JOSH IZAAC

COMPUTATIONAL PHYSICIST AND
QUANTUM SOFTWARE DEVELOPER

Toronto, ON
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PROFILE

I'm a quantum physicist, experienced quantum software developer, and science writer with a demonstrated history of working in the publishing industry. I am currently working for quantum computing company Xanadu Quantum Technologies as a theoretical physicist, using my background in quantum computation and software development to perform research and drive forward the field of quantum software.

EXPERTISE

- Quantum computation
- Scientific research
- Technical writing and documentation
- Quantum software
- Open-source software development
- Growing open-source ecosystems and communities
- Science outreach
- Quantum photonics
- High performance computation
- Testing, packaging, and CI

SKILLS

Python C++ Mathematica Fortran Unix Git Bash scripting AWS OpenMP MPI LaTeX Docker DevOps Testing/CI Creativity Communication Motivation Organization Teamwork

EDUCATION

BSc (Hons) Physics and Mathematics
University of Western Australia
Weighted average mark: 91.4%
GPA: 7.0/7.0 (First class honours)

Complex numerical analysis was performed using high performance supercomputing facilities, exploring both quantum dynamics and nanomagnetics.

2009 - 2012

PhD Physics
University of Western Australia
Thesis: Continuous-time quantum walks: simulation and application.

Explored efficient numerical simulation of the continuous-time quantum walk, and potential real-world applications to graph isomorphism and network centrality.

2013 - 2017

EXPERIENCE

Theoretical physicist Sep 2017 – Present
Xanadu

Physics researcher and software developer, working across the entire Xanadu software stack. Working alongside and overseeing a talented team – projects included

- Architecting a cloud platform to interface Xanadu's software with photonic hardware, leading to the **first public quantum photonic cloud service**.
- Creating and actively maintaining software libraries for **quantum optics simulation** (*Strawberry Fields*), hardware-driven **quantum machine learning** (*PennyLane*), designing a quantum photonic **programming language** (*Blackbird*), and developing **cutting-edge algorithms** to simulate quantum systems (*Hafnian*).
- Developing and deploying an online web application for simulation of photonic quantum circuits, using Flask, Docker, WebSocket, Celery, Redis, and AWS.
- Developing organizational software best-practices and testing policies.

My role also included research, speaking engagements, outreach, representing Xanadu at the Creative Destruction Lab training session/hackathon, working with investors, and collaborating with Google (OpenFermion), IBM, Rigetti (pyQuil), and D-Wave on software offerings.

Science Writer Aug 2015 – Present
Freelance

Keeping up to date with scientific research across disciplines, developing and pitching story ideas and technical book proposals to editors, interviewing researchers, and writing articles. I have developed and **written an undergraduate university textbook**, *Computational Quantum Mechanics*, introducing students to scientific programming and numerical techniques published by Springer-Nature. My short-form work has so far appeared in Australian Geographic and Science Magazine.

Lecturer and Tutor Feb 2012 – Jul 2017
University of Western Australia

Lecturer, tutor, and marker working for the School of Physics. Courses taught include:

- *Computational Quantum Mechanics* (master's level): teaching numerical methods in physics, Fortran, and approaches for simulating dynamical quantum systems.
- *Computational Mathematics (3rd year undergraduate)*: helping students with problems in applied mathematics and demonstrating how computational tools such as Mathematica can be used to complement traditional methods.
- *Quantum computation (3rd year undergraduate)*: compiling assignments and marking.

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AWARDS

Hackett Postgraduate Scholarship 2012
Awarded to the top-ranked PhD applicants

John and Patricia Farrant Scholarship 2011
Awarded to the top physics student undertaking honours

Physics (Level 3) Prize 2011
Top student in 3rd year physics

Digby Fitzhardinge Memorial Prize 2010
Top student in 2nd year physics

Lady James Prize in Chemistry 2009
Top student in 1st year chemistry

INTERESTS

- Technology
- Quantum technology
- Open-source software
- Programming
- Travelling
- Cooking and baking
- Strength training

REFERENCES

Professor Jingbo Wang
jingbo.wang@uwa.edu.au

Doctoral supervisor, Head of Department of Physics, UWA

Additional references available upon request.

