Nicolas Christianson

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Research interests

I am broadly interested in decision-making under uncertainty, with a specific focus on designing new algorithms to enable deploying AI and machine learning to complex, real-world problems while ensuring provable guarantees on reliability and robustness. My research agenda spans theory and practice, with particular motivation from applications in energy and sustainability.

Keywords: decision-making under uncertainty, reliable machine learning, online algorithms, energy and sustainability

Education

California Institute of Technology. Pasadena, CA — 2025 (expected)
Ph.D. in Computing and Mathematical Sciences.
Advisors: *Adam Wierman and Steven Low*
NSF Graduate Research Fellow
PIMCO Graduate Fellow in Data Science
Resnick Sustainability Institute (RSI) Scholar

Harvard College. Cambridge, MA — 2020
A.B. *summa cum laude* in Applied Mathematics. GPA: 3.976/4.0

Industry Collaborations

Microsoft Research — 2023 – present
Developing new algorithms to reliably deploy machine learning to power grid contingency analysis in collaboration with Microsoft Research Special Projects group; conference manuscript under review (working paper 2).

Amazon Prime Video — 2023 – 2024
Developed new algorithms for adaptive bitrate video streaming leveraging advancements in online optimization and learning. Yielded substantial improvements over the state-of-the-art and deployment to the Amazon Prime Video production environment, with results documented in a paper at SIGCOMM 2024 (conference publication 2).

Beyond Limits — 2022 – present
Developing algorithms for robust and efficient operation of real-world electricity/steam cogeneration resources in grids with high renewables penetration. Wrote a manuscript documenting results (journal paper 1) and incorporated the system model into SustainGym, an open-source library of sustainability-related benchmarks for reinforcement learning, documented in a paper at NeurIPS 2023 (conference publication 7).

Honors and Awards

PIMCO Graduate Fellowship in Data Science — 2024
Awarded to two Caltech graduate students in CMS or HSS each year.
NSF Graduate Research Fellowship — 2021
Phi Beta Kappa Junior 24 — 2019
One of 24 members of the Harvard College Class of 2020 inducted into Phi Beta Kappa in the Junior year.
John Harvard Scholarship — 2017, 2019
Blair Research Fellowship — 2018
Award supporting undergraduate research at the University of Pennsylvania.
Detur Book Prize — 2017

Working Papers

** indicates equal contribution*
† indicates undergraduate I advised

1. **Risk-Sensitive Online Algorithms**
   Journal version in preparation
   Nicolas Christianson, Bo Sun, Steven Low, Adam Wierman
   Preliminary version accepted for presentation at COLT '24 (conference publication 1)
2. **Fast and Reliable $N-k$ Contingency Screening with Input-Convex Neural Networks**
   Under review
   Nicolas Christianson, Wenqi Cui, Steven Low, Weiwei Yang, Baosen Zhang
3. **End-to-End Conformal Calibration for Optimization Under Uncertainty**
   Under review
   Christopher Yeh*, **Nicolas Christianson***, Alan Wu, Adam Wierman, Yisong Yue
   Preliminary version appeared at ICLR '23 Workshop on Tackling Climate Change with Machine Learning (workshop paper 1)
4. **Online Conversion with Switching Costs: Robust and Learning-Augmented Algorithms**
   Journal version in preparation
   Adam Lechowicz, **Nicolas Christianson**, Bo Sun, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy
   Preliminary version accepted to ACM SIGMETRICS/IFIP Performance 2024 (conference publication 5)
5. **CarbonClipper: Optimal Algorithms for Carbon-Aware Spatiotemporal Workload Management**
   Accepted to ACM SIGMETRICS 2025
   Adam Lechowicz, **Nicolas Christianson**, Bo Sun, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy
6. **Learning for Online Scheduling with Competitive Fairness Guarantees**
   In preparation
   Pengfei Li, Jianyi Yang, **Nicolas Christianson**, Adam Wierman, Shaolei Ren
7. **Memoryless algorithms for learning-augmented online optimization with switching costs**
   In preparation
   Junxuan Shen†, **Nicolas Christianson**, Adam Wierman
8. **Learning Dynamic Graphs, Too Slow**
   Preprint
   Andrei A. Klishin, **Nicolas H. Christianson**, Cynthia S.Q. Siew, Dani S. Bassett

