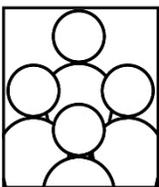
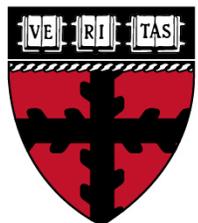


**Year in Review**  
**2016 - 2017**



**CRCS** Center for Research on  
Computation and Society

at Harvard John A. Paulson School of Engineering and Applied Sciences

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The Center for Research on Computation and Society (CRCS) at the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) is a multidisciplinary organization that brings together computer scientists and scholars from a broad range of fields to make advances in computational research that serves public interest. We are engaged in interdisciplinary projects in areas such as Economics & Computer Science; Healthcare Informatics; Privacy & Security; Technology & Accessibility; and Automation & Reproducibility of Data Analysis. CRCS is informed by a deep knowledge of the societal issues at stake and by a commitment to advancing the human condition through cutting edge collaboration between computational and social science.

At CRCS, we believe that the most powerful strides are made when researchers pool their expertise and work together. As such, we pride ourselves on our collaborations with sister organizations such as the Berkman Klein Center (BKC) and the Institute for Applied Computational Science (IACS).

The backbone of CRCS is its thriving postdoc program. In the 2016-2017 academic year, we hosted nine postdoctoral fellows from six countries, with diverse backgrounds and varying research interests. They have experience in everything from statistics to transportation engineering to healthcare informatics. Our postdocs share an open office, where they collaborate on projects and help one another at every stage of the research process, from conception to publication. Our postdocs are motivated to work together because they know that, through collaboration at CRCS, their work is made greater than the sum of its parts.

As this record of our year will attest, CRCS rejects the idea of opposing disciplinary poles. We are not merely conducting qualitative analysis of the status quo; nor are we doing quantitative research for research's sake alone. Rather, CRCS is designing a new future through the integration of computational and social science. We are creating new technologies ahead of economic demand, with a focus on social good. Our postdocs learn from one another other daily and assist one another with everything from the logistics of settling in Cambridge as an international scholar to finessing the technical details of a research problem. They are colleagues, mentors, and good friends. They share a mutual respect for one another's expertise and keep an eye on the scientific horizon. It is this wealth of shared knowledge that makes CRCS a special place in the Harvard community.

Perhaps most importantly, CRCS members possess the wisdom that we aren't working in a vacuum, that our research questions are best addressed from a breadth of disciplinary angles, and that the ultimate goal - the development of innovative technology for the betterment of society - is a collective rather than an individual endeavor.

Greetings CRCS fans!

I am delighted to be writing to you in our first ever annual report. When I became director of CRCS in 2015, I looked forward to connecting CRCS to the greater Harvard community. I'm happy to report that we've made great strides in that direction and that more remains to be done.

We continue our close, cooperative relationship with the Berkman Klein center, whose fellows frequently join us for CRCS events and with whom we often share visitors and speakers. A particular highlight this year was a visit from Justice Mariano-Florentino "Tino" Cuellar. Tino is an Associate Justice of the California Supreme Court and, more recently, a member of the Harvard Board of Overseers. He participated in a lively lunchtime discussion with our CRCS fellows. In other joint undertakings, we partnered with the Harvard Business School to host the second "Engineering and Entrepreneurship" event as part of Harvard's participation in Hubweek, Boston's annual innovation festival. Our day-long symposium featured a talk by Chicago CTO Brenna Berman, a case study presented by HBS Professor Rajiv Lal, and a series of technical talks by SEAS colleagues around the theme of the Internet of Things.

We continue to partner regularly with the Institute for Applied Computational Science, co-sponsoring the J-term ComputeFest, a Symposium entitled "Data, Dollars, and Algorithms: The Computational Economy," and the first ever Boston-area Women in Data Science event. We're also excited to report that we began joint postdoctoral activities with a select group of postdocs from the Harvard Medical school. Finally, we wrapped up the year with a timely event on Fake News, which drew participants from SEAS and IQSS as well as colleagues from local colleges and universities.

In addition to directing a great deal of energy externally, we improved our internal programming and developed a series of professional development events for our postdocs -- mentoring sessions, practice interviews, panel discussions, and of course, a series of fun community-building events. You'll all be relieved to know that our team successfully "escaped the room."

I am honored to be concluding my second year as director of CRCS, and I remain awed by the energy, enthusiasm, and passion of our community. I hope that all of you reading this will find an excuse to participate in our activities in the coming year.

Sincerely,  
Margo Seltzer  
Faculty Director, Center for Research on Computation and Society

# CRCS Faculty



Margo Seltzer, Herchel Smith Professor of Computer Science and Faculty Director of the Center for Research on Computation and Society, conducts research that ranges from designing and building new storage systems to building new operating systems to developing systems for collecting and tracking provenance of digital data.



Yiling Chen, Gordon McKay Professor of Computer Science, does research that is situated at the interface between computer science and economics and lies in the emerging area of social computing.



Stephen Chong, Gordon McKay Professor of Computer Science, conducts research that helps programmers write trustworthy programs. His primary area of interest is language-based information security: using programming language techniques to provide information security assurance.



Krzysztof Gajos, Gordon McKay professor of Computer Science, conducts research in human-computer interaction, artificial intelligence and applied machine learning. He studies how intelligent technologies enable new ways of interacting with computation and addresses the challenges that human limitations and preferences create for machine learning algorithms embedded in interactive systems.



Finale Doshi-Velez, Assistant Professor of Computer Science, conducts research in machine learning, computational statistics, and data science. By designing and implementing robust, principled models and developing probabilistic methods to address computational problems, Doshi-Velez is accelerating scientific progress and improving the practical impact of machine learning in healthcare and other domains.



Cynthia Dwork, Gordon McKay Professor of Computer Science, Radcliffe Alumnae Professor at the Radcliffe Institute for Advanced Study, and Affiliated Faculty at Harvard Law School, uses theoretical computer science to place societal problems on a firm mathematical foundation. Dwork has made significant contributions to the field of cryptography and is a PI on the Privacy Tools Project.



Barbara Grosz, Higgins Professor of Natural Sciences, works in Artificial Intelligence, with a focus on Collaborative Systems and Human-Computer Communication. One of her research goals is for computer-agent systems to function as successful team members over the long term and in uncertain, dynamic environments.



Scott Kuindersma, Assistant Professor of Engineering and Computer Science, is working toward increasing the efficiency, robustness, and versatility of highly dynamic and under-actuated robots. He is Director of the Harvard Agile Robotics Laboratory.



