QUANT²AI:

END-TO-END QML-BENCHMARK SOFTWARE

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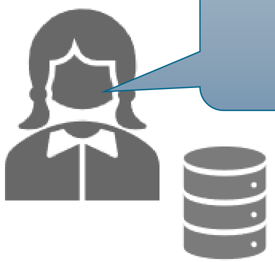
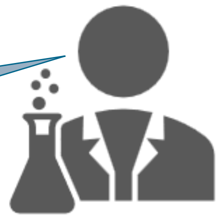
DLR

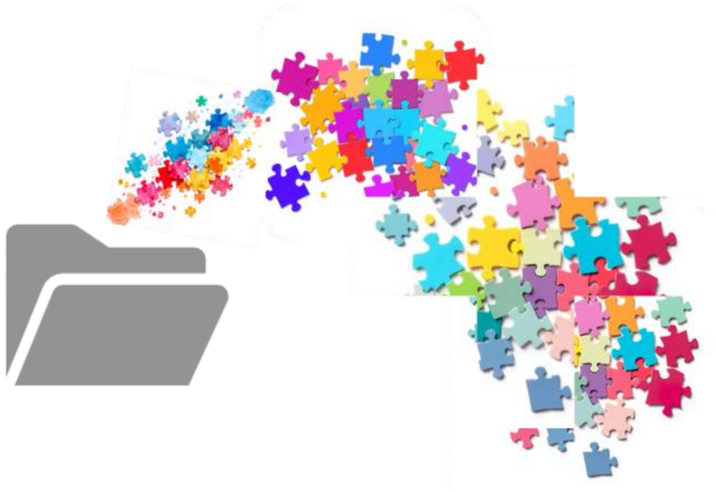
Finding a suitable solution

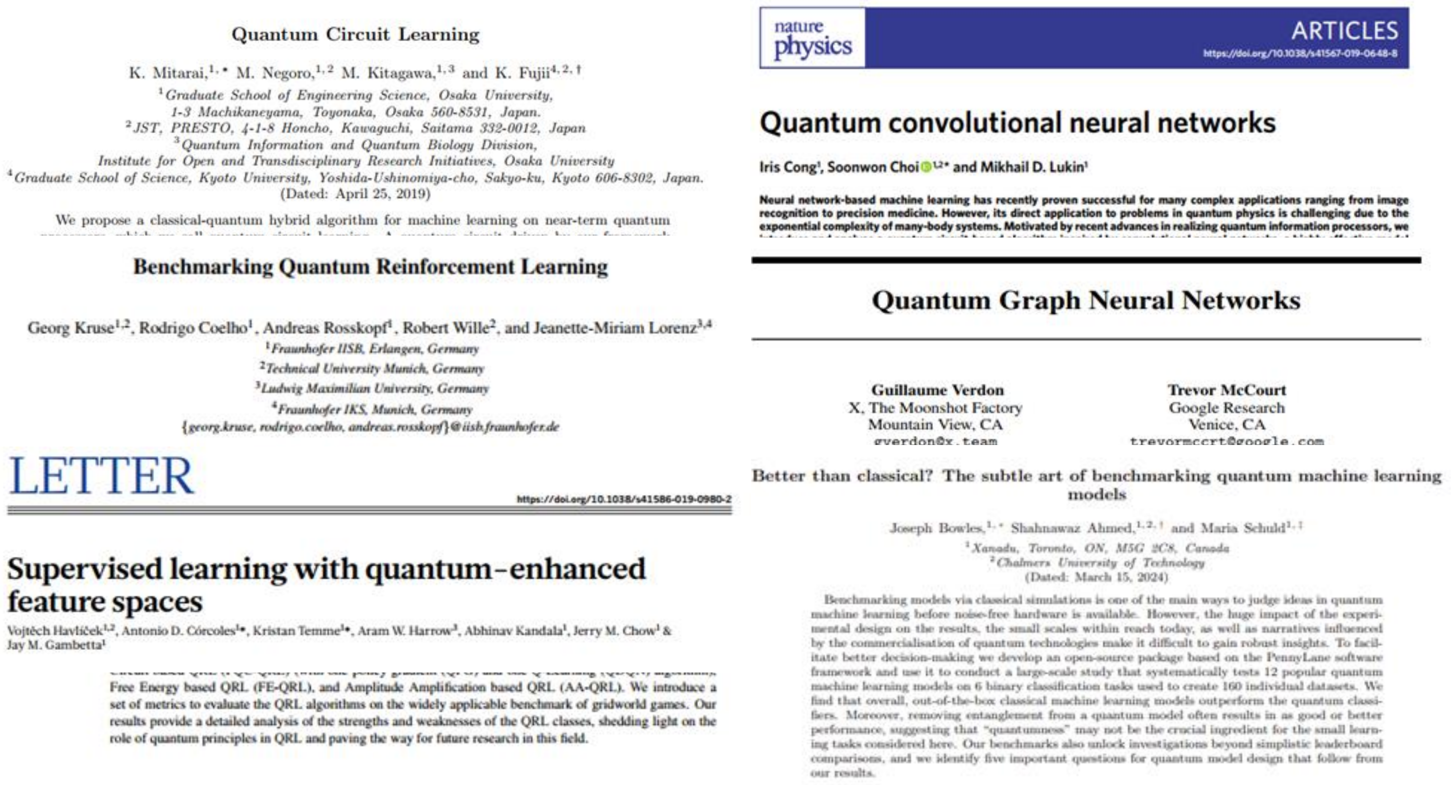


I have a use-case. Help me find a quantum algorithm, please.

Sure, look how many tools we have!







Quantum Circuit Learning

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(Dated: April 25, 2019)

We propose a classical-quantum hybrid algorithm for machine learning on near-term quantum

Benchmarking Quantum Reinforcement Learning

Georg Kruse[1,2], Rodrigo Coelho[1], Andreas Rosskopf[1], Robert Wille[2], and Jeanette-Miriam Lorenz[3,4]
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Free Energy based QRL (FE-QRL), and Amplitude Amplification based QRL (AA-QRL). We introduce a set of metrics to evaluate the QRL algorithms on the widely applicable benchmark of gridworld games. Our results provide a detailed analysis of the strengths and weaknesses of the QRL classes, shedding light on the role of quantum principles in QRL and paving the way for future research in this field.

LETTER https://doi.org/10.1038/s41586-019-0980-2

Supervised learning with quantum-enhanced feature spaces

Vojtěch Havlíček[1,2], Antonio D. Córcoles[1*], Kristan Temme[1*], Aram W. Harrow[3], Abhinav Kandala[1], Jerry M. Chow[1] & Jay M. Gambetta[1]

nature physics ARTICLES https://doi.org/10.1038/s41567-019-0648-8

Quantum convolutional neural networks

Iris Cong[1], Soonwon Choi[1,2*] and Mikhail D. Lukin[1]

Neural network-based machine learning has recently proven successful for many complex applications ranging from image recognition to precision medicine. However, its direct application to problems in quantum physics is challenging due to the exponential complexity of many-body systems. Motivated by recent advances in realizing quantum information processors, we

Quantum Graph Neural Networks

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Better than classical? The subtle art of benchmarking quantum machine learning models

