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Waldemir Cambiucci

Hypaq Technologies São Paulo, Brazil

Constraint-Preserving Quantum Approximate Optimization for the Train Marshalling Problem

Abstract

The Train Marshalling Problem (TMP) is a core operational bottleneck in railway logistics, where inbound railcars must be reorganized into a target order that respects block integrity, minimizes shunting movements, and reduces downstream yard delays. As yards scale in size and constraints become increasingly interdependent—destination sequencing, yard topology, crew operations—classical heuristics and mixed-integer formulations struggle to maintain plan quality under real-world conditions. Motivated by these operational challenges, and building on the general theory of constraint-preserving mixers for QAOA, we develop the first TMP-specific constrained Quantum Approximate Optimization Algorithm. We introduce a Railway-Constrained Mixer (RCM) inspired by railway shunting dynamics that restricts quantum evolution to the feasible subspace of valid car position permutations, ensuring that all sampled states correspond to operationally meaningful marshalling plans. Unlike generic CPM constructions, the RCM encodes adjacency structures derived from realistic local shunting actions, enabling transitions that reflect the physical rearrangement capabilities of classification yards. TMP is formulated as a QUBO capturing destination-block disruptions and assignment inconsistencies, from which we construct a logistics-aligned cost Hamiltonian. Using Ket's sparse-state simulator, we will evaluate instances up to 100 qubits and expect to observe significant reductions in infeasible-state sampling, higher optimization stability, and an increased probability of generating near-optimal marshalling sequences compared with standard X-mixer QAOA. This work will represent the first integration of TMP-tailored constrained mixers within the Ket environment and is expected to demonstrate the practical role of domain structured QAOA in hybrid quantum-classical

optimization pipelines for rail networks, intermodal corridors, and port-rail operations.

Keywords: quantum approximate optimization algorithm; train marshalling problem; constraint preserving mixers; quantum logistics optimization; railway shunting simulation.

Biography

Dr. Waldemir Cambiucci is an Quantum Researcher Scientis and an IT professional with over 30 years of experience, recognized for his work in digital transformation, artificial intelligence, and quantum computing in Brazil and abroad. He worked at Microsoft Brazil for more than 20 years, covering areas such as consulting, architecture, solutions, and emerging technologies for enterprise space. He participated in the launch of two technology centers in the country, the Microsoft Technology Center (MTC), where he served as chief architect and director. He holds a degree in Computer Engineering, as well as a Master's and PhD from the Polytechnic School of the University of São Paulo (USP), with certifications from MIT xPRO, IBM Qiskit Dev, INSEAD, and DelftX. His research focuses on quantum computer architecture, distributed quantum computing, and algorithms. He is a member of the Brazilian Computer Society (SBC), the IEEE Quantum Technical Community, and the IEEE Computer Society, with dozens of papers published in international conferences and journals. He also served as a Microsoft Azure Quantum Ambassador between 2022 and 2025, leading initiatives in quantum computing and post-quantum cryptography. He is a frequent speaker at technology forums and innovation events in Brazil and abroad.

**Venkatesan M**

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National Institute of Technology Puducherry*

From Planarians to Qubits: Quantum Neural Models for SST Prediction

Abstract

Accurate sea surface temperature (SST) prediction is a key indicator for climate science, disaster preparedness, and marine resource management. We present the Quantum Planarian Neural Network (QPNN), a novel quantum neural architecture inspired by the compact neural motifs of planarians. Designed for efficiency, QPNN operates with shallow quantum circuits and minimal qubit overhead while capturing the nonlinear, physics-driven dynamics of ocean systems. In QPNN, oceanographic indices are encoded into entangled qubit states, enabling the direct learning of spatiotemporal dependencies and atmospheric-ocean interactions. Unlike conventional deep networks, the model requires no heavy feature compression, achieving high sparsity and rapid convergence within a few training epochs. The integration of physics-guided quantum gates further enforces conservation principles, ensuring predictions remain physically consistent. Preliminary evaluations demonstrate that QPNN achieves accurate SST forecasting with significantly fewer computational resources, highlighting its suitability for real-time and scalable environmental prediction. By uniting biological inspiration, quantum computing, and physics constraints, QPNN represents a paradigm shift in oceanographic modeling. This work positions QPNN as a foundation for quantum environmental intelligence, extending beyond SST to broader challenges in Earth system forecasting.