PRESENTATIONS

[1] J. A. Izaac, “The evolution of quantum software.” Speaker and panelist at the Inside Quantum Technology Conference, Boston, MA. (2019)

[2] J. A. Izaac, “Automatic differentiation and machine learning of quantum computations.” Talk presented at FOSDEM, Brussels, Belgium. (2019)

[3] Two-day Xanadu training session presented at the Creative Destruction Lab quantum machine learning bootcamp at the Rotman School of Management, University of Toronto. (2018)

[4] J. A. Izaac, X. Zhan, J. Li, P. Xue, P. C. Abbott, X. S. Ma, and J. B. Wang, “Quantum centrality ranking via quantum walks and its experimental realization.” Talk presented at 17th Asian Quantum Information Science Conference, Singapore. (2017)

[5] J. A. Izaac, J. B. Wang, P. C. Abbott, and X. S. Ma, “Quantum centrality testing on directed graphs via PT-symmetric quantum walks.” Poster presented at PHHQP16: Progress in Quantum Physics with Non-Hermitian Operators, Kyoto, Japan. (2016)

[6] J. A. Izaac and P. J. Metaxas, “Nanomagnetism with GPUs: simulations of hybrid vortex–domain wall devices.” Paper presented at the annual iVEC Symposium, Perth, Australia. (2013)

PUBLICATIONS

[1] T. Wu, J. Izaac, Z. Li, K. Wang, Z. Chen, S. Zhu, J. Wang, and X. Ma, "Experimental Multi-Photon Quantum Walk on a Directed Graph," in APS Meeting Abstracts (2019).

[2] M. Schuld, V. Bergholm, C. Gogolin, J. Izaac, and N. Killoran, "Evaluating analytic gradients on quantum hardware," Physical Review A 99(3), (2019).

[3] K. K. Sabapathy, H. Qi, J. Izaac, and C. Weedbrook, "Production of photonic universal quantum gates enhanced by machine learning," Physical Review A 100(1), (2019).

[4] N. Quesada, L. Helt, J. Izaac, J. Arrazola, R. Shahrokhshahi, C. Myers, and K. Sabapathy, "Simulating realistic non-Gaussian state preparation," arXiv:1905.07011 (2019).

[5] N. Killoran, J. Izaac, N. Quesada, V. Bergholm, M. Amy, and C. Weedbrook, "Strawberry fields: A software platform for photonic quantum computing," Quantum 3, 129 (2019).

[6] J. M. Arrazola, T. R. Bromley, J. Izaac, C. R. Myers, K. Brádler, and N. Killoran, "Machine learning method for state preparation and gate synthesis on photonic quantum computers," Quantum Science and Technology 4(2), 024004 (2019).

[7] K. K. Sabapathy, H. Qi, J. Izaac, and C. Weedbrook, "Near-deterministic production of universal quantum photonic gates enhanced by machine learning," arXiv:1809.04680 (2018).

[8] J. Izaac and J. Wang, Computational Quantum Mechanics (Springer Berlin Heidelberg, 2018).

[9] K. Bradler, S. Friedland, J. Izaac, N. Killoran, and D. Su, "Graph isomorphism and Gaussian boson sampling," arXiv:1810.10644 (2018).

[10] V. Bergholm, J. Izaac, M. Schuld, C. Gogolin, and N. Killoran, "Pennylane: Automatic differentiation of hybrid quantum-classical computations," arXiv:1811.04968 (2018).

[11] S. S. Zhou, T. Loke, J. A. Izaac, and J. B. Wang, "Quantum Fourier transform in computational basis," Quantum Information Processing 16(3), (2017).

[12] J. R. McClean, I. D. Kivlichan, D. S. Steiger, Y. Cao, E. S. Fried, C. Gidney, T. Häner, V. Havlíček, J. Izaac, Z. Jiang, and others, "OpenFermion: the electronic structure package for quantum computers," arXiv:1710.07629 (2017).

[13] J. A. Izaac, X. Zhan, Z. Bian, K. Wang, J. Li, J. B. Wang, and P. Xue, "Centrality measure based on continuous-time quantum walks and experimental realization," Physical Review A 95(3), (2017).

[14] J. A. Izaac and J. B. Wang, "Systematic dimensionality reduction for continuous-time quantum walks of interacting fermions," Physical Review E 96(3), (2017).

[15] J. A. Izaac, J. B. Wang, P. C. Abbott, and X. S. Ma, "Quantum centrality testing on directed graphs via PT-symmetric quantum walks," Physical Review A 96(3), (2017).

[16] A. C. H. Hurst, J. A. Izaac, F. Altaf, V. Baltz, and P. J. Metaxas, "Reconfigurable magnetic domain wall pinning using vortex-generated magnetic fields," Applied Physics Letters 110(18), 182404 (2017).

[17] A. Mahasinghe, J. A. Izaac, J. B. Wang, and J. K. Wijerathna, "Phase-modified CTQW unable to distinguish strongly regular graphs efficiently," Journal of Physics A: Mathematical and Theoretical 48(26), 265301 (2015).

[18] J. A. Izaac and J. B. Wang, "pyCTQW: A continuous-time quantum walk simulator on distributed memory computers," Computer Physics Communications 186, 81–92 (2015).

[19] Z. J. Li, J. A. Izaac, and J. B. Wang, "Position-defect-induced reflection, trapping, transmission, and resonance in quantum walks," Physical Review A 87(1), (2013).

[20] J. A. Izaac, J. B. Wang, and Z. J. Li, "Continuous-time quantum walks with defects and disorder," Physical Review A 88(4), (2013).