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Quantum Summit-2026

International Experts Summit on
Quantum Computing and Applications

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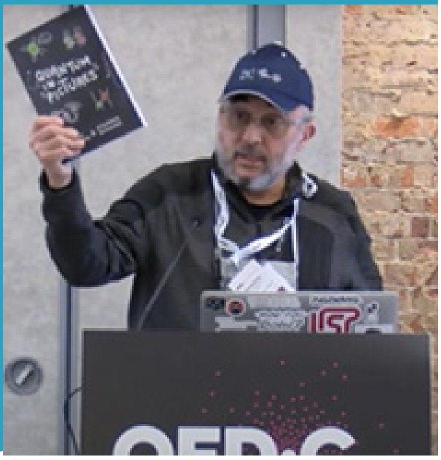
ABSTRACT BOOK

Table Of Contents

7	Title: Optimal Scheduling in a Quantum Switch: Capacity and Throughput Optimality	
	Thirupathaiah Vasantam, Department of Computer Science Durham University, UK	
8	Title: Quantum-Chemical DFT/TD-DFT Study of NCS-Modified Ruthenium Sensitizers for Dye-Sensitized Solar Cells	
	Said Kerraj, 1Laboratory of Physical Chemistry of Applied Materials, Faculty of Sciences Ben M'Sik, Hassan II University of Casablanca, Morocco	
9	Title: Quantum Interpreter for Lung Images in Multicategory Disease Diagnosis via Variational Quantum Classifier (VQC)	
	Samantha Sakowicz Moscofian Cabrera, Phd Advisor : Graça Bressan Universidade de São Paulo – Poli	
10	Title: Helium-3 from the Moon: How Are You Going to Cool Your Quantum Computer?	
	Chris Salvino,	
11	Title: Gate Teleportation vs Circuit Cutting in Distributed Quantum Computing	
	Daniel Dilley, Argonne National Laboratory, IL 60439, USA	
12	Title: Mapping the effect of Quantum Computing in Global Software Development: two decades of bibliometric Analysis	
	Eshika Aggarwal, Indian Institute of Management Jammu, India	
13	Title: Digital-Analog quantum Rabi simulation in the Deep Strong Coupling Regime	
	Noureddine Rochdi, LPHE-Modeling and Simulation, Faculty of Sciences, Mohammed V University in Rabat, Morocco.	

14	Title: Quantum Superposition of the Past and Future, and the Emergence of Fuzzy Present
	Pratap, Ram
15	Title: High-Frequency Quantum Sensing Without Fast Pulses Using Interaction-Engineered Two-Qubit System
	Rizwan Abbas, School of Science & Engineering, Lahore University of Management Sciences, Opposite Sector U, D.H.A, Lahore 54792, Pakistan
16	Title: Quantum Machine Learning in Multi-Qubit Phase Space
	Timothy Heightman, ICFO - The Institute of Photonic Sciences Mediterranean Technology Park, Avinguda Carl Friedrich Gauss, 3, 08860 Castelldefels, Barcelona, Spain
17	Title: From Planarians to Qubits: Quantum Neural Models for SST Prediction
	Venkatesan M, Department of Computer Science and Engineering National Institute of Technology Puducherry
	FEATURED SPEAKERS
18	Title: Beyond Accuracy: A Kernel-Level Comparative Analysis of Quantum and Classical Support Vector Machines
	Shahryar Rza, School of Computer and Information Sciences, University of Hyderabad, Hyderabad, Telangana, 500046, India
19	Title: A Quantum Bagging Algorithm with Unsupervised Base Learners for Label Corrupted Datasets
	Neeshu Rathi, Department of Mathematics, Indian Institute of Technology Roorkee, Uttarakhand 247667, India

20	Title: TiN Process and Quality Analysis of Coplanar Waveguide on High-Resistivity Silicon
	Chiang Pei Ju, CYCU, Taoyuan 320, Taiwan; TSRI, Hsinchu 300, Taiwan
21	Title: Non-Hermitian Spin-Spin Interaction Mediated by Chiral Phonons: Chirality Induced Non-Hermiticity
	Haowei Xu, Department of Physics, City University of Hong Kong, Hong Kong, China
22	Title: Quantum Computing for Satellite Earh Observation: A Thales Alenia Space Perspective
	Tommaso Catuogno, Thales Alenia Space Italy, Via Saccomuro 24, Roma



