KIPU QUANTUM

Quarterly Highlights – Q3 2024

October 2024

Kipu Quantum provides application- and hardware-specific algorithms for early industrial usefulness within the next 12 to 24 months

Kipu Quantum – We stand at the forefront of quantum computing algorithms

We are specializing in application- and hardware-specific quantum software solutions that drastically reduce the requirements for solving industry use cases.

These solutions enable even the currently small and noisy quantum processors to yield significantly improved results, while approaching industrial usefulness.

Commercial Quantum Advantage Era – With Kipu!

Tackling major industry challenges with quantum computers requires algorithms that use over 70 qubits. Despite having processors with over 100 noisy qubits, this remains out of reach. Current qubit specifications and gates are inadequate for greedy quantum algorithms.

However, we anticipate overcoming this limitation in the next 12-24 months with advancements in quantum computing paradigms and hardware. This is particularly promising for optimization problems.

Kipu's Tech Edge – Our algorithmic compression achieves a massive reduction in the required circuit depth

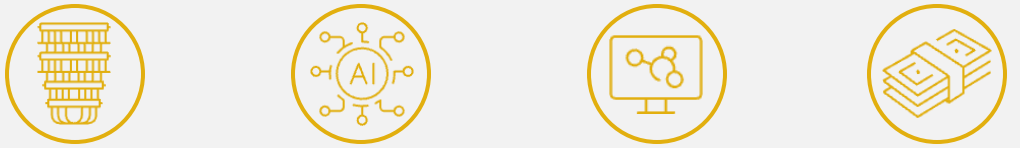
We outperform competing state-of-the-art quantum algorithms through our digital, analog and digital-analog compression techniques, dramatically reducing the necessary circuit depth by orders of magnitude.

Our technology seamlessly integrates with leading hardware concepts such as superconducting circuits, ion traps, and neutral atoms.

Presenting our Quarterly Highlights!

Kipu Quantum constantly moves the needle on our path to making quantum computers useful. In the third quarter of 2024, we realized several breakthroughs, which we briefly discuss in this document.

Please reach out if you would like to learn more!



In Q3, the Kipu team achieved several new milestones on our journey towards early industrial usefulness

We solved the largest optimization problem on IBM, using all 156 qubits.

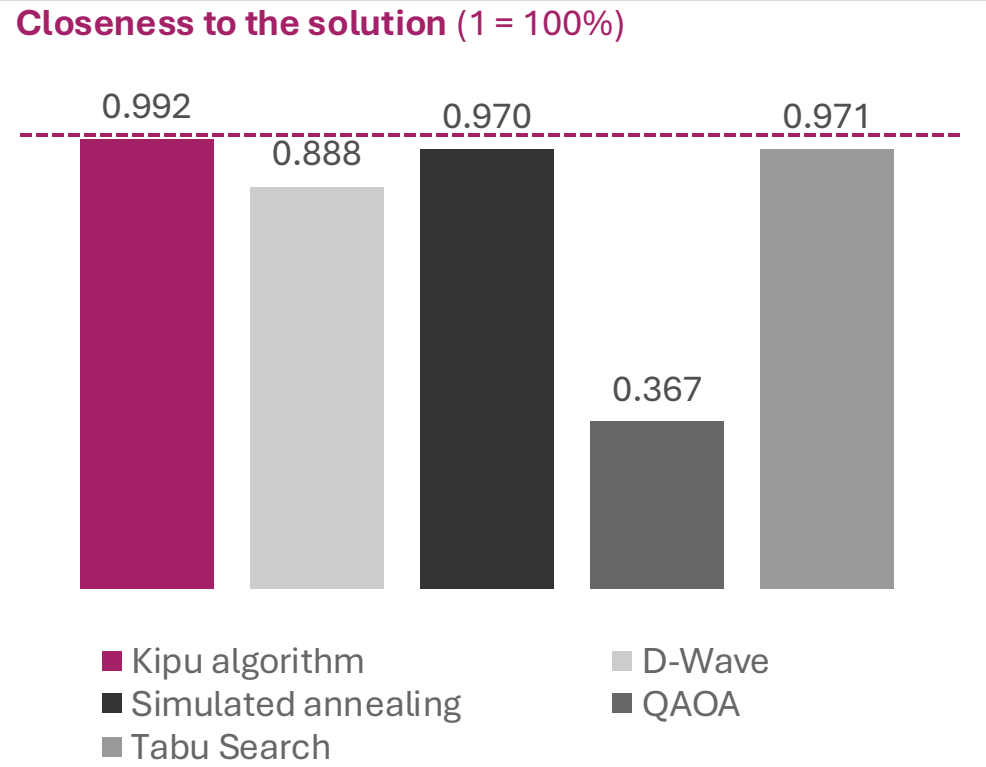
We enhance AI by boosting the performance of feature selection.

