Research Statement

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19 (Day) 12 (Month) 2024 (Year)

Background

My primary research interest lies in **disruptive technologies in finance**, with a primary focus on **quantum computing** and secondarily on **blockchain/distributed ledger technologies (DLT)**. These technologies are reshaping the foundations of financial infrastructure, computation, trust, and risk management.

Quantum computing is transitioning from theory to practical applicability. Hardware capabilities—qubit count, coherence, gate fidelity, and photonic/qudit architectures—are improving rapidly, and access to real systems is becoming mainstream. Because quantum computers operate on principles fundamentally different from classical systems, they hold the potential to transform how we solve complex, non-deterministic, and high-dimensional problems. These challenges are ubiquitous in finance: risk modelling, rare-event estimation, portfolio optimisation, derivative pricing, credit scoring, and fraud detection.

Blockchain and smart contracts are increasingly adopted by corporations and governments, with the financial sector leading early implementations in settlement, asset tokenisation, digital identity, and cross-border payments. Their continued evolution will influence nearly every industry that depends on secure, transparent, and decentralised workflows.

This research matters because the **financial sector sits at the frontier of both opportunity and vulnerability** as these technologies mature. Markets are becoming more automated, more data-driven, and more interconnected. Firms require faster, more accurate simulations; more efficient optimisation; and more robust trust infrastructures. My work directly addresses these needs through industry-aligned projects on quantum-enhanced market simulations, trade-settlement optimisation, quantum machine learning for credit risk, and blockchain consensus mechanisms. By collaborating with industry partners and delivering funded research, my work helps bridge the gap between emerging technologies and practical deployment, ensuring that Singapore’s financial ecosystem remains competitive, secure, and innovation-driven.

Research Areas

Quantum Computing

Recent and Current Work

My research in quantum computing focuses on applying emerging quantum algorithms to real financial problems, leveraging the rapidly improving accessibility of quantum hardware. Earlier work with industry partners such as TradeTeq and OneConnect explored whether hybrid quantum–classical neural networks could improve credit-risk assessment and decentralised consensus mechanisms. These collaborations resulted in publications in *Nature Scientific Reports* and TechInnovation conference papers, demonstrating early pathways to quantum advantage in credit scoring and blockchain consensus.

In the past year, my work has expanded significantly in scale and depth, driven by externally funded projects with **UOB Asset Management, SGX, and OCBC**, and access partnerships with **Classiq, Quantinuum, and QCi**. I am currently developing:

- **Quantum Monte Carlo (QMC) methods for rare-event modelling and market simulation**, addressing the difficulty of estimating low-probability, high-impact financial outcomes.
- **Quantum optimisation methods** for trade-settlement workflows, counterparty-risk exposure, and portfolio adjustments.
- **Quantum machine learning (QML)** models for fraud detection and credit scoring.

These efforts directly address industry challenges such as computational bottlenecks in simulation, limited explainability in ML models, and the difficulty of optimising high-dimensional financial decisions.

Contribution to the Field

My work contributes to quantum finance by:

- Demonstrating **practical hybrid quantum workflows** on real industry datasets.
- Providing some of the earliest **quantum-enhanced rare-event models** in collaboration with UOB AM.
- Advancing **visualisation tools** that help researchers and practitioners better understand the behaviour of quantum circuits and QNNs.
- Producing **industry-aligned benchmarks** that help banks understand when quantum hardware becomes commercially relevant.

Future Directions

Going forward, I plan to advance research in three directions:

1. **Scalable quantum–classical optimisation frameworks**, especially for risk-adjusted portfolio construction and goal-based wealth management.
2. **Quantum Monte Carlo for systemic-risk stress testing**, addressing MAS and BIS priorities around stability and resilience.

3. **Foundational research on photonic-qudit quantum devices**, leveraging collaborations with QCi to build algorithms that exploit higher-dimensional qudit states.

These problems are important because they target the financial sector's most computationally intensive tasks and pave the way for Singapore to lead in quantum-finance innovation.

Summary and Strategic Outlook

My research over the years has contributed frameworks, algorithms, and prototypes that integrate quantum computing with practical financial use cases. This includes a book chapter on quantum computing applications in business, new work on the intersection of quantum computing and blockchain, and multiple ongoing projects with major financial institutions.

As quantum hardware and DLT infrastructures continue to mature, I aim to explore **industry-deployable hybrid solutions** for optimisation, simulation, ML explainability, consensus, for financial services and beyond. The long-term goal is to position quantum finance and DLT innovation as core capabilities in Singapore's financial ecosystem, contributing both to academic advancement and national competitiveness.

Selected Publications and Outputs

1. Quantum Technologies in Decentralization, Paul Griffin, Rudy Raymond, and Tsuyoshi, Ide, Handbook of Blockchain, Digital Finance, and Inclusion, Volume 3 - 1st Edition | Elsevier Shop
2. "QuLTSF: Long-Term Time Series Forecasting with Quantum Machine Learning", Hari Hara Suthan Chittoor; Paul Robert Griffin; Ariel Neufeld; Jayne Thompson and Mile Gu, https://www.scitepress.org/PublicationsDetail.aspx?ID=D2dkFAwUa0k=&t=1
3. "Exponential Qubit Reduction in Optimization for Financial Transaction Settlement", Elias X. Huber, Benjamin Y. L. Tan, Paul R. Griffin, Dimitris G. Angelakis, https://arxiv.org/abs/2307.07193
4. Quantum Machine Learning for Credit Scoring, Nikolaos Schetakis, Davit Aghamalyan, Michael Boguslavsky, Agnieszka Rees, Marc Raktomalala, Paul Griffin,https://www.mdpi.com/2227-7390/12/9/1391
5. "Review of some existing QML frameworks and novel hybrid classical–quantum neural networks realising binary classification for the noisy datasets", N. Schetakis, D. Aghamalyan, P. Griffin & M. Boguslavsky, https://www.nature.com/articles/s41598-022-14876-6
6. "Binary classifiers for noisy datasets: a comparative study of existing quantum machine learning frameworks and some new approaches", N. Schetakis, D. Aghamalyan, M. Boguslavsky, P. Griffin, 2021, arXiv : 2111.03372 [quant-ph].
7. "An application framework for implementing quantum computing", by Griffin, Paul R.; Boguslavsky, Michael; Huang, Junye; Kauffman, Robert; Tan, Brian R.. (2021). In Taneja, Kavita; Kumar, Kuldeep; Ouh, Eng Lieh; Taneja, Harunish; Selwal, Arvind; Bhatnagar, Vishal; Bali, Vikram. (Ed.), Data Science and Innovations for Intelligent Systems: Computational Excellence and Society 5.0 (pp. 1-23) Taylor and Francis.
8. "Quantum Consensus", J. Seet and P. Griffin, 2019 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE), Melbourne, VIC, Australia, 2019, pp. 1-8, doi: 10.1109/CSDE48274.2019.9162386.

9. P. Griffin and R. Sampat, "Quantum Computing for Supply Chain Finance," 2021 IEEE International Conference on Services Computing (SCC), 2021, pp. 456-459, doi: 10.1109/SCC53864.2021.00066.