

Quantum Computing

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Abstract—Quantum Computing is the procedure of using quantum-mechanics for resolving complex and massive operations quickly and proficiently. As classical computers are used for execution of classical computations, similarly, a Quantum computer is used for performing Quantum computations. Quantum Computations are so complex that it becomes almost unbearable to solve them with classical computers. The word 'Quantum' is derived from the idea of Quantum Mechanics in Physics that describes the physical properties of the nature of electrons and photons. Quantum is the fundamental framework for deeply unfolding and understanding nature. Thus, it is the reason that quantum calculations deal with complexity. It describes the best way of dealing with a difficult computation. Quantum-mechanics is based on the phenomena of superposition and entanglement, which are used to perform the quantum computations.

Keywords—Quantum Computing, Computer, quantum physics, super-state, bits, entanglement, super-position.

INTRODUCTION (WHAT IS COMPUTING?)

Computing is any goal-oriented activity requiring, benefiting from, or creating computing machinery. It includes the study and experimentation of algorithmic processes and development of both hardware and software. It has scientific, engineering, mathematical, technological and social aspects. Major computing disciplines include computer engineering, computer science, cyber security, data science, information systems, information technology and software engineering. The term "computing" is also synonymous with counting and calculating. In earlier times, it was used in reference to the action performed by mechanical computing machines, and before that, to human computers.

I. What is Quantum?

Quantum in quantum computing

In physics, a quantum is the minimum possible distinct unit of any physical property. It typically relates to properties of atomic or subatomic particles, such as electrons, neutrinos, and photons. In this whole world the tiniest possible unit in a body or object or a thing is quantum. Now you may be able to imagine a computer with quantum physics.



Fig 1 Quantum Computer

II. What is Quantum computing?

A qubit is the rudimentary unit of information in quantum computing.

Qubits play a comparable role in quantum computing as bits play in classical computing, but they act very inversely. Classical bits are binary and can hold only a position of 0 or 1, but qubits can hold a superposition of all possible states. By this it can prepare combinations at the time of executions.

TERMS RELATED TO QUANTUM COMPUTING:

A. Absolute Zero

Absolute zero is the lowermost temperature that is tentatively possible, at which the motion of particles that releases heat would be minimal. It is zero on the Kelvin scale, equivalent to -273.15°C or -459.67°F .

In order to increase stability, most quantum computing systems operate at temperatures near absolute zero.

B. Superposition

In superposition, quantum particles are a grouping of all likely states. They vary until they're observed and measured. One way to picture the alteration between binary position and superposition is to envision a coin.

Classical bits are measured by "flipping the coin" and getting heads or tails. However, if you were able to look at a coin and see both heads and tails at the same time, as well as every state in between, the coin would be in superposition.

C. Entanglement

Entanglement is the aptitude of quantum particles to relay their measurement outcomes with each other. When qubits are entangled, they form a single system and inspire each other. We can use the measurements from one qubit to draw assumptions about the others. By adding and entangling more qubits in a system, quantum computers can compute exponentially more information and solve more complicated problems.

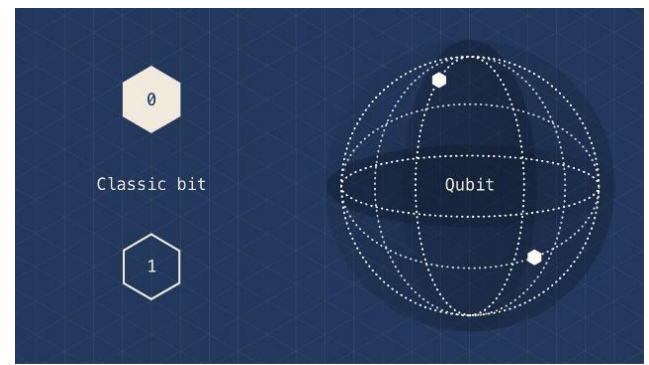


Fig 2 Superposition

D. Quantum Interference

Quantum interference is the inherent behavior of a qubit, due to superposition, to impact the possibility of it collapsing one way or another. Quantum computers are designed and built to lessen interference as much as likely and ensure the most meticulous results.

III. Bits

Bits is what on which computers and machines operate. The classical computer and machines with processors or with logic gates operate on binary bits which are 1 and 0 and on other hand quantum computers operate on qubits. So let's dive into it and learn about bits and qubits and how it affects its functionalities.

TYPES OF BITS:

A. Classical BITS

A Bit is the smallest possible unit in a computer's memory. This BIT can either 1 or 0. A collection of bits is what we call a machine learning language. When we code the assembler converts the code to machine language and feeds the processor that is in the form of 1 and 0, the output is processed by it. A collection of 4 bits is a NIBBLE and that of 8 Bits is a BYTE.

B. Qubits

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IV. HOW DOES QUANTUM COMPUTING WORK?

A quantum computer has three primary parts:

- A part that houses the qubits
- A method for relocating signals to the qubit
- A classical computer to run a program and lead instructions.