Biography

Venkatesan M. Sundaram is an Associate Professor and Head of CSE at National Institute of Technology Puducherry, with 25 years of teaching experience. He holds a Ph.D. in Computer Science and Engineering from VIT University and has authored 50+ publications in reputed journals and conferences. He has led government-funded projects from ISRO-SAC and DST-ICPS, with research interests in Quantum Computing, AI, Quantum machine learning, geospatial analytics, and computational intelligence.



Sunjay

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Quantum Geosciences Lithosphere Subsurface Imaging

Abstract

Quantum geosciences integrate advanced quantum technologies to enable ultra-high-precision subsurface imaging of the lithosphere, offering transformative capabilities for exploration and monitoring. These emerging approaches support applications across hydrocarbon and mineral exploration, mining and coal resources, geothermal systems, natural geological hydrogen, helium-3 for nuclear fusion, aquifer and paleo-fossil water mapping, as well as archaeological site detection. Key enabling technologies include quantum sensing, quantum computing, quantum communication, quantum artificial intelligence (QAI), and quantum machine learning (QML). Specialized techniques such as quantum wavelet transforms, quantum metrology systems, quantum cryptographic networks, muography, and geoneutrino detection further enhance subsurface characterization by improving sensitivity, resolution, and signal fidelity. Quantum-enhanced sensors play a central role in geophysical data acquisition. These include superconducting quantum interference devices (SQUIDs) for gravimetry and magnetometry, atomic clocks for high-precision geodesy, quantum fiber-optic sensors, and quantum accelerometers and gyroscopes. Together, they enable unprecedented measurement accuracy in gravity, magnetic, seismic, and deformation fields. In parallel, quantum seismic imaging is emerging as a powerful framework for processing and interpreting seismic data. By leveraging quantum computing paradigms such as quantum annealing and quantum machine learning, this approach addresses the computational complexity of seismic problems, including traveltime inversion, seismic inversion, and fault detection. These methods promise higher resolution and improved accuracy compared to classical algorithms, particularly for large-scale and highly nonlinear subsurface models. Secure and efficient handling of seismic data is

supported through confidential computing and quantum-resistant encryption, ensuring data integrity and privacy during acquisition, transmission, and analysis. For wireless seismic systems, Orthogonal Frequency Division Multiplexing (OFDM) and Orthogonal Frequency Division Multiple Access (OFDMA) enable high-throughput, low-latency data transmission from dense geophone networks, overcoming the constraints of traditional cable-based deployments. Additionally, compressed sensing synergizes with quantum sensing by exploiting the sparsity of many geophysical signals. This allows accurate reconstruction from significantly fewer measurements, reducing acquisition time and data volume while preserving high dynamic range and sensitivity. As a result, quantum-enabled compressed sensing supports faster, more efficient, and more accurate subsurface imaging in challenging environments.

Biography

M.Sc (Tech) 1998 Exploration Geophysics BHU Varanasi India .

PhD Thesis submitted Seismic data processing and interpretation by wavelet transform for hydrocarbons exploration, Geophysics BHU Varanasi India.

Lithosphere subsurface imaging extractive industry hydrocarbon exploration seismic imaging, Seismic data spectral decomposition by wavelet transform thin bed seismic imaging.

My participation in IGCP UNESCO Projects 700 carbonate reservoir hydrocarbons exploration South East Asia carbonate research laboratory Seacarledu.wordpress.com.

