

Sam Foreman's Résumé

Sam Foreman

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About

Computational Scientist at Argonne National Laboratory.

Scaling AI for science on supercomputers.

samforeman.me [GitHub](#) • [Google Scholar](#) • [ORCID](#) • [Twitter](#)

Education

- **Ph.D., Physics**
University of Iowa | 2015–2019
 - *Learning Better Physics: A Machine Learning Approach to Lattice Gauge Theory*
- **B.S. in Engineering Physics**
University of Illinois at Urbana-Champaign | 2010–2015
 - Energy Storage in Quantum Resonators (US Patent #US9741492B2)
- **B.S. in Applied Mathematics**
University of Illinois at Urbana-Champaign | 2010–2015

Professional Experience

- **Assistant Computational Scientist**
 - *Argonne National Laboratory*, Leadership Computing Facility (ALCF) Lemont, IL | 2022–Present
 - * Research lead on scaling large language models (LLMs) and generative AI for science on supercomputers (Aurora, Frontier, LUMI, Leonardo, ...).
 - Co-lead the Models and Pretraining team of the [AuroraGPT](#) project
 - * Optimize large-scale training of foundation models and language models for scientific applications.
 - * Collaborate with interdisciplinary teams to enhance simulation efficiency and scalability
 - * Focus on AI and HPC for scientific applications, including:
 - Training large language models on supercomputers
 - Genome scale language models (GenSLMs) for studying SARS-CoV-2 evolutionary dynamics
 - Direct Preference Optimization (DPO) for multimodal protein design workflows
 - Climate modeling and weather forecasting using foundation models
 - Developing improved sampling algorithms for lattice quantum chromodynamics (QCD)
 - * <https://www.alcf.anl.gov/about/people/sam-foreman>
- **Postdoctoral Researcher**
 - *Argonne National Laboratory*, Leadership Computing Facility (ALCF) Lemont, IL | 2019 – 2022
 - * Applied deep learning to lattice gauge theory and quantum field simulations.
 - * Developed ML-enhanced Monte Carlo methods for QCD ([l2hmc-qcd](#)).
 - * Engaged in AI-for-Science collaborations with national labs and university partners.
- **Graduate Researcher (DOE SCGSR Fellowship)**
 - *Argonne National Laboratory*, Mathematics and Computer Sciences Division (MCS) Lemont, IL | 2018 – 2019
 - * Development of [l2hmc-qcd](#) in collaboration with ALCF for my PhD Thesis research

Publications

Note

You can find a full list of my publications on my [Google Scholar](#)

1. **AERIS: Argonne Earth Systems Model for Reliable and Skillful Predictions** (Hatanpää et al. (2025))
 - *2025 ACM Gordon Bell Prize for Climate Modeling Finalist*
2. Aurora: Architecting Argonne's First Exascale Supercomputer for Accelerated Scientific Discovery (Allen et al. (2025))
3. **HiPerRAG: High-Performance Retrieval Augmented Generation for Scientific Insights** (Gokdemir et al. (2025))
4. **Automated Tuning for HMC Mass Ratios** (Torsiello et al. (2025))
5. **MOFA: Discovering Materials for Carbon Capture with a GenAI and Simulation-Based Workflow** (Yan et al. (2025))
6. **MProt-DPO: Breaking the ExaFLOPS Barrier for Multimodal Protein Design with DPO** (Dharuman et al. (2024))
 - *2024 ACM Gordon Bell Finalist*
7. **Intro to HPC Bootcamp: Engaging New Communities Through Energy Justice Projects** (Leung et al. (2024))
8. **Thorough Characterization and Analysis of Large Transformer Model Training At-Scale** (Cheng et al. (2024))
9. **MLMC: Machine Learning Monte Carlo for Lattice Gauge Theory** (Sam Foreman, Jin, and Osborn (2023))
10. **Protein Generation via Genome-scale Language Models with Bio-physical Scoring** (Dharuman et al. (2023))
11. **DeepSpeed4Science Initiative: Enabling Large-Scale Scientific Discovery** (Song et al. (2023))
 - DeepSpeed4Science.ai Blog Post
 - Looooooooong Sequence Lengths
12. **Comprehensive Performance Study of LLMs on Novel AI Accelerators** (Emani et al. (2023))
13. **Exploratory Analysis of Climate Data with ClimRR, Intro to HPC Bootcamp @ NERSC** (Sam Foreman (2023))
14. **GenSLMs: Genome-scale language models reveal SARS-CoV-2 evolutionary dynamics** (Zvyagin et al. (2023))
 - Winner of the *ACM Gordon Bell Special Prize for High Performance Computing-Based COVID-19 Research*

