QUANTUM COMPUTERS VS CLASSICAL COMPUTERS

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Abstract. *Quantum computing is an interdisciplinary field that seeks to understand the processing of information using quantum mechanics principles. Quantum computing is the exploitation of properties of quantum states such as superposition and entanglement to perform computation. It has shown its supremacy over conventional computing. Quantum computing can outperform much more than existing computers. As such, it represents a paradigm shift for computing technology in its development history. Currently, quantum information technology is state-led research and is considered as an emerging industry. Although a full-scale quantum computer has not yet been developed, it has great growth potential.*

Keywords: algorithms, atom, computing, computers, qubits, quantum, state, superposition.

Introduction

Quantum computers and classical computers are fundamentally different in terms of their architecture, processing capability, and approach to problem-solving. While both types of computers can store and process information, quantum computers leverage the principles of quantum mechanics to perform certain types of calculations much faster than classical computers.

Quantum computers vs classical computers

Quantum computing is a branch of computer science that uses the principles of quantum mechanics to process information [1]. The basic unit of quantum information is called a quantum bit or qubit, which can be in multiple states simultaneously. This contrasts with classical computers, which use classical bits that can only be in one of two states (0 or 1) [2].

Quantum computers can exploit this property to perform certain types of calculations much faster than classical computers. For example, a quantum computer can perform a specific calculation called Shor's algorithm [3], which is used to factor large numbers, exponentially faster than a classical computer. This makes quantum computers particularly useful for cryptography and code breaking [4].

Quantum computers also use quantum gates and quantum circuits, which are quantum mechanical equivalents of classical gates and circuits. These quantum gates and circuits allow quantum computers to perform complex quantum algorithms that are not possible on classical computers [5].

Classical computers, on the other hand, use classical bits to process information. They are based on the Von Neumann architecture, which was first proposed in the 1940s. The architecture consists of a central processing unit (CPU), memory, and input/output devices [6].

Classical computers use binary arithmetic to perform calculations, and they rely on transistors to store and process information. They can only perform one calculation at a time, and they must perform each calculation in a sequential manner [7].

Classical computers are very good at performing many types of calculations, and they are widely used for a variety of applications, including data processing, scientific simulations, and gaming. The most significant difference between quantum and classical computers is the way they process information. Quantum computers use the principles of quantum mechanics to process information, while classical computers use classical bits.

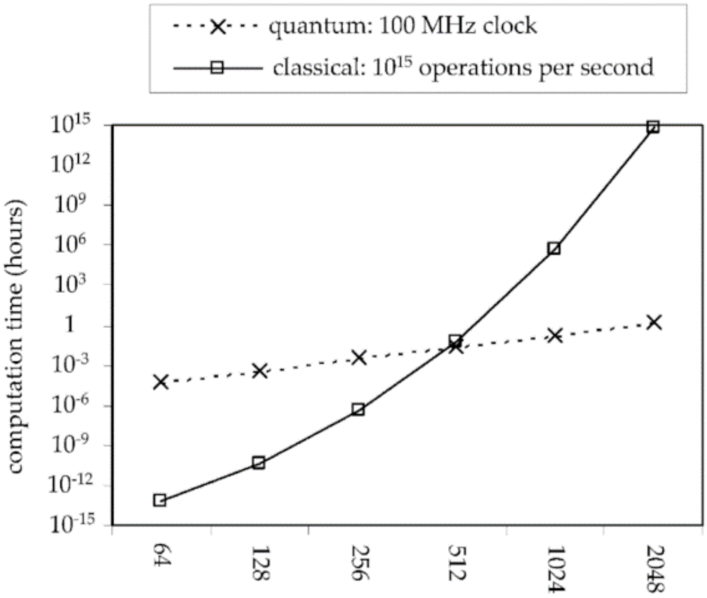

Figure 1. Speed of computing operations [8]

Another major difference is the speed at which each type of computer can perform certain types of calculations. While classical computers can perform many types of calculations very quickly, quantum computers can perform certain types of calculations much faster than classical computers. And other types of calculation they can perform at the same time which means that the time for computations becomes exponentially better.

Quantum computers are also more versatile than classical computers, as they can be used to perform a wider range of calculations. However, they are also more difficult to build and maintain than classical computers, as they require precise control over the quantum states of the qubits.

Quantum computers advancements

As you can see in the graph made by research gate quantum computing is better and quicker than classic computing in terms of operations made per second.

Quantum computers are also more versatile than classical computers, as they can be used to perform a wider range of calculations. However, they are also more difficult to build and maintain than classical computers, as they require precise control over the quantum states of the qubits, which is a great task to deal with.

Quantum computers and classical computers are fundamentally different in terms of their architecture, processing capability, and approach to problem-solving. While both types of computers have their strengths and weaknesses, they each play an important role in the field of computing.

Quantum computers are advancing, and they will continue to advance at a higher rate as time goes by, they have the potential to revolutionize many areas of science and technology. However, classical computers will likely continue to play an important role in many areas for the foreseeable future and will not be replaced by quantum computers. It's more likely that these two will work in parallel on different basis and different projects.

Quantum computing is a relatively young field that is transforming the way we process information. Unlike traditional computers, which are based on classical physics, quantum computers are built entirely on the principles of quantum mechanics. This leads to some fundamental differences in their design and functionality, how they store data or how they process the data all of these are different in a way or another than classical computers.

One of the key distinctions between quantum and classical computers is the way they store and process data. Classical computers store data as bits, which are either 0 or 1, whereas quantum computers store data as qubits, which can be in multiple states simultaneously [9]. This unique feature allows quantum computers to perform multiple calculations at once, making them much faster and more efficient than classical computers. Quantum Computers have a distinct design that is different from any other computer. Because of qubits, all the boards, micro-processors, CPU, GPU, etc. are made different so they can process the data formed as qubits.

Another major difference between quantum and classical computers lies in the way they solve problems. As time becomes a big problem in many problems, the Quantum Computing becomes more and more viable. Classical computers use algorithms to solve problems, which are step-by-step instructions. Quantum computers, however, use quantum algorithms, such as quantum key distribution and post-quantum cryptography, that take advantage of the properties of qubits to solve problems more efficiently [10].

Quantum computing is particularly important in the field of cryptography, as quantum computers can crack the encryption algorithms that are very sophisticated and used by classical computers, posing a significant threat to internet security. This has led to the development of quantum-resistant encryption algorithms, such as quantum key distribution and post-quantum cryptography, to address this issue. If those types of encryptions become somehow usable on a classical computer, then there will be no way to crack something as complex as those algorithms.

The impact of quantum computing is not limited to cryptography, however. It is also having a significant impact on other fields, such as chemistry, finance, and machine learning. In chemistry, quantum computers are being used to simulate the behaviour of molecules, which can help researchers to develop new materials. In finance, quantum computers are being used to optimize portfolios and reduce financial risk. And in machine learning, quantum computers are being used to develop new algorithms that can learn from large amounts of data much faster than traditional computers.

Conclusions

In conclusion, quantum computers are changing the way we process information and solve problems, with the potential to revolutionize many fields. Despite their numerous benefits, they also pose new challenges, such as the need for new encryption algorithms to secure the internet. As the field of quantum computing continues to evolve, it will be interesting to see how these challenges and opportunities are addressed. Even though it is still a very young technology it's potential cannot be denied, and the future will depend on that technology.

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