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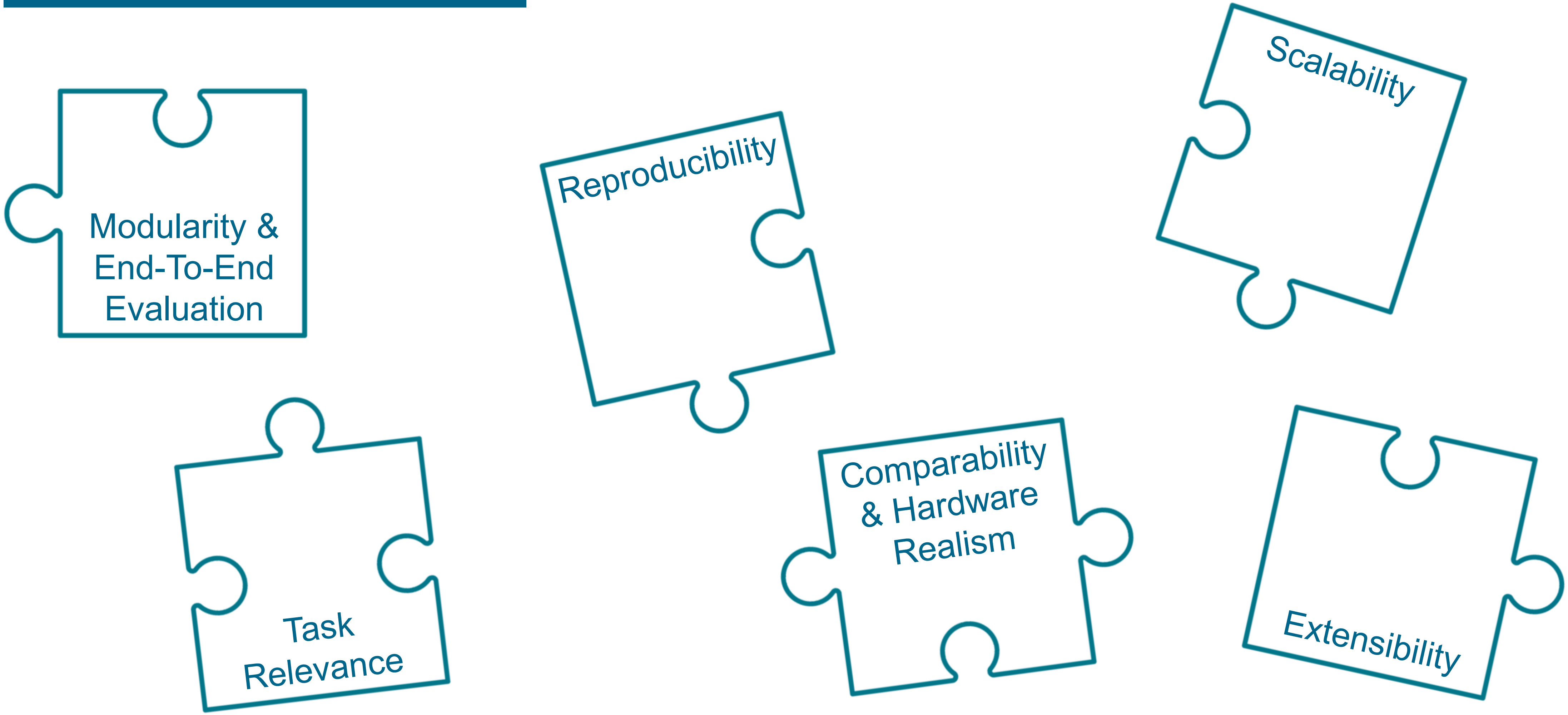
(Dated: March 15, 2024)

Benchmarking models via classical simulations is one of the main ways to judge ideas in quantum machine learning before noise-free hardware is available. However, the huge impact of the experimental design on the results, the small scales within reach today, as well as narratives influenced by the commercialisation of quantum technologies make it difficult to gain robust insights. To facilitate better decision-making we develop an open-source package based on the PennyLane software framework and use it to conduct a large-scale study that systematically tests 12 popular quantum machine learning models on 6 binary classification tasks used to create 160 individual datasets. We find that overall, out-of-the-box classical machine learning models outperform the quantum classifiers. Moreover, removing entanglement from a quantum model often results in as good or better performance, suggesting that "quantumness" may not be the crucial ingredient for the small learning tasks considered here. Our benchmarks also unlock investigations beyond simplistic leaderboard comparisons, and we identify five important questions for quantum model design that follow from our results.

What Defines a Good Benchmark for Quantum Machine Learning Pipelines?