Adrian German
Indiana University Bloomington, IN 47408, USA

Workforce Development and the Quantum Ecosystem

Abstract

There are two aspects to workforce development: short term (retraining and reskilling of the current workforce) and long term. Short term needs are the norm in the emerging quantum ecosystem. Long term needs clearly demand creating a(n appropriate) pipeline. But building the pipeline takes time and going through the pipeline also takes time. Industry at this stage does not want to (nor can it afford to) wait1. A few years ago in the QED-C Workforce Development TAC this perspective was articulated to which we subscribe: “I absolutely believe that industry will have to train [the workforce because academic institutions will not be] fast enough, nimble enough, cost effective enough, aligned to the proper training timeframes for true capability building or have the right organizational motivations to produce students to be productive at the time they are hired.” It basically says that the type of cooperation between industry and academia as addressed by the some of the NSF supported Quantum Leap Challenge Institutes and/or Industry/University Cooperative Research Centers is simply vital. In the long term the quantum ecosystem clearly needs a pipeline. Notice though two things about pipelines for the quantum: (a) first, there is more than one pipeline. A lot of traditional engineers, for example, are also needed in the quantum industry they are just not aware of it. Second, (b) a current quantum pipeline does exist. It may not be as wide as needed or have the diversity or throughput it needs to have, but it exists. But even the long-term pipeline has severe short-term needs. Witness the very complex need to re-train and reskill HS teachers to teach quantum. Quantum4All, IQC at the University of Waterloo, Qubit x Qubit, Q2Work, Q12 and several other organizations are already working on this problem. In this talk I would like to describe the impact that the Center for Quantum Technologies (a joint enterprise between Indiana University

Bloomington, Purdue University, the University of Notre Dame and IU Indianapolis) has had in the state of Indiana and with assistance from IN-CSTA and AAPT-IN across the nation. The key is to integrate in synergy, go beyond current basic education and build a new type of workforce through creative new programs like IU's new MS in QIS program, established in 2021 and to establish a robust long-term pipeline through dual credit (advanced placement) classes within the Indiana HS Pathways to Quantum Information Science framework. I will also survey a few other trailblazing developments in the Midwest such as those led by PsiQuantum in Chicago.

Biography

Adrian German is a Teaching Professor of Computer Science and Director of Outreach for Indiana University Quantum Science and Engineering Center. In this capacity he has established a Faculty Learning Community (FLC) in Quantum Computing for HS and middle school teachers in Indiana. Now in its third year the FLC has 25+ members in five states (IN, CA, HI, TN, NC) with prospective members in AZ and NM. In 2021 he served as Chair for the Technical Advisory Committee on Workforce Development in the Quantum Economic Development Consortium (QED-C) a broad international group of stakeholders from industry, academia, national labs and professional organizations that aims to enable and grow the US quantum industry and its associated supply chain. From 2021 until 2024 he was a member of the ACM/IEEE-CS/AAAI CS2023 Task Force, and responsible for the design and development of the Quantum Architectures Knowledge Unit in the CS2023 Curricular Guidelines.

Dan-Adrian German

Indiana University Bloomington, IN 47408, USA

A Term-Rewriting Semantics for Pure Quantum States

Abstract

Terry Rudolph introduced an elementary rewriting system to accurately describe the basics of quantum circuits and quantum computation (QC) to high-school (HS) and middle school students. Both the accessibility and effectiveness of the system are remarkable: the Grover search and Deutsch Josza algorithms, Bernstein-Vazirani and the phase kickback phenomenon, superdense coding, quantum teleportation, entan glement swapping and the GHZ game have all since been described in terms accessible to HS and middle school students using this formalism. Recently, with help from CSTA Indiana a Faculty Learning Community (FLC) in QC for HS and middle school teachers was established, with more than 25 teachers in 5 states (IN, GA, CA, HI, TN) and prospective members in AZ, NM. The rewriting system introduced by Terry Rudolph (that relies on a representation of quantum states as “misty states”) greatly simplifies calculations and makes them accessible to first time learners using only simple arithmetic and without sacrificing accuracy. Furthermore this system can be effectively used to facilitate transition to the conventional quantum-mathematical apparatus. This paper is written for those who, teaching QC, would like to explore using the misty state formalism in their classroom. We describe a new, general representational semantics of the formalism and then show concrete examples of computa tional effectiveness via a new category of misty states that are in some sense irreducible yet are able to drastically simplify calculation overall. Recently, the extension described here was used successfully to address topics of quantum error correction (i.e., the bit flip, sign flip and Shor codes) using misty states at a level accessible to HS and middle-school students and teachers. Index Terms—quantum, computing, outreach, high-school.