My participation in IGCP UNESCO Project 432,619 Deepwater hydrocarbon exploration carbonate reservoir



Timothy Heightman

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Quantum Machine Learning in Multi-Qubit Phase Space

Abstract

Quantum machine learning (QML) seeks to exploit the intrinsic properties of quantum mechanical systems, including superposition, coherence, and quantum entanglement for classical data processing. However, due to the exponential growth of the Hilbert space, QML faces practical limits in classical simulations with the state-vector representation of quantum systems. On the other hand, phase-space methods offer an alternative by encoding quantum states as quasi-probability functions. Building on prior work in qubit phase-space and the Stratonovich-Weyl (SW) correspondence, we construct a closed, composable dynamical formalism for one- and many-qubit systems in phase-space. This formalism replaces the operator algebra of the Pauli group with function dynamics on symplectic manifolds, and recasts the curse of dimensionality in terms of harmonic support on a domain that scales linearly with the number of qubits. It opens a new route for QML based on variational modelling over phase-space.

Biography

Timothy Heightman is a PhD student in the Quantum Information Theory Group of Prof. Acin at ICFO. Arriving in the group three years ago with a Dean's list award from Imperial College London (BSc and MSc, graduating top 5), his work focuses on mathematical foundations of quantum machine learning and its interface with contemporary techniques in the AI sector. He is a lecturer in University of Barcelona, delivering an MSc course "Machine Learning Quantum and Classical", and is currently engaged with Springer to write a book on recent advancements in this topic. Other problems of interest for him are deep learning methods in process tomography, and neural differential equations.

**Pratap, Divya***India*

Quantum Superposition of the Past and Future, and the Emergence of Fuzzy Present

Abstract

This conceptual model integrates entropy, time, and information, and offers a novel perspective on quantum superposition of the past and future and the emergence of the 'fuzzy' present. In addition to Eddington's future- directed conventional timeline aligned with increasing entropy of the universe, the model introduces a human-centric past-directed timeline. The model, further, demonstrates that the progression of time is not strictly linear but inherently helical, represented by two opposite-handed independent helices evolving in opposite directions, and obeying the time- reversal symmetry of Schrodinger equation. The model leverages Shannon's information entropy which associates high entropy with unpredictable / unspecific information, and the low entropy with predictable / specific information. Eventually, each time helix embodies entropic, temporal, and informational characteristics. To unify these facets, a new fundamental unit called QUIIT (Quantum Unit of Integrated Information and Time), analogous to a qubit, is introduced. Also, as target-oriented future actions are essentially based on the selective information and experiences of the past, the past must have the encrypted signatures of the future- outcomes. Such Quantum Entanglement of the past and the future is unified under the framework of Bell states. Finally, the helical progression of time unveils the possibility of six-dimensional spacetime manifold--three spatial and three temporal.

Keywords:

Eddington's Time line, Human- Centric Timeline, Dual Time- helices, Information entropy, QUIIT, Quantum Superposition and Entanglement, Kāla-Chakra.



Mohamed Bennai

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Digital-Analog quantum Rabi simulation in the Deep Strong Coupling Regime

Abstract

We study the quantum Rabi model (QRM) in the deep strong coupling (DSC) regime. To capture the full dynamics of the QRM in the DSC regime, we implemented single-qubit rotations combined with integrated digital steps and qubit-bosonic blocks. This approach leads to a paradigm known as digital analog quantum simulations (DAQSs). In this work, we review the encoding of QRM in the DSC regime through emerging paradigms of digital and analog techniques. Using DAQSs encoding, an efficient simulation can be performed on state-of-the-art circuit quantum electrodynamics platforms. Finally, we provide detailed information on the dynamics of the QRM in variety of parameter regions. We demonstrate the effectiveness of the DAQS paradigms in achieving prolonged coherent measurements during time evolution, even in the case of perturbative DSC regime dynamics. This proposal lays the groundwork for simulating complex many-body dynamics that involve bosonic modes.

