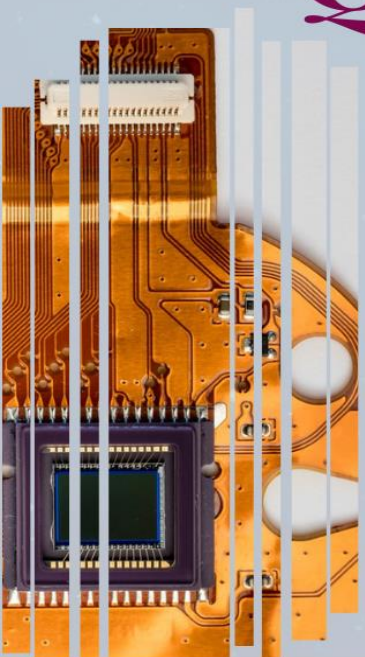
Abstract Booklet

Welcome to

Quantum Latino

The Largest Quantum Event in Latin America

June 9th - 11th, 2021



Organised by

QURECA
quantum resources & careers

|Ψ⟩

Quantum-South

Abstract Titles

8:30 AM – 9:00 AM

Encoding a qubit into the continuous variables modes of a single photon.

Nicolas Fabre
Postdoctoral Researcher, Center of New technologies, Warsaw University

Abstract Encoding quantum information in continuous variables is intrinsically faulty. Nevertheless, redundant qubits can be used for error correction, as proposed in Phys. Rev. A 64, 012310 (2001). We show how to experimentally implement this encoding using Ame-frequency conAnuous degrees of freedom of photon pairs produced by spontaneous parametric down-conversion. We illustrate our results using an integrated AlGaAs photon-pair source. We show how single-qubit gates can be implemented and propose a theoretical scheme for correcting errors in a circuit-like and in a measurement-based architecture.

9:00 AM – 9:30 AM

Quantum logic gates and entanglement with arrays of organic molecules.

Cristian Edwin Susa Quintero
Professor, Universidad de Córdoba, Colombia

Abstract Arrays of covalently bound organic molecules possess potential for light-harvesting and energy transfer applications due to the strong coherent dipole-dipole coupling between the transition dipole moments of the molecules involved. Here, we show that such molecular systems, based on perylene-molecules, can be considered as arrays of qubits that are amenable for laser-driven quantum coherent control. Specifically, we demonstrate quantum logic gates and entanglement in bipartite (dimer) and tripartite (trimer) systems of perylene-based arrays. In dimers, naturally entangled states with a tailored degree of entanglement can be produced. The nonlocality of the molecular trimer entanglement is demonstrated by testing Mermin's (Bell-like) inequality violation.

9:30 AM – 10:00 AM

How much for an image acquired by a quantum imaging system?

Jorge Arturo Rojas Santana
Professor, Instituto Tecnológico de Toluca

Abstract The advances in quantum systems inspired by optical coherence tomography promise increased capabilities in studying the internal structure of semitransparent material. In this work, we estimate the operational cost of the techniques of induced coherence tomography and quantum optical coherence tomography in image acquisition.

10:00 AM – 10:30 AM

Solving Financial equations using Quantum Computing.

Dr Antoine (Jack) Jacquier
Reader in Mathematics and Director MSc in Mathematics and Finance, Imperial College London, United Kingdom

Abstract The purpose of this talk is to introduce a quantum algorithm to solve a simple, yet fundamental PDE arising in Quantitative Finance. This will serve as a basis to discuss potential future applications of Quantum Computing in a field always eager to look for new solutions.

10:45 AM – 11:15 AM

Interactive Quantum Computing in Constant Space.

Prof. Dr. Marcos Villagra
Research Professor, Universidad Nacional de Asunción, Paraguay

Abstract One way to characterize the complexity class PSPACE is with the class of languages recognized by interactive proof systems with polynomial-time verifiers. Similarly, the class NP can be characterized using non-interactive protocols with polynomial-time verifiers. In this presentation, we will introduce quantum non-interactive protocols where verifiers only have available a constant-space amount of memory. In order to model these weak verifiers we will use quantum finite automata that interact with quantum and classical provers with arbitrary computational power.