Conference Publications

1. **Risk-Sensitive Online Algorithms**
   *37th Annual Conference on Learning Theory (**COLT 2024**)*
   Nicolas Christianson, Bo Sun, Steven Low, Adam Wierman
   Journal version: In preparation (working paper 1)
2. **SODA: An adaptive bitrate controller for consistent high-quality video streaming**
   SIGCOMM 2024
   Tianyu Chen, Yiheng Lin, **Nicolas Christianson**, Zahaib Akhtar, Sharath Dharmaji, Mohammad Hajiesmaili, Adam Wierman, Ramesh K. Sitaraman

3. **Chasing Convex Functions with Long-term Constraints**
   *41st International Conference on Machine Learning (**ICML 2024**)*
   Adam Lechowicz, **Nicolas Christianson**, Bo Sun, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy

4. **Online Algorithms with Uncertainty-Quantified Predictions**
   *41st International Conference on Machine Learning (**ICML 2024**)*
   Bo Sun, Jerry Huang†, **Nicolas Christianson**, Mohammad Hajiesmaili, Adam Wierman, Raouf Boutaba

5. **Online Conversion with Switching Costs: Robust and Learning-Augmented Algorithms**
   ACM SIGMETRICS/IFIP PERFORMANCE 2024
   Adam Lechowicz, **Nicolas Christianson**, Bo Sun, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy
   Journal version: Under review (working paper 4)

6. **The Online Pause and Resume Problem: Optimal Algorithms and An Application to Carbon-Aware Load Shifting**
   ACM SIGMETRICS/IFIP PERFORMANCE 2024
   Adam Lechowicz, **Nicolas Christianson**, Jinhang Zuo, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy
   Journal version: POMACS 2023 (journal publication 2)

7. **SustainGym: Reinforcement Learning Environments for Sustainable Energy Systems**
   *36th Annual Conference on Neural Information Processing Systems (**NeurIPS 2023**), Datasets and Benchmarks Track*
   Christopher Yeh, Victor Li, Rajeev Datta, Julio Arroyo, **Nicolas Christianson**, Chi Zhang, Yize Chen, Mohammad Mehdi Hosseini, Azarang Golmohammadi, Yuanyuan Shi, Yisong Yue, Adam Wierman

8. **Pricing Uncertainty in Stochastic Multi-Stage Electricity Markets**
   *62nd IEEE Conference on Decision and Control (**CDC 2023**)*
   Lucien Werner*, **Nicolas Christianson***, Alessandro Zocca, Adam Wierman, Steven Low

9. **Optimal robustness-consistency tradeoffs for learning-augmented metrical task systems**
   *26th International Conference on Artificial Intelligence and Statistics (**AISTATS 2023**)*
   Nicolas Christianson, Junxuan Shen†, Adam Wierman

10. **Smoothed Online Optimization with Unreliable Predictions**
    ACM SIGMETRICS 2023
    Daan Rutten, **Nicolas Christianson**, Debankur Mukherjee, Adam Wierman
    Journal version: POMACS 2023 (journal publication 3)

11. **Dispatch-aware planning for feasible power system operation**
    *22nd Power Systems Computation Conference (**PSCC 2022**)*
    Nicolas Christianson, Lucien Werner, Adam Wierman, Steven Low
    Journal version: EPSR 2022 (journal publication 4)

12. **Chasing Convex Bodies and Functions with Black-Box Advice**
    *35th Annual Conference on Learning Theory (**COLT 2022**)*
    Nicolas Christianson, Tinashe Handina, Adam Wierman