INTRODUCTION:

The Quantum Rabi model (QRM) is a fundamental theoretical framework to understand the interaction between light and matter [1]. However, simulating this model in the deep strong coupling (DSC) regime [3] within quantum technologies remains an open question. Exploring the full dynamics of QRM under these regimes on different physical platforms and parameter settings, as discussed in [4, 6], continues to pose ongoing challenges. This framework provides an effective model for describing the interaction between a two-level system and a single radiation mode [7]. Researchers are exploring new areas that challenge our understanding of quantum systems. In the ultra-strong

coupling regime (USC), USC [8] refers to a scenario in which the coupling strength gR becomes comparable to the energy associated with the frequency of the bosonic mode ω_R , with the coupling ratio $gR/\omega_R \simeq 0.6$ termed the USC regime [2]. This novel domain provides opportunities to investigate previously inaccessible exotic quantum phenomena [9]. The dynamics in USC regimes may result in unconventional behavior, offering unique opportunities for manipulating quantum states and advancing applications in quantum information processing. Furthermore, examination of the DSC regime reveals another layer of complexity in quantum systems [10–12]. In this case, the observed dynamics of quantum Rabi physics become particularly relevant to the regime $gR/\omega_R \simeq 1$ referred to as the DSC regime. As a result, the relationship between a qubit and a quantized harmonic mode [13, 14] becomes much clearer, leading to complex and interesting interaction Hamiltonians. In this context, the interplay between the celebrated Jaynes Cummings model and the QRM is particularly interesting, especially when considering the influence of the DSC beyond the co-rotating terms wave approximation under weak coupling.



Prof. Eshika Aggarwal

Indian Institute of Management Jammu, India

Mapping the effect of Quantum Computing in Global Software Development: two decades of bibliometric Analysis

Abstract

Quantum computing (QC) is ushering in a transformative era for the business world, offering unprecedented speed and efficiency in solving complex challenges. In this rapidly advancing domain, global software development (GSD) is playing a pivotal role, striving to propel the field forward and unlock its vast potential. Accordingly, this study aims to synthesise and trace two decades of research focused on quantum computing in global software development.

This study performs a bibliometric analysis of papers published between 2000 and 2025. Data retrieved from the Scopus database includes a total of 68 papers for the final analysis. The authors utilized the VOSviewer and Biblioshiny packages to conduct a comprehensive bibliometric analysis, encompassing performance evaluation and science mapping.

The study outlined the contributions and explored the theoretical and thematic structure of Global Software Development (GSD) in information technology scholarship. Additionally, the authors traced the evolution of the thematic structure, providing insights into potential research gaps.

By examining the “who,” “where,” “how,” “what,” and “when” of quantum computing within global software development in information technology, this study enriches current knowledge and informs future advancements for both theorists and practitioners. However, the analysis is limited to peer-reviewed papers available in the Scopus database.

The findings highlight the existing body of scholarship, offering valuable guidance for information technology professionals and policymakers in designing information systems and policy interventions.

To the best of the authors' knowledge, this is the first study to conduct a bibliometric analysis of quantum computing in global software development, offering valuable insights and guidelines for future researchers, policymakers, and practitioners.

Biography

Dr. Eshika Aggarwal is a researcher in the fields of Information Systems and Artificial Intelligence, with her work published in several international journals, including Soft Computing, Journal of Intelligent & Fuzzy Systems, and International Journal of Mathematics in Operational Research. Her research has been accepted and presented at prestigious conferences such as the PAN IIM World Management Conference and INDAM. She holds a Ph.D. and an MBA from the Indian Institute of Management Lucknow, and a bachelor's degree from Punjab Technical University, along with professional certifications such as Lean Six Sigma and SCJP. Dr. Aggarwal has nine years of extensive industry experience in IT with firms including NIIT Technologies, IBM, and Tata Consultancy Services, and has also consulted for global organizations such as Cisco, Airtel, and Voya.

**Chris Salvino***United States*

Helium-3 from the Moon: How Are You Going to Cool Your Quantum Computer?