Key Requirements for Credible Performance Claims



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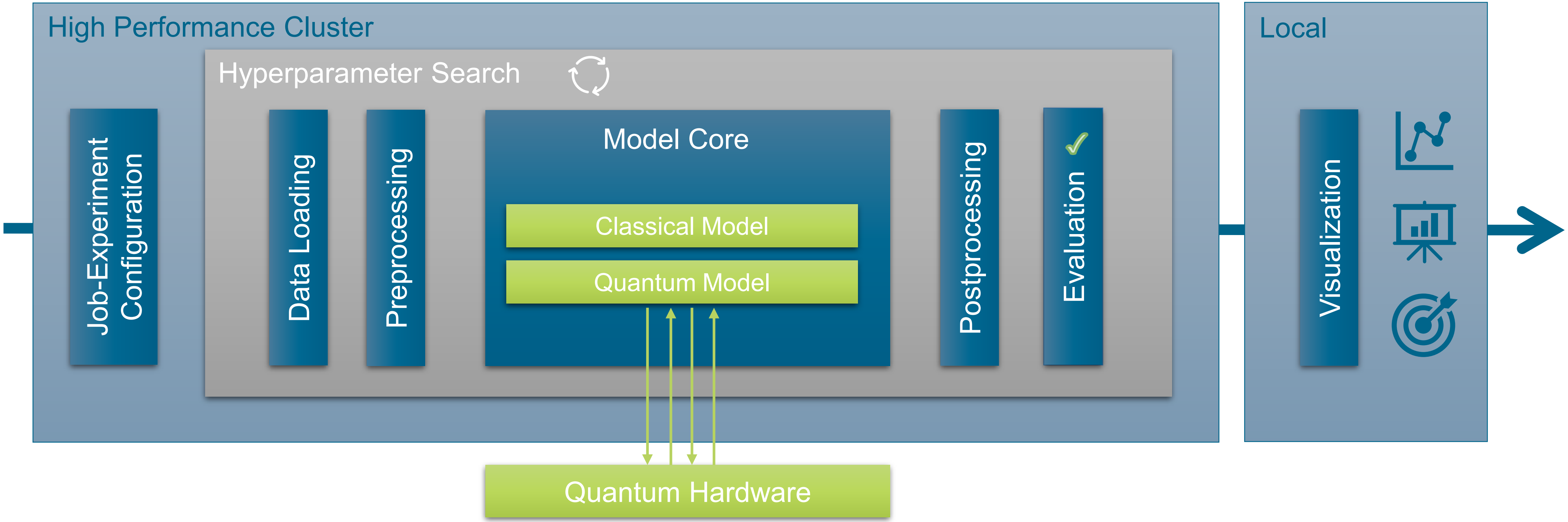
QUANT²AI – QML-BENCHMARKING FRAMEWORK FOR RESEARCHERS AND PRACTITIONERS