11:15 AM – 11:45 AM

Quantum Computing Applications to High-Energy Physics

Andrea Delgado
Research Scientist, Physics Division and Quantum Computing Division, Oak Ridge National Laboratory

Abstract Particle physics is the branch of physics that seeks to understand matter at the most fundamental level. Starting from the atomic model, followed by a deeper understanding of the quantum properties of the atom, to the standard model. However, advances in this field will be limited by the information processing technologies available at the time. Therefore, it is imperative to explore alternative solutions to conventional computing, such as quantum computing. During this talk, I will overview the current applications that seek to harness the quantum mechanical properties of matter to process information efficiently. Furthermore, quantum computing promises to speed up computationally expensive tasks in high-energy physics, such as classifying events and clustering particles into so-called particle jets. Nonetheless, there is a clear need to understand quantum computers better, how quantum-assisted algorithms can be used for high-energy physics applications, and identify where these algorithms can outperform their classical counterparts.

11:45 AM – 12:15 PM

Testing the performance of VQE on Knapsack problem variations

Laura Gatti Dorpich
Director of Development, Quantum South, Uruguay

Abstract

The present work is about the VQE performance on special cases of Ising Problems. The importance of the starting point and the ansatz selection in the algorithm convergence is highlighted. We show how the algorithm performance is dramatically improved when a good starting point is given. The starting point is directly related with the ansatz (variational form) choice since the ansatz election spans the search space that can be tracked in the optimization problem. As Ising Problems always have diagonal Hamiltonians, and therefore, the solution will always be a state of the computational basis, it is not clear that entangled ansatze help algorithm convergence. We present the comparative performance of VQE using several types of ansatze tested on different classical optimization algorithms.

12:30 PM – 1:00 PM

Variational Quantum Algorithms

Ernesto Campos
PhD Student, Skoltech, Mexico

Abstract

Variational quantum algorithms are considered the best choice for using the potential of today's quantum computers as they are a universal model of quantum computing and resist various systematic hardware errors. These algorithms require a classical coprocessor that iteratively optimizes a parameterized quantum circuit. Because of their similarities, they are considered quantum analogues to artificial neural networks. In this talk we will review some of the advantages, limitations, and unknowns of these algorithms.

1:00 PM – 1:30 PM

Quantum-safe blockchain networks

Marcos Allende López
IT Specialist in Quantum Technologies, Blockchain, and SSI,
Inter-American Development Bank and LACChain, United States

Abstract

The advent of quantum computing threatens internet protocols and blockchain networks because they utilize non-quantum resistant cryptographic algorithms. When quantum computers become robust enough to run Shor's algorithm on a large scale, the most used asymmetric algorithms, utilized for digital signatures and message encryption, such as RSA, (EC)DSA, and (EC)DH, will be no longer secure. Quantum

computers will be able to break them within a short period of time. Similarly, Grover's algorithm concedes a quadratic advantage for mining blocks in certain consensus protocols such as proof of work. Today, there are hundreds of billions of dollars denominated in cryptocurrencies that rely on blockchain ledgers as well as the thousands of blockchain-based applications storing value in blockchain networks. Cryptocurrencies and blockchain-based applications require solutions that guarantee quantum resistance in order to preserve the integrity of data and assets in their public and immutable ledgers. This conference presents a layer-two solution to secure the exchange of information between blockchain nodes over the internet and introduced a second signature in transactions using post-quantum keys.

1:30 PM – 2:00 PM

How quantum technologies can foster research in quantum matter

Karen Hallberg
Principal researcher, CONICET and Professor, Balseiro Institute, Argentina

Abstract

I will describe how our research in quantum condensed matter profited from concepts developed in the field of quantum information. I will also show how recent advances in quantum computation reproduced our results in systems with strongly correlated electrons, in particular the emergent phenomenon of charge and spin separation. If time allows, I'd like to present other recent developments in quantum technologies in Argentina.

2:30 PM – 3:00 PM

Careers in Quantum

Dr. Araceli Venegas-Gómez
CEO and Founder, QURECA Ltd., United Kingdom

Abstract

In this talk, I will provide an overview of quantum technologies worldwide, from the funding of the field to some examples of real use cases. Where does the public funding comes from? Where are the startups distributed? Then, I will focus on career opportunities in the field of quantum technologies, providing some advice on how to identify your skills, and steer your professional career in the right direction. I will finalise presenting how at QURECA we tackle the quantum workforce skills bottleneck by creating the first online platform for quantum training and resourcing, to support individuals and businesses to be part of the quantum revolution.

