

Edith Law

Assistant Professor
David R. Cheriton School of Computer Science
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CURRENT EMPLOYMENT

University of Waterloo (Waterloo, ON)

Assistant Professor, David R. Cheriton School of Computer Science (2014-present)

EDUCATION AND PROFESSIONAL PREPARATION

Harvard University (Cambridge, MA) (2012-2014)

Postdoctoral Researcher, School of Engineering and Applied Sciences

Carnegie Mellon University (Pittsburgh, PA) (2006-2012)

PhD in Machine Learning (2012)

Advisors: Luis von Ahn (Computer Science) and Tom Mitchell (Machine Learning)
Dissertation: *Attribute Learning using Joint Human and Machine Computation*

McGill University (Montreal, QC) (2003-2005)

M.Sc. in Computer Science (2005)

Advisors: Doina Precup
Dissertation: *Risk-Directed Exploration in Reinforcement Learning*

University of British Columbia (Vancouver, BC) (1995-2000)

B.Sc. in Computer Science (2000)

Advisors: Maria Klawe

MAJOR HONORS AND AWARDS

Best paper honorable mention award at ACM CHI (2016)

Harvard Center for Research on Computation and Society Fellowship (2012-2014)

Best paper honorable mention award at ACM CHI (2012)

FQRNT Postdoctoral Fellowship (Declined) (2012-2014)

Microsoft Graduate Research Fellowship (2009-2011)

Best paper honorable mention award at ACM CHI (2009)

Robin Popplestone Fellowship, University of Massachusetts Amherst (Declined) (2006)

NSERC Postgraduate Scholarship PGSD3 (Declined) (2006-2009)

FUNDING

PI, “Teachable Agent for Enhancing Student Curiosity” (2018)

NSERC Strategic Project Grant (in preparation)

PI, “Curiosity-Driven Learning” (2018)

French Embassy in Canada: Mobility Funding for Researchers

- PI, “Designing for Curiosity in Physical Spaces”** (2017)
Waterloo-Bordeaux Joint Grant (Awarded: 15,000 EUROS)
- PI, “CrowdCurio: Infrastructure for Research-Oriented Crowdsourcing”** (2016)
CFI-JELF (Awarded: \$110,000 CAD)
- PI, “Doctoral Symposium for HCOMP 2016”** (2016)
Artificial Intelligence Journal (AIJ) Grant for Promoting AI Research (Awarded: 3000 EUROS)
- PI, “A Framework for Hybrid Machine and Human Computation for the Accurate and Scalable Analysis of Human Clinical EEG Recordings”** (2015-2019)
NSERC-CIHR Collaborative Health Project (CHRP) Grant (Awarded: \$435,000 CAD)
- PI, “Driven by Curiosity: Interaction Techniques and Incentive Mechanisms for Crowdsourcing Scientific Tasks”** (2015-2020)
NSERC Discovery Grant (Awarded: \$115,000 CAD)
- co-PI, “Waterloo/Twente Partnership to Accelerate Research in Data Driven Persuasive Health”** (2015)
International Research Partnership (IRPG) Grant (Awarded: \$55,000 CAD)
- “Effectively Leveraging Contributions in Human Computation Systems”** (2010-2013)
NSF Social-Computational Systems SoCS Grant (Awarded: \$737,500 USD)

BOOKS

- B.1 **Law, E.** and von Ahn, L. *Human Computation*. Morgan and Claypool Synthesis Lectures on Artificial Intelligence and Machine Learning, 2011.

BOOK CHAPTERS

- B.2 **Law, E.** Human Computation for Music Classification. In Li, T., Ogihara, M., Tzanetakis, G. ed. *Music Data Mining*, CRC Press/Chapman Hall, 2011, 281—301.

REFEREED JOURNAL ARTICLES

- J.1 Willis, C., **Law, E.**, Williams, A., Franzone, B., Bernardos, R., Bruno, L., Hopkins, C., Schorn, C., Weber, E., Park, D. and Davis, C. CrowdCurio: an online crowdsourcing platform to facilitate climate change studies using herbarium specimens. In *New Phytologist*, 215(1):479—488, 2017.
- J.2 O’Leary, M. A., Alphonse, K., Mariangeles, A. H., Cavaliere D., Cirranello, A., Dietterich, T., Julius, M., Kaufman, S., **Law, E.**, Passarotti, M., Robalino, J., Simmons, N., Smith, S., Stevenson, D., Theriot, E., Velazco, P., Walls, R., Yu, M., Daly, M. Crowd replicate performance of scientific experts scoring phylogenetic matrices of phenotypes. In *Systematic Biology*, May 2017.

