

Nicolas Christianson

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Research interests	<p>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.</p> <p>Keywords: decision-making under uncertainty, reliable machine learning, online algorithms, energy and sustainability</p>	
Education	California Institute of Technology. Pasadena, CA Ph.D. in Computing and Mathematical Sciences <i>Advisors: Adam Wierman and Steven Low</i> <i>NSF Graduate Research Fellow</i> <i>Resnick Sustainability Institute (RSI) Scholar</i>	2025 (expected)
	Harvard College. Cambridge, MA A.B. <i>summa cum laude</i> in Applied Mathematics. GPA: 3.976/4.0	2020
Industry Collaborations	Microsoft Research <i>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 3).</i>	2023 – present
	Amazon Prime Video <i>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).</i>	2023 – 2024
	Beyond Limits <i>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).</i>	2022 – present
Honors and Awards	NSF Graduate Research Fellowship Phi Beta Kappa Junior 24 <i>One of 24 members of the Harvard College Class of 2020 inducted into Phi Beta Kappa in the Junior year.</i> John Harvard Scholarship Blair Research Fellowship <i>Award supporting undergraduate research at the University of Pennsylvania.</i> Detur Book Prize	2021 2019 2017, 2019 2018 2017

Working Papers

* indicates equal contribution
† indicates undergraduate I advised

1. **Online Conversion with Switching Costs: Robust and Learning-Augmented Algorithms**
Under review at Operations Research
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)
2. **Risk-Sensitive Online Algorithms**
In Preparation
Nicolas Christianson, Bo Sun, Steven Low, Adam Wierman
Preliminary version accepted for presentation at COLT '24 (conference publication 1)
3. **Fast and Reliable $N - k$ Contingency Screening with Input-Convex Neural Networks**
Under review
Nicolas Christianson, Wenqi Cui, Steven Low, Weiwei Yang, Baosen Zhang
4. **CarbonClipper: Optimal Algorithms for Carbon-Aware Spatiotemporal Workload Management**
Under review
Adam Lechowicz, **Nicolas Christianson**, Bo Sun, Noman Bashir, Mohammad Hajiesmaili, Adam Wierman, Prashant Shenoy
5. **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)
6. **Learning for Online Scheduling with Competitive Fairness Guarantees**
In preparation
Pengfei Li, Jianyi Yang, **Nicolas Christianson**, Adam Wierman, Shaolei Ren
7. **Learning Dynamic Graphs, Too Slow**
Preprint
Andrei A. Klishin, **Nicolas H. Christianson**, Cynthia S.Q. Siew, Dani S. Bassett

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. 1, iss. 2, 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 G³⁰²GGGY 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

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 2)
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 1)

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

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 5)
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 * <i>denotes invited</i>	Reliable ML-Augmented Algorithms for Energy and Sustainability	
	* <i>INFORMS Annual Meeting.</i>	October 2024
	* <i>UMass Amherst – Sustainability Seminar.</i>	October 2024
	* <i>Cornell ORIE – Young Researchers Workshop.</i>	October 2024
	* <i>UC Berkeley – Energy Modeling, Analysis, & Control Group.</i>	September 2024
	Learning-augmented algorithms for online optimization and beyond	
	* <i>Alberta Machine Intelligence Institute (Amii) AI Seminar.</i>	July 2024
	Risk-Sensitive Online Algorithms	
	<i>Conference on Learning Theory (COLT).</i>	July 2024
	<i>Mathematical Modeling and Analysis Workshop, ACM SIGMETRICS.</i>	June 2024
	Robust Machine-Learned Algorithms for Efficient Grid Operation	
	* <i>CAST Annual Program Review, Caltech.</i>	October 2023
	Provable Guarantees on AI/ML for Metrical Task Systems and Classification	
	* <i>UMass Amherst – CS Theory Seminar.</i>	October 2023
	Optimal Robustness-Consistency Tradeoffs for Learning-Augmented Metrical Task Systems	
	* <i>INFORMS Annual Meeting.</i>	October 2023
	Chasing Convex Bodies and Functions with Black-Box Advice	
	* <i>Asilomar Conference on Systems and Signals.</i>	November 2022
	* <i>Harvard University – Na Li’s Research Group.</i>	October 2022
	* <i>UMass Amherst – Data Science Deep Dive Seminar.</i>	October 2022
	* <i>INFORMS Annual Meeting.</i>	October 2022
	<i>Conference on Learning Theory (COLT).</i>	July 2022
	Dispatch-aware planning for feasible power system operation	
	<i>Power Systems Computation Conference (PSCC).</i>	June 2022
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Undergraduate Research Mentorship	James Chen '24	2023 – 2024
	<i>Topic: Senior thesis on learning-augmented online optimization with ramp constraints</i>	
	<i>NSF Graduate Research Fellowship — Honorable Mention</i>	
	<i>Next step: MIT EECS PhD student</i>	
	Junxuan (Helen) Shen '24	2022 – 2024
	<i>Topic: Learning-augmented algorithms for multiserver convex function chasing</i>	
	<i>Next step: MIT EECS PhD student</i>	
	Jerry Huang '24	2022 – 2023
	<i>Topic: Online algorithms with uncertainty-quantified predictions</i>	
	<i>Next step: CMU CS PhD student</i>	
Teaching Experience	California Institute of Technology	
	→ <i>Teaching Assistant</i>	
	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	
	→ <i>Peer Tutor, Harvard Bureau of Study Counsel/Academic Resource Center</i>	
	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
	→ <i>Course Assistant</i>	
	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	
	→ <i>Conferences</i>	
	<i>Asilomar Conference on Signals, Systems, and Computers.</i>	2022, 2024
	<i>ACM SIGMETRICS.</i> (subreviewer)	2022, 2023, 2024
	<i>ACM e-Energy.</i> (subreviewer)	2023, 2024
	→ <i>Workshops</i>	
	NeurIPS Workshop on Computational Sustainability	2023
Outreach	<i>Pasadena Public Schools.</i> Science Night volunteer 2023 – present	
	<i>Designing and organizing hands-on CS activities for elementary school students for “Science Nights” at public schools in and around Pasadena.</i>	
	<i>Caltech Accountability Partners Program.</i> PhD application mentor	2022 – present
	<i>iSTEM Scholars.</i> Summer research mentor	2021
	<i>Project SHORT.</i> PhD application mentor	2020 – present
Work Experience	Microsoft Research. Redmond, WA Summer 2023	
	<i>Research Intern</i>	
	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.