3:00 PM – 3:30 PM

Quantum algorithms to solve fluid dynamics problems

Eduardo Inacio Duzzioni
Professor of Physics at Federal University of Santa Catarina and CTO of QuanBy Quantum Computing, Brazil

Abstract

In this talk I will present quantum algorithms to solve the heat and Burguers equations based on quantum annealing technique. We approach the heat equation in the stationary regime by the finite difference method, reducing the problem to the solution of a system of coupled linear equations. In order to solve larger systems of equations we used the block Gauss-Seidel method to split the coupled equations into smaller ones. To solve the Burguers equation we classically trained artificial neural networks to learn solutions, initial and boundary conditions of this partial differential equation. A quantum version of the boosting machine learning method was applied to obtain from weak learners a stronger neural network. The solutions obtained in both cases by the D-Wave Systems 2000Q and Advantage achieved good results, which were benchmarked by the classical solutions.

3:30 PM – 4:00 PM

Natural deduction and quantum computing

Alejandro Díaz-Caro
Professor at Universidad Nacional de Quilmes and CONICET Researcher at Universidad de Buenos Aires, Argentina

Abstract

In this talk I will present an unsuspected connection between non harmonious logical connectives, such as Prior's tonk, and quantum computing. We defend that non harmonious connectives model the information erasure, the non-reversibility, and the non-determinism that occur, among other places, in quantum measurement. More concretely, we introduce a propositional logic with a non harmonious connective "sup" and show that its proof language forms the core of a quantum programming language. This is a joint work with Gilles Dowek. The draft is available at arXiv:08994.

4:00 PM – 4:30 PM

Quantum Software Engineering

Carlos Pérez-Delgado
Research Professor, University of Kent, United Kingdom

Abstract

Software engineering is one of the essential breakthroughs that allowed computation to go from being solely a theoretical and mathematical pursuit, to everything that it is today. While quantum software engineering is a very young field today, its development is a fundamental

step in transforming quantum computing from a solely scientific pursuit into an advanced technological industry.

4:45 PM – 5:00 PM

Quantum Machine Learning with E-Commerce

Rodolfo Bonnin
Student, Universidad Nacional de San Luis, Argentina

Abstract

In this talk, we will present the main problem areas within the e-commerce field, and how Quantum Machine Learning techniques are able to tackle them, mentioning current implementations, in a simulated or real-life environment. Finally, a number of experiments will be presented, using MercadoLibre's data, Quantum Neural Networks, and Quantum Nearest Neighbors to attack high-priority problems.

5:00 PM – 5:15 PM

Practical quantum tokens without quantum memories and experimental tests

Damián Pitalúa-García
Student, DAMPT, The University of Cambridge, United Kingdom

Abstract

Unforgeable quantum money tokens were the first invention of quantum information science but remain technologically challenging as they require quantum memories and/or long-distance quantum communication. More recently, virtual "S-money" tokens were introduced. These are generated by quantum cryptography, do not require quantum memories or long-distance quantum communication, and yet in principle guarantee many of the security advantages of quantum money. Here, we describe implementations of S-money schemes with off-the-shelf quantum key distribution technology, and analyse security in the presence of noise, losses, and experimental imperfection. Our schemes satisfy near instant validation without cross-checking. We show that, given standard assumptions in mistrustful quantum cryptographic implementations, unforgeability and user privacy could be guaranteed with attainable refinements of our off-the-shelf setup. We discuss the possibilities for unconditionally secure (assumption-free) implementations.

5:15 PM – 5:30 PM

Quantum Walks over Genotype Networks

Miguel Angel Ruiz Ortiz
Student, Universidad de Guanajuato, Mexico

Abstract

In this talk, we are going to see a new way of understanding biological evolution, introduced by Santiago-Alarcon et al (2020), through continuous quantum walks (Venegas-Andraca, 2012) over genotype networks.

Genotype networks are graphs of genotypes with same phenotype, where two nodes of the network (i.e., genotypes) are connected if one genotype is obtained through a single step mutation of the other. The union of different genotype networks is called a genotype space (Wagner, 2011). Since genes are quantum and there have been efforts of modelling adaptive mutations through quantum mechanics (McFadden and Al-Khalili, 1999), quantum walks over genotype networks can help us to understand better the structure of genotype networks. For instance, the hitting time of quantum walks can help us to understand how novel phenotypes arise through time.

