JOSH IZAAC

COMPUTATIONAL PHYSICIST AND
QUANTUM PRODUCT 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 Head of Product, using my background in quantum computation and software development to design and develop product strategy 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.

Feb 2009 – Jan 2013

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.

Jan 2013 – Sep 2017

EXPERIENCE

Director of Product Oct 2022 – Present
Xanadu

Head of Quantum Software Nov 2021 – Oct 2022
Xanadu

My work involves leading the product development of Xanadu's open-source quantum software libraries, including PennyLane and Strawberry Fields, and has recently evolved to the entire product portfolio at Xanadu. This includes:

- Setting and coordinating project goals and objectives, and driving the overall vision
- Ensuring our product development initiatives and strategy aligns with wider company vision
- Providing both technical leadership and people management to our team of quantum software developers
- Communicating and liaising with project stakeholders and external users/collaborators

Theoretical Physicist Sep 2017 – Dec 2021
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 (*The Walrus*).
- 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), AWS, IBM, Rigetti (pyQuil), and D-Wave on software offerings.

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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.

SELECTED PRESENTATIONS

[1] J. A. Izaac, "What are quantum computers, and how can we train them in Python?" PyCon US (2021)

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

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

[4] 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)

[5] 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)

[6] 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)

SELECTED PUBLICATIONS

[1] M. Schuld, V. Bergholm, C. Gogolin, J. Izaac, and N. Killoran, *Evaluating Analytic Gradients on Quantum Hardware*, **Phys. Rev. A** (2019).
[2] J. R. McClean, N. C. Rubin, K. J. Sung, I. D. Kivlichan, X. Bonet-Monroig, Y. Cao, C. Dai, E. S. Fried, C. Gidney, B. Gimby, P. Gokhale, T. Häner, T. Hardikar, V. Havlíček, O. Higgott, C. Huang, J. Izaac, et al., *OpenFermion: The Electronic Structure Package for Quantum Computers*, **Quantum Sci. Technol**. 5 (2020).
[3] V. Bergholm, J. Izaac, M. Schuld, C. Gogolin, M. S. Alam, S. Ahmed, J. M. Arrazola, C. Blank, A. Delgado, S. Jahangiri, K. McKiernan, J. J. Meyer, Z. Niu, A. Száva, and N. Killoran, *PennyLane: Automatic Differentiation of Hybrid Quantum-Classical Computations*, arXiv:1811.04968 (2020).
[4] 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).
[5] J. Stokes, J. Izaac, N. Killoran, and G. Carleo, *Quantum Natural Gradient*, **Quantum** 4, 269 (2020).
[6] J. M. Arrazola, V. Bergholm, K. Brádler, T. R. Bromley, M. J. Collins, I. Dhand, A. Fumagalli, T. Gerrits, A. Goussev, L. G. Helt, J. Hundal, T. Isacsson, R. B. Israel, J. Izaac, et al., *Quantum Circuits with Many Photons on a Programmable Nanophotonic Chip*, **Nature** 591, 54 (2021).
[7] S. Lloyd, M. Schuld, A. Ijaz, J. Izaac, and N. Killoran, *Quantum Embeddings for Machine Learning*, arXiv:2001.03622 (2020).