Abstract

Quantum computing is poised to transform global technology, security, and economics—but it is also constrained by the extreme cooling required to stabilize qubits at 0.01 K. The only isotope capable of achieving and sustaining these cryogenic temperatures is helium-3. On Earth, reserves total only a few kilograms, and there is no known way to create or mine it at scale. As a result, helium-3 is effectively exhausted on Earth, setting a hard limit on how far quantum computing—and the strategic dominance it enables—can advance without a new source. The Moon contains an estimated one million tons of helium-3 implanted by the solar wind, making it the only viable reservoir capable of supporting both quantum computing and nuclear fusion, the only pathway to scalable green energy. Without helium-3 from the Moon, it will not be possible to scale quantum computers to their temperature goal of 0.01 K organically. Lunar Helium-3 Mining (LH3M) is developing this capability through multiple issued and pending U.S. and international patents for lunar-specific helium-3 detection, staged thermal extraction, gas separation, and containment systems engineered to function in the Moon's low-concentration deposits, abrasive regolith, and vacuum environment. LH3M's extraction system works “with” the lunar environment not “against it”. Unlike other lunar objectives that rely entirely on government funding, helium-3 extraction represents a self-sustaining, revenue-generating mission architecture. The combined markets for fusion energy and quantum computing represent a potential \$17 trillion annual industry, meaning this is one of the few lunar missions capable of paying for itself. This presentation will detail how LH3M's private-sector model can turn lunar resource utilization into a profitable, strategically vital enterprise—providing the fuel

to power green fusion on Earth, cool quantum computers, and redefine economic and technological leadership in space.



Samantha Sakowicz Moscofian Cabrera

*Phd Advisor : Graça Bressan Universidade de São Paulo
– Poli*

Quantum Interpreter for Lung Images in Multicategory Disease Diagnosis via Variational Quantum Classifier (VQC)

Abstract

Pulmonary X-rays are among the most widely used diagnostic tools in global healthcare due to their accessibility, speed, and effectiveness in detecting a range of thoracic conditions. However, traditional machine learning models still face challenges in multicategory disease classification, especially when dealing with imbalanced datasets, subtle radiographic features, and the need for interpretability. This research proposes a novel approach that integrates Quantum Machine Learning (QML) with classical image and machine learning analysis models, specifically to enhance the accuracy and efficiency of diagnosing multiple pulmonary diseases from a single X-ray image. The core of this approach is the implementation of a Variational Quantum Classifier (VQC), adapted to handle high-dimensional medical image embeddings and trained using hybrid quantum classical techniques. The study leverages quantum frameworks such as Qiskit, PennyLane, and Azure Quantum to simulate and evaluate performance across different quantum backends. By combining the representational power of quantum circuits with the semantic richness of medical image parsing, the proposed method aims to improve diagnostic precision, reduce training data requirements, and offer interpretable outputs for clinical decision-making. This research contributes to the growing field of quantum-enhanced medical imaging by demonstrating how QML can address current limitations in radiographic analysis, particularly in multiclass and multilabel classification scenarios. The results are expected to pave the way for more scalable, explainable, and high-performance diagnostic tools in digital health. Keywords: quantum machine learning, variational quantum classifier, pulmonary X-rays, multicategory diagnosis, medical imaging, hybrid models.

Biography

Samantha Sakowicz Moscofian Cabrera is a seasoned IT professional with over 20 years of experience in global companies such as Microsoft, Intel, Accenture, and Goodyear. She holds a master's degree in computer science from USP and is currently pursuing a Ph.D. in Quantum Computing and Quantum Machine Learning at Escola Politécnica da USP. Samantha is fluent in English and Spanish and certified by MIT in Quantum Computing. She led AI and cloud initiatives across Latin America and the U.S., architecting and deploying enterprise solutions using LLMs, Generative AI, and AI agents for sectors including healthcare, education, banking, and retail. Her expertise spans technical architecture, project management, and service delivery, offering a holistic approach to innovation and execution. With international experience and over 15 certifications in cloud, AI, and agile methodologies.

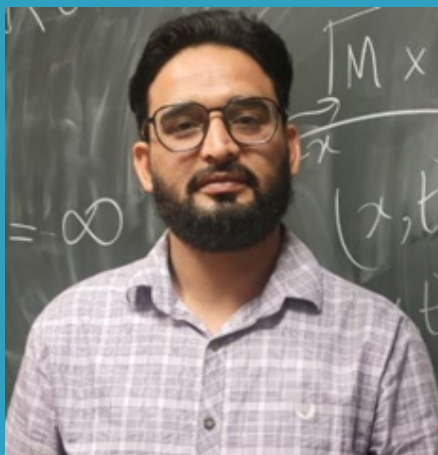
**Alessandro Grilli***Thales Alenia Space Italy, Via Saccomuro 24, Roma***Quantum Computing for Satellite Earth Observation: A Thales Alenia Space Perspective****Abstract**

