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Editorial

# Exploring the Horizon: The Future of Quantum Computation and the Role of Quantum Machine Learning

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The landscape of quantum computation has undergone significant evolution since the visionary ideas of Yuri Manin and Richard Feynman emerged four decades ago. Their pioneering concepts laid the groundwork for a field that promises to revolutionize computational paradigms. In this article, we delve into the future of quantum computation and its potential convergence with quantum machine learning. Additionally, we address skepticism surrounding the field and highlight recent achievements.

Yuri Manin and Richard Feynman envisioned a computing paradigm beyond the confines of classical physics, paving the way for quantum computation. The quantum bits, or qubits, introduced by these visionaries, have the remarkable ability to exist in multiple states simultaneously, unlocking the potential for parallelism and computational efficiency.

Central to the viability of quantum computation is the threshold theorem proposed by Dorit Aharonov. This theorem asserts that, with error correction, quantum computations can be executed reliably, dispelling concerns about the inherent fragility of quantum systems. Aharonov's work has been instrumental in addressing the challenges posed by decoherence and noise, providing a theoretical foundation for the practical implementation of quantum algorithms.

The exponential speedup offered by quantum computation holds great promise for machine learning applications. Quantum machine learning algorithms, harnessing the power of qubits, exhibit the potential to outperform their classical counterparts in specific tasks. The inherent parallelism of quantum computation enables the exploration of vast solution spaces simultaneously, offering a unique advantage in complex optimization problems and large-scale data analysis.

Despite the promising advancements, skepticism persists in some quarters, with claims that quantum computation is merely a hyped phenomenon that can be replaced by classical supercomputers. It is essential to critically evaluate these assertions, considering the distinctive capabilities and potential applications of quantum computation. Rigorous scrutiny is necessary to separate genuine concerns from premature dismissals of a technology still in its infancy.

In assessing the current state of quantum computation, notable achievements have been realized. Quantum supremacy, demonstrated by Google's 2019 experiment, marked a milestone where a quantum processor outperformed classical supercomputer in a specific task. Additionally, progress has been made in quantum error correction, quantum communication, and the development of quantum algorithms, showcasing the growing maturity of the field.

The exponential increase in power reportedly makes calculations almost instantly that conventional supercomputers would take 47 years to complete. Though the specific task the computer was asked to complete has little or no real-world applications, it serves to demonstrate the evolving potential of quantum computing systems [1].

There have been huge interest recently on doing research on quantum machine learning but we are generally far from any real life or business application of quantum machine learning and quantum computation. Theoretically nothing stops us from achieving quantum supremacy and reaching our dreams but in practice it takes a lot of innovation and passionate, hard work to have at least a quantum computer which has 10000 qubits, approximately a reasonable amount of qubits to achieve quantum supremacy. Although we need to have in mind that reaching quantum supremacy depends on other factors such as error rates and error correction, gate fidelity, qubit coherence time, connectivity and qubit coupling and scalability. Noise is our ENEMY.

Quantum mechanics, we may not a complete understanding from it, but it is one of the most successfully tested scientific theories. Doubting the fundamentals of quantum mechanics or revolutionizing it might be a very interesting idea but it is far from an engineering mentality.

After talking to the director of a famous quantum computing center in 2014, he said “we do not use any of theories for error correction existing in papers, such as decoherence free subspaces in order to make our quantum computer work, we have our own engineering technology”.

The future of quantum computation is characterized by exciting possibilities and challenges. The synergy between quantum computation and machine learning holds the potential to reshape the technological landscape. As we navigate through skepticism and build upon foundational theorems, it is imperative to approach quantum computation with cautious optimism. The journey from theoretical concepts to practical applications is ongoing, and collaborative efforts across academia and industry will play a pivotal role in realizing the transformative potential of quantum computation in the years to come.

## Bibliography

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