Sam **Foreman**

PhD. Candidate · Science Enthusiast

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

Education

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

Bachelor of Science, Engineering Physics — *August 2010 - May 2015*

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

Bachelor of Science, Applied Mathematics — *August 2010 - May 2015*

University of Iowa — *Iowa City, IA*

PhD., Physics — *August 2015 - May 2019 (expected)*

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 quantumchromodynamics (LQCD).
- Used unsupervised learning techniques (PCA, k-means clustering) as an alternative method for learning about the phase transition of the Ising model. By representing equilibrium configurations of the system as two-dimensional greyscale images, I was able to obtain a relationship between the first principal component of the covariance matrix associated with a collection of such images, and the specific heat capacity (the physical quantity used to describe the phase transition).
- Built and trained a multi-layer convolutional neural network in tensorflow used for classifying configurations of the Ising model by temperature. By studying the classification accuracy as a function of temperature, the existence of a phase transition can be identified by where the network begins to fail (characterized by a sharp spike in the classification error).
- Currently, I am working on using deep feed-forward neural networks and restricted Boltzmann machines to find ways for improving the efficiency of Monte Carlo simulations in LQCD.

Experience

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

Research Assistant — *Spring 2016 - Fall 2016*

- Software and hardware development for HaloSat, a miniaturized satellite built with the goal of better understanding the missing baryon problem.
- Helped to design the event detection logic and was responsible for creating the interface necessary for digitizing and interpreting received signals.
- Worked with a team to build the telemetry system that handled data transmission between the satellite and ground communications networks.
- Contributed to the in-flight optimization algorithms aimed at maximizing the incoming X-ray signals (by minimizing background noise) while in operation.

Center for Complex Systems Research — *Champaign, IL*

Research Assistant — *Spring 2011 - Spring 2015*

- Helped to construct a model describing the energy density and self-discharge time of nanoscale capacitors. These results helped to identify flaws in many of the previous models and allowed us to create a new design capable of a significantly longer self-discharge time, and consequently, a much larger maximum energy density.
- 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++, 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

- S. Foreman, J. Giedt, Y. Meurice and J. Unmuth-Yockey, "RG inspired Machine Learning for lattice field theory," arXiv:1710.02079 [hep-lat].
- S. Foreman, Y. Meurice, J. Giedt and J. Unmuth-Yockey, "Machine learning inspired analysis of the Ising model transition," (in progress)
- A. Hubler, S. Foreman, J. Liu, and L. Wortsmann, "Large Energy Density in Three-Plate Nanocapacitors due to Coulomb Blockade." Journal of Applied Physics. (in review)