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Mason DiCicco

Summary

Ph.D. candidate in Computer Science with research focused on theoretical computer science, including learning theory, communication complexity, and circuit lower bounds. Recent work explores the reasoning capabilities of large language models, including fine-tuning on formal mathematical tasks. Broader experience includes general and physics-informed machine learning, heuristic/combinatorial search algorithms, and neuromorphic computing. Primary-author publications in ISIT, ITCS, TCS, and NeurIPS. Interested in advancing the intersection of artificial intelligence and formal reasoning.

Education

2020-2025 **Ph.D. Computer Science**, *Worcester Polytechnic Institute*, 4.0 GPA.
Advised by Daniel Reichman

2016-2020 **B.S. Computer Science**, *University of Connecticut*, 3.9 GPA.
Concentration: Theory and Algorithms

2016-2020 **B.A. Mathematics**, *University of Connecticut*, 3.9 GPA.
Concentration: Pure Mathematics

Coursework

Graduate Level: Combinatorics, Analysis, Algebra, AI, Reinforcement Learning, Deep Learning, Networks.

Mathematics: Abstract/Linear Algebra, Differential Equations, Analysis, Topology, Probability.

Computer Science: Systems Programming, Computer Architecture, Algorithms and Complexity, Machine Learning, Computational Geometry, Operating Systems, Modern Cryptography, Numerical Methods.

Research Experience

September 2020 - Present **Graduate Student**, *Worcester Polytechnic Institute*, Advisor: Daniel Reichman.
Conducting research in theoretical computer science focused on proving hardness results in communication complexity, learning theory, and circuit complexity using novel reductions and complexity-theoretic constructions; contributed to multiple peer-reviewed publications.

September 2022 **Research Visit**, *Santa Fe Institute*, Host: Cris Moore.
Derived combinatorial upper bounds on the expected length of the longest common subsequence in random strings, towards computing the exact value of the Chvatal-Sankoff constant.

Publications

Accepted papers

May 2021 - September 2022 **The Learning and Communication Complexity of Subsequence Containment**, *ISIT 2023*.
Proved tight lower and upper bounds for the learning and communication complexity of subsequence detection. Demonstrated that non-contiguity leads to increased complexity.

December 2022 - May 2023 **Inoculation Strategies for Bounded Degree Graphs**, *Theoretical Computer Science, Vol. 1035*.
Analyzed epidemic containment as a game on graphs and established tight bounds on the price of anarchy for many families of graphs in terms of their maximum degree. Explored conditions (e.g., contagion thresholds and cost variations) that reduce equilibrium inefficiency.

January 2024 - October 2024 **The Karp Dataset**, *NeurIPS MATH-AI Workshop 2024*.
Constructed the Karp Dataset, a structured collection of reductions between NP-hard decision problems, tailored towards training language models on advanced reasoning tasks.

November 2023 - January 2024 **Nearest Neighbor Complexity and Boolean Circuits**, *ITCS 2025*.
Established new connections between nearest neighbor classification and Boolean circuit complexity. Proved exponential lower bounds on the k-nearest neighbor complexity of explicit functions and demonstrated separations between 1-NN and k-NN models. Results address open problems posed by Hajnal et al. (2022).

Professional Experience

May 2023 - July 2023 **Naval Research Lab**, *Washington, D.C.*.
- Implemented physics-informed neural networks (PINNs) and UDE frameworks towards anomaly detection in physical systems.
- Designed a localized spectral neural operator that improves learning accuracy on spatially heterogeneous datasets.

June 2019 - August 2019 **Naval Information Warfare Center**, *San Diego, CA*.
- Applied persistent homology to visualize and interpret activation landscapes in deep/spiking neural networks.
- Built a custom spiking neural network simulator in Python to test learning rules and benchmark neuromorphic performance against traditional NNs.

July 2015 - September 2015 **United Technologies Aerospace Systems**, *Windsor Locks, CT*.
- Created a Dymola simulation of the Integrated Fuel Pump Control system, improving accuracy over prior iterations.

Talks

March 2024 **Communication complexity and linear arrangements**, *Discrete Math Seminar*, WPI.

July 2024 **Nearest neighbor complexity and boolean circuits**, *CS Theory Seminar*, Tufts University.

November 2023 **Threshold circuit lower bounds from communication complexity**, *Discrete Math Seminar*, WPI.

September 2023 **Introduction to nearest neighbor complexity**, *Discrete Math Seminar*, WPI.

September 2022 **Expected length of the longest common subsequence**, *Discrete Math Seminar*, WPI.

October 2021 **The communication complexity of subsequence detection**, *Discrete Math Seminar*, WPI.

Teaching Experience

September 2020 - May 2025 Supported >400 students across 20+ terms. Held office hours, graded assignments, and occasionally led lectures.

(Many instances) **Foundations of Computer Science**, *Teaching Assistant*, WPI.
Introduction to finite automata, context-free grammars, and Turing machines.

(Many instances) **Introduction to Machine Learning**, *Teaching Assistant*, WPI.
Regression, MLE, clustering, neural networks.

(Many instances) **Algorithms: Design and Analysis**, *Teaching Assistant*, WPI.
Divide and conquer, dynamic programming, etc., amortized analysis, NP completeness

Specific Skills

Programming Python (advanced), Julia (advanced), Java, C, C++, Javascript (node.js)

ML/AI frameworks Torch, Tensorflow, OpenAI Gym, Unsloth

Techniques Deep Learning, Reinforcement Learning, Meta Learning, Few-shot Learning, Fine-tuning of LLMs

Other Tools Git, LaTeX, Linux CLI, HPC systems