

# Nicolas Christianson

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<b>Research interests</b>	<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><b>Keywords:</b> decision-making under uncertainty, reliable machine learning, online algorithms, energy and sustainability</p>	
<b>Education</b>	<b>California Institute of Technology.</b> Pasadena, CA Ph.D. in Computing and Mathematical Sciences Advisors: <i>Adam Wierman and Steven Low</i> <i>NSF Graduate Research Fellow</i> <i>PIMCO Graduate Fellow in Data Science</i> <i>Resnick Sustainability Institute (RSI) Scholar</i>	2025 (expected)
	<b>Harvard College.</b> Cambridge, MA A.B. <i>summa cum laude</i> in Applied Mathematics. GPA: 3.976/4.0	2020
<b>Industry Collaborations</b>	<b>Microsoft Research</b> <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
	<b>Amazon Prime Video</b> <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
	<b>Beyond Limits</b> <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
<b>Honors and Awards</b>	PIMCO Graduate Fellowship in Data Science <i>Awarded to two Caltech graduate students in CMS or HSS each year.</i>	2024
	NSF Graduate Research Fellowship	2021
	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>	2019
	John Harvard Scholarship	2017, 2019
	Blair Research Fellowship <i>Award supporting undergraduate research at the University of Pennsylvania.</i>	2018
	Detur Book Prize	2017

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## 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 G<sup>302</sup>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

**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<sup>†</sup>, **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<sup>†</sup>, 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>	<b>Reliable ML-Augmented Algorithms for Energy and Sustainability</b>	
	* <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, &amp; Control Group.</i>	September 2024
	<b>Learning-augmented algorithms for online optimization and beyond</b>	
	* <i>Alberta Machine Intelligence Institute (Amii) AI Seminar.</i>	July 2024
	<b>Risk-Sensitive Online Algorithms</b>	
	<i>Conference on Learning Theory (COLT).</i>	July 2024
	<i>Mathematical Modeling and Analysis Workshop, ACM SIGMETRICS.</i>	June 2024
	<b>Robust Machine-Learned Algorithms for Efficient Grid Operation</b>	
	* <i>CAST Annual Program Review, Caltech.</i>	October 2023
	<b>Provable Guarantees on AI/ML for Metrical Task Systems and Classification</b>	
	* <i>UMass Amherst – CS Theory Seminar.</i>	October 2023
	<b>Optimal Robustness-Consistency Tradeoffs for Learning-Augmented Metrical Task Systems</b>	
	* <i>INFORMS Annual Meeting.</i>	October 2023
	<b>Chasing Convex Bodies and Functions with Black-Box Advice</b>	
	* <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
	<b>Dispatch-aware planning for feasible power system operation</b>	
	<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	<b>California Institute of Technology</b>	
	→ <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

	<b>Harvard College</b>	
	→ <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
<b>Funding: Proposals and awards</b>	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	
<b>Professional Service</b>	<b>Workshop Organization</b>	
	Co-Chair, <a href="#">Learning-augmented Algorithms: Theory and Applications</a> at ACM SIGMETRICS/IFIP PERFORMANCE 2024.	June 2024
	<b>Journal Reviewing</b>	
	IEEE/ACM Transactions on Networking	2023, 2024
	<b>Conference and Workshop Reviewing</b>	
	→ <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
<b>Outreach</b>	<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
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<b>Work Experience</b>	<b>Microsoft Research.</b> 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.