REFEREED CONFERENCE ARTICLES

- C.1 Schaekermann, M., Goh, J., Larson, K. and **Law, E.** Crowd deliberation as a tool for analyzing edge cases. (in submission)
- C.2 Cartwright, M., Seals, A., Salamon, J., Williams, A., Mikloska, S., MacConnell, D., **Law, E.**, Bello, J.P., Nov, O. Seeing Sound: Investigating the Effects of Visualizations and Complexity on Crowdsourced Audio Annotations. In *Proceedings of the ACM on Human-Computer Interaction, vol. 1(2): Computer-Supported Cooperative Work and Social Computing, CSCW '17*, 2017.
- C.3 A. Williams, J. Goh, C. Willis, A. Ellison, J. Brusuelas, C. Davis and **E. Law**. Deja Vu: Characterizing Worker Reliability Using Task Consistency. In *Proceedings of the AAAI Conference on Human Computation and Crowdsourcing, HCOMP '17*, 2017.
- C.4 **E. Law**, V. Cai, E. Liu, S. Sasy, J. Goh, A. Blidaru and D. Kulic. A Wizard-of-Oz Study of Curiosity in Human-Robot Interaction. In *Proceedings of the IEEE International Symposium on Robot and Human Interactive Communication, RO-MAN '17*, 2017.

- C.5 P. Jaini, Z. Chen, P. Carbajal, **E. Law**, L. Middleton, K. Regan, M. Schaekermann, G. Trimponias, J. Tung, and P. Poupart. Online Bayesian Transfer Learning for Sequential Data Modeling. In *Proceedings of the 5th International Conference on Learning Representations, ICLR '17*, 2017.
- C.6 **E. Law**, K. Z. Gajos, A. Wiggins, M. Gray and A. Williams. Crowdsourcing as a Tool for Research: Implications of Uncertainty. In *Proceedings of the ACM Conference on Computer-Supported Cooperative Work and Social Computing, CSCW '17*, 2017.
- C.7 Tse, T., Salamon, J., Williams, A., Jiang, H. and **Law, E.** Ensemble: A Hybrid Human-Machine System for Generating Melody Scores from Audio. In *Proceedings of the International Conference on Music Information Retrieval, ISMIR '16*, 2016.
- C.8 Pan, S., Larson, K., Bradshaw, J. and **Law, E.** Dynamic Task Allocation Algorithm for Hiring Workers that Learn. In *Proceedings of the International Joint Conference on Artificial Intelligence, IJCAI '16*, 2016.
- C.9 Law, E., Yin, M., Goh, J., Chen, K., Terry, M. and Gajos, K. Curiosity Killed the Cat, but Makes Crowdsourcing Better. In *Proceedings of the CHI Conference on Human Factors in Computing Systems, CHI '16*, 2016. **(Best Paper Honorable Mention)**
- C.10 Amir, O., Grosz, B., **Law, E.** and Stern, R. Collaborative Health Plan Support. In Proceedings of the International Conference on Autonomous Agents and Multiagent Systems, AAMAS '13, 2013. **(Best Paper Second Prize, Challenges and Visions Track)**
- C.11 Zhang, H., **Law, E.**, Gajos, K. Z., Horvitz, E., Miller, R. C. and Parkes, D. Human Computation Tasks with Global Constraints: A Case Study. In *Proceedings of the CHI Conference on Human Factors in Computing Systems, CHI '12*, 2012. **(Best Paper Honorable Mention)**
- C.12 **Law, E.**, Bennett, P. and Horvitz, E. The Effects of Choice in Routing Relevance Judgments. In *Proceedings of the ACM SIGIR Conference on Research and Development in Information Retrieval, SIGIR '11*, 2011.
- C.13 **Law, E.**, and Zhang, H. Towards Large-Scale Collaborative Planning: Answering High-Level Search Queries Using Human Computation. In *Proceedings of the AAAI Conference on Artificial Intelligence, AAAI '11*, 2011.
- C.14 **Law, E.**, Settles, B. and Mitchell, T. Learning to Tag using Noisy Labels. In *Proceedings of the European Conference on Machine Learning, ECML '10*, 2010.
- C.15 **Law, E.**, West, K., Mandel, M., Bay, M. and Downie, S. Evaluation of Algorithms Using Games: The Case of Music Tagging. In *Proceedings of the International Conference on Music Information Retrieval, ISMIR '09*, 2009.
- C.16 **Law, E.** and von Ahn, L. Input-agreement: A New Mechanism for Data Collection using Human Computation Games. In *Proceedings of the CHI Conference on Human Factors in Computing Systems, CHI '09*, 2009. **(Best Paper Honorable Mention)**
- C.17 Law, E., von Ahn, L., Dannenberg, R. and Crawford, M. TagATune: a Game for Sound and Music Annotation. In *Proceedings of the International Conference on Music Information Retrieval, ISMIR '07*, 2007.