Jawad Hussain Awan
Japan

Quantum-Assisted Graph Analytics for Decentralized Financial Networks

Abstract

Blockchain transaction networks have emerged as complex graph structures that can be effectively analyzed using advanced graph learning techniques. This presentation explores the application of Graph Neural Networks (GNNs) for link prediction in Bitcoin transaction graphs, aiming to identify potential future transactions and uncover hidden relationships among network entities. The study discusses data preprocessing, graph representation learning, model architecture, performance evaluation, and practical implications for fraud detection, financial analytics, and cybersecurity. The findings demonstrate the potential of GNN-based approaches in enhancing predictive capabilities within decentralized financial ecosystems.

Taro Kishimoto

New Energy and Industrial Technology Development Organization, MKCT 1310 Omiya-cho Saiwai-ku, Kawasaki City, Japan

NEDO Challenge: A Government-Led Framework for the Systematic Creation of World-First Use Cases

Abstract

NEDO (New Energy and Industrial Technology Development Organization) has launched a prize-driven program to accelerate the development of practical use cases for quantum computers and to cultivate human resources in the quantum domain. In this program, we define open challenge issues to collect proposals from both industry and academia. We provide structured educational activities for newcomers to quantum computing, and offer access to advanced quantum computing environments based on multiple hardware platforms in coordination with high-performance computing resources. Through this program, numerous quantum computing use cases have been proposed and developed. These use cases cover a broad range of industrial domains, including logistics, manufacturing, energy, and materials and chemical industries. They employ a variety of quantum algorithmic approaches such as the Variational Quantum Eigensolver (VQE), the Quantum Approximate Optimization Algorithm (QAOA), quantum machine learning, Grover's algorithm, and related methods. We are conducting a quantitative evaluation of these use cases in terms of required quantum and classical computational resources, the applicability and performance of existing quantum algorithms, and their potential industrial and societal impact. Our methodology combines algorithmic complexity estimates with resource and performance simulations on near-term and future quantum architectures. Based on survey data and project outcomes, we analyze how such a national-scale program can influence the trajectory of quantum computing research and its industrial deployment. In particular, we examine how program design factors, such as the structure of prize challenges, access to heterogeneous quantum hardware, and the degree of integration with high-performance classical computing,

shape the types and characteristics of use cases that emerge. We also analyze how these factors contribute to aligning academic research agendas with industrial needs. This presentation highlights representative use cases from the program and reports preliminary quantitative results on their resource requirements and expected industrial impact. We also outline a conceptual model for the social implementation of quantum computing derived from these results, and argue that this model can inform resource allocation across quantum hardware platforms, the design of incentive schemes for use-case development, and the coordination of future research directions between academia, industry, and government.

Biography

Taro KISHIMOTO: Graduated from the Graduate School of Agricultural and Life Sciences, University of Tokyo. Engaged in protein research at Tanabe Mitsubishi Pharma Corporation.

Obtained a PhD in Medicine from Tokyo Medical and Dental University. Seconded to the New Energy and Industrial Technology Development Organization (NEDO) in 2023.

Responsible for the NEDO Challenge Quantum Computing Project and the P5G Quantum Industrialization Project.

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.

Waldemir Cambiucci, Regina Melo Silveira and Evandro C. R. da Rosa

Hypaq Technologies São Paulo, Brazil
University of São Paulo São Paulo, Brazil
Quantuloop Santa Catarina, 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.

Thirupathaiah Vasantam
Department of Computer Science Durham University, UK

Optimal Scheduling in a Quantum Switch: Capacity and Throughput Optimality

Abstract

With a growing number of quantum networks in operation, there is a pressing need for performance analysis of quantum switching technologies. A quantum switch establishes, distributes, and maintains entanglements across a network. In contrast to a classical switching fabric, a quantum switch is a two-sided queueing network. The switch generates Link-Level Entanglements (LLEs) across links that connect users to the switch, which are then fused to process the network's entanglement requests. First, we characterize the capacity region that is defined as the set of entanglement request rates for which there exists a scheduling policy stabilizing the system. We then show that a sequence of Max-Weight policies that we propose achieve throughput optimality in the asymptotic sense. Our proof techniques analyse a two-time scale separation phenomenon at the fluid scale for a general switch topology. This allows us to demonstrate that the optimal fluid dynamics are given by a scheduling algorithm that solves a certain average reward Markov Decision Process.