Our algorithms are now accessible as a service on our platform.

We boost neural networks to improve performance at ~1,000 fewer data inputs.

Underlying tech – see our whitepaper LINK

Kipu Quantum starts the commercial quantum advantage era, by solving relevant optimization problems on IBM's 156-qubit quantum processors

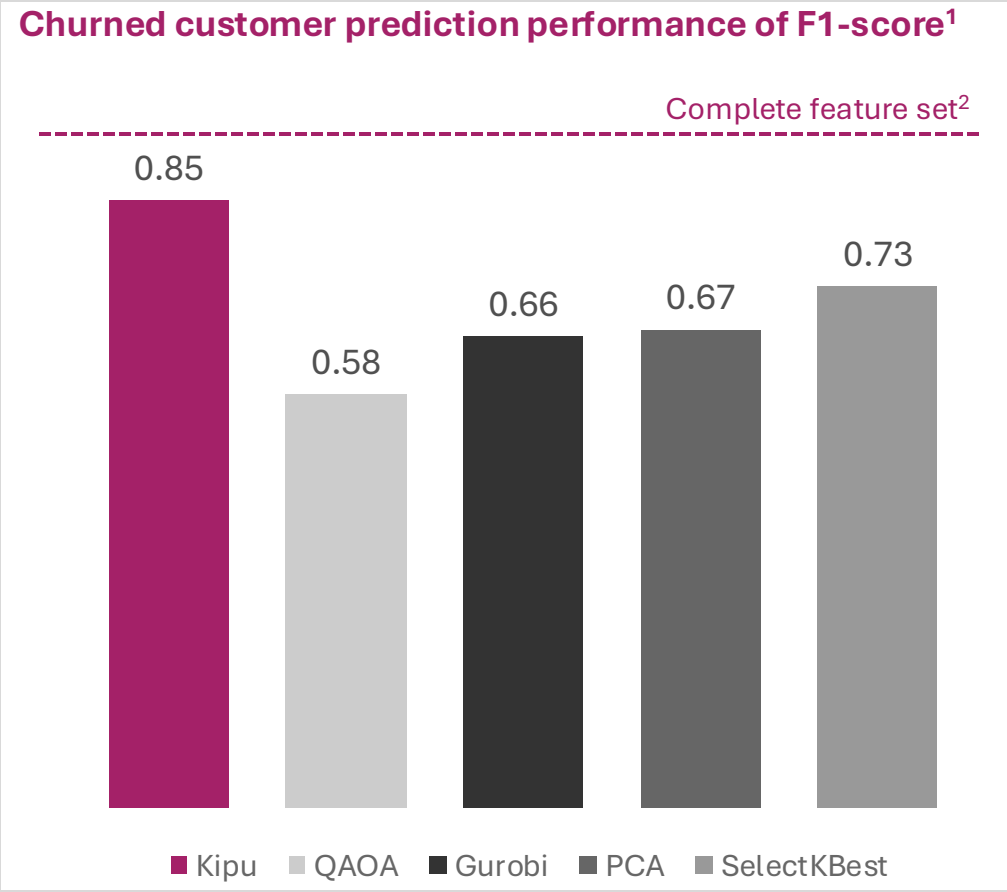


Click here for the paper!

- Kipu has successfully tackled **the largest and most complex HUBO problem**, by utilizing all 156 qubits of IBM's quantum processor, marking the **largest optimization experiment** to date
- We solved optimization problems with **higher-order interaction variables** directly[1]
- Our method can also be adapted for larger processors, e.g. 433 qubits
- In contrast to the QAOA algorithm[2], we maximizes the capabilities of current commercial quantum hardware by
  - Improving the quality of the solution by **more than 90%**
  - Saving computation resources by reducing the circuit depths **by 7 times** and required iterations on hardware **by 720 times**
- Our solution uses **HUBO mapping**, which fits to a wide range of industry use cases, **complex mixed-integer optimization, protein folding, portfolio optimization, network design, and decision-making processes**

1) Without mapping to quadratic unconstrained binary optimization formulation (QUBO)
2) Requires classical optimization and multiple hardware iterations; may get stuck in local minima or suboptimal solutions

