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 powering quantum computation. These interests have more recently led me to machine learning, where I'm trying to use my broad analytical background to develop tools for better understanding machine learning models. 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

Volunteer research, Montreal Institute of Learning Algorithms, October 2018 - present
- Applying tools from many-body quantum systems to characterize and develop a novel family of physics-inspired kernel learning models

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 tracking the sun and for fitting circuit parameters from calibration 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

Teaching & Service

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

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

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

Proficiencies

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

Software tools: Numpy, TensorFlow/Keras, LaTeX, Inkscape, Git, Linux/GNU toolchain

Analytical tools: Linear and multilinear/tensor algebra, statistics, complexity theory, group/representation theory, complex dynamics, percolation theory, category theory, denotational semantics, abstract algebra, graph theory, topology, ...

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

Publications & Projects

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

- Used a family of group theoretic models to give evidence for the capability of a phase of quantum many-body states to power a universal quantum computer

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, found some widely applicable optimizations and counterintuitive tricks along the way

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

- Developed variant of standard quantum computing protocol which uses topological phases of quantum matter, proved universality of this architecture using percolation simulations

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

- Used representation theory over tensor train decomposition of complex quantum states to prove the existence of a phase of quantum matter with uniform computational power

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

- Developed a new mathematical notational system based upon Chinese characters

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 embarking on a 14,000 mile motorcycle road trip across the US and Canada in late 2017
- Backpacked across East Asia for 4 months in 2018, hiking, meeting new people, and drinking a lot of tea in Taiwan, Hong Kong, Mainland China, South Korea, and Japan