Harry Lewis, Gordon McKay Professor of Computer Science, has worked on the algorithmic solvability of logical, computational, and combinatorial systems, attempting to clarify the relations between them and to identify their common characteristics. Until recently, he served as Director of Undergraduate Studies in Computer Science. Lewis has authored fifteen books, including “Elements of the Theory of Computation,” “Blown to Bits,” and “Excellence Without a Soul.”



Na (Lina) Li, Assistant Professor in Electrical Engineering and Applied Mathematics, conducts research in the design, analysis, optimization and control of distributed network systems, with particular applications to power networks and systems biology/physiology.



James Mickens, Associate Professor of Computer Science, conducts research that focuses on the problems that arise when distributed systems must scale to many users and many machines, investigating how to provide high performance to those systems despite the presence of faulty or subverted machines.



David Parkes, George F. Colony Professor of Computer Science, has research interests that include: multi-agent systems, the digital economy, machine learning, causal inference, market design, preference modeling, bounded rationality, mechanism design, and algorithmic game theory.



Stuart Shieber, James O. Welch, Jr. and Virginia B. Welch Professor of Computer Science, conducts research in computational linguistics, the study of natural language from the standpoint of computer science.



Yaron Singer, Assistant Professor of Computer Science, is interested in algorithms, mechanisms, and data mining techniques that guide the design of systems powered by social interactions and data.



Latanya Sweeney, Professor of Government and Technology in Residence, conducts research that creates and uses technology to assess and solve societal, political and governance problems, teaching others how to do the same. Her research focuses on the scientific study of technology's impact on humankind and on data privacy.



Salil Vadhan, Vicky Joseph Professor of Computer Science and Applied Mathematics, conducts research that centers around the interface between computational complexity theory and cryptography, with a special focus on pseudorandomness. He also researches methods to improve the safety and efficacy of sharing research data and is lead PI on the Privacy Tools Project.



Jim Waldo, Gordon McKay Professor of the Practice of Computer Science, is the Chief Technology Officer for SEAS. His research focuses on distributed systems and privacy, as well as the intersection of technology and policy.



Jonathan Zittrain, George Bemis Professor of International Law, is co-founder and director of the Berkman Klein Center for Internet and Society. His research interests include battles for control of digital property and content, cryptography, electronic privacy, the roles of intermediaries within internet architecture, human computing, and the useful and unobtrusive deployment of technology in education.

# CRCS Fellows

We are proud to present the postdoctoral class of 2016 - 2017!

## Shiri Hassid, PhD



Shiri Hassid's research focuses on healthcare informatics from an interdisciplinary perspective. She integrates theories and tools from different disciplines: medicine, psychology and information technology. So far, her research has focused on the effects of Healthcare Information Technology (HIT) on the doctor-patient interaction and applying methodologies to maximize HIT use and potential without compromising patient-centered care. Her current research focuses on the use of electronic health records (EHRs) in inpatient care. As part of her research she spent time observing and interviewing clinicians working at Brigham and Women's Hospital medical wards to learn about the challenges they face with the current EHR. Shiri is funded by CRCS. We are pleased to announce that Shiri will continue her CRCS fellowship for another year. Her goal in the upcoming year is

to formulate solutions on the technological system design level and help design training solutions to improve EHR use.

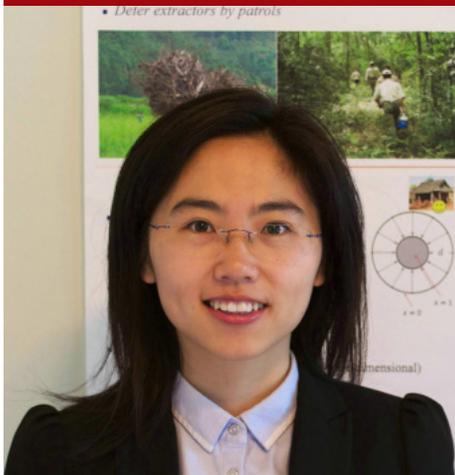
## Avshalom Elmalech, PhD



Avshalom Elmalech's research interests lie at the intersection of computer science and psychology. He is interested in automated methods for improving people's decision-making. He is exploring novel techniques to assist and support people with everyday decisions. He is currently investigating new techniques to effect people's behavior. In particular, he is interested in developing new methods to increase people's engagement level in domains such as healthcare and education. This year Avshalom focused on methods for improving people's behavior in online labor markets such as Amazon mechanical Turk. In one project, he demonstrated an innovative method to improve workers' attention span. In another, he presented new methods for improving workers' engagement on tasks that lack ground-truth. This year, Avshalom has been working on developing methods to coordinate

large scale meetings and improve participation rates in crowd based labor markets. He was funded by CRCS. Next year, Avshalom will start a tenure-track position at the information school of Bar Ilan University, Israel.

## Fei Fang, PhD



Fei Fang's research interest lies in Artificial Intelligence, focusing on multi-agent systems and game theory. This year, Fei has worked on several research projects. In one project, she designed a spatio-temporal pricing mechanism for surge pricing to maximize social welfare in ridesharing systems such as Uber. In collaboration with her fellow postdoc Avshalom Elmalech, she worked on scheduling working time for tasks that involve multiple rounds and multiple workers in online marketplaces such as Amazon Mechanical Turk. She has also worked on several projects in which she applies machine learning and game theory to protecting wildlife and forests from illegal activities such as poaching. Fei was funded by CRCS. She will join Carnegie Mellon University as an Assistant Professor in August 2017. She is planning to continue working on integrating machine learning and game theory

to design computational tools for various domains including security and sustainability. In 2017, Fei won the Best Dissertation Award in Computer Science and the William F. Ballhaus, Jr. Prize for Excellence in Graduate Engineering Research at the University of Southern California. Her dissertation was selected as the runner-up for IFAAMAS Victor Lessor Dissertation Award. Her paper, "Optimizing Peer Teaching to Enhance Team Performance," has been nominated as best paper for the First International Workshop on Teams in Multiagent Systems and has been selected for publication in the AAMAS 2017 Workshops Best Papers volume.