[8] A. Mari, T. R. Bromley, J. Izaac, M. Schuld, and N. Killoran, *Transfer Learning in Hybrid Classical-Quantum Neural Networks*, **Quantum** 4, 340 (2020).
[9] 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 Sci. Technol**. 4, 024004 (2019).
[10] T. R. Bromley, J. M. Arrazola, S. Jahangiri, J. Izaac, N. Quesada, A. D. Gran, M. Schuld, J. Swinarton, Z. Zabaneh, and N. Killoran, *Applications of Near-Term Photonic Quantum Computers: Software and Algorithms*, **Quantum Sci. Technol**. 5, 034010 (2020).
[11] Z. J. Li, J. A. Izaac, and J. B. Wang, *Position-Defect-Induced Reflection, Trapping, Transmission, and Resonance in Quantum Walks*, **Phys. Rev. A** 87, 012314 (2013).
[12] N. Quesada, L. G. Helt, J. Izaac, J. M. Arrazola, R. Shahrokhshahi, C. R. Myers, and K. K. Sabapathy, *Simulating Realistic Non-Gaussian State Preparation*, **Phys. Rev. A** 100, 022341 (2019).
[13] K. K. Sabapathy, H. Qi, J. Izaac, and C. Weedbrook, *Production of Photonic Universal Quantum Gates Enhanced by Machine Learning*, **Phys. Rev. A** 100, 012326 (2019).
[14] B. Gupt, J. Izaac, and N. Quesada, *The Walrus: A Library for the Calculation of Hafnians, Hermite Polynomials and Gaussian Boson Sampling*, **JOSS** 4, 1705 (2019).
[15] 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*, **Phys. Rev. A** 95, 032318 (2017).
[16] S. S. Zhou, T. Loke, J. A. Izaac, and J. B. Wang, *Quantum Fourier Transform in Computational Basis*, **Quantum Inf Process** 16, 82 (2017).
[17] K. Brádler, S. Friedland, J. Izaac, N. Killoran, and D. Su, *Graph Isomorphism and Gaussian Boson Sampling*, **Special Matrices** 9, 166 (2021).
[18] J. A. Izaac and J. B. Wang, *PyCTQW: A Continuous-Time Quantum Walk Simulator on Distributed Memory Computers*, **Computer Physics Communications** 186, 81 (2015).
[19] J. A. Izaac, J. B. Wang, and Z. J. Li, *Continuous-Time Quantum Walks with Defects and Disorder*, **Phys. Rev.** A 88, 042334 (2013).
[20] J. Izaac and J. Wang, *Computational Quantum Mechanics* (**Springer International Publishing**, Cham, 2018).
[21] D. Wierichs, J. Izaac, C. Wang, and C. Y.-Y. Lin, *General Parameter-Shift Rules for Quantum Gradients*, arXiv:2107.12390 (2021).
[22] J. A. Izaac, J. B. Wang, P. C. Abbott, and X. S. Ma, *Quantum Centrality Testing on Directed Graphs via P T -Symmetric Quantum Walks*, **Phys. Rev. A** 96, 032305 (2017).
[23] T. Wu, J. A. Izaac, Z.-X. Li, K. Wang, Z.-Z. Chen, S. Zhu, J. B. Wang, and X.-S. Ma, *Experimental Parity-Time Symmetric Quantum Walks for Centrality Ranking on Directed Graphs*, **Phys. Rev. Lett**. 125, 240501 (2020).
[24] A. Delgado, J. M. Arrazola, S. Jahangiri, Z. Niu, J. Izaac, C. Roberts, and N. Killoran, *Variational Quantum Algorithm for Molecular Geometry Optimization*, **Phys. Rev. A** 104, 052402 (2021).
[25] J. E. Bourassa, N. Quesada, I. Tzitrin, A. Száva, T. Isacsson, J. Izaac, K. K. Sabapathy, G. Dauphinais, and I. Dhand, *Fast Simulation of Bosonic Qubits via Gaussian Functions in Phase Space*, **PRX Quantum** 2, 040315 (2021).
[26] J. M. Arrazola, S. Jahangiri, A. Delgado, J. Ceroni, J. Izaac, A. Száva, U. Azad, R. A. Lang, Z. Niu, O. Di Matteo, R. Moyard, J. Soni, M. Schuld, R. A. Vargas-Hernández, T. Tamayo-Mendoza, C. Y.-Y. Lin, A. Aspuru-Guzik, and N. Killoran, *Differentiable Quantum Computational Chemistry with PennyLane*, arXiv:2111.09967 (2021).