Thales Alenia Space Italy, and specifically our Domain Observation and Navigation, is actively engaged in assessing the potential of quantum computing to address computational challenges relevant to the space sector. In particular, we are investigating optimization problems arising in satellite operations and Earth Observation (EO) applications, where classical approaches face scalability and performance limitations. Quantum optimization techniques, including hybrid quantum–classical algorithms, may offer novel pathways to improve the efficiency and responsiveness of space-based systems. Over the past few years, our efforts have concentrated on the optimization of satellite mission planning, exploring formulations that leverage quantum algorithms to handle complex constraints, dynamic environments, and multi-objective criteria. In this context, we are also investigating tensor network-based techniques as a promising approach to efficiently represent and solve high dimensional optimization problems, exploiting their ability to capture correlations and reduce computational complexity in both classical and quantum frameworks. Beyond optimization, we are expanding our research into quantum machine learning (QML) to tackle demanding space-related tasks such as orbit determination and the analysis of multispectral and hyperspectral data. These efforts aim to exploit quantum-enhanced models for pattern recognition, anomaly detection, and data fusion, ultimately contributing to more accurate and autonomous decision-making in EO and satellite operations. Through this ongoing research, we aim to identify practical and high-impact quantum computing use cases that could enhance future Earth Observation and space infrastructure management capabilities. In this presentation, we will share the vision of Thales Alenia Space on the

role of quantum computing in space applications and present our most recent findings in this emerging field.

Biography

Alessandro Grilli holds a Master's degree in Physics of Data from the University of Padova and a Bachelor's degree in Physics from the University of Bologna, in 2021 and 2024 respectively. With a strong background in physics, he specializes in data science, artificial intelligence, and quantum computing. He is currently working as Quantum Satellite Solution Architect at Thales Alenia Space Italy, within the Advanced Technologies Unit, where he works on quantum computing applications for Earth observation and navigation. His research focuses on quantum algorithms, optimization, and deep learning techniques for autonomous on-board computing



Rizwan Abbas

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High-Frequency Quantum Sensing Without Fast Pulses Using Interaction-Engineered Two-Qubit System

Abstract

Quantum sensors have emerged as powerful tools for detecting extremely weak time-varying fields with remarkable accuracy. Conventional sensing strategies typically rely on tracking the dynamics of a single qubit and using fast control pulses to probe an external oscillating signal. However, when the field frequency becomes high, these methods demand increasingly short pulse intervals, making the protocol sensitive to pulse-width limitations and control errors.

In this work, we introduce a sensing architecture that avoids the need for such rapid pulsing. Our approach employs a pair of interacting qubits whose mutual coupling is influenced by the external oscillating field. By monitoring the resulting modulation in the interaction strength, the amplitude of the field can be inferred. We evaluate the sensitivity of this scheme using Fisher information and analyze its robustness under realistic noise sources. Furthermore, we demonstrate how suitable control strategies can be incorporated to suppress noise-induced degradation. Notably, our protocol maintains high precision without requiring extremely short pulse separations, making it a promising alternative for high-frequency quantum sensing applications.

Biography

Rizwan Abbas is a fourth-year PhD student at the Lahore University of Management Sciences (LUMS), specializing in quantum sensing and advanced quantum technologies. He holds third position in his BSc and second position in his MSc. Rizwan's research focuses on quantum

metrology and computational methods in quantum systems, with his recent work published in Physical Review A in 20 November 2025. His interdisciplinary approach combines theoretical physics with practical applications, aiming to push the boundaries of quantum measurement. Rizwan has contributed significantly to the field, demonstrating a strong commitment to advancing quantum science and technology.



