topics.

**Selected Press & Case Coverage**

Research about employee referrals in New York Times:

- **Scientific Management Redux: The Difference is in the Data** by Steve Lohr. 4/21/2013. link
- **How Big Data Is Playing Recruiter for Specialized Workers**. by Matt Richtel. 4/27/2013. link

Research on internal prediction markets in New York Times:

- **At Google, Workers are placing their Bets** by Ian Austen. 11/26/2005. link.
- **Future Divined by the Crowd** by Joe Nocera. 3/07/2006. link.
- **Google's Lunchtime Betting Game** by Noam Cohen. 1/7/2008. link.

Protagonist, **Harvard Business School Case Study N9-607-088: Prediction Markets at Google**. link.

**Financial Times: Table Talk** by Tim Harford. 1/19/2008. link.

**Businessweek: Workers Place your Bets** by Rachel King. August 3, 2006. link.

**Bloomberg: Google Gets Answers as Staff Bets on GMail, 'Star Wars' Success** By Crayton Harrison, 7/10/2008. link.

**BBC World Service (Radio): Business Daily**: Feb 19, 2008 interview about markets inside of companies.

Updated: May 31, 2018

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## EDUCATION

Aug 2016 – ongoing, **Columbia Business School** — New York, USA

- PhD Student in Management

Sep 2015, **London Business School** — London, UK

- Master of Research in Economics

Oct 2013, **Università Luigi Bocconi** — Milan, Italy

- Master of Science in Economics and Social Sciences (DES/ESS)

Aug 2011, Sep 2012, **Allianz Summer Academy – Allianz Alumni Academy** — Munich – Berlin, Germany

Mar 2010, **Università Luigi Bocconi** — Milan, Italy

- Bachelor in Economics and Social Sciences
- 6-month Exchange Program: MGIMO University — Moscow, Russia

## WORK IN PROGRESS

*"CSR, Political Donations, and Political Access"*

*"Biased Programmers? Or Biased Training Data? Field Experimental Evidence on the Sources of Algorithmic Bias"* (with Bo Cowgill)

*"The Future of Work Routines and Knowledge: an Empirical Exploration"* (with Bruce Kogut and Patryk Perkowski)

*"Entrepreneurship Training and Migration: a Field Experiment in Southern Europe"* (with Andrea Contigiani)

## RESEARCH AND TEACHING EXPERIENCE

2017, **Columbia Business School**, Teaching Assistance for "*Strategy Formulation*", Dr. Bo Cowgill.

2015 and 2016, **London Business School**, Teaching Assistance for "*The Global Macroeconomy*", Dr. Hélène Rey. Review Sessions Lead Instructor. Average Student Evaluation Score: 4.68/5.

2015, **London Business School**, *Strategy and Entrepreneurship*, Research Assistance for Dr. Keyvan Vakili.

2014-16, **London Business School**, *Economics*, Research Assistance for Dr. Elias Papaioannou (RA work for "The long-run effects of the Scramble for Africa", *American Economic Review*, 2016), Dr. Paolo Surico, Dr. Richard Portes.

## WORK EXPERIENCE

Jul 2012 - Sep 2014, **Spotlime (Co-Founder and CMO - Data Analyst)** — Milan, Italy

- Mobile event app active in 12 Italian cities. Total funding of €1.2M

Mar 2012 - Apr 2013, **Rubicon Keys Ltd (Co-Founder and Director)** — London, UK

Aug 2011 – Oct 2012, **HousingExchange.it (Co-Founder) – Exit to HousingAnywhere.com** — Milan, Italy

Apr - Jul 2010, **Promos – Special Agency of Milan's Chamber of Commerce** — Moscow, Russia

## LANGUAGES AND IT SKILLS

**Languages:** Italian (native); English (fluent); Russian (professional); Written Latin.

**IT Skills**: Stata, R, Databases (SQL), Ruby on Rails, LaTeX, html, css, Python (basic).

## CONFERENCES AND OTHER ACHIEVEMENTS

2017, London Business School, Trans-Atlantic Doctoral Conference, Presenter

2017, The Wharton School, Wharton Social Impact Initiative, Doctoral Group Presenter

2016, London Business School, Trans-Atlantic Doctoral Conference, Presenter

2014 - 2016, Allianz Alumni Council, elected member

2013 - 2015, ESRC Studentship

2013 - 2015, Co-Founder of the European Startup Initiative, www.startupheatmap.eu. Conference "*Accelerate EU – Making Europe an easy place for startups*" (Allianz Cultural Foundation Jackpot winner project)

2011-2012, organizer of the Tunisia-EU Youth Workshop on the Arab Spring (ACF Jackpot winner project). The *Tunisian Human Rights League*, among the recipients of the *2015 Nobel Peace Prize*, participated to the workshop

2010, Bocconi ISU Grant