

Tutorial

Quantum and Quantum-Inspired Machine Learning for Sustainable and Efficient AI

ORGANIZERS



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ABSTRACT:

Artificial intelligence is becoming a central component of modern digital infrastructure, yet the rapid growth of machine learning models raises important questions about computational cost, energy consumption, and long-term sustainability. At the same time, concepts emerging from quantum computing are inspiring new algorithmic approaches that may enable more efficient representations and processing of information.

This tutorial introduces the fundamentals of quantum computing and quantum-inspired machine learning to a broad technical audience with no prior background in quantum technologies. The first part of the tutorial provides an accessible overview of the basic principles of quantum information, including qubits, quantum gates, and quantum circuits, together with a discussion of the current state of quantum hardware and the challenges that remain before large-scale quantum advantage can be achieved.

The second part focuses on quantum-inspired techniques that can already be applied on classical computers, such as tensor network methods and other representations originating from quantum many-body physics. These approaches have recently shown promising results in machine learning tasks including anomaly detection, pattern recognition, and efficient representation of high-dimensional data. Emphasis will be placed on how these methods can enable compact model representations and compression of neural networks, potentially reducing the computational and energy footprint of modern and real-time AI systems.

Finally, the tutorial will discuss emerging directions where quantum technologies may contribute to sustainable technological development. These include applications such as optimization of energy grids and large-scale infrastructure, discovery of new materials for batteries, and optimization problems in logistics and transportation systems.

The tutorial concludes with an outlook on how quantum and quantum-inspired computing could become part of future sustainable computing ecosystems.

ABOUT ORGANIZERS:

EMA PULJAK is a Quantum Algorithms Expert at planqc, working on quantum and quantum-inspired machine learning for real-world applications. She completed a collaborative PhD between the European Organization for Nuclear Research (CERN), the Barcelona Supercomputing Center, and the Universitat Autònoma de Barcelona, where her research focused on improving anomaly detection methods using quantum and quantum-inspired techniques for applications in medical imaging and high-energy physics. Her work sits at the intersection of quantum computing, machine learning, and high-performance computing, with a focus on developing scalable methods that bridge near-term quantum technologies with classical computing approaches. Ema is also active in science communication and regularly delivers talks and tutorials introducing quantum computing, tensor networks, and quantum machine learning to interdisciplinary audiences. She has participated in many international conferences and has actively contributed to numerous schools, hackathons, and workshops aimed at fostering collaboration and education in quantum technologies.

SANJA DJURDJIĆ MIJIN is a quantum physicist (PhD, 2022) with nine years of research experience in experimental quantum photonics, specializing in solid-state single-photon sources and scalable qubit platforms for communication and computing. She develops room-temperature quantum light technologies and has authored peer-reviewed publications in journals such as ACS Applied Materials & Interfaces and Physical Review, in addition to delivering more than 40 international conference presentations, including invited and plenary talks. Beyond research, she actively contributes to quantum education and technology outreach through lectures, workshops, and summer schools, translating complex quantum-hardware concepts into clear, application-driven narratives for researchers, engineers, and industry audiences. She combines deep experimental expertise with structured technical storytelling to support the positioning and understanding of advanced quantum technologies.