Journal Publications

1. **Robust Machine-Learned Algorithms for Efficient Grid Operation**
   Environmental Data Science, in press
   Nicolas Christianson, Christopher Yeh, Tongxin Li, Mehdi Hosseini, Mahdi Torabi Rad, Azarang Golmohammadi, Adam Wierman
   Preliminary version appeared at NeurIPS '22 Workshop on Tackling Climate Change with Machine Learning (workshop paper 2)
2. **The Online Pause and Resume Problem: Optimal Algorithms and An Application to Carbon-Aware Load Shifting**
   Proc. of the ACM on Measurement and Analysis of Computing Systems; vol. 7, iss. 3, art. 45, pp. 1-32, 2023
   Adam Lechowicz, **Nicolas Christianson**, Jinhang Zuo, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy
   Also appeared at ACM SIGMETRICS/IFIP PERFORMANCE '24 (conference publication 6)
3. **Smoothed Online Optimization with Unreliable Predictions**
   Proc. of the ACM on Measurement and Analysis of Computing Systems; vol. 7, iss. 1, art. 12, pp. 1-36, 2023
   Daan Rutten, **Nicolas Christianson**, Debankur Mukherjee, Adam Wierman
   Also appeared at ACM SIGMETRICS/IFIP PERFORMANCE '24 (conference publication 10)
4. **Dispatch-aware planning for feasible power system operation**
   Electric Power Systems Research; vol. 212: 108597, 2022
   Nicolas Christianson, Lucien Werner, Adam Wierman, Steven Low
   Also appeared at PSCC '22 (conference publication 11)
5. **Optimizing the human learnability of abstract network representations**
   Proceedings of the National Academy of Sciences; vol. 119, iss. 35: e2121338119, 2022
   William Qian, Christopher W. Lynn, Andrei A. Klishin, Jennifer Stiso, **Nicolas H. Christianson**, Dani S. Bassett
6. **Architecture and evolution of semantic networks in mathematics texts**
   Proceedings of the Royal Society A; vol. 476, iss. 2239: 20190741, 2020
   Nicolas H. Christianson, Ann Sizemore Blevins, Dani S. Bassett
7. **Structural and Functional Influence of the Glycine-Rich Loop G^{302}GGGY on the Catalytic Tyrosine of Histone Deacetylase 8**
   Biochemistry; vol. 55, iss. 48: 6718-6729, 2016
   Nicholas J. Porter, **Nicolas H. Christianson**, Christophe Decroos, David W. Christianson
8. **Biochemical and Structural Characterization of HDAC8 Mutants Associated with Cornelia de Lange Syndrome Spectrum Disorders**
   Biochemistry; vol. 54, iss. 42: 6501-6513, 2015
   Christophe Decroos, **Nicolas H. Christianson**, Laura E. Gullett, Christine M. Bowman, Karen E. Christianson, Matthew A. Deardorff, David W. Christianson

Workshop Papers

1. **Decision-Aware Uncertainty-Calibrated Deep Learning for Robust Energy System Operation**
   *Workshop on Tackling Climate Change with Machine Learning at **ICLR 2023***
   Christopher Yeh, **Nicolas Christianson**, Steven Low, Adam Wierman, Yisong Yue
   Full version: Under review (working paper 3)

2. **Robustifying Machine-Learned Algorithms for Efficient Grid Operation**
Workshop on Tackling Climate Change with Machine Learning at ***NeurIPS 2022***
Nicolas Christianson, Christopher Yeh, Tongxin Li, Mahdi Torabi Rad, Azarang Golmohammadi, Adam Wierman
Full version: Accepted at Environmental Data Science (journal paper 1)

Selected Talks
∗ ***denotes invited***

Reliable ML-Augmented Algorithms for Energy and Sustainability
**INFORMS Annual Meeting.* October 2024
**UMass Amherst – Sustainability Seminar.* October 2024
**Cornell ORIE – Young Researchers Workshop.* October 2024
**UC Berkeley – Energy Modeling, Analysis, & Control Group.* September 2024

Learning-augmented algorithms for online optimization and beyond
**Alberta Machine Intelligence Institute (Amii) AI Seminar.* July 2024

Risk-Sensitive Online Algorithms
Conference on Learning Theory (COLT). July 2024
Mathematical Modeling and Analysis Workshop, ACM SIGMETRICS. June 2024

Robust Machine-Learned Algorithms for Efficient Grid Operation
**CAST Annual Program Review, Caltech.* October 2023

Provable Guarantees on AI/ML for Metrical Task Systems and Classification
**UMass Amherst – CS Theory Seminar.* October 2023

Optimal Robustness-Consistency Tradeoffs for Learning-Augmented Metrical Task Systems
**INFORMS Annual Meeting.* October 2023

Chasing Convex Bodies and Functions with Black-Box Advice
**Asilomar Conference on Systems and Signals.* November 2022
**Harvard University – Na Li's Research Group.* October 2022
**UMass Amherst – Data Science Deep Dive Seminar.* October 2022
**INFORMS Annual Meeting.* October 2022
Conference on Learning Theory (COLT). July 2022

Dispatch-aware planning for feasible power system operation
Power Systems Computation Conference (PSCC). June 2022

Undergraduate Research Mentorship

James Chen '24 2023 – 2024
Topic: Learning-augmented online optimization with ramp constraints
NSF Graduate Research Fellowship — Honorable Mention
Next step: MIT EECS PhD student

Junxuan (Helen) Shen '24 2022 – 2024
Topic: Learning-augmented algorithms for multiserver convex function chasing
Next step: MIT EECS PhD student