## Vishesh Karwa, PhD



Vishesh Karwa has been working on developing algorithms for differentially private confidence intervals for means and difference of means tests and differentially private causal inference. This year at CRCS, he has had two major accomplishments. Last year, he developed the theory and algorithms for estimating confidence intervals for the mean of a normal distribution with known and unknown variance. This year, he performed several empirical evaluations of these algorithms. He also developed new algorithms that work well in finite sample and use ideas from robust statistics, such as the trimmed mean and the median. He has extended these algorithms for estimating the confidence interval for difference-in-means when the data comes from a normal distribution. Finally, he is in the process of developing differentially private causal inference procedures. The first step toward this goal is to develop an algorithm that allows for matching

the treatment groups on relevant covariates. Once the matching is done, the next step is to estimate a difference of means on the matched dataset using appropriate weights. He has also developed a differentially private variant of a commonly used algorithm called Coarsened Exact matching, which is currently undergoing empirical evaluations. He hopes to incorporate these algorithms into the PSI tool by the end of the year. Vishesh was funded by CNS-1237235. He is leaving CRCS to join Ohio State University as a tenure-track assistant professor in the department of Statistics.

# Georgios Kellaris, PhD



George's research revolves around data security and privacy. He is a member of CRCS' Privacy Tools Project. As part of the Privacy Tools team, George has helped in designing applications and algorithms that allow people to use a tool called differential privacy – a rigorous mathematical definition of privacy that maximizes the accuracy of queries from statistical databases while minimizing the chances of identifying its records. He also contributes to a new project - organized by CRCS and funded by a grant from the National Science Foundation - on secure outsourced database systems. George (alongside researchers Kobbi Nissim, George Kollios, and Adam O'Neill) has designed efficient attacks that reconstruct the sensitive attributes of any database, independent of the encryption scheme. This work has been published in CCS '16. As a next step, he and his co-authors have developed a new paradigm where

strong cryptographic techniques are seamlessly combined with differential privacy to design new and provably secure database systems that are resilient to these attacks. George was funded by NSF grants 1237235 and 1565387. He is leaving CRCS to join TandemLaunch in Montreal as an Entrepreneur in Residence working towards commercializing his work on secure databases.

# Thomas Pasquier, PhD



Since July 2016, Thomas has worked as a post-doctoral research fellow in the lab of Professor Margo Seltzer. This year, alongside colleagues at Harvard Forest and CERN, he explored the use of data provenance to help with the reproduction of scientific experiments. Thomas' work also consists of a collaboration with colleagues at the University of Cambridge, England, that investigates how data provenance might be used to verify compliance with regulations. He also explored the use of machine learning algorithms to perform intrusion detection using data provenance in a cloud computing environment. Thomas is funded by NSF ACI-1450277. We are pleased to announce that Thomas will remain at CRCS for a second year, during which he will pursue research in the aforementioned areas and assist with adoption of the tools he has developed. In the coming year, he also plans to work on the verificaof

compliance in widely distributed systems.

# Goran Radanovic, PhD



The recent success in machine learning is largely a consequence of successful human-machine interactions. Goran's research interest lies in studying these interactions between humans and artificial intelligences from game theoretic and machine learning perspectives. This year at CRCS, his research focused on data elicitation and aggregation in crowdsourcing; reinforcement learning with AI and human agents; and fairness in machine learning. Goran is funded by NSF CCF-1301976. We are happy to say that Goran will be joining us for a second year at CRCS, during which he will be work on reinforcement learning algorithms for the helper AI problem; that is, the problem of designing an AI agent that improves the performance of a human agent, who acts sub-optimally either due to human behavioral biases or incorrect private information. Furthermore, Goran plans to work on expanding the existing

fairness frameworks and generalizing the findings of his preliminary work.

## Nisarg Shah, PhD



Nisarg Shah is broadly interested in research at the intersection of computer science and economics --- theory and applications. He has primarily focused on fair division, voting, game theory, peer prediction, and incentives in machine learning. In the past year at CRCS, he has worked on a variety of research projects. He extended peer prediction techniques, which incentivize truthful elicitation of subjective tastes, to handle heterogeneous users that exhibit different behaviors. He also investigated the feasibility of fairly dividing resources when the allocations to users are kept private. In ongoing work, he is designing strategy-proof and efficient linear regression algorithms and investigating the trade-off between elicitation and welfare maximization in voting. He was awarded the IFAAMAS Victor Lesser Distinguished Dissertation award, which is given to an outstanding doctoral

dissertation in the areas of autonomous agents or multiagent systems. Nisarg is funded by NSF CCF-1301976. In August 2017, Nisarg is joining the University of Toronto as an assistant professor in the department of Computer Science.

## Uri Stemmer, PhD



Many modern data analysts face the challenge of performing computations on sensitive individual data, while at the same time protecting the privacy of those individuals. Uri's work is focused on differential privacy, a mathematical definition for privacy providing rigorous guarantees. His research theme is driven by the following question: When can we construct privacy preserving analogues to existing data analysis algorithms, and what price do we pay? During his year at CRCS, Uri has been studying the compatibility of various data analysis tasks with differential privacy such as learning algorithms, histograms estimation, and clustering related tasks. He also studies the reverse connection between privacy and data analysis, namely: Can differential privacy be used as a tool to construct new (non-private) data analysis algorithms? In a new line of work, Uri studies the task of answering adaptively chosen statistical queries about a distribution

using a sample, and relates the problem to differential privacy, which can be used as a tool for obtaining accurate answers. This year, Uri has been working on ways to extend this connection between differential privacy and statistical validity. He is funded by NSF CNS-1565387. In November 2017, he intends to return home to Israel to pursue another fellowship.

# Bi-Weekly Seminar Series

CRCS hosts a bi-weekly seminar series featuring expert speakers from a range of disciplines. Speakers are chosen by CRCS postdocs according to their research interests. Lectures culminate in vibrant discussion and often lead to exciting research collaborations. To watch videos of past CRCS seminars, please visit our Youtube channel at: <https://www.youtube.com/user/HarvardCRCS>.

## **Empower the Defender with Unpredictability: Game-Theoretic Approaches for Real-World Security and Sustainability Challenges**

**Fei Fang**, Monday, September 12, 2016

Motivated by the problem of resource allocation in security and sustainability domains, Fang proposed models and algorithms to handle massive games with complex spatio-temporal settings. First, focusing on games where actions are taken over continuous time, she provided an efficient solution while accurately modeling the continuous action space. Second, for problems with repeated interaction such as preventing poaching and illegal fishing, she introduced the green security game model which accounts for adversaries' behavior change and provides algorithms to plan effective sequential defender strategies. Third, she incorporated complex terrain information and designed PAWS (Protection Assistant for Wildlife Security) which generates patrol routes to combat poaching. The applications of Fang's game-theoretic algorithms include deployments for protecting the Staten Island Ferry in New York City and tiger conservation in Southeast Asia. Fei Fang is a 2016 - 2017 CRCS Postdoc. She received her Ph.D. from the Department of Computer Science at the University of Southern California in 2016.