Our quantum solution enhances AI by outperforming traditional feature selection algorithms by 47%



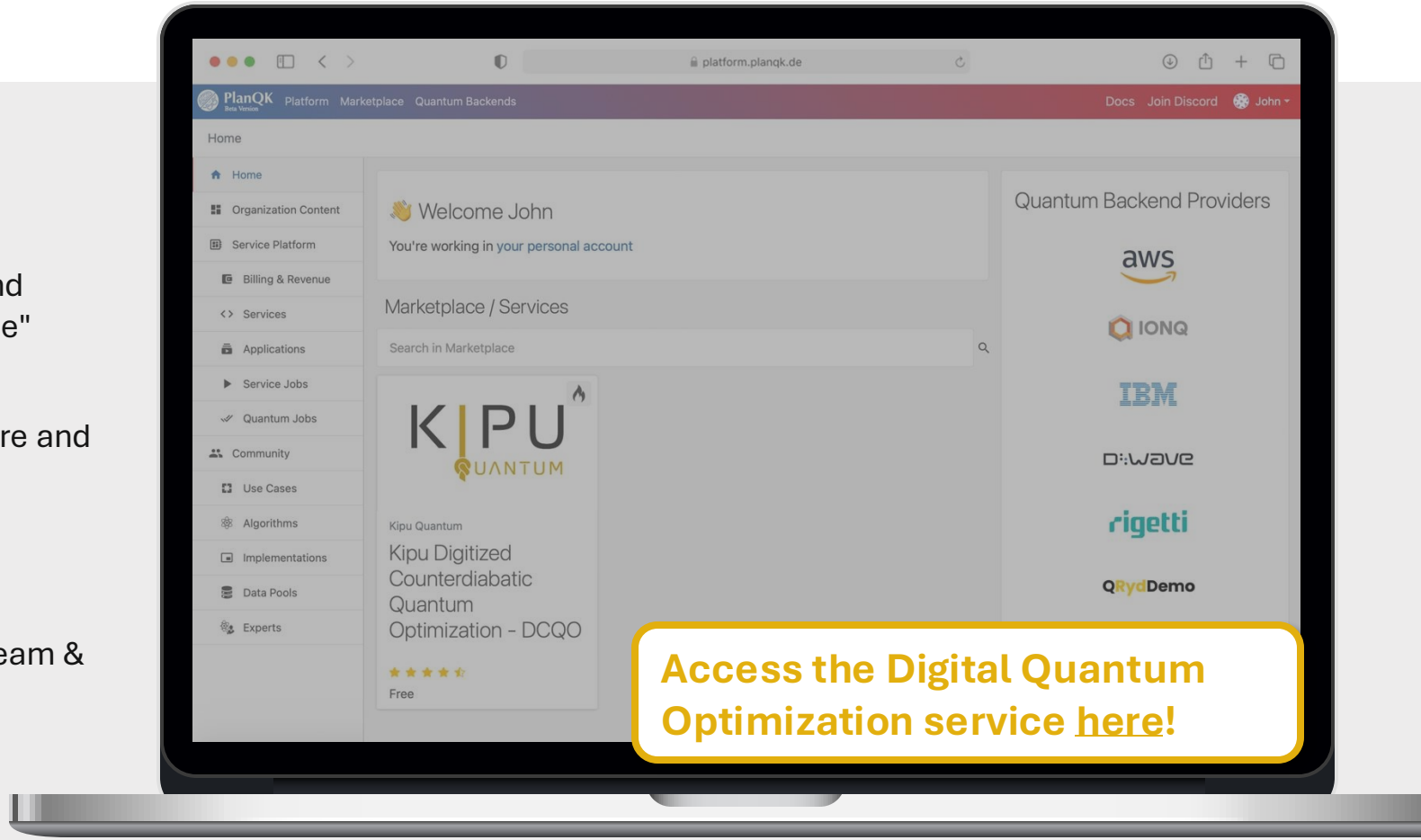
- **Feature selection is essential in AI**, for model efficiency, accuracy, and decision-making, reducing unnecessary computational overhead, especially for large data set. Mastering it improves model accuracy, reduces complexity, and enhances interpretability, all while lowering cost and preventing overfitting
- **But: Traditional tools struggle with complex datasets**, necessitating a faster and more precise solution. High-dimensional data, such as that used for predicting churned customers, poses significant challenges
- By selecting only 63% of the features, **Kipu's solution surpasses benchmarked algorithms by up to 47%**
- This enables **simultaneous exploration of vast feature spaces**, leading to faster and more accurate identification of key predictive features suitable for **classification problems, for instance in finance**