REFEREED PAPERS ACCOMPANYING POSTERS AND DEMOS

- P.1 **Law, E.**, Dalton, C., Merrill, N., Young, A., Gajos, K. Z. CrowdCurio: A Platform for Supporting Mixed-Expertise Crowdsourcing. In *Proceedings of the AAAI Conference of Human Computation and Crowdsourcing, HCOMP '13*, 2013.
- P.2 **Law, E.**, Mityagin, A. and Chickering, M. Intentions: A Game for Classifying Search Query Intent. In *Proceedings of the CHI Conference on Human Factors in Computing Systems Work-In-Progress, CHI '09*, 2009.

REFEREED WORKSHOP ARTICLES

- W.1 Williams, A., Bradshaw, J., Schaekermann, M., Tse, T., Callaghan, W. and **Law, E.** The Big Picture: Preserving Context in the Decomposition of Complex Expert Tasks. In *Proceedings of the CHI Productivity Decomposed Workshop*, 2016.
- W.2 Schaekermann, M., **Law, E.**, Williams, A. and Callaghan, W. Resolvable vs Irresolvable Ambiguity: A new hybrid framework for dealing with uncertain ground truth. In *Proceedings of the CHI Workshop on Human-Centered Machine Learning*, 2016.

- W.3 **Law, E.**, Grosz, B., Sanders, L. M. and Fischer, S.H. SimplyPut: Leveraging a Mixed-Expertise Crowd to Improve Health Literacy. In *Proceedings of the AAMAS Workshop on Human-Agent Interaction Design and Models*, 2013.
- W.4 **Law, E.**, Settles, B., Snook, A., Surana, H., von Ahn, L. and Mitchell, T. Human Computation for Attribute and Attribute Value Acquisition. In *Proceedings of the CVPR Workshop on Fine-Grained Visual Categorization*, 2011.
- W.5 Betteridge, J., Carlson, A., Hong, S., Hruschka, E. Jr., **Law, E.**, Mitchell, T. and Wang, S. Towards Never Ending Language Learning. In *Proceedings of the AAAI Spring Symposium on Learning by Reading and Learning to Read*, 2009
- W.6 **Law, E.**, von Ahn, L. and Mitchell, T. Search Wars: A Game for Improving Web Search. In *Proceedings of the Human Computation Workshop*, 2009.
- W.7 **Law, E.** The Problem of Accuracy as An Evaluation Criterion. In *ICML Workshop on Evaluation Methods for Machine Learning*, 2008

OTHER PUBLICATIONS

- O.1 **Law, E.**, Oudeyer, P-Y., Yin, M., Schaekermann, M. and Williams, A. Designing for Curiosity: An Interdisciplinary Workshop. In *Proceedings of the CHI Conference on Human Factors in Computing Systems Extended Abstract*, CHI '17, 586-592. (workshop abstract)
- O.2 **Law, E.**, Williams, A., Wiggins, A., Brier, J., Preece, J., Shirk, J. and Newman, G. The Science of Citizen Science: Theories, Methodologies and Platforms. In *CSCW Companion 2017*, 395–400. (workshop abstract)

