Sam **Foreman**

PhD. Candidate · Physicist / Data Scientist

(630) 873-0945 | samuel-foreman@uiowa.edu | saforem2 | saforem2

Education

University of Iowa — *Iowa City, IA*

PhD. Physics, supervisor: Yannick Meurice — *May 2019 (expected)*

University of Illinois at Urbana-Champaign — *Champaign, IL*

B.S. Engineering Physics — *May 2015*

University of Illinois at Urbana-Champaign — *Champaign, IL*

B.S. Applied Mathematics — *May 2015*

Thesis Research

University of Iowa, Department of Physics & Astronomy — *Iowa City, IA*

Research Assistant — *Spring 2016 - Present*

- Carried out interdisciplinary research focused on applying ideas from machine learning and data science to simulations in lattice gauge theory (LGT) and lattice quantum chromodynamics (LQCD).
- Discovered a new method for describing the phase transition in the 2-dimensional Ising model by applying unsupervised learning techniques (PCA, k-means clustering) to Monte Carlo simulation images.
- Helped to create a new technique for implementing renormalization group transformations on arbitrary image sets, and explored potential applications in dynamic image analysis and action recognition.
- Worked with tensorflow/keras to construct convolutional neural networks capable of classifying configurations of the Ising model by temperature.
- Current work focuses on improving the efficiency of the hybrid Monte Carlo algorithm by using neural networks to improve the quality of the sampler.

Experience

Argonne National Laboratory, Computational Sciences Division — *Lemont, IL*

Graduate Research Fellow — *Summer 2018 - Summer 2019*

- Software development focused on applying machine learning models to help improve the efficiency of Hybrid Monte Carlo simulations and their use in Lattice QCD.
- Built and deployed learning models in tensorflow on Argonne's massively parallel, many-core supercomputer (Theta) using state-of-the-art high-performance computing techniques.
- Helped to develop a method for training Markov Chain Monte Carlo kernels parameterized with deep neural networks that shows promise in out performing traditional methods on a variety of different models.

University of Iowa, Department of Physics & Astronomy — *Iowa City, IA*

Research Assistant — *Spring 2016 - Fall 2016*

- Software and hardware development for HaloSat, a nanosatellite built with the goal of better understanding the missing baryon problem.
- Contributed to the in-flight optimization algorithms aimed at maximizing the incoming X-ray signals (by minimizing background noise) while in operation.

University of Illinois, Center for Complex Systems Research — *Champaign, IL*

Research Assistant — *Spring 2011 - Spring 2015*

- Actively maintained the legacy code base (C++ / MATLAB) for our research group and helped to test/debug new contributions.
- Helped to construct a model describing the energy density and self-discharge time of nanoscale capacitors.
- This work was submitted as a patent (pending) titled "Energy Storage in Quantum Resonators", on which I was designated a co-inventor together with my advisor Alfred Hübler.

Programming Skills & Projects

- **Languages: Python** (including numpy, pandas, tensorflow, and scikit-learn), **C/C++**, **MATLAB** and brief experience with **SQL**,**R**, **Go**, and **Ruby**.
- **LatticeMC:** A python library used for performing highly efficient Monte Carlo simulations on various lattice models and analyzing and interpreting the results.

Publications & Talks

- S. Foreman, Y. Meurice, J. Giedt and J. Unmuth-Yockey, "Examples of renormalization group transformations for image sets," *Physical Review E*.
- S. Foreman "Machine learning inspired analysis of the Ising model transition," The 36th Annual International Symposium on Lattice Field Theory.
- S. Foreman, J. Giedt, Y. Meurice and J. Unmuth-Yockey, "RG inspired Machine Learning for lattice field theory." *arXiv:1710.02079*.
- S. Foreman, "Machine Learning Analysis of Ising Worms." Brookhaven National Laboratory, Dec. 2017 (invited speaker)
- A. Hubler, S. Foreman, J. Liu, and L. Wortsmann, "Large Energy Density in Three-Plate Nanocapacitors due to Coulomb Blockade." *Journal of Applied Physics*.