Neeshu Rathi

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A Quantum Bagging Algorithm with Unsupervised Base Learners for Label Corrupted Datasets

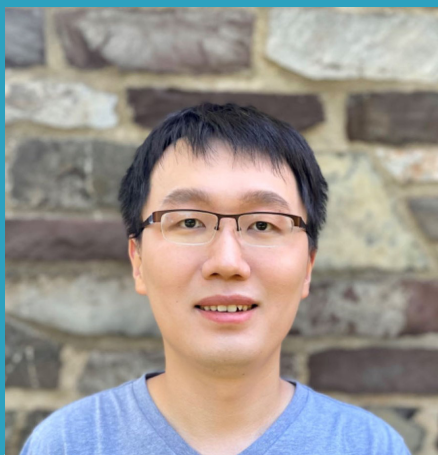
Abstract

The development of noise-resilient quantum machine learning (QML) algorithms is critical in the noisy intermediate-scale quantum (NISQ) era. In this work, we propose a quantum bagging framework that uses QMeans clustering as the base learner to reduce prediction variance and enhance robustness to label noise. Unlike bagging frameworks built on supervised learners, our method leverages the unsupervised nature of QMeans, combined with quantum bootstrapping via QRAM based sampling and bagging aggregation through majority voting. Through extensive simulations on both noisy classification and regression tasks, we demonstrate that the proposed quantum bagging algorithm performs comparably to its classical counterpart using KMeans while exhibiting greater resilience to label corruption than supervised bagging methods. This highlights the potential of unsupervised quantum bagging in learning from unreliable data.

Biography

Neeshu Rathi is a PhD scholar in the Department of Mathematics at the Indian Institute of Technology Roorkee, India. Her doctoral research focuses on quantum machine learning algorithms, with particular emphasis on quantum Krylov subspace methods and quantum ensemble learning. She has contributed to the development of quantum conjugate gradient methods, quantum GMRES and Arnoldi-type algorithms, and noise-resilient quantum bagging frameworks with unsupervised base learners. Her work has led to publications in journals

such as Soft Computing and Concurrency and Computation: Practice and Experience, with several manuscripts currently under review. Her research interests include quantum iterative solvers, quantum ensemble and bagging algorithms, quantum linear algebra, and resource-efficient quantum machine learning methods tailored for NISQ devices.



Haowei Xu

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Hong Kong, China

Non-Hermitian Spin-Spin Interaction Mediated by Chiral Phonons: Chirality Induced Non-Hermiticity

Abstract

Non-Hermiticity and chirality are two fundamental properties that give rise to various intriguing phenomena. However, their interconnection remains largely unexplored. In this work, we bridge this gap by introducing chirality induced non-Hermiticity (CINH). Particularly, we demonstrate an off-diagonal non-Hermitian spin-spin interaction mediated by chiral phonons. This interaction arises from the spin-selectivity due to the locking between phonon momentum and angular momentum in chiral materials. The resulting non-Hermitian interaction mediated by the vacuum field of chiral phonons can exceed the kHz range for electron spins, potentially leading to observable effects in the quantum regime. Moreover, the long-range nature of phonon-mediated interactions enables the realization of non-Hermitian interaction among multiple spins in condensed matter systems, which has been a key challenge. The effect proposed in this work may have wide-ranging applications in e.g., cascaded quantum systems, quantum simulation of non-Hermitian many-body physics, and non-Hermitian cooling.

Biography

Haowei XU is a presidential assistant professor at City University of Hong Kong in the Department of Physics. He earned his Bachelor's degree in Physics from Peking University and his Ph.D. in Quantum Science and Engineering from the Massachusetts Institute of Technology (MIT). He subsequently worked as a Postdoctoral Associate at MIT from 2023 to 2025. Haowei Xu's research lies at the intersection of condensed matter physics, computational materials science, and quantum engineering. His work is particularly focused on

developing innovative quantum control strategies based on nonlinear light-matter interactions. These efforts span fundamental theory, large-scale numerical simulations, and applications in emerging quantum technologies. He has authored over 40 peer-reviewed publications in high-impact journals such as Physical Review Letters and Nature Communications. His outstanding doctoral research has earned him honours like the MathWorks Fellowship and the Del Favero Thesis Prize from MIT.