INVITED TALKS

Plenary talks

1. *Crowd Computing*. Invited talk at ETH Zurich and Collegium Helveticum. Zurich, Switzerland. December 2017. (upcoming)
2. *The Case of Thoreau's Field Notes: How CrowdCurio Helps to Advance Science and Citizen Science*. Invited talk at HCI International Conference (HCII) 2017 Panel. Vancouver, BC. July 2017.
3. *Designing for Curiosity*. Invited talk at the International Conference on Graphics, Visualization and Human-Computer Interaction (GI). Victoria, BC. May 2016.
4. *Mixed Expertise Crowdsourcing*. Invited keynote at the ICML Workshop on "Machine Learning Meets Crowdsourcing". Atlanta, Georgia. June 2013.
5. *SimplyPut: A Crowdware System for Improving Health Communication and Literarcy*. Invited talk at the Academic Pediatric Association Annual Meeting. May 2013.

University colloquia

6. *Socio-technical Challenges in Scientific and Medical Crowdsourcing*. Invited talk at the Carnegie Mellon University HCII and LTI Crowdsourcing Seminar. April 2018.
7. *Designing for Curiosity*. Invited talk at the Toronto User Experience (TUX) Speaker Series. University of Toronto, ON. February 2016.
8. *Balancing Task-Centric and Human-Centric Objectives in Human Computation Systems*. Harvard Center for Research on Computation and Society. Cambridge, MA. September 2012.

Tutorials

9. *Crowdsourcing as a Tool for Research and Public Engagement*. 5-day course at the Digital Humanities Summer Institute, University of Victoria, BC. June 2015.
10. *Human Computation: A Broad Perspective*. 4-hour tutorial at the ACM Intelligent User Interfaces (IUI) Conference. March 2013.
11. *Human Computation: Core Research Questions and State of the Art*. 4-hour tutorial at the AAAI Conference. March 2011.

Industry talks

12. *The "What" and the "How": Two Studies of Curiosity-Inducing Interfaces*. Microsoft Research Redmond, Redmond, WA. July 2017.

RESEARCH EXPERIENCE

Faculty Fellow, Element AI (Montreal, QC) (2017-present)

Research Intern, Microsoft Research (Redmond, WA) (summer 2010)

Mentors: Paul Bennett and Eric Horvitz

Research Intern, Microsoft Live Labs (Bellevue, WA) (summer 2008)

Mentor: Max Chickering

PROFESSIONAL EXPERIENCE

AI Programmer, Ubisoft Entertainment Inc (Montreal, QC) (2005-2006)

Software Developer, IBM Canada (Vancouver, BC) (2000-2003)

Software Developer, Sony Inc. (Tokyo, Japan) (1998)

TEACHING

CS 889: Human-in-the-loop Systems (fall 2014, fall 2015)

This *new* graduate course gives a broad overview of various models for combining human and machine intelligence to solve computational problems. Through weekly seminars and a class project, we examine three roles that humans play in computational systems -- humans as computers, humans as teachers, and humans as collaborators. This course covers both literature from HCI and AI, and the topics include human computation and crowdsourcing, learning by demonstration, mixed initiative systems, active learning from human teachers, and interactive machine learning.

Student Evaluation: 4.2/5 (fall 2014), 4.5/5 (fall 2015)

CS 349: User Interfaces (winter 2015)

This course provides an introduction to contemporary user interfaces, including the basics of human-computer interaction, the user interface design/evaluation process, and the architectures within which user interfaces are developed. In 2015, I completely re-structured the course materials for CS349 to teach user interface concepts via web technology (i.e., HTML, CSS, Javascript).

Student Evaluation: 3.7/5 (section 2), 3.8/5 (section 3)

CS 889: Human-AI Interaction (winter 2018)

AI and machine learning technologies has become increasingly integrated with our everyday lives. Yet, such systems are often complex, unpredictable and unfamiliar to users, making it difficult for them to understand, trust and adopt them. This *new* graduate course involves a survey of existing literature on Human-AI interaction, on topics such as safety, fairness, interpretability, ethics, trust, and human-in-the-loop computation. The course is also in part a methodology course---students study different HCI data collection (e.g., experiments, diary studies, interviews, etc.) and analysis (e.g., statistical modeling, grounded theory analysis, etc.) techniques and apply them to research questions related to Human-AI interaction. The coursework involves a weekly seminar and a course project.

