Jacob Miller, Ph.D.

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Personal Statement

I've had a passion for math, science, and computers since childhood, extending into a graduate career developing interdisciplinary frameworks for enabling quantum computation. These interests have more recently led me to machine learning, where I'm trying to use my strong analytical background to develop better tools for understanding deep learning. I work well on teams, love sharing my interests with others, and produce surprising insights often.

Highlights

- ✓Top student in physics PhD cohort
- ✓Powerful analytical tool kit drawing from diverse range of disciplines
- ✓Strong research career with good publication record
- ✓Genuinely nice person, good on individual and team projects
- ✓Clear and effective communicator
- ✓Decently fluent in Mandarin, too!

Research & Work Experience

Graduate research in quantum computation, University of New Mexico, 2013 - 2017
- Used tensor toolbox and diverse software simulations to characterize computational behavior of quantum systems in terms of distinct phases of matter (as in, liquid, solid, gas,...)
- Developed non-traditional blend of analytical and numerical techniques to prove unexpected applications of different quantum computer architectures

Undergraduate research, Perimeter Institute for Theoretical Physics, Summer 2010
- Studied applications of non-classical logics and probabilistic semantics to quantum foundations

Quantum simulation research, Wellesley College, Summer 2009
- Built MATLAB simulator for probing behavior of interacting Bose-Einstein condensates

Renewable energy internship, All Earth Renewables, Summer 2007 & 2008
- Wrote software for solar tracking and for fitting circuit parameters from data

(Formal) Education

MS & PhD in Physics, University of New Mexico, 2011 - 2017
- Graduate dissertation, "*Measurement-based quantum computation and symmetry-protected topological order*", was top physics thesis of 2014-2017

BS in Engineering w/ Physics, Olin College of Engineering, 2007 - 2011
- Received four year full tuition F.W. Olin Scholarship

Distinctions

- Chair's Dissertation Award for best graduate physics dissertation, 2017
- Two lead author publications in top-tier physics journal *Physical Review Letters,* 2018 & 2015
- William G. Larsen award for best graduate physics/math TA, 2012

Teaching & Service

Teaching assistant for student labs, University of New Mexico, 2011 - 2013
- Supervised undergraduate physics labs, was chosen as best physics/math TA for 2012

Course design and instruction, University of New Mexico, 2013 - 2014
- Co-designed and co-taught new intro-level math class from scratch

Head of TACLA coffee club, University of New Mexico, 2014 - 2017
- Handled purchasing, billing, and maintenance of popular coffee room in physics dept.

Proficiencies

Languages: Python and MATLAB, along with some Haskell, C++, and Javascript

Software tools: Numpy, Scipy, TensorFlow, Keras, LaTeX, Jekyll, Git, Linux CLI

Analytical tools: Linear and multilinear/tensor algebra, statistics, complexity theory, percolation theory, programming language semantics, convex optimization, graph theory, game theory, abstract algebra, category theory, topology, ...

Publications & Projects

J. Miller and A. Miyake, "*Latent computational complexity of symmetry-protected topological order with fractional symmetry*", Physical Review Letters **120**, 170503 (2018)

- Using simplified model of 2D quantum states, gave evidence for the existence of a phase of computationally universal quantum matter
- Proof utilized self-taught techniques from homological algebra, along with optimized numerical search in space of rank-3 tensors encoding states

J. Miller, S. Sanders, and A. Miyake, "*Quantum supremacy in constant-time MQC: A unified architecture for sampling and verification*", Physical Review A **96**, 062320 (2017)

This project was especially cool!

- Laid out new architecture for sampling from provably quantum probability distribution
- Discovered several unexpected improvements arising from surprising insights into computational complexity theory and statistical analysis

J. Miller and A. Miyake, "*Hierarchy of universal entanglement in 2D measurement-based quantum computation*", npj Quantum Information **2**, 16036 (2016)

- Discovered surprising variant of classic quantum computing protocol which has interesting connection with novel phases of quantum matter
- Crucial part of protocol involved numerical simulation of novel percolation problem

J. Miller and A. Miyake, "*Resource quality of a symmetry-protected topologically ordered phase for quantum computation*", Physical Review Letters **114**, 120506 (2015)

- Used analytic characterization of tensors to prove an entire phase of matter can be uniformly utilized for certain quantum computing tasks

J. Miller, "*The Adumbrant Notational System*", Humanities Capstone Project (2011)

- Studied lexicographically-derived "allowances" in existing mathematical notation, and how a hypothetical notational system using Chinese ideograms as variables might work

Other Information

- Born and raised on a dirt road in rural Vermont
- Learned Mandarin via 5 month immersive college study away program in Beijing
- Took a "gap year" after grad school to travel and relax, first going for a 14,000 mile motorcycle trip across the US and Canada in late 2017
- Backpacked across East Asia for 4 months in 2018, hiking, meeting friends, and drinking tea in Taiwan, Hong Kong, Mainland China, South Korea, and Japan