LIAM MADDEN

5719 NE 180th St Kenmore, WA

liam.madden@colorado.edu

RESEARCH

My research is in probability theory, linear algebra, and real analysis with applications to machine learning, quantum computing, and optimization. I develop new algorithms, prove general mathematical results, and prove mathematical results for particular applications. My work can be categorized into five projects: time-varying optimization, quantum circuit compilation, stochastic optimization, memory capacity, and next-token prediction capacity.

EDUCATION

University of Colorado Boulder	Boulder, CO
Ph.D., Applied Mathematics	2017 - 2022
M.S., Applied Mathematics	2017 - 2020
GPA: 3.92	

California Polytechnic State University	San Luis Obispo, CA
Double B.S., Mechanical Engineering and Mathematics	2012 - 2017
Magna Cum Laude	
Charles J. Hanks Excellence in Math Award	2017
George H. McMeen Scholarship (Mathematics Department)	2016

POSITIONS

DSI Postdoctoral Fellow	2022 - Present
University of British Columbia	
Supervised by Christos Thrampoulidis and Mark Schmidt	

Research Intern	
IBM Dublin	2021
IBM Yorktown Heights	2020
Supervised by Andrea Simonetto	

Research Assistant	2019 - 2022
University of Colorado Boulder	
Supervised by Emiliano Dall'Anese and Stephen Becker	

Teaching Assistant	2017 - 2019
University of Colorado Boulder	
Classes: APPM 1360, Calculus 2 for Engineers	
APPM 2350, Calculus 3 for Engineers	
APPM 2360, Introduction to Differential Equations with Linear Algebra	

JOURNAL PAPERS

High-probability Convergence Bounds for Non-convex Stochastic Gradient Descent with Sub-Weibull Noise. Liam Madden, Emiliano Dall'Anese, Stephen Becker. *Journal of Machine Learning Research*, **25**(241):1-36, 2024.

A Stochastic Operator Framework for Optimization and Learning with Sub-Weibull Errors. Nicola Bastianello, Liam Madden, Ruggero Carli, Emiliano Dall'Anese. *IEEE Transactions on Automatic Control*, 2024.

Memory Capacity of Two Layer Neural Networks with Smooth Activations. Liam Madden, Christos Thrampoulidis. *SIAM Journal on Mathematics of Data Science*, **6**(3):679-702, 2024.

Best Approximate Quantum Compiling Problems. Liam Madden, Andrea Simonetto. *ACM Transactions on Quantum Computing,* **3**(2):1-29, 2022.

Bounds for the Tracking Error of First-Order Online Optimization Methods. Liam Madden, Stephen Becker, Emiliano Dall'Anese. *Journal of Optimization Theory and Applications*, **189**:437-457, 2021.

Optimization and Learning with Information Streams: Time-varying Algorithms and Applications. Emiliano Dall'Anese, Andrea Simonetto, Stephen Becker, Liam Madden. *IEEE Signal Processing Magazine*, **37**(3):71-83, 2020.

CONFERENCE PAPERS

Convergence of the Inexact Online Gradient and Proximal-Gradient Under the Polyak-Łojasiewicz Condition. Seunghyun Kim, Liam Madden, Emiliano Dall'Anese. In *IEEE Conference on Decision and Control*, 2022.

Sketching the Best Approximate Quantum Compiling Problem. Liam Madden, Albert Akhriev, Andrea Simonetto. In *IEEE International Conference on Quantum Computing and Engineering (QCE)*, 2022.

Online Sparse Subspace Clustering. Liam Madden, Stephen Becker, Emiliano Dall'Anese. In *IEEE Data Science Workshop (DSW)*, 2019.

PRE-PRINTS

Interpolation with Deep Neural Networks with Non-polynomial Activations: Necessary and Sufficient Numbers of Neurons. Liam Madden. *arXiv preprint arXiv:2405.13738*, 2024.

Next-token Prediction Capacity: General Upper Bounds and a Lower Bound for Transformers. Liam Madden, Curtis Fox, Christos Thrampoulidis. *arXiv preprint arXiv:2405.13718*, 2024.

DISSERTATION

First-order Methods for Online and Stochastic Optimization, and Approximate Compiling. *University of Colorado Boulder*, 2022.

TALKS

Upper and Lower Memory Capacity Bounds of Transformers for Next-token Prediction. *Math Machine Learning Seminar,* Max Planck Institute for Mathematics in the Sciences and University of California Los Angeles, 2024.

Upper and Lower Memory Capacity Bounds of Transformers for Next-token Prediction. Industry Talk at F5, 2024.

Memory Capacity of Two Layer Neural Networks. *Mathematics of Information, Learning and Data Seminar*, University of British Columbia, 2024.

Memory Capacity of Two-layer Neural Networks with Analytic Activations. *Mathematics of Computation, Application and Data Seminar*, Simon Fraser University, 2024.

Memory Capacity of Two-layer Neural Networks with Analytic Activations. *Mathematics of Information, Data, and Signals Seminar*, University of California San Diego, 2023.

Tracking Error Bounds for Smooth Strongly Convex Time-Varying Optimization. *SIAM Conference on Optimization*, 2023.

Best Approximate Quantum Compiling Problems. *European Quantum Technologies Conference (EQTC)*, 2021.

SOFTWARE

Contributed to "Approximate Quantum Compiler" in *Qiskit Terra*. Documentation: *https://qiskit.org/documentation/apidoc/synthesis_aqc.html*, 2021.

PEER REVIEW

Journal of Machine Learning Research (JMLR)

IEEE Journal on Selected Areas in Information Theory (JSAIT)

IEEE Transactions on Control of Network Systems (TCNS)

International Conference on Machine Learning (ICML)