CS 449: Human Computer Interaction (spring 2018)

Human-Computer Interaction teaches the fundamental issues that underlie the creation and evaluation of usable and useful computational artifacts. Over the term, students learn how to design novel computational artifacts that enable a well-defined user group to achieve specific goals more effectively. More specifically, students learn and directly apply: (1) Rapid ethnography, which includes learning how to perform interviews and in situ observations, (2) User-centered design techniques, including contextual design and low-fidelity, high-iteration prototyping practices (e.g., paper-based prototyping and Wizard-of-Oz studies), (3) Evaluation methods for measuring how a design compares to existing methods of accomplishing a task. The course involves lectures, in-class activities, assigned readings and group projects.

Participant, Graduate Supervision Series, University of Waterloo (Waterloo, ON) (2017)
Completion of 6 workshops on the topic of graduate supervision, including CTE 801-806.

Participant, Eberly Center Documentation of Teaching Development Program, Carnegie Mellon University (Pittsburgh, PA) (2006-2012)
The program involves 10 teaching seminars, two videotaped teaching observations, a course and syllabus design session and a pedagogy project exploring some aspects of teaching.

Teaching Assistant, Carnegie Mellon University (Pittsburgh, PA)
CS 15-323 Computer Music Systems and Information Processing (spring 2012)
CS 15-396 Science of the Web (fall 2008)

Teaching Assistant, McGill University (Montreal, QC)
COMP 526, AI and Probabilistic Reasoning (spring 2005)
COMP 424 Artificial Intelligence I (fall 2004)

CURRENT GRADUATE STUDENTS

| | |
|--|------------------|
| Alex Williams (Ph.D., co-advised with Ed Lank) | (2015 – present) |
| William Callaghan (M.Math.) | (2015 – present) |
| Tim Tse (M.Math., co-advised with Pascal Poupart) | (2015 – present) |
| Mike Schaekermann (Ph.D., co-advised with Kate Larson) | (2016 – present) |
| Sangho Suh (Ph.D., co-advised with Ed Lank) | (2017 – present) |
| Jessy Ceha (Ph.D., co-advised with Dana Kulic) | (2017 – present) |
| Alexandra Vtyurina (Ph.D., co-advised with Charlie Clarke) | (2017 – present) |
| Nalin Chhibber (M.Math.) | (2017 – present) |
| Louis Kuang (M.Math., co-advised with Kate Larson) | (2017 – present) |
| Greg D'Eon (M.Math., co-advised with Kate Larson) | (2017 – present) |
| Colin Vandenhof (M.Math.) | (2017 – present) |

FORMER GRADUATE STUDENTS

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|---|--------|
| Sundra Yunjia Sun (M.Math, co-advised with Ed Lank, now at Google Waterloo) | (2016) |
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UNDERGRADUATE STUDENTS

| | |
|--------------------------|----------------|
| Helga Jiang (URA, co-op) | (2015-present) |
| Meng Dong (URA, CS 499T) | (2017) |
| Stephanie Mikloska (URA) | (2016) |
| Clarice Ng (URA) | (2016) |
| Eddie Du (URA) | (2016) |
| Maoning Guo (URA) | (2016) |
| Jing Tao (URA) | (2016) |
| Mark Martinez (URA) | (2016) |
| Josh Bradshaw (co-op) | (2015) |
| Tiasa Mondol (URA) | (2015) |
| Kevin Chen (URA) | (2015) |
| Charlie Wu (URA) | (2015) |
| Ruiming Zhu (URA) | (2014) |
| Rui Lin (URA) | (2014) |
| Wenchao Du (URA) | (2014) |
| Susu Dong (URA) | (2014) |
| Elkan Wang (URA) | (2014) |

MAJOR PROFESSIONAL SERVICE

Conference Leadership:

HCOMP: AAAI Conference on Human Computation and Crowdsourcing (as General Chair) (2019)

OTHER PROFESSIONAL SERVICE

Conference Organizing Committees:

CHI: ACM Conference on Human Factors in Computing Systems (2019)
Accessibility Co-chair

HCOMP: AAAI Conference on Human Computation and Crowdsourcing
Co-chair of the Doctoral Symposium (2016)

Workshop Organizing Committees:

CHI: Designing for Curiosity: An Interdisciplinary Workshop (2017)

CSCW: Science of Citizen Science: Theories, Methodologies and Platforms (2017)

