

NQCC SparQ Access Showcase Talks

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Connecting the Quantum Dots: AI Pathfinders from Access to Discovery

Elham Kashefi

Director, Quantum Software Lab (QSL)

Abstract

Every SPARQ project turns access to hardware into a result, one project at a time. The pieces needed for complete, end-to-end results exist across the UK, but they rarely meet. In this talk I ask whether AI can help connect them. I will present Pathfinder, an AI pipeline built at the Quantum Software Lab that searches for links between research and hardware results. I will show what it has found so far, where it falls short, and why the next step needs this whole community.

Quantum advantage on IBM hardware for real-time dynamics of Quantum Field Theory

Bipasha Chakraborty

University of Southampton

Abstract

Real-time dynamics of quantum fields remain beyond the reach of classical supercomputers. We demonstrate a scalable quantum algorithm for Quantum Electrodynamics in 2+1 and 3+1 dimensions, implemented on quantum hardware. The approach overcomes key bottlenecks of classical simulation and provides a concrete route to quantum advantage in fundamental physics, enabling future studies of particle creation, scattering and non-equilibrium quantum field dynamics in high energy physics.

A Structure-Aware Quantum Vision-Language Model on NISQ-Era Quantum Computers

Mehrnoosh Sadrzadeh

University College London

Abstract

Standard vision-language models (e.g., Open AI’s CLIP) fail at compositional tasks, acting like bags of words. While classical fixes require massive scaling, we introduced QuCLIP, the first quantum vision-language model that uses a linguistic ansatz, mapping semantics into hardware-aware quantum circuits via unitaries and feature maps. QuCLIP was trained on classical computers and tested on a range of NQCC SparQ Access platforms, revealing limitations and showcasing successes.

When Noise Looks Like an Attacker: Evaluating BB84 Eavesdropping Detection on IBM Quantum Processors

Adam Gorine

University of the West of England, Bristol

Abstract

The BB84 quantum key distribution protocol detects eavesdropping by analysing the quantum bit error rate (QBER). However, on NISQ devices, hardware noise can obscure attack signatures and reduce detection reliability. This study evaluates BB84 security on IBM superconducting quantum processors, comparing hardware noise with intercept–resend attacks. Results from over 300 trials across three IBM backends show that noise can become indistinguishable from attacks, challenging QKD deployment.

Forecasting chaotic systems with quantum reservoir computing

Osama Ahmed

Imperial College London / Qronon

Abstract

Forecasting physical systems, especially for chaotic systems like the atmosphere, strains both classical physics-based and data-driven methods. Recurrence-free quantum reservoir computing exploits Hilbert-space expressivity and entanglement to forecast chaotic dynamics and extreme events using compact models on current hardware. Validated from prototypical turbulence to real-world forecasting, these quantum approaches point toward scalable, resource-efficient fluid prediction.

On the feasibility of Quantum Cryptocurrency Mining

Lee Armstrong

University of Kent

Abstract

In the search for practical and feasible NISQ applications, we explore the design and implementation of a Mini-Bitcoin mining circuit and the results from running it on current day NISQ hardware – where Mini-Bitcoin is a representative toy model of Bitcoin. Then we give a trajectory for what the hardware requirements will need to be to run a full Bitcoin mining circuit on future hardware.

Quantum products of experts

Marcin Jastrzebski

University of Sheffield

Abstract

We give background on differentiable quantum generative modeling. We present an ensembling method which samples from a coherent "product of experts" of such models. Results from IBM hardware runs are presented.

Hybrid Classical-Quantum Generative Models for Synthetic Medical Data

Soraya Vaani Panambalom

Newcastle University

Abstract

Rare paediatric cancers leave cohorts too small to train and validate machine learning models. We ask whether a hybrid classical-quantum generative model can enlarge one with usable synthetic patients, by placing a variational quantum circuit in the latent space of a tabular VAE. Architectures are compared under a fixed statistical protocol, and quantum readouts are judged on hardware cost as well as quality, alongside how depolarising noise and finite sampling affect the patients generated.

First Complete Gravitational Wave Encoded on a Quantum Computer

Hong Qi

Queen Mary University of London

Abstract

We report the first encoding of a complete gravitational waveform onto quantum hardware. Reduced order modeling compresses a GW150914-like signal from the collision of two black holes to a 9-qubit register at the accuracy required by parameter estimation, verified on simulators and encoded onto quantum computers.