## **SwellRT: Facilitating decentralized real-time collaboration**

**Samer Hassan**, Monday, September 26, 2016

The Web 2.0 model, which has become mainstream in current online software platforms, has enabled user-driven participation and collaboration. However, it has also facilitated the emergence of centralized hubs of information that collect massive amounts of user data, with multiple negative impacts such as privacy issues, monopolies, surveillance and single legislation. Samer Hassan described how these issues have triggered the emergence of a new wave of decentralized technologies. He introduced SwellRT, a development framework for building decentralized, real-time, collaborative apps. Samer Hassan (PhD) is an activist and researcher, a fellow at the Berkman Klein Center for Internet & Society, and an associate professor at the Universidad Complutense de Madrid (Spain).

## **An Experimental Evaluation of Regret-Based Econometrics**

**Gali Noti**, Monday, October 3, 2016

Noti discussed her research on regret-based economics. Using data obtained in a controlled ad-auction experiment that she ran, she evaluated the regret-based approach to econometrics. She found that despite the weak regret-based assumptions, the results were at least as accurate as those obtained using classical equilibrium-based assumptions. She studied to what extent humans actually minimize

regret and found a significant difference between the “high types” who indeed rationally minimized regret and the “low types” who significantly over-bid in the ad-auction. Gali Noti is a PhD student at the School of Computer Science and at the Center for the Study of Rationality, at the Hebrew University of Jerusalem.

## **Social Cognition in Virtual Reality**

**Mazharin Banaji**, Monday, October 24, 2016

Can we use technology to neither deceive participants nor give up creating “mundane realism” – the feeling that the lab experience is close to what a person might experience in the real world? Banaji discussed what early studies have shown in response to this question and proposed a

collaboration with attendees on experiments in “Social Cognition in Virtual Reality” Using VR, these experiments would study how we view those who are different from us along lines of gender, race, sexuality, age, etc. They would attempt to shift the sense of self - through virtual reality - to allow participants to effectively “be” someone else. Banaji suggested that VR can help us address the important question of how flexible and changeable our social categories truly are. Mazharin Banaji is Richard Clarke Cabot Professor of Social Ethics in the department of Psychology at Harvard while also serving as the first Carol K. Pforzheimer Professor at the Radcliffe Institute for Advanced Study.



## **Visual Urban Sensing**

**Nikhil Naik**, Monday, November 7, 2016

Street View services have documented the visual appearance of more than 3,000 cities across the world in the past decade. Naik’s research designs computer vision tools that harness Street View imagery to conduct computer-driven automated surveys of the built environment at street-level resolution and global scale. In this talk, he described two algorithms that computationally evaluate urban appearance from imagery. The first algorithm, Streetscore, quantifies the perceived safety of a street block by harnessing data from a crowdsourced game. The second algorithm quantifies the growth or decay of cities from time-series Street View imagery obtained over several years. Naik demonstrated the use of these algorithms for studying important questions in urban economics, sociology, and urban planning. Nikhil Naik is a PhD candidate at the MIT Media Laboratory.

## **Amazon’s Price and Sales-Rank Data – What can we Learn from the World’s Largest Online Retailer?**

**Jörn Boehnke**, Monday, November 21, 2016

Collecting data on online retail transactions is increasingly common, but it is a challenge to collect data that are directly comparable over time and across products. In this seminar, Boehnke discussed how his team circumvented this problem by analyzing graphs containing price histories from sites that track Amazon’s prices and sales-ranks. He extracted the underlying data from the graphs to reverse-engineer a price series going back as far as 2008. Using these data, he attempted to identify (1)

sales volumes from sales ranks, (2) strategic algorithmic price setting, and (3) temporary “sales” prices to distinguish between theories of price stickiness. Jörn Boehnke joined the Center for Mathematical Sciences and Applications at Harvard University as a postdoctoral fellow in 2015.

## Using Design Thinking to Improve Patient Safety

**Wanda Pratt**, Monday, January 30, 2017

Recent studies indicate that medical errors are the third leading cause of death in the United States. Although this problem has received substantial national attention, very little work has actively involved patients in preventing, detecting, and recovering from these errors. In this seminar, Pratt detailed her efforts to use design thinking to support patients and their caregivers in playing an active role to safeguard their own health in the hospital. Using mixed methods approaches, her research assesses the information needs of hospitalized patients and creates new technology designs and insights for how to address those needs. Dr. Wanda Pratt is a Professor in the Information School with an adjunct appointment in Biomedical & Health Informatics in the Medical School at the University of Washington.

## Perpetually enhancing human learning through collaborative, dynamic, personalized experimentation

**Joseph Jay Williams**, Monday, February 13, 2017

There is a proliferation of websites and mobile apps for helping people acquire information and learn how to form positive health habits and behavior. In this seminar, Williams asked how we can use data from real-world users to rapidly enhance and personalize these technologies. He showed how we can build self-improving systems by reimagining randomized A/B experimentation as an engine for collaboration, dynamic enhancement, and personalization. He presented a series of self-improving systems, which use experiments as a bridge between designers, social-behavioral scientists and researchers in statistical machine learning. Joseph Jay Williams is a Research Fellow at Harvard’s Office of the Vice Provost for Advances in Learning, and a member of the Intelligent Interactive Systems Group in Computer Science.

## Challenges for Socially-Beneficial Artificial Intelligence

**Dan Weld**, Monday, February 27, 2017

Stephen Hawking, Bill Gates, and other luminaries warn that an “intelligence explosion” may lead to the extinction of humanity at the hands of rampant robots. At the same time, many pundits see a prosperous future in which self-driving cars reduce highway fatalities while AI advisors improve medical care and minimize malpractice. In this seminar, Weld argued that the utopian outcome is more likely, but only if we address several key social and technical challenges such as the accidental harm that AI systems have the potential to cause. Daniel S. Weld is Thomas J. Cable / WRF Professor of Computer Science & Engineering and Entrepreneurial Faculty Fellow at the University of Washington.



## **Utility-Cost of Provable Privacy: A Case Study on US Census Data**

**Ashwin Machanavajjhala**, Friday, March 10, 2017

Privacy is an important constraint that algorithms must satisfy when analyzing sensitive data from individuals. Differential privacy has revolutionized the way we reason about privacy and has enabled the creation of data analysis algorithms with provable privacy guarantees. In this seminar, Machanavajjhala highlighted key challenges in designing differentially private algorithms for emerging applications, and highlighted research from his group that tries to address these challenges. He described his recent work on modernizing the data publication process for a US Census Bureau data product, called LODS/OnTheMap. He demonstrated how he has been able to release summaries of the data with error comparable to, or even better than, current releases, which are not provably private. Ashwin Machanavajjhala is an Assistant Professor in the Department of Computer Science, Duke University.