HCOMP: Citizen + X: Crowdsourcing in Science, Public Health and Government (2014)

NIPS: Human Computation for Science and Computational Sustainability (2012)

AAAI: Human Computation Workshop (HCOMP) (2011-2012)

KDD: Human Computation Workshop (HCOMP) (2009-2010)

Conference Program Committees as Associate Chair:

CHI: ACM Conference on Human Factors in Computing Systems (2019)

CSCW: ACM Conference on Computer-Supported Cooperative Work and Social Computing (2015, 2018)

CHI Play: ACM SIGCHI Annual Symposium on Computer-Human Interaction in Play (2015)

Conference Program Committees as PC member:

CI: Collective Intelligence (2018)

UMAP: ACM Conference on User Modeling, Adaptation and Personalization (2018)

SIGIR: ACM Conference on Research and Development in Information Retrieval (2018)

WWW: International World Wide Web Conference (2014, 2017)

IJCAI: International Joint Conference on Artificial Intelligence (2016)

HCOMP: AAAI Conference on Human Computation and Crowdsourcing (2013, 2014)

AAAI: Conference on Artificial Intelligence (2012, 2013)

ICWSM: International AAAI Conference on Web and Social Media (2010)

Reviewer of Conference Publications:

CHI: ACM Conference on Human Factors in Computing Systems (2009-present)

UIST: ACM Symposium on User Interface Software and Technology (2011, 2013-2016)

IUI: ACM International Conference on Intelligent User Interfaces (2011)

NIPS: Conference on Neural Information Processing Systems (2011, 2012)

ICRA: IEEE International Conference on Robotics and Automation (2012)

CSCW: ACM Conference on Computer Supported Cooperative Work (2016, 2018)

Workshop Program Committees:

IEEE PerCom: Annotation of User Data for Ubiquitous Systems (2017)

KDD: Interactive Data Exploration and Analytics Workshop (2016)

EC: Crowdsourcing and Online Behavioural Experiments (2014)

ECIR: Gamification for Information Retrieval (2014)

KDD: Crowdsourcing and Data Mining (2012)

AAAI: Wisdom of the Crowd (2012)

NIPS: Computational Social Science and the Wisdom of the Crowds (2010-2011)

SIGIR: Crowdsourcing for Information Retrieval (2011)

Reviewer of Journal Publications:

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| ACM Transactions on Interactive Intelligent Systems (TiiS) | (2017) |
| ACM Transactions on Computer-Human Interaction (ToCHI) | (2014) |
| Transaction on Pattern Analysis and Machine Intelligence | (2014) |
| ACM Transactions on Intelligent Systems and Technology (TIST) | (2012) |
| Journal of Information Retrieval: Special Issue on Crowdsourcing | (2011) |
| EURASIP Journal on Audio, Speech and Music Processing | (2011) |
| Citizen Science: Theories and Practice | (2016) |

Reviewer of Book Proposals:

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| Cambridge University Press | (2017) |
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Grant Review Panels

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| NSF | (2015, 2016) |
| NSERC-CIHR Collaborative Health Research (CHRP) Project | (2015) |

Journal Editorial Boards:

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| PACMHCI: Proceedings of ACM-HCI (as Information Director) | (2017—present) |
| Citizen Science: Citizen Science: Theory and Practice (as Board Member) | (2015 – 2017) |

Advisory Boards:

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| Linguistic Data Consortium: NSF Computing Research Infrastructure project titled “Novel Incentives and Workflows in Linguistic Data Collection and Annotation” | (2017 – present) |
| Cornell: NSF project titled “Crowd ID: Collaborative Tools Connecting People to Biodiversity through Social Networks and Machine Learning” | (2010 – 2014) |
| Penn State University: NSF IGERT project titled “Big Data Social Science” | (2013 – 2014) |

DEPARTMENTAL SERVICE

Graduate Recruiting Committee: (2014-present)

I proposed and helped create a new graduate recruiting event called Undergraduate Research Opportunities Conference (UROC), where we invite top undergraduate students from across Canada to come to University of Waterloo for a 3-day program, to learn about graduate school and our research in computer science. As a direct result of this new conference, many UROC attendees ended up applying to graduate school at University of Waterloo as well as other universities in Canada and abroad. The conference is now an annual event.