Biography

Thirupathaiah Vasantam is an Assistant Professor of Computer Science at Durham University, UK. Before that, he worked as a Postdoc in the College of Information and Computer Sciences at the University of Massachusetts, Amherst, USA. He received his PhD from the department of Electrical and Computer Engineering at the University of Waterloo, Canada, in November 2019. He obtained his Bachelors and Masters degrees in Engineering from Osmania University and Indian Institute of Science, Bangalore, respectively. His research focuses on performance modeling and analysis of communication networks that have applications in Quantum networking, Cloud computing, and Internet of Things.

Said Kerraj

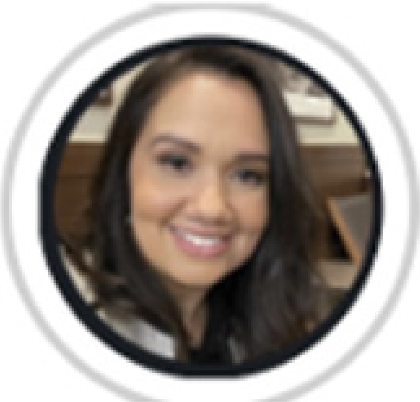
Laboratory of Physical Chemistry of Applied Materials, Faculty of Sciences Ben M'Sik, Hassan II University of Casablanca, Morocco

Quantum-Chemical DFT/TD-DFT Study of NCS-Modified Ruthenium Sensitizers for Dye-Sensitized Solar Cells

Abstract

In this study, DFT and TD-DFT calculations were performed to examine the effect of pseudohalide ligand modification on the optoelectronic properties of ruthenium-based dye sensitizers for DSSC applications. The parent ruthenium dye was compared with two modified analogues obtained by replacing sulfur atoms in the thiocyanate groups with oxygen and selenium. Molecular geometries, frontier orbitals, electronic parameters, UV–Vis absorption spectra, NBO interactions, and Hirshfeld charge distributions were analyzed in the gas phase and acetonitrile solvent. The results show that oxygen substitution induces a blue shift and enhances absorption intensity, whereas selenium substitution produces a red shift and extends absorption toward the near-infrared region. Moreover, the selenium-modified dye exhibits stronger intramolecular charge-transfer character, suggesting improved electron-injection ability. These findings indicate that pseudohalide ligand modification, particularly selenium substitution, is a promising strategy for tuning ruthenium-based sensitizers for DSSC applications.

Keywords: Ruthenium sensitizers; Pseudohalide modification; Chalcogen substitution; DFT/TD-DFT; DSSCs; Charge transfer.



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.

Chris Salvino

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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.

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.

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.

Noureddine Rochdi

LPHE-Modeling and Simulation, Faculty of Sciences, Mohammed V University in Rabat, Morocco

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 plat forms. Finally, we provide detailed information on the dynamics of the QRM in varity 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.

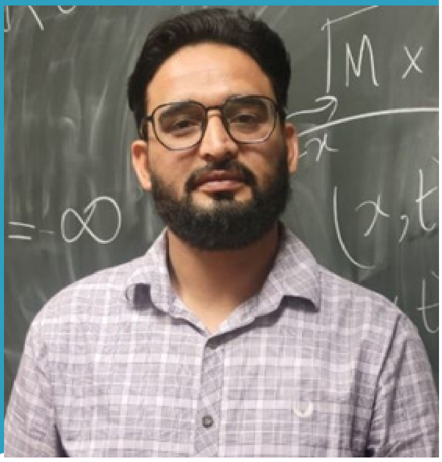
Pratap, Ram
xxxxxxxxxxxxxxxxxxxx

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.



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.*

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.

Venkatesan M, Amar Shree V and Prabhavathy P

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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

1st Author

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.

2nd Author

Amar Shree V received the bachelor's degree in Information Technology from VIT University, Vellore, India, in 2011, and the master's degree in computer science and engineering from Maharaja Institute of Technology, Affiliated to Anna University, Coimbatore, in 2013. She is a Researcher from the National Institute of Technology, Puducherry, Karaikal, India. Her research interests include Quantum Computing, Oceanography, and Artificial Intelligence.

3rd Author

Prabhavathy Paneer is a Professor in the Department of Information Technology, VIT Vellore. She has completed an ISRO-SAC funded project and published over 20 journal papers and several conference papers. Her research interests include computational intelligence, data mining, data science, machine learning, and deep learning.

