Alex Edmonds

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CURRICULUM VITAE

ABOUT

I completed my PhD at the University of Toronto, supervised by Aleksandar Nikolov and Toni Pitassi. The focus of my research was on differential privacy, particularly the local model, with connections to learning theory, information theory, and duality. Our research provided algorithms which we showed to be nearly optimal in sample complexity for solving fundamental statistical estimation and PAC learning tasks. Currently, I am interested in becoming more involved in implementations of differential privacy. I can bring a strong theoretical grounding to the task of putting differential privacy into practice.

EDUCATION

Doctor of Philosophy 2017 - 2023
University of Toronto – Computer Science

Master of Science 2015 - 2017
University of Toronto – Computer Science

Honours Bachelor of Science 2008 - 2014
University of Toronto – Mathematics Specialist Program

ACADEMIC AWARDS

PhD Thesis recommended for departmental award by external examiner	2023
University College Galois Mathematics Scholarship	2014
University College Alumni Association Scholarship	2012
George Roderick Fraser Scholarship for Mathematical Studies	2008

RESEARCH

Edmonds, A. (2023). "Sample-Complexity Optimality Under Local Differential Privacy and Related Models" (PhD Thesis).
www.cs.toronto.edu/~edmonds/doc/alex-edmonds.phd-thesis.pdf.

My PhD thesis gives a harmonized presentation of the results from [ENU19] and [ENP22] on the sample complexity of learning and estimation tasks under local differential privacy (LDP), while also extending the previous work with new results from joint research with Nikolov and Pitassi related to pan-privacy and the correlational statistical query model.

Edmonds, A., A. Nikolov, T. Pitassi (2022). "Learning versus Refutation in Non-interactive Local Differential Privacy". NeurIPS 2022. arxiv.org/abs/2210.15439.

This paper's main result is a complete characterization of the sample complexity of agnostic PAC learning for non-interactive LDP protocols in terms of the

approximate γ_2-norm of a natural matrix associated with the class. Combined with previous work, this gives an equivalence between learning and refutation in the agnostic setting. We also give results for realizable variants of learning and refutation.

Edmonds, A., A. Nikolov, J. Ullman (2020). "The Power of Factorization Mechanisms in Local and Central Differential Privacy". Symposium on Theory of Computing, STOC 2020. arxiv.org/abs/1911.08339.

This work gives a general characterization for answering linear queries under non-interactive local differential privacy (LDP). In particular, we provide a generalization of the factorization mechanism and, by providing a lower bound, we show this approach to be nearly optimal in sample complexity. This result is extended to draw implications for particular PAC learning tasks as well.

Edmonds, A. (2017). "Concepts of Efficient Samplability". MSc Thesis.
www.cs.toronto.edu/~edmonds/doc/alex-edmonds.msc-thesis.pdf.

My MSc at the University of Toronto was supervised by Dan Roy, with whom I studied formalizations of the notion of computationally efficient probabilistic sampling, in relation to traditional open problems in complexity theory.

PROJECTS

OpenDP: Truncated and modular noise mechanisms 2024 (ongoing)

Currently, I am working with Michael Shoemate on OpenDP's Rust codebase, implementing parameters which would enable noise mechanisms for differential privacy to be post-processed by way of truncation or modular arithmetic.

CSC2401 Project: Unsupervised dialect translation with Word2Vec 2016

This project explored techniques for unsupervised translation between languages whose vocabularies sufficiently overlap, by way of semantic vector embeddings. These techniques were applied towards translation from both Middle English and Elizabethan English to contemporary English and vice versa.

CSC2515 Project: Attribute prediction with bidirectional RNNs 2015

This joint project with classmate Noah Fleming, applied an LSTM neural network to a corpus of amateur fiction to predict author attributes.

Undergraduate Final Project: Gödel's incompleteness theorem 2014

As a final undergraduate project, I gave seminar for my peers which presented the classic proof of Gödel's First Incompleteness Theorem.