## **Uncovering Vote Trading Through Networks and Computation**

**Ulrich Matter**, Monday, April 10, 2017

Vote trading, also commonly known as logrolling, is a cornerstone of the positive analysis of politicians' behavior in collective decision making. Matter has developed a general and scalable methodology that facilitates the detection of logrolling on a large scale. His approach can be applied to a broad variety of voting data and refined for specific contexts. It allows him to study whether the prevalence of logrolling differs between different institutional settings and how it evolves over time. The flexibility of his method is expected to shed new light on many aspects of legislative logrolling. In this seminar, he validated his method with a Monte Carlo study in which he had full control over the number of traded votes. Then he demonstrated his framework in an analysis of four decades of roll call voting in the U.S. Congress. Ulrich Matter is a researcher at the Berkman Klein Center for Internet & Society at Harvard University and an assistant professor in Applied Econometrics at the University of St. Gallen, Switzerland.

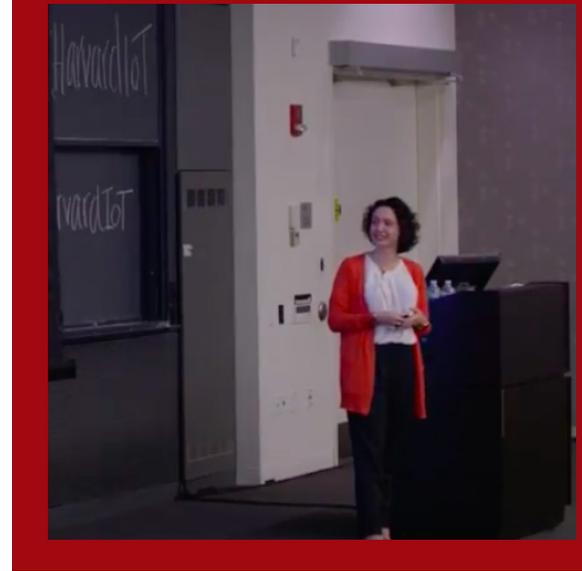
## **Forced Localization of Online Services – Is Privacy the Real Driver?**

**Christopher Millard**, Monday, April 24, 2017

The vision of an open, global Internet is increasingly threatened by the construction of virtual barriers between countries. Mistrust regarding the security of cloud computing and other online services is widespread, and the temperature of the global debate has risen dramatically since revelations of systematic, mass surveillance. Restrictions on data flows between the US and EU remain contentious. In 2018, a new EU Regulation on data protection comes into force with global reach and substantial penalties for non-compliance. This seminar explored the motivations behind Internet 'Balkanization' initiatives and provided examples of alternatives to location-based data sovereignty rules. Christopher Millard is Professor of Privacy and Information Law in the Centre for Commercial Law Studies, Queen Mary University of London (QMUL), and is Senior Counsel to the law firm Bristows.

# Special Events

CRCS hosts a number of special events throughout the year, designed to engage our diverse community at every level. Some events energize our postdocs and faculty, others bring CRCS into dialog with the broader Harvard community. Many events draw on our connections to the cities of Boston and Cambridge, while others expand our reach even further, harnessing collaborations across the country and around the world. Wherever you happen to be, we hope you will join us in the year ahead! For more information about past events, please visit the “Symposia and Special Events” tab at <https://crccs.seas.harvard.edu/>.



## Postdoc Mixers

One of CRCS’ goals is to help researchers develop the skills to communicate deep technical information across disciplinary boundaries. To this end, we hosted a series of professional development mixers for postdocs in CRCS and its sister organizations. These included:

### Making the Most of your Postdoc Experience

Monday, September 19, 2016

CS, Stats, and IACS postdocs attended this social event. After they were introduced to one another, they discussed their goals for the year. Finally, they honed their ability to describe what they do to their friends!

### Job Tricks and Treats: Preparing for the Job Circuit

Monday, October 31st, 2016

Postdocs prepared for interview season by conducting practice interviews with faculty. They learned to prepare materials, and paired with their peers to review research and teaching statements. Then they attended a Professional Development Panel, which included Q&A about the job search and tips for communicating your research to those in other fields. As it was Halloween, many of our postdocs came in creative costumes and shared seasonal treats.

### CRCS/HMS Mixer: Bridging the Gap between Medicine and Computer Science

Monday, March 27th, 2017

CRCS invited a select group of postdocs from Harvard Medical School to participate in a facilitated networking opportunity. Postdocs from CRCS and HMS delivered 1-slide “flash talks,” followed by discussion. The goal was to generate collaborations and identify projects of interest and innovation that bridge the gap between medicine and computer science.

## Hubweek Symposium

Hubweek is Boston's annual weeklong multidisciplinary innovation festival. It celebrates cutting-edge artistic, scientific, and technological accomplishment throughout the Boston area. In 2016, CRCS partnered with Harvard Business School and Hubweek for the second installment of an annual series on Engineering and Entrepreneurship.

### Engineering and Entrepreneurship: The Internet of Things

Friday, September 30, 2016



The “Internet of Things,” in which everyday objects possess network connectivity that allows them to send and receive data, is poised to radically transform the way we live and work. As part of its collaborative series on engineering and entrepreneurship, the Harvard John A. Paulson School of Engineering and Applied Sciences and the Harvard Business School hosted a symposium on the Internet of Things, exploring the thrilling opportunities it provides for technological innovation and social organization as well as its potential security risks. The event featured a keynote by Chicago Department of Innovation and Technology (DoIT) Commissioner and CIO Brenna Berman, lightning talks by experts in the field, and a case study discussion. The symposium culminated in transportation to the Hynes Convention Center for Demo Day, where local start-up companies, innovation labs, and change-making organizations shared their exciting new work that makes Boston a hub of visionary research.

Brenna Berman discussed the emerging role of IOT in urban environments. Cities produce 70% of the world's greenhouse gases, use 70% of its energy, and are responsible for 80% of our global GDP. They are rapidly expanding, and in so doing, they must contend with outdated infrastructure and environmental challenges. Berman envisions a comprehensive digital infrastructure in the city of Chicago. She wants to close the digital divide by using technology to modernize infrastructure, engage the community, and solve some of Chicago's most persistent problems. Berman has launched an “open grid” initiative, which harnesses Chicago's existing data portal to turn open data into a utility. Berman is moving Chicago toward a comprehensive digital urban infrastructure through the implementation of a full-scale sensor network. An urban sensor network project, called the “array of things,” in which fine-grained data is gathered via 500 multi-sensor nodes in clusters throughout the city.