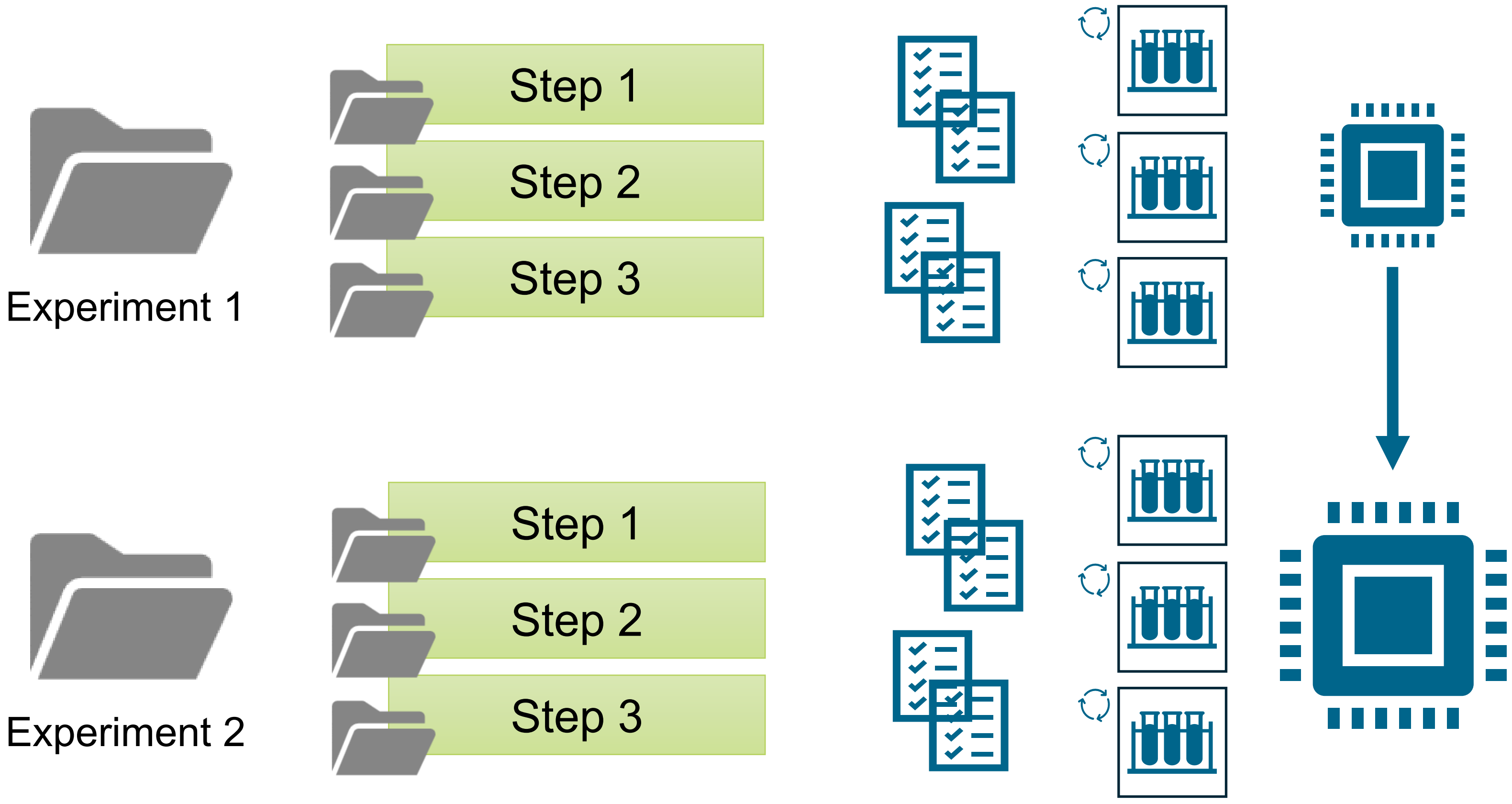
Modularity & End-to-End Evaluation

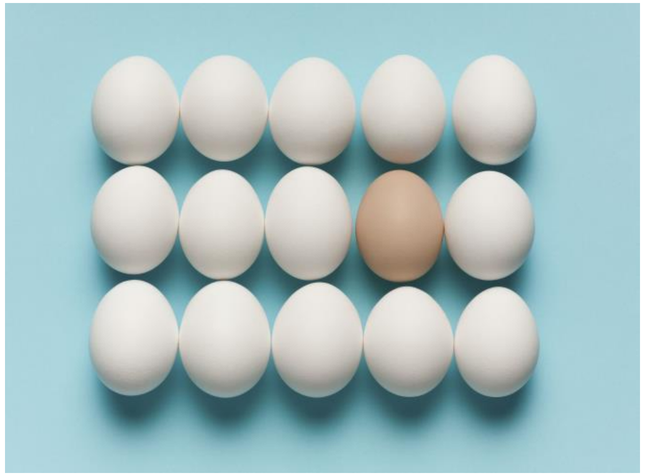
Input and Output Standardization Ensure Compatibility of Each Neighboring Block



Reproducibility & Scalability

Experiments are Set Up with Same and Clean Environment Necessary for a Fair Verification



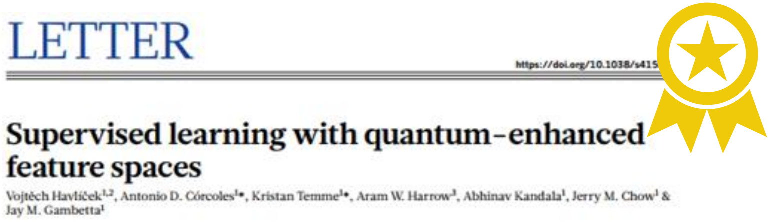


Comparability and Hardware Realism

Metric evaluation and aggregations for scientific rigor
Statistical meaningfulness