1) F1-score is the harmonic mean of precision and recall. It is a metric suitable in scenarios where the data is imbalanced. We validated the tool on 11 qubits using IBM Torino noisy simulator (11 variables).
2) Complete feature set: analysis of the complete classical dataset without selecting any features

The benefits from Kipu algorithms can now be reaped easily as services on our platform – a free version was launched for testing

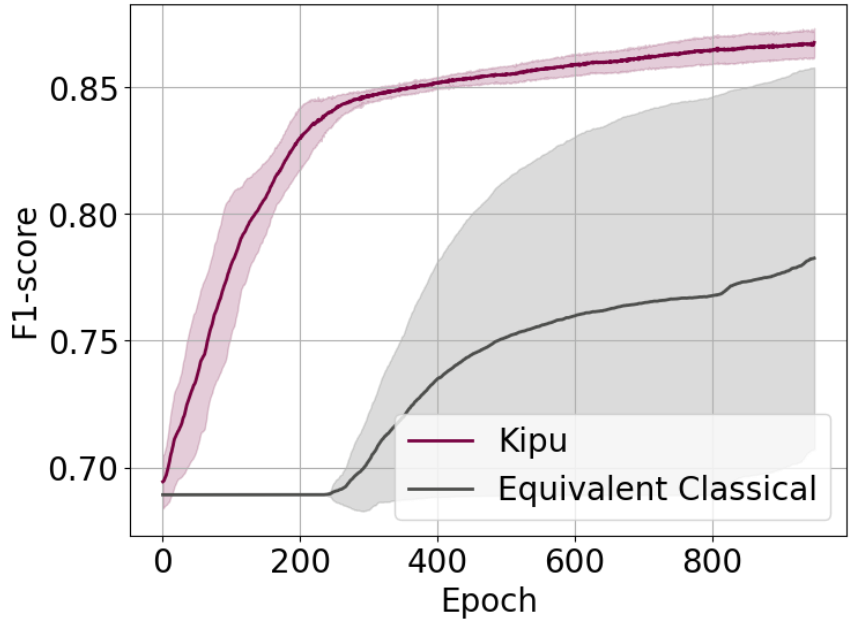
PlanQK platform users can now access Kipu‘s digital quantum optimization service based on our powerful DCQO[1] algorithm and benefit from:

- ”As a service" consumption through frictionless and automated execution - ”pay-as-you-go" or ”flat-rate" pricing model
- Access to different quantum and classical hardware and simulators
- Easy integration into existing processes and tools through API access
- Customization with Kipu's algorithm engineering team & possibility to build custom showcases for the management and / or marketing purposes



1) Digitized Counterdiabatic Quantum Optimization – see https://arxiv.org/abs/2201.00790

Coupling neural networks with quantum offers better performance at less input for tabular data sets – for instance in loan default predictions



- **Accurate loan default prediction is critical for financial institutions**. As default rates climb to 5.5 – 6%[1], improving these predictions can reduce financial losses and strengthen institutional stability
- **Conventional ML struggles** to balance high-risk loans with missed opportunities, **requiring large amounts of training data**. Predicting loan defaults is particularly challenging due to the limitations of conventional models and data constraints
- Leveraging IBM Quantum, Kipu's algorithm **improves loan default prediction accuracy by 8%[2] using around 1,000 fewer training data**
- **Our quantum-enhanced preprocessing outperforms classical competitors today[3]** and can be applied to other financial classification problems, such as churn prediction and fraud detection
- This capability is based on **coupling neural networks with quantum** and can be extended to other **use cases based on tabular data**, for instance in health care

1) "Defaults expected to rise towards 5.5% in Europe and reach 6% in the US", ING Article and "Default Rates to Rise in U.S. and Europe as Weaker Growth Offsets Rate Cuts", Fitch Ratings Commentary.
2) The used Credit Risk Dataset: https://www.kaggle.com/datasets/laotse/credit-risk-dataset
3) F1-score is the harmonic mean of precision and recall. It is a metric suitable in scenarios where the data is imbalanced. We validated the tool on 11 qubits using IBM Torino noisy simulator (11 variables).

Application- and hardware-specific algorithms for early industrial usefulness

Ways to engage with the Kipu Quantum team

- Enter the discussion regarding your use cases, value, and strategy
- Work with us on a showcase
- Develop a concrete pilot with us
- Embark on a 12 – 24 months journey to demonstrate first usefulness

Join us on our journey towards useful quantum computing!