**Daniel Dilley***Argonne National Laboratory, IL 60439, USA*

Gate Teleportation vs Circuit Cutting in Distributed Quantum Computing

Abstract

Distributing circuits across quantum processor modules will enable the execution of circuits larger than the qubit count limitations of monolithic processors. While distributed quantum computation has primarily utilized circuit cutting, it incurs an exponential growth of sub-circuit sampling and classical post-processing overhead with increasing number of cuts. Entanglement-based gate teleportation approach does not inherently incur exponential sampling overhead, provided quantum interconnects of requisite performance are available for generating high-fidelity Bell pairs. Recent advances in photonic entanglement of atomic qubits have motivated discussion on optical link metrics required to achieve remote gate performance approaching circuit-cutting techniques. We model noisy remote (teleported) gates between superconducting qubits entangled via noisy microwave-to-optical (M2O) transducers over optical links. We incorporate the effect of the transducer noise added on the Bell pair state preparation circuit and inject noisy Bell pairs into remote CNOT gates. We perform comparative simulation of Greenberger–Horne–Zeilinger (GHZ) states generated between processor modules using remote gates and gate cuts by studying the dependence of the Hellinger fidelity on the primary source of error for the two approaches. We identify break-even points and regimes where noisy remote gates achieve parity with gate-cuts. In particular, our work suggests that within 10-fold reduction in the present M2O transducer noise added figures, generating multipartite entangled states would favor remote gates over circuit cutting due to exponential sampling overhead for the latter. Our work informs on near-term quantum interconnect hardware metrics and motivates a hybrid quantum-classical distributed computation approach, where both quantum links and circuit-cuts are employed to minimize quantum runtime.

Biography

Daniel Dilley received his Ph.D. in Applied Physics from Southern Illinois University Carbondale in 2019, where his dissertation focused on asymmetric Bell inequalities and their relevance for realistic Bell experiments. He is currently completing his second year as a Postdoctoral Researcher at Argonne National Laboratory. His research spans several areas of quantum information science, including quantum error correction and mitigation, entanglement and nonlocality theory, open-system dynamics, and quantum algorithm design with an emphasis on circuit optimization. During his first 20 months at Argonne, he has authored more than ten publications and is actively pursuing over seven additional projects involving theory, simulation, and applications of near-term quantum technologies. His work aims to develop practical tools for improving quantum device performance and for understanding how quantum resources behave in noisy, distributed, and strongly interacting settings. He has over five years of teaching experience and has presented his research at multiple scientific conferences.

**Chiang Pei Ju**

CYCU, Taoyuan 320, Taiwan; TSRI, Hsinchu 300, Taiwan

TiN Process and Quality Analysis of Coplanar Waveguide on High-Resistivity Silicon

Abstract

Coplanar waveguide (CPW) are critical components in superconducting microwave devices and quantum hardware, where the internal quality factor (Q_i) and structural edge morphology directly affect device performance. To enhance CPW performance, this study, in collaboration with the Taiwan Semiconductor Research Institute (TSRI), investigates the optimization of TiN film deposition and etching processes on high-resistivity silicon substrates. TiN films were deposited under various conditions to evaluate their impact on subsequent etching and Q_i . The CPW geometries were then defined via e-beam lithography, followed by etching to achieve precise edge profiles. Finally, structural and film properties were characterized using optical microscopy (OM), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) to assess edge morphology, thickness uniformity, compositional distribution, and Q_i performance. It is expected that through systematic control of process variables, optimal deposition and etching conditions can be identified, resulting in uniform CPW edges and maximized Q_i , thereby improving the reliability and performance of superconducting microwave devices and providing a foundation for the development of high-quality quantum hardware.

Biography

Chiang Pei Ju is a Master's student in the Department of Electronics Engineering at Chung Yuan Christian University (CYCU), Taiwan. Her current research focuses on the fabrication and optimization of TiN coplanar waveguides (CPWs) for superconducting microwave devices.

She collaborates with the Taiwan Semiconductor Research Institute (TSRI) to enhance device performance through systematic process development, studying the effects of film deposition and etching on structure and internal quality factor (Qi).



Thank You