Quantum Generative Diffusion Model for Real-World Time Series

Jack Waller

Kingston University

Abstract

We propose QDiffusion-TS, the first quantum generative diffusion model for time series synthesis, validated on the IQM quantum processor. By replacing feed-forward components in a denoising transformer with quantum neural networks, we reduce trainable parameters by three orders of magnitude per component. Evaluated on financial time series, the model reduces Wasserstein distance by 44% versus classical counterparts, and improves forecasting RMSE by up to 71% through synthetic data augmentation.

Quantum simulation of atomic nuclei

Professor Paul Stevenson

University of Surrey

Abstract

Atomic nuclei, made of protons and neutrons, are prime candidates for simulation on quantum computers, since they obey the same quantum rules as qubits. We will present a broad overview of what interesting questions in nuclear physics can be tackled on quantum computers, and show results for the progress made so far in exploring these questions on IBM machines under the NQCC access programmes

Analysing Biological Networks using QAOA and Gaussian Boson Sampling

Lily Lee

Imperial College London

Abstract

TBA

Hermitian Matrix Product Operators on Quantum Computers

Naivasha Williams

University College London

Abstract

MPOs allow for computation of local observables, which is particularly useful for streamlining tensor network algorithms. Since most MPOs are nonunitary, current state-of-the-art methods favour block-encoding for implementation. However, utility is limited by circuit depth and ancilla overhead on current hardware. We propose a new, more hardware efficient implementation of Hermitian MPOs and show that both circuit width and depth are significantly reduced for the Transverse Field Ising Model.

Mean-field ansätze for quantum sampling algorithms

Freddie Burns

University of Bristol

Abstract

Sampling algorithms aim to find subspaces of a Hamiltonian that yield accurate eigenvalues. This work pools measurements from an ensemble of ansätze, each produced rotating a spin-broken mean-field determinant into a spin-restricted basis, and projecting into a target spin state. We benchmark against an LUCJ ansatz on small hydrogen systems, in both simulation and on hardware, showing shallower circuits and improved sampling efficiency while retaining full ground-state support.

Quantum Assisted Rendezvous

Joshua Tucker

University of Kent

Abstract

Quantum entanglement enables powerful correlations between spatially separated systems. A key application is non-local games, where isolated players cooperate towards a joint objective. Building on the quantum advantage recently found by Piotr Mironowicz in the "Rendezvous" game, this talk explores its foundations through explicit algorithms. We extend this work to complex scenarios where players lack complete environmental information. Finally, we present simulations of our algorithms running on classical and Noisy Intermediate-Scale Quantum (NISQ) processors

Hybrid Quantum Strategy Search for the graph domination game

Christopher Weeks

University of Kent

Abstract

Hybrid algorithms provide an opportunity to make use of the advantages of both classical and quantum computation. We study quantum advantage in the 1-step graph domination game on cycle graphs through the use of NISQ processors in a hybrid quantum algorithm. We find methods to reduce the quantum runtime required to run a genetic algorithm and demonstrate that NISQ computers realise the predicted quantum advantages despite these changes.

Solving larger Travelling Salesman Problem networks

Daniel Goldsmith

Kingston University

Abstract

The Travelling Salesman Problem (TSP) is a well-known NP-Hard combinatorial optimisation problem. Although TSP has been studied extensively on quantum computers, it is rare to find quantum solutions of TSP network with more than a dozen locations. This talk presents results of runs on real quantum hardware on networks of up to 15 locations of a hybrid penalty-free, circuit-model, Variational Quantum Algorithm (VQA), and studies the impact of the problem formulation and optimiser.

From Access to Understanding: Lessons, Surprises and Progress through SparQ

Virag Umathe

Quantum Software Lab, The University of Edinburgh

Abstract

Through the SparQ Access Programme, our group has engaged with IBM and IonQ quantum hardware across five projects. This talk outlines our key technical outcomes, development of hardware-aware research pipelines, and the transition of workflows from simulation to real backends. We present how direct hardware access shaped our understanding of device behaviour establishing a reusable and scalable project pipeline, and how active collaborations are driving forward our current research directions.

Quantum Computing for Brain Network Analysis

Erika Molteni

University College London

Abstract

Quantum algorithms for community detection in complex networks are presented, with applications in neuroscience. Functional brain connectivity networks are widely used to study neurological and psychiatric disorders. Identifying modular structure in these networks is a central analytical task, but modularity maximisation is computationally demanding and naturally expressed as a combinatorial optimisation problem. We will discuss gate based and annealer based solutions.