PRESENTATIONS

Conference on Neural Information Processing Systems (NeurIPS) 2022
Learning versus Refutation in Noninteractive Local Differential Privacy

Symposium on Theory of Computing (STOC) 2020
The Power of Factorization Mechanisms in Local and Central Differential Privacy

Theory and Practice of Differential Privacy (poster presentation) 2019
The Power of Factorization Mechanisms in Local and Central Differential Privacy

Brookfield Institute for Innovation and Entrepreneurship 2019
Introduction to Differential Privacy

RESEARCH PROGRAMS

Data Privacy: Foundations and Applications 2019
Simons Institute – Visiting Graduate Student

Foundations of Machine Learning 2017
Simons Institute – Visiting Graduate Student

CONFERENCES & WORKSHOPS

Conference on Neural Information Processing Systems (NeurIPS) 2022

Symposium on the Theory of Computing (STOC) 2020

ACM CCS 2019
- *Theory and Practice of Differential Privacy*

Data Privacy: Foundations and Applications 2019
Simons Institute
- *Privacy and the Science of Data Analysis*
- *Beyond Differential Privacy*

ACM CCS 2018
- *Theory and Practice of Differential Privacy*

CanaDAM: Canadian Discrete and Algorithmic Mathematics Conference 2017

Foundations of Machine Learning 2017
Simons Institute
- *Computational Challenges in Machine Learning*
- *Representation Learning*
- *Interactive Learning*
- *Foundations of Machine Learning Boot Camp*

Avi Wigderson is 60: A Celebration of Mathematics & Computer Science 2016
Institute for Advanced Study

PoCo: Summer School in Polyhedral Combinatorics 2015

Existential Polytime and Polyhedral Combinatorics 2015

REVIEW

Reviewer for:
- *ACM Transactions on Algorithms (TALG)* 2020

- *IEEE Symposium on Foundation of Computer Science (FOCS)* 2020
- *Journal of Privacy and Confidentiality* 2019

COURSES A selection of courses taken at the University of Toronto.

Graduate

- CSC2429 *Algebraic Gems in Theoretical CS and Discrete Mathematics*
- CSC2556 *Algorithms for Collective Decision Making*
- CSC2429 *Proof Complexity, Mathematical Programming and Algorithms*
- CSC2501 *Computational Linguistics*
- CSC2506 *Probabilistic Graphical Models*
- CSC2515 *Machine Learning*
- CSC2404 *Computability and Logic*
- CSC2401 *Computational Complexity*

Undergraduate

- MAT357, MAT457, MAT458 *Real Analysis*
- MAT347 *Groups, Rings & Fields*
- MAT461 *Combinatorial Method*
- MAT332 *Complex Analysis*
- MAT327 *Topology*
- MAT309 *Mathematical Logic*
- MAT332 *Graph Theory*
- MAT402 *Classical Geometry*

TEACHING

Course Instructor – *University of Toronto* 2018

Responsible for all aspects of the course, including: delivering and planning lectures; organizing tutorials; creating assignments, tests, and marking schemes; providing office hours; supervising teaching assistants.

- CSC236 *Introduction to the Theory of Computation*

Graduate Teaching Assistant – University of Toronto 2015 - 2023

Led tutorials, held office hours, and graded assignments and exams.

- CSC2541 *AI and Ethics: Mathematical Foundations and Algorithms* (graduate course)
- CSC2412 *Algorithms for Private Data Analysis* (graduate course)
- CSC263 *Data Structures and Analysis*
- CSC240 *Enriched Introduction to the Theory of Computation*
- CSC236 *Introduction to the Theory of Computation*

Graduate Teaching Assistant – Toronto Metropolitan University 2014 - 2015

Led tutorials and graded assignments and exams.

- MTH110 *Discrete Math I*
- MTH210 *Discrete Math II*
- MTH141 *Linear Algebra*
- MTH240 *Calculus II*

TECHNICAL SKILLS Python, Rust, Go, Lua, C, C++, Matlab.

COMMUNITY Administrator of CS Graduate Student Union Matrix server for instant messaging 2020-2023

CS Theory Student Seminar organizer 2020

CS Theory Student Camping Retreat organizer 2019

CS Graduate Student Union Board Games Club organizer 2017 - 2020

PERSONAL INTERESTS Open-source software and hardware. Knowledge management. Contact improvisational dance. Folk music. Classic movies.