Daniel James Mills

About

I am a Senior Research Scientist at Quantinuum with extensive interdisciplinary experience in mathematics, physics and computer science, developed in academia and industry. I am eager to widen the utilisation, applicability, and understanding of quantum computation through novel research.

Highlights

- PhD on "Benchmarking, verifying and utilising near term quantum technology".
- Masters of science by research on quantum computing (Distinction, top of class).
- Masters of Mathematics (1st class).
- Proven record of peer reviewed publication.
- Experienced in research leadership.
- Programmer, writer, and presenter.
- Well practised teacher and educator.

Current Role

Senior Research Scientist (Quantum Software) Quantinuum July 2020 - Present

My interests in using software tools to optimise the use of near term quantum devices. I've held leading roles in collaborations on error mitigation, distributed quantum computing, and full stack benchmarking. I have active interests in quantum circuit compilation, the simulation of noise in quantum devices, measurement based quantum computing, diagrammatic reasoning, and the theoretical foundations for quantum computational supremacy.

Education

The University of Edinburgh Doctorate 2016 - 2020

- Thesis "Benchmarking, Verifying and Utilising Near Term Quantum Technology" supervised by Professor Elham Kashefi. Focusing on the verification of early stage quantum computers by observing limited architecture, experimental noise, etc.
- Other research areas: quantum machine learning, classical simulation of quantum computations, superiority of quantum over classical computing, quantum computing software.

The University of Edinburgh MSc by research: Distinction, top of class 2015 - 2016

- Grade of 90% for dissertation 'Information Theoretically Secure Hypothesis Test for Temporally Unstructured Quantum Computing', supervised by Professor Elham Kashefi.
- Courses on machine learning, categorical quantum computing, and complexity theory.

The University of Warwick MMath: 1st class 2011 - 2015

- Broad studies with a focus on analysis; particularly information theory and dynamical systems. Fourth year project, 'Communication Over Binary Symmetric Channel With Random Failure Rate', supervised by Professor Oleg Zaboronski.
- Extensive coverage of algebra, number theory, probability theory, geometry, fluid dynamics, computational mathematics, numerical analysis and scientific programming; as well as many modules from physics including those on quantum mechanics and cosmology.

Other Recent Experience

Supervisor - Quantum Computing **The University of Cambridge** **2021 - 2023**

- Supervised 6 students each year, meeting biweekly to assess and discuss problem sheets.

Tutor - Introduction to Quantum Computing **The University of Edinburgh** **2019**

- Designed, prepared and presented biweekly tutorials for $\tilde{1}5$ students.

Research Intern **Cambridge Quantum Computing** **2019 (3 months)**

- Developing benchmarking procedures for quantum technology, at all layers of the technology stack, taught me about results in quantum complexity, the intricacies of quantum computing architectures, and a variety of applications of quantum computers.
- Implementing these benchmarks familiarised me with interfaces for quantum devices such as Rigetti's Forest SDK and cloud service, and the IBM Quantum Platform.

Makerspace Technician **The University of Edinburgh** **2018 - 2019 (13 months)**

- Maintained, utilised, and taught the use of digital manufacturing technologies and related software, including: 3D printing, scanning and design; CNC milling and cutting; virtual and augmented reality; Raspberry Pis and electronics.

Research and Development Intern **Atos** **2017 - 2018 (6 months)**

- Implemented a parallelised, high performance classical simulator of quantum computation.
- Utilised classical simulation and HPC as a tool to provide new insights into quantum computing and, in particular, into the impact of physically motivated noise.

Other Skills and Achievements

Software development tools: programming languages Java, MATLAB, Python, Rust, C++ and C; quantum computation programming tools such as pyQuil, pytket, and qiskit; Linux and Windows; Microsoft Office and LaTex; project management tools such as Jira; code quality and management tools such as pytest, linting, Git, and automactic documentation generation.

Popular Science Communication: I hosted my own science news show on the Edinburgh student radio station and was elected as head of the news team. I was also part of the team producing the Edinburgh informatics pod-cast.

Event organisation: I co-organised QuHackEd, Scotland's first quantum computing hackathon. This four day event, consisting of talks and a competition, taught me to manage and mediate between suppliers, communicate with speakers and motivate attendees, and acquire sponsorship totalling £15000.

Peer-review: I have been a reviewer for several journels, for example Quantum, Quantum Machine Intellegence, and Physical Review journels, and conferences, such as QIP, QPL, and IWQC.

Personal Information and Contact Details

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Publications

Pre-Prints

Gustiani, Cica, Dominik Leichtle, Daniel Mills, Jonathan Miller, Ross Grassie, and Elham Kashefi. **On-Chip Verified Quantum Computation with an Ion-Trap Quantum Processing Unit.** arXiv preprint arXiv:2410.24133 (2024).

Lubinski, Thomas, Joshua J. Goings, Karl Mayer, Sonika Johri, Nithin Reddy, Aman Mehta, Niranjan Bhatia et al. **Quantum Algorithm Exploration using Application-Oriented Performance Benchmarks.** arXiv preprint arXiv:2402.08985 (2024).

Published

Pablo Andres-Martinez, Tim Forrer, Daniel Mills, Jun-Yi Wu, Luciana Henaut, Kentaro Yamamoto, Mio Murao, and Ross Duncan. **Distributing circuits over heterogeneous, modular quantum computing network architectures.** Quantum Science and Technology 9, no. 4 (2024): 045021.

Jun-Yi Wu, Kosuke Matsui, Tim Forrer, Akihito Soeda, Pablo Andrés-Martínez, Daniel Mills, Luciana Henaut, and Mio Murao. **Entanglement-efficient bipartite-distributed quantum computing.** Quantum 7 (2023): 1196.

Cristina Cirstoiu, Silas Dilkes, Daniel Mills, Seyon Sivarajah, and Ross Duncan. **Volumetric benchmarking of error mitigation with qermit.** Quantum 7 (2023): 1059.

Daniel Mills, Seyon Sivarajah, Travis L. Scholten, and Ross Duncan. **Application-motivated, holistic benchmarking of a full quantum computing stack.** Quantum 5 (2021): 415.

Brian Coyle, Daniel Mills, Vincent Danos, and Elham Kashefi. **The Born supremacy: quantum advantage and training of an Ising Born machine.** npj Quantum Information 6, no. 1 (2020): 60.

Vankov, Iskren, Daniel Mills, Petros Wallden, and Elham Kashefi. **Methods for classically simulating noisy networked quantum architectures.** Quantum Science and Technology 5, no. 1 (2019): 014001.

Daniel Mills, Anna Pappa, Theodoros Kapourniotis, and Elham Kashefi. **Information theoretically secure hypothesis test for temporally unstructured quantum computation.** Electronic Proceedings in Theoretical Computer Science (QPL 2017).

Notable Presentations

Besides the following, additional presentations may be found at `https://dan-mills.com/`

Quantum Buisiness Europe Congress 2023 (invited speaker): Best Practices in Running Quantum Algorithms on NISQ Devices.

IWQC 2023: Distributing circuits over heterogeneous, modular quantum computing network architectures.

IEEE Quantum Week 2022: Developing and Executing Error-mitigated NISQ Algorithms across Devices and Simulators.

APS March 2022 (invited speaker): Application-motivated, holistic benchmarking of a full quantum computing stack.

Quantum Simulation and Computing 2019: The Born Supremacy - Quantum Advantage and Training of an Ising Born Machine

QPL 2017: Information Theoretically Secure Hypothesis Test for Temporally Unstructured Quantum Computation.