Sam Foreman's Résumé

Sam Foreman

2025-04-26

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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

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
    - Loooooooong 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))

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-:
  – 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](2025-09-20_machine.md) Learning and Quantum Computing for Earth Sciences](#) at 17th U. S. National Congress on Computational Mechanics, July 2023

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Boyda, Denis, Salvatore Caĺì, 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.

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