Jerry Huang '24 2022 – 2023
Topic: Online algorithms with uncertainty-quantified predictions
Next step: CMU CS PhD student

Teaching Experience

California Institute of Technology

→ *Teaching Assistant*

CS 146: Control and Optimization of Networks	Spring 2024
CS 42: Computer Science Education in K-14 Settings	Winter 2024
CS 146: Control and Optimization of Networks	Winter 2023
CS 42: Computer Science Education in K-14 Settings	Winter 2023

Harvard College

→ *Peer Tutor, Harvard Bureau of Study Counsel/Academic Resource Center*

Math 25a: Theoretical Linear Algebra and Real Analysis I	Fall 2019
CS 181: Machine Learning	Spring 2019
APMTH 50: Introduction to Applied Mathematics	Spring 2019, Spring 2020
Math 132: Differential Topology	Spring 2019
APMTH 106: Applied Algebra	Fall 2018
STAT 110: Introduction to Probability	Fall 2018
CS 51: Intro to Computer Science II	Spring 2018, Spring 2019, Spring 2020
Math 25b: Theoretical Linear Algebra and Real Analysis II	Spring 2018

→ *Course Assistant*

Math Ma: Introduction to Functions and Calculus I	Fall 2017

Funding: Proposals and awards

Assisted in preparation of two proposals (PI: Adam Wierman) through Caltech's Center for Autonomous Systems and Technology, funded by Beyond Limits in 2022 and 2023. $230,000

NSF Graduate Research Fellowship, awarded 2021. $138,000

Professional Service

Workshop Organization

Co-Chair, Learning-augmented Algorithms: Theory and Applications *at ACM SIGMETRICS/IFIP PERFORMANCE 2024.* June 2024

Journal Reviewing

IEEE/ACM Transactions on Networking 2023, 2024

Conference and Workshop Reviewing

→ *Conferences*

Asilomar Conference on Signals, Systems, and Computers.	2022, 2024
Learning for Dynamics & Control Conference.	2024
ACM SIGMETRICS. (subreviewer)	2022, 2023, 2024
ACM e-Energy. (subreviewer)	2023, 2024

→ *Workshops*

NeurIPS Workshop on Computational Sustainability	2023

Internal Service

Student Member of Caltech CMS AI/ML Admissions Committee	2022 – 2025
Caltech CMS Prelim Exam Preparation Coordinator	2021 – 2022

Outreach

Pasadena Public Schools. Science Night volunteer 2023 – present
Designing and organizing hands-on CS activities for elementary school students for "Science Nights" at public schools in and around Pasadena.

Caltech Accountability Partners Program. PhD application mentor 2022 – present

iSTEM Scholars. Summer research mentor 2021

Project SHORT. PhD application mentor 2020 – present

Work Experience

Microsoft Research. Redmond, WA — Summer 2023
Research Intern
Intern in the Special Projects group, developing reliable machine learning methods to accelerate contingency analysis in energy grids while ensuring provable guarantees on performance.

KOACORE. Remote — Spring 2023
Machine Learning Lead and Consultant
Led development of proof-of-concept and product strategy for KOA-SUPPLY, an AI-driven healthcare supply chain marketplace which has since been acquired by Stead Impact Ventures.

The Boston Consulting Group. Boston, MA — Summer 2019
Summer Associate
Partnered with a top-10 global biopharmaceutical company to optimize its supply and manufacturing networks, using data and digital-driven techniques to forecast production needs and increase efficiency.

Covance. Princeton, NJ — Summer 2017
Data Science Intern
Developed statistical and machine learning models to forecast clinical trial patient recruitment.

References

Adam Wierman adamw@caltech.edu
Carl F Braun Professor of Computing and Mathematical Sciences
Director of Information Science and Technology
California Institute of Technology

Steven Low slow@caltech.edu
Frank J. Gilloon Professor of Computing and Mathematical Sciences and Electrical Engineering
California Institute of Technology

Mohammad Hajiesmaili hajiesmaili@cs.umass.edu
Associate Professor of Computer Science
University of Massachusetts Amherst

Baosen Zhang zhangbao@uw.edu
Keith & Nancy Rattie Endowed Career Development Professor and Associate Professor of Electrical and Computer Engineering
University of Washington

Debankur Mukherjee debankur.mukherjee@isye.gatech.edu
Leo and Louise Benatar Early Career Professor and Assistant Professor of Industrial and Systems Engineering
Georgia Institute of Technology