After Brenna Berman's keynote address, four Harvard SEAS professors gave lightning talks about their research on the Internet of Things. Scot Martin, Gordon McKay Professor of Environmental Chemistry, spoke about how “Drone-Based Sensing Opens New Frontiers in the Environmental Sciences: Possibilities for Amazonia.” Na Li, Assistant Professor of Electrical Engineering and Applied Mathematics, gave a talk about “Distributed Energy Management in Power Networks.” She spoke about the emergence of a “smart grid,” informed by distributed sensing, computation, communication, and actuation systems. David Brooks, Haley Family Professor of Computer Science, talked about “Taking Machine Learning to Edge Devices.” He discussed the ways in which deep learning methods have transformed numerous aspects of computing. Jim Waldo, Gordon McKay Professor of the Practice of Computer Science, gave a talk on “Some Ethical Considerations of the Internet of Things.” He asked participants to consider the ethical implications of their work in IoT, suggesting that they move from a paradigm in which they think only about what can be done to one in which they think about what should be done.

## CRCS & IACS Joint Seminar

CRCS joined forces with its sister organization, the Institute for Applied Computational Science (IACS), for a lively discussion with Alfred Spector on opportunities and perils in data science.

### Opportunities and Perils in Data Science

Alfred Spector, Friday, December 2, 2016



In recent decades, empiricism has become the third leg of computer science, adding to the field's traditional bases in mathematical analysis and engineering. This shift is due to growth in the scale of computation, networking, and usage, as well as progress in machine learning and related technologies. Resulting data-driven approaches have led to extremely powerful prediction and optimization techniques and hold great promise, even in the humanities and social sciences. However, no new technology arrives without complications: In this seminar, Alfred Spector balanced the opportunities provided by big data and associated artificial intelligence approaches with a discussion of the various challenges. He enumerated ten categories, including those that are technical (e.g., resilience and complexity), societal (e.g., difficulties in setting objective functions or understanding causation), and humanist (e.g., issues relating to free-will or privacy). He provided many example problems and made suggestions for how to address some of the unanticipated consequences of Big Data.

Alfred Spector is Chief Technology Officer and Head of Engineering at Two Sigma, a firm dedicated to using information to optimize diverse economic challenges.

## Celebration of Computer Science at Harvard in Honor of Harry Lewis

Wednesday, April 19, 2017

On Wednesday, April 19th, CRCS joined the Computer Science department in hosting a celebration in honor of Harry Lewis, Gordon McKay professor of computer science and former Dean of the College. Friends, family, students, and colleagues gathered to celebrate Professor Lewis' 70th birthday and the news that - in his words - he would "someday be retiring." They spoke of the myriad ways Professor Lewis has enriched their lives through his personal investment in their success, his emphasis on character over knowledge, and his insistence on integrity over popularity. The day-long celebration - at times joyful, at times poignant - was evidence of the profound legacy Professor Lewis leaves in Harvard's institutional memory and in the lives of all those he has mentored throughout the years.

## Six Reasons Fake News is the End of the World as we Know It

Tuesday, May 2, 2017

During the 2016 U.S. presidential election, fake news became a global issue, spanning popular media, academia, and industry. On May 2nd 2017, CRCS hosted an exploratory discussion on how computer science can address the problem of fake news. Discussions included both technical and policy-facing perspectives from guests in academia and journalism.

Our speakers included P. Takis Metaxas, of Wellesley College & CRCS; David Lazer, of Northeastern University; Giorgos Zervas, of Boston University; Fil Menczer, of Indiana University; Merce Crosas, of Harvard University; Wendy Seltzer, of the World Wide Web Consortium; Oren Tsur, of Harvard University & Northeastern University; and Nicole Immorlica, of Microsoft.

## The Privacy Tools Project

There are myriad ways in which data about people can be used for societal benefit - in domains such as research on human health and behavior, novel services offered through electronic commerce, and improved law enforcement and national security. However, many of these uses of data raise justified concerns about privacy, as we learn that de-identified data can be readily re-identified and used in ways that have the potential to harm individuals.

In 2009, CRCS led the launch of the Privacy Tools project, which is a broad, multidisciplinary effort to enable the collection, analysis, and sharing of sensitive data while providing privacy for individual subjects. A particular focus of the Privacy Tools project is on the sharing of data to support research in computational and quantitative social science. Bringing together computer science, social science, statistics, and law, the investigators on the Privacy Tools Project refine and develop definitions and measures of privacy and data utility and design an array of technological, legal, and policy tools for dealing with sensitive data. In addition to contributing to research infrastructure around the world, the ideas developed in this project will benefit society more broadly as we grapple with data privacy issues in many other domains, including public health and electronic commerce.

The Privacy Tools Project is defining and measuring privacy in both mathematical and legal terms and exploring alternate definitions of privacy that may be more general or more practical. The project studies variants of differential privacy and develops new theoretical results for its use in contexts where it is currently inappropriate or impractical. Differential privacy, discovered by CRCS faculty member Cynthia Dwork, visiting scholar Kobbi Nissim, and collaborators in 2006, is a rigorous mathematical definition of privacy. An algorithm is said to be differentially private if, by looking at the output, one cannot tell whether or not any individual's data was included in the original dataset. In other words, the guarantee of a differentially private algorithm is that its behavior hardly changes when a single individual joins or leaves the dataset -- anything the algorithm might output on a database containing some individual's information is almost as likely to have come from a database without that individual's information. This guarantee holds for any individual and any dataset. Therefore, regardless of how eccentric any single individual's details are, and regardless of the details of anyone else in the database, the guarantee of differential privacy still holds. This gives a formal guarantee that individual-level information about participants in the database is not leaked.

The goals of the Differential Privacy research group, which operates within the Privacy Tools Project, are to design and implement differentially private tools that will enable social scientists to share useful statistical information about sensitive datasets; to integrate these tools with the widely-used platforms developed by the Institute for Quantitative Social Science for sharing and exploring research data; and to advance the theory of differential privacy in a variety of settings, including statistical analysis (e.g. statistical estimation, regression, and answering many statistical queries), machine learning, and economic mechanism design.

The other major area of research in the Privacy Tools Project is DataTags. DataTags is a system designed to help data holders navigate complex issues surrounding data privacy. It enables computer-assisted assessments of the legal, contractual, and policy restrictions that govern data sharing decisions. Assessments are performed through interactive computation, in which the DataTags system asks a user a series of questions to elicit the key properties of a given dataset and applies inference rules to determine which laws, contracts, and best practices are applicable. The output is a set of recommended DataTags, or simple, iconic labels that represent a human-readable and machine-actionable data policy, and a license agreement that is tailored to the individual dataset. The DataTags system is being designed to integrate with the open source data repository software

Dataverse and its suite of access controls and statistical analysis tools. It will also operate as a standalone tool and as an application that can be integrated with other platforms.