15. [Lattice QCD and Particle Physics](#) (Kronfeld et al. (2022))
16. [Applications of ML to Lattice QFT](#) (Boyda et al. (2022))
17. [LeapFrogLayers: Trainable Framework for Effective Sampling](#) (Sam Foreman et al. (2021))
18. [HMC with Normalizing Flows \[slides\]](#) (Sam Foreman et al. (2021))
19. [Deep Learning Hamiltonian Monte Carlo \[+ poster\]](#) (Sam Foreman, Jin, and C. (2021))
20. [Machine Learning and Neural Networks for Field Theory](#) (Sam Foreman, Jin, and Osborn (2020))
21. [Examples of renormalization group transformations for image sets](#) (Samuel Foreman et al. (2018))
22. [RG inspired Machine Learning for lattice field theory](#) (Sam Foreman et al. (2018))
23. [Large Energy Density in Three-Plate Nanocapacitors due to Coulomb Blockade](#) (Hubler et al. (2018))
24. [Superconductivity of In and Sn Samples](#) (Deamont and Foreman (2014))

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- Boyda, Denis, Salvatore Cah, Sam Foreman, Lena Funcke, Daniel C Hackett, Yin Lin, Gert Aarts, et al. 2022. “Applications of Machine Learning to Lattice Quantum Field Theory.” *arXiv Preprint arXiv:2202.05838*. <https://arxiv.org/abs/2202.05838>.
- Cheng, Scott, Jun-Liang Lin, Murali Emani, Siddhisanket Raskar, Sam Foreman, Zhen Xie, Venkatram Vishwanath, and Mahmut Taylan Kandemir. 2024. “Thorough Characterization and Analysis of Large Transformer Model Training at-Scale.” *Proc. ACM Meas. Anal. Comput. Syst.* 8 (1). <https://doi.org/10.1145/3639034>.
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- Dharuman, Gautham, Logan Ward, Heng Ma, Priyanka V Setty, Ozan Gokdemir, Sam Foreman, Murali Emani, et al. 2023. “Protein Generation via Genome-Scale Language Models with Bio-Physical Scoring.” In *Proceedings of the SC’23 Workshops of the International Conference on High Performance Computing, Network, Storage, and Analysis*, 95–101.
- Emani, Murali, Sam Foreman, Varuni Sastry, Zhen Xie, Siddhisanket Raskar, William Arnold, Rajeev Thakur, Venkatram Vishwanath, and Michael E Papka. 2023. “A Comprehensive Performance Study of Large Language Models on Novel AI Accelerators.”

- arXiv Preprint arXiv:2310.04607.* <https://arxiv.org/abs/2310.04607>.
- Foreman, Sam. 2023. “Energy Justice Analysis of Climate Data with ClimRR.” August 7, 2023. <https://saforem2.github.io/climate-analysis>.
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- Foreman, Sam, Xiao-Yong Jin, and Osborn James C. 2021. “Deep Learning Hamiltonian Monte Carlo.” <https://arxiv.org/abs/2105.03418>.
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- Zvyagin, Maxim, Alexander Brace, Kyle Hippe, Yuntian Deng, Bin Zhang, Cindy Orozco Bohorquez, Austin Clyde, et al. 2023. “GenSLMs: Genome-Scale Language Models Reveal SARS-CoV-2 Evolutionary Dynamics.” *The International Journal of High Performance Computing Applications* 37 (6): 683–705.

Awards and Honors

- Nominated to serve on the US **Coordinating Panel for Software and Computing** by the Division of Particles and Fields of the American Physical Society (APS).
- **Finalist, ACM Gordon Bell Prize in Climate Modeling, 2025**
 - Recognized for our work on **AERIS** (Hatanpää et al. (2025)): The first billion-parameter pixel-level diffusion model for global weather and subseasonal-to-seasonal forecasting. Trained efficiently at scales from 1.3–80B parameters with our sequence-window parallelism (SWiPe) strategy, we achieve a sustained mixed-precision performance of 10.21 ExaFLOPS and peak performance of 11.21 ExaFLOPS, scaling to 10,080 nodes (120,960 GPUs) on the Aurora supercomputer.
- **Finalist, ACM Gordon Bell Prize, 2024**
 - Acknowledged for the MProt-DPO (Dharuman et al. (2024)) project, which achieved over 4 ExaFLOP sustained performance in multimodal protein design workflows using Direct Preference Optimization.
 - * [Argonne team breaks new ground in AI-driven protein design – Argonne @ SC](#)
- **ACM Gordon Bell Special Prize for High Performance Computing-Based COVID-19 Research, 2022**
 - Recognized for contributions to the GenSLMs (Zvyagin et al. (2023)) project, which developed genome-scale language models to study SARS-CoV-2 evolutionary dynamics.
 - * [ACM Gordon Bell Special Prize for HPC-Based COVID-19 Research Awarded to Team for Modelling How Pandemic-Causing Viruses, Especially SARS-CoV-2, are Identified and Classified](#)

- **DOE Office of Science Graduate Student Research Fellow, 2018**
 - Awarded by the Department of Energy for outstanding research contributions during graduate studies.