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Beyond Accuracy: A Kernel-Level Comparative Analysis of Quantum and Classical Support Vector Machines

Abstract

The quantum machine learning community has largely assessed quantum kernel methods simply by classification accuracy, which means they left a very basic question unanswered: do quantum kernels genuinely represent different similarity structures than classical kernels, or are they just getting similar representations by different pathways? We answer this question with a detailed kernel-level comparison of classical support vector machines with radial basis function kernels versus quantum support vector classifiers using ZZFeatureMap and PauliFeatureMap fidelity kernels on various synthetic and real-world datasets.

Apart from the regular accuracy and runtime benchmarking, we explore the kernel geometry and statistical model via methods such as centered kernel alignment, Hilbert-Schmidt Independence Criterion, eigenvalue spectrum analysis, spectral entropy, and effective rank. Besides that, we delineate the work along two axes which were not less of prior: a multi-feature map comparison revealing that ZZFeatureMap and PauliFeatureMap generate almost identical kernel geometries though being structurally different in their circuits, and a noise degradation experiment which demonstrates how depolarizing noise at realistic error rates decreases kernel alignment and classification performance. A divergence regime analysis for varying dataset complexity and noise levels pinpoints the exact conditions when quantum and classical kernels start to structurally differ from each other.

Our findings reveal that quantum fidelity kernels consistently stand at a stable middle

ground with moderate geometric alignment to RBF kernels (CKA: 0.29-0.58), have strong statistical dependence, and hence result in comparable but systematically lower classification performance across all tested datasets. Deepening the circuits does not lead to representational advantage and in fact, performance on more complex datasets gets actively degraded. The data point to the fact that within the low-dimensional regime explored, quantum kernels do not give rise to fundamentally different decision geometries, and the performance discrepancies noticed are structural kernel similarities rather than representational mechanisms that are different. We argue kernel-level dissection be a quantum machine learning research accuracy-based evaluations essential companion.

Biography

Shahryar is currently pursuing his Integrated Master's in Computer Science from University of Hyderabad. He will complete his degree in June 2026 at the age of 23. He is also doing his internship in R&D dept. of GE Vernova. He has completed two other internships in the field of Quantum Computing in the year 2024-2025. He is looking forward to pursue his PhD in the coming year.

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.*

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

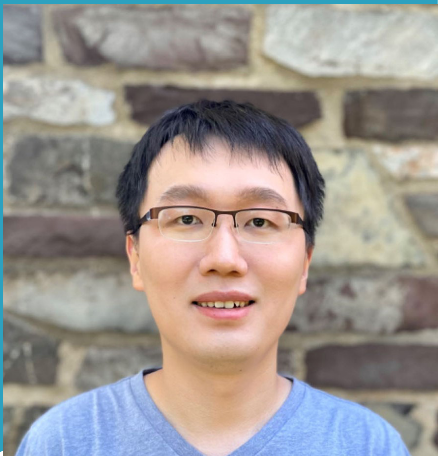
Abstract

Coplanar waveguide (CPW) are critical components in superconducting microwave devices and quantum hardware, where the internal quality factor (Qi) 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 Qi. 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 Qi 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 Qi, 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).



Haowei Xu

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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.*

Tommaso Catuogno

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

Tommaso Catuogno, Senior Researcher in Quantum Technologies and Photonics at Thales Alenia Space, belongs to the Observation and Navigation domain (DON-I). He is now the Technical reference in the domain for Quantum Technologies within the R&D of the DON-I domain. In this context he is the Reference interface for TAS over the Quantum Computing Spoke of the Italian National Center in High-Performance Computing. Regarding his background, He achieved his M.Sc graduation at Scuola Superiore Sant'Anna in High-Performance Computing and Communications, pursuing a curriculum that allowed his specialization in Optical communications and Photonic technologies. He has been working as researcher at Scuola Superiore Sant'Anna, exploring the field of Capacity estimation problems on the nonlinear optical channel, designing Entropy Estimators for its estimation. He has been part of the R&D team in Optical & Photonic Systems at Ericsson Research, where he focused on Quantum Technologies, attempting to identify the potentials and limitations preventing the industrial deployment of these technologies. In this context, he filed a plethora of patents identifying novel schemes for applying Quantum Technologies to the industrial sector, contributing altogether to the writing of two Technical manuals on the subject.

Thank You