The research being conducted by the Privacy Tools Project is providing a better understanding of the practical performance and usability of a variety of algorithms for analyzing and sharing privacy-sensitive data. It is developing secure implementations of these algorithms and legal instruments, which will be made publicly available and used to enable wider access to privacy-sensitive data sets in the Harvard Institute for Quantitative Social Science's Dataverse Network.

Like all CRCS endeavors, the Privacy Tools Project is profoundly collaborative. It is led by SEAS Professor Salil Vadhan, whose team at CRCS partners with researchers at the Berkman Klein Center for Internet and Society (BKC), the Institute for Quantitative Social Science (IQSS), the Data Privacy Lab, and MIT Libraries' Program on Information Science. This year, Privacy Tools team members presented at conferences around the world, including the 10th Annual Privacy Law Scholar's Conference (PLSC); the 8th Annual ESPAnet Israel 2017; the Simons Institute's Data Privacy Planning Workshop; and the Third Biennial Secure and Trustworthy CyberSpace Principal Investigators' Meeting (SaTC PI Meeting '17). Harvard Magazine highlighted the Privacy Tools Project in its article on Privacy and Security, and Principal Investigator and CRCS Professor Latanya Sweeney was recently named one of Forbes' "20 Incredible Women Working in AI Research."

The Privacy Tools Project is funded by the National Science Foundation, the Sloan Foundation, the US Bureau of the Census, and Google.

For more information, please visit <http://privacytools.seas.harvard.edu>



## Technology for Equitable and Accessible Medicine (TEAM)

<https://team.seas.harvard.edu>

Technology for Equitable and Accessible Medicine (TEAM) is a new initiative sponsored by SEAS and supported by CRCS, in collaboration with the Harvard John F. Kennedy School of Government; the Harvard T.H. Chan School of Public Health; Harvard Medical School; and the Harvard John A. Paulson School of Engineering and Applied Sciences.

TEAM's mission is to integrate Harvard's strengths in technology, medicine, and life sciences to develop innovative, equitable approaches to healthcare that improve the lives of patients. To this end, TEAM has launched a series of pilot projects that leverage core technical strengths (namely in computer science, robotics, and sensors) across participating organizations. TEAM brings together a diverse community of experts in medicine and technology to formulate creative, equitable solutions to healthcare problems for the benefit of all members of society.

### TEAM pilot projects include:

- “Addictive Behaviors and the Diversity in Human Reinforcement Learning”
- “Co-Adaptation of Humans and Wearable Robots”
- “Data Driven Functional Tele-Rehabilitation of the Hand with SoV Wearable Robots”
- “Improving Care Coordination for Children with Complex Chronic Conditions”
- “High Dose Neuro-Rehabilitation for Pediatric Applications”
- “IVF-in-a-Box”



# Awards

Congratulations to the 2016 - 2017 CRCS Fellows and faculty members who received recognition for outstanding work in their fields!

In February 2017, Margo Seltzer, Faculty Director of CRCS and Herchel Smith Professor of Computer Science, was awarded the Undergraduate Research Faculty Mentoring Award by the Education Committee of the Computing Research Association (CRA-E). Seltzer was one of three awardees recognized for their “exceptional mentorship” and for providing undergraduate research opportunities.

In February 2017, David Parkes, George F. Colony Professor of Computer Science, was awarded the 2017 ACM/SIGAI Autonomous Agents Research Award. The award recognizes researchers in autonomous agents whose current work is an important influence on the field. Parkes was singled out for his application of machine learning to the production of new results and techniques for human computation, mechanism design, and social choice.

In March 2017, Cynthia Dwork, Gordon McKay Professor of Computer Science, was awarded the 2017 Gödel Prize for her outstanding paper in the Journal of Privacy and Confidentiality. Dwork shares the award with co-authors Frank McSherry, Adam Smith, and Kobbi Nissim.

In March 2017, Postdoctoral Fellow Nisarg Shah was awarded the IFAAMAS Victor Lesser Distinguished Dissertation award, which is given to an outstanding doctoral dissertation in the areas of autonomous agents or multiagent systems. His winning dissertation was entitled “Optimal Social Decision Making.”

In March 2017, Postdoctoral Fellow Fei Fang won the William F. Ballhaus Jr. Prize for Excellence in Graduate Engineering Research at the University of Southern California. Fang was awarded this prize for her work on how best to deploy limited security resources is aiding the U.S. Coast Guard and protecting endangered tigers in Malaysia.

In March 2017, Fang’s dissertation was selected as the runner-up for the IFAAMAS Victor Lesser Dissertation Award.

In May 2017, Fang’s paper, “Optimizing Peer Teaching to Enhance Team Performance,” was nominated for best paper by the First International Workshop on Teams in Multi-Agent Systems, and was selected for publication in the AAMAS 2017 Workshop’s “best paper” volume.

In May 2017, Fang won the University of Southern California’s Viterbi Best Dissertation Award in Computer Science.

In May 2017, Barbara Grosz, Higgins Professor of Natural Sciences at SEAS, received an Everett Mendelsohn Excellence in Mentoring Award from Harvard’s Graduate Student Council. The award, presented to five individuals in 2017, honors faculty advisors who have gone above and beyond in guiding students along their path to the Ph.D. Professor Grosz was nominated by her students.

Grosz was a 2016 - 2017 Phi Beta Kappa Visiting Scholar. In this role, she lectured at Mt. Holyoke College; Middlebury College; Whittman College; University of Georgia; Southwestern University; Union College; and University of California, Irvine).

In July 2017, Former CRCS Faculty Director Salil Vadhan was named Area Chair of the SEAS Computer Science Department.

# Publications by CRCS Fellows

Arpit Agarwal, Debmalya Mandal, David C. Parkes, and Nisarg Shah. Peer Prediction with Heterogeneous Users. In Proceedings of the 18th ACM Conference on Economics and Computation (EC), pp. 81-98, 2017.

Debarun Kar, Benjamin Ford, Shahrzad Gholami, Fei Fang, Andrew Plumptre, Milind Tambe, Margaret Driciru, Fred Wanyama, and Aggrey Rwetsiba. Cloudy with a Chance of Poaching: Adversary Behavior Modeling and Forecasting with Real-World Poaching Data. In Proceedings of the 16th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2017), May 2017.

