The Token
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In the Name of Allah, the Most Compassionate, the Ever-Merciful

Say: 'Travel through the earth and see (with a warned eye) what has been the

'(al-An'ām, 6 : 11)

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Most of these ideas, which are still in research papers, will come out of the conception stages and make their way to programming libraries and packages. More and more new quantum algorithms will begin to see the light of the day, and these will be conceived, debated, and finalized incrementally.

While we say that, theoretically, quantum computers are superior and can perform anything classical computers do, this is not always the case. As an example, multiplication of large numbers performed through classical algorithm sheds information during calculation, whereas quantum computers can't shed information. Thus, a new quantum method of multiplication had to be implemented which doesn't involve the shedding of information. It has also been observed that though quantum computing is developing rapidly, quantum algorithms are relatively immobile. Scientists have now proven that this can be improved. Similar to Fast Fourier Transformation, there is the Kravchuk transformation [10], which can be developed for quantum algorithms. I believe this will lead to quantum algorithms for processing handwritten text, printed text, sign language, gestures, and faces.

Quantum algorithms are not necessarily similar in approach to classical algorithms, and thus there will be a renewed focus on new algorithms and approaches to convert the existing classical algorithms into quantum algorithms. Both of these will consider what quantum properties to use that work precisely and leverage their computational power.

2. Performance improvement and optimization of quantum noise

Using evolving algorithms to try to solve challenging real-world problems means that the quantum process requires more qubits and low error rates. For processors with many qubits, the market is currently witnessing the era of NISQ (Noisy Intermediate Scale Quantum) devices. These quantum computers, however, are not fault-tolerant and are incapable of carrying out tasks of practical interest on a large scale.

A fully fault-tolerant system could be achieved through Quantum Error Correction (QEC) by protecting quantum information from noise. Since QEC currently requires thousands of qubits and processing operations, and presently NISQ systems do not have enough resources to implement QTC, building fault-tolerant systems are not yet an option. This means that the current research

for QEC is directed towards reducing the number of qubits required. In the meanwhile, scientists are coming up with innovative techniques to mitigate the effects of noise in the quantum computer, such as Zero Noise Extrapolation and Dynamic Decoupling*.

In the Zero Noise Extrapolation method, the result of a computation can be estimated to an ideal state where noise is absent by extrapolating the computations of a program that are repeated multiple times with varying noise levels.

The Dynamic Decoupling technique aims to reduce decoherence time by manipulating a repeated sequence of pulses to protect the qubits from surrounding noise.

3. Increase of industrial use cases suitable for quantum computing

The quantum computing market is rapidly growing across industries and regions. Based on basic premises and marquee benefits of quantum technology, researchers have identified a range of applications that will benefit from a large amount of data processing such as real-time response, and other applications that are currently requiring high computational power.

With error mitigation and correction being a crucial part of quantum computation, significant progress can be expected in developing quantum algorithms with effective noise-mitigating techniques.

Given these applications described above, there will be few industries and areas that won't be impacted by quantum technology.

Organizations will see more widespread use of this new paradigm of computation by taking a hybrid approach to solving real-world problems. That will lead to the emergence of novel ways to solve the existing business problems and new opportunities that were inconceivable so far in different value chain areas.

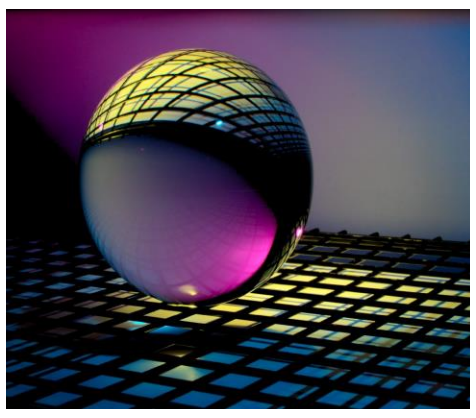
Quantum computing will bring drastic changes in multiple industries, including finance & banking, manufacturing, hospitality, healthcare, media, and technology and being adapted for the new emerging technologies like artificial intelligence, machine learning, and blockchain. There will be multiple potential developments in drug discovery, product development, and process optimization, while in finance it is possible that quantum computing will lead to improvements in credit risk, high frequency training and fraud detection. Quantum cryptography or quantum encryption algorithms will bring a revolution in cybersecurity. These advances will give early adopters major business advantages.

4. Quantum computing enterprise adoption at scale

Adoption of quantum at scale is another area that we should keep an eye on. Though it might seem to be a distant reality, effort and work in the next one to two years will determine the speed at which the industry can start strategizing, building, and deploying quantum applications. Research in storage, integrations, deployments, and security of quantum applications will pave the way for adopting seemingly distant quantum technology at scale.

The development of quantum computers will be faster because of the known route of development of the classical computer. The adoption of classical algorithms into quantum algorithms for computing advantages is still in earlier days and remains an ongoing process. There will be a focus on developing quantum random access memory for solving storage problems and developing integrated (classical and quantum) and user-friendly platforms similar to cloud services.

Conclusion



The demand for products and platforms that support various algorithms, frameworks, and hardware with unified development and deployment experience to the developers and architects will start gaining traction as we advance with ongoing research and innovation in quantum technology. We saw some initial attempts in this area in 2019–20, and those will get further momentum in 2021. However, other essential components of any software applications, such as integrations and security, have yet to gain traction from investors and academia in the quantum world. This is an area where we should keep a watch out for future developments.