5:30 PM – 5:45 PM

Quantum Spectral Clustering for Image Segmentation

José Ignacio Espinoza-Camacho
Student, Tecnológico de Monterrey, Mexico

Abstract

The increasing size of data sets is a motivation to develop new optimal and low time-taking algorithms. Quantum computing is a promising alternative, as they provide computational speed-up for some problems. Spectral clustering algorithms are unsupervised machine learning algorithms that make use of the space of eigenvalues and eigenvectors (spectrum) of matrices derived from the data to make an efficient partition. However, this spectral transformation becomes computationally expensive when dealing with thousands or even hundreds of data points, as is the case for the segmentation of large images. Recently, a new quantum algorithm for spectral clustering [1] proved a speed-up over the classical algorithm. In this work, we propose a quantum spectral clustering algorithm for image segmentation based on [1,2]. Our work compares our image segmentation results with those produced by normalized cuts.

[1] Iordanis Kerenidis and Jonas Landman. Quantum spectral clustering, 2021.
[2] Jianbo Shi and J. Malik. Normalized cuts and image segmentation. IEEE Transactions on Paeern Analysis and Machine Intelligence, 22(8):888–905,2000.

5:45 PM – 6:00 PM

Finding Solutions to MaxSAT using a Quantum Computer.

Student, Tecnológico de Monterrey, Mexico

Abstract

This work proposes the idea of finding solutions to a 3MaxSAT instance of by means of a two-stage Quantum Mechanical procedure. The first stage consists in building a unitary operator whose eigenvectors are individually associated to each possible truth assignment over the set of Boolean variables, and whose eigenvalues are phase-encoded with the

total number of non-satisfiable clauses that would be observed by evaluating such instance. The second stage consists in finding an eigenstate of such operator whose eigenvalue has the minimum encoded phase. Such eigenstate directly corresponds to the truth assignment with the least number of non-satisfiable clauses, and thus our solution to the MaxSAT instance. We present an algorithm to build such operator in a limited number of Quantum gates linearly bounded by the number of clauses of the instance in the case of 3-MaxSAT, and a second algorithm that combines Quantum Phase Estimation and Amplitude Amplification to find a solution to any 3-MaxSAT instance with a Quadratic Speedup over conventional black-box search.

6:00 PM – 6:15 PM

Quantum computing and AI: The intersected paths

Diego Carlos Luna Márquez
Student, National Centre for Research and Technological Development, Mexico

Abstract

In recent years we have experienced a lot of improvements in the computer processing area, ranging from Moore's law increased number of transistors in a CPU to massive parallel and specialized tensors and machine learning hardware. Despite these advances physics limits impose restrictions in circuit miniaturization. Using superposition, entanglement and interference quantum computing looks like a good option to overcome some of this limitations. This paper is a brief review of some of the applications of Quantum Computing in Artificial Intelligence.

11:30 AM – 12:00 PM

Running algorithms on ion-trap quantum computers

Sonika Johri
Senior Quantum Application Researcher, IonQ

Abstract

A variety of quantum computing platforms are rapidly becoming available for access over the cloud. These systems are characterized by a limited number of qubits and available computing time. Combined with innovative error mitigation techniques, these systems may soon begin to surpass classical computers in some application areas. In this talk, I will discuss recent demonstrations of IonQ quantum computers in studying diverse problems in machine learning, optimization and the simulation of quantum many-body systems.

3:00 PM – 3:30 PM

Quantum Safe Communications; Protecting your data from the quantum threat

Tom Crabtree
Business Development Manager, KETS Quantum Security Ltd., United Kingdom

Abstract

I will be talking about the threat quantum computers are bringing to the security of the world's data and how quantum technologies can counter that threat.

6:30 PM – 7:00 PM

D-Wave Quantum Hybrid Systems

Daniel Ley
Senior Vice President, D-Wave Systems, United States

Abstract

Quantum computing has left the research lab and is now being used to solve real-world applications at scale. Hear from D-Wave about how leading companies are getting business value today from their use of D-Wave quantum hybrid systems.