Jatinder Singh, Thomas Pasquier, Jean Bacon, Raluca Diaconu, Julia Powles, and David Eysers. Big Ideas paper: Policy-driven middleware for a legally-compliant Internet of Things. In Proceedings 17th ACM/IFIP/Usenix Middleware, 2016.

Kobbi Nissim and Uri Stemmer. 03/2017. Concentration Bounds for High Sensitivity Functions Through Differential Privacy.

Kobbi Nissim, Uri Stemmer, and Salil Vadhan. Locating a Small Cluster Privately. In ACM SIGMOD/PODS Conference, San Francisco, USA, 2016.

Nitin Kamra, Fei Fang, Debarun Kar, Yan Liu, and Milind Tambe. Handling Continuous Space Security Games with Neural Networks. In the First International Workshop on A.I. in Security held at the International Joint Conference on Artificial Intelligence (IJCAI-17).

Raef Bassily, Kobbi Nissim, Adam Smith, Thomas Steinke, Uri Stemmer, and Jonathan Ullman. Algorithmic Stability for Adaptive Data Analysis. In 48th Annual Symposium on the Theory of Computing, 2016.

Shahrzad Gholami, Benjamin Ford, Fei Fang, Andrew Plumptre, Milind Tambe, Margaret Driciru, Fred Wanyama, Aggrey Rwetsiba, Mustapha Nsubaga, and Joshua Mabonga. Taking it for a Test Drive: A Hybrid Spatio-temporal Model for Wildlife Poaching Prediction Evaluated through a Controlled Field Test. In the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases.

Thomas Pasquier, David Evers, and Jean Bacon. PHP2Uni: Building Unikernels using Scripting Language Transpilation. In IEEE International Conference on Cloud Engineering (IC2E'17), Vancouver, Canada, 2017.

Thomas Pasquier, Jatinder Singh, Julia Powles, David Evers, Margo Seltzer and Jean Bacon. Data provenance to audit compliance with privacy policy in the Internet of Things. In Journal of Personal and Ubiquitous Computing, accepted.

Thomas Pasquier, Matthew K. Lau, Ana Trisovic, Emery Boose, Ben Couturier, Merce Crosas, Aaron M. Ellison, Valerie Gibson, Chris Jone, and Margo Seltzer. If these data could talk. In Nature Scientific Data, accepted.

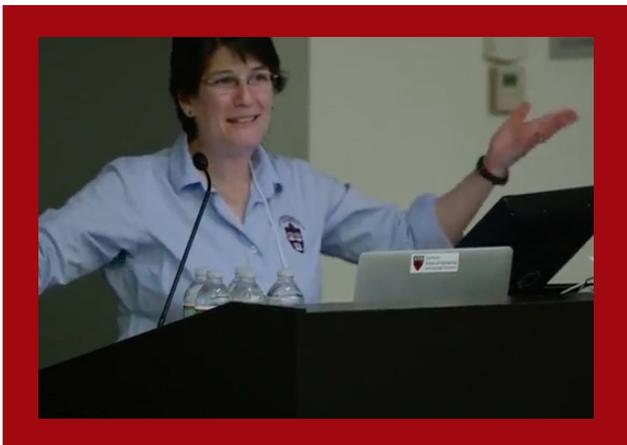
Vincent Conitzer, Rupert Freeman, and Nisarg Shah. Fair Public Decision Making. In Proceedings of the 18th ACM Conference on Economics and Computation (EC), pp. 629-646, 2017.

Xueyuan Han, Thomas Pasquier, Tanvi Ranjan, Mark Goldstein, and Margo Seltzer. FRAPpuccino: Fault-detection through Runtime Analysis of Provenance. In IEEE Workshop on Hot Topics in Cloud Computing (HotCloud'17), 2017.

Yang Liu and Mingyan Liu. Crowd Learning: Improving Online Decision Making Using Crowdsourced Data. IJCAI 2017, Melbourne, Australia.

Yang Liu and Yiling Chen. Machine Learning Aided Peer Prediction. ACM EC 2017, Cambridge, United States.

Zheyuan Shi and Fei Fang. Optimizing Peer Teaching to Enhance Team Performance. In AAMAS 2017



# Looking Ahead

We extend a hearty congratulations to our outgoing postdocs and celebrate the postdocs - incoming and remaining - who will join us for the 2017 - 2018 academic year:



## **Melanie F. Pradier - inaugural joint fellow in Data Science and CRCS**

Melanie Pradier has a PhD from the University Carlos III in Madrid. Her research focuses on Bayesian nonparametric models for data exploration, with direct impact for personalized medicine and biomedical applications. Her interests include modeling of high dimensional/structured data, sparse latent feature models, fast DP/IBP inference, scalable MCMC and variational inference approaches, and dependent random measures.



## **Berk Ustun**

Berk Ustun has a PhD in Electrical Engineering and Computer Science from MIT, where he worked with Cynthia Rudin on optimization, machine learning, and statistics. He is broadly interested in developing new tools for data-driven decision-making for applications in healthcare, criminal justice, and revenue management.



## **Maia Jacobs**

Maia Jacobs has a PhD in Human Centered Computing from the Georgia Institute of Technology. Her research examines how technology can provide users with the means to better cope with significant life changes. Specifically, she studies life changes in the context of breast cancer, exploring how mobile technology can support breast cancer patients as they move through the cancer journey, adapting to patients' changing needs, goals and priorities. Her research areas include human-computer interaction (HCI), ubiquitous computing, and computer supported cooperative work (CSCW).



## **Sarah Keren**

Sarah Keren has a PhD from the Faculty of Industrial Engineering and Management of the Technion - Israel Institute of Technology. She holds a M.Sc. degree under the supervision of Professor Carmel Domshlak in the same department. The main focus of her doctoral thesis was Goal Recognition Design.



## **Nir Rosenfeld**

Nir Rosenfeld has a PhD from the Hebrew University of Jerusalem. He was a long-term intern at Microsoft Research in Israel. His main research goal is to develop machine learning methods for tasks involving dynamic social data and to apply those methods to gain insight into social and behavioral processes. He uses social dynamics as an inspiration for designing learning and inference algorithms. Lately, he has become interested in various aspects of incorporating humans into the learning process.

In 2017 - 2018, we will also be joined by current postdocs Shiri Hassid, Thomas Pasquier, and Goran Radanovic.



Thank you for being a part of the vibrant CRCS community. We hope you will join us in 2017 - 2018!

For information about our upcoming events, please visit [www.crcs.seas.harvard.edu](http://www.crcs.seas.harvard.edu)



# Welcome to the CRCS!

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