- Machine Learning Metric
- Quantum Metric
- Cluster Information
- Custom/ Research Metric

Visualization Tool



LETTER

Supervised learning with quantum-enhanced feature spaces

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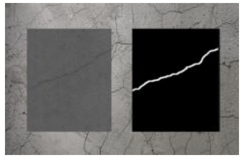
Extensibility & Task Relevance

It Helps to Keep the Software Updated for the Upcoming Progress
Expandable Collection of Real-World Datasets, ML Tasks, and Custom Algorithms

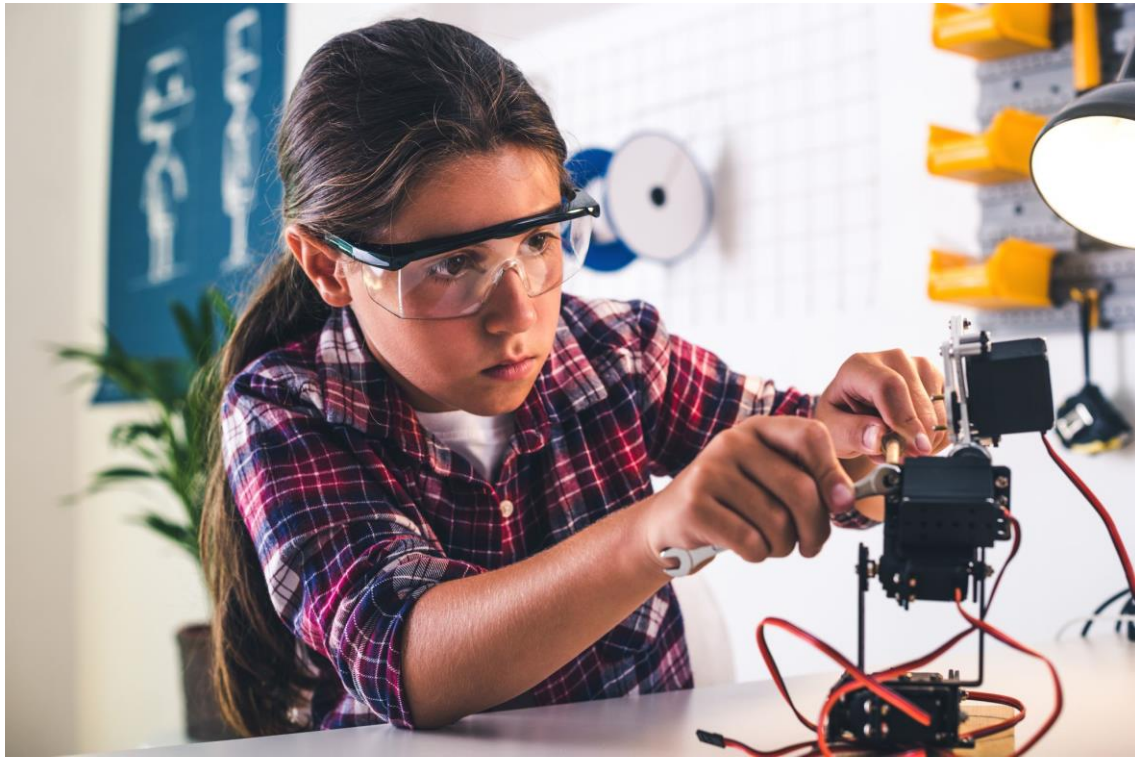
Material Analysis Data
Iris Dataset
Additional



QNN
SVM
Additional

ML Metrics
Hardware Info
Additional

Quantum Devices
Simulations
Additional



Digest – Towards Trustworthy QML Benchmarks

- Quant²AI: A scalable, reproducible, modular benchmarking framework
- Execution on HPC with connection to quantum hardware and simulators
- Large set of datasets (both toy and real-world examples), (Q)ML models, pipeline modules, and metrics
- Both the benchmarking and the visualization provide spacious possibilities for extensions

Get Involved! Feel Free to Contact Us!

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