Talks

Note

You can see all of my talks online at <https://samforeman.me/talks/>

- 2025-:
 - 12: [Training Foundation Models on Supercomputers](#) @ Argonne National Laboratory
 - 10: [Training Foundation Models on Supercomputers](#) @ University of Illinois at Urbana-Champaign
 - 10: [Training Foundation Models on Supercomputers](#) @ Georgia Institute of Technology
 - 10: [AERIS: Argonne's Earth Systems Model](#) @ 2025 ALCF Hands-On HPC Workshop
 - 09: [Scientific AI at Scale: AI for Science](#) @ Open SkAI 2025
 - 09: [Scientific AI at Scale: Distributed Training](#) @ Open SkAI 2025
 - 07: [Large Scale Training on Diverse Accelerators](#) @ Scalable Deep Learning, SIAM AN2025
 - 05: [LLMs on Aurora: AuroraGPT](#) @ 2025 ALCF INCITE GPU Hackathon
 - 05: [LLMs on Aurora: ezpz](#) @ 2025 ALCF INCITE GPU Hackathon
 - 02: [AuroraGPT: Foundation Models for Science](#) @ Foundation Models for the Electric Grid
- 2024-:
 - 11: [Parallel Training Methods](#) @ AI-for-Science on Supercomputers
 - 10: [AuroraGPT](#) @ 2024 ALCF Hands-On HPC Workshop
 - 10: [Machine Learning and Foundation Models at Scale](#) @ 2024 ALCF Hands-On HPC Workshop
 - 09: [AuroraGPT](#) @ HPC User Forum, 2024
 - 08: [Training LLMs at Scale](#) @ ATPESC, 2024
 - 07: [LLMs on Polaris](#) @ Center for Scientific Foundation Models, Summer School 24'
 - 03: [Parallel Training Techniques](#) @ AI-4-Science Training Series
 - 02: [LLMs from Scratch](#) @ LLM Tutorial Workshop
- 2023-:
 - 11: [Creating Small\(-ish\) LLMs](#) @ LLM Tutorial Workshop (1)

- 10: [Exascale Science on Aurora](#) @ Intel oneAPI Workshop @ UIC
 - 10: [LLM Lunch Talk](#) @ ALCF Hands On HPC Workshop
 - 08: [Scaling LLMs for Science](#) @ Data-Intensive Computing + AI/ML at Scale
 - 07: [MLMC: Machine Learning Monte Carlo](#) @ Lattice 2023
 - 07: [Generative Modeling and Efficient Sampling](#) @ PASC23
 - 04: [Efficient Sampling for LGT](#) @ Deep Fridays @ U. Bologna
- 2022-:
 - 11: [Large Scale Training](#) @ AI4Science on Supercomputers (ALCF)
 - 10: [Hyperparameter Management](#) @ ALCF SDL Workshop
 - 08: [Statistical Learning](#) @ ATPESC 2022
 - 05: [Scientific Data Science: An Emerging Symbiosis](#) @ ANL (05/2022)
 - 03: [Machine Learning in HEP](#) @ UNC Greensboro
- 2021-:
 - 12: [Accelerated Sampling Methods for LGT](#), @ DWQ @ 25 [BNL]
 - 09: [Training Topological Samplers for LGT](#) @ ML4HEP, ECT* Trento
 - 05: [Deep Learning HMC for Improved Gauge Generation](#) @ ML in LQCD Workshop [2021]
- 2020:
 - 02: [Machine Learning for Lattice QCD](#) @ U. Iowa [2020]

Events

- Organizer for:
 - [SC25 Workshop: High Performance Python for Science at Scale \(HPPSS\)](#), November 2025
 - [SC25 Tutorial: Accelerating and Scaling Python for HPC](#)
 - [SC24 Workshop: High Performance Python for Science at Scale \(HPPSS\)](#), November 2024
 - [SC23 Workshop: High Performance Python for Science at Scale \(HPPSS\)](#), November 2023
 - [Machine Learning and Quantum Computing for Earth Sciences](#) at 17th U. S. National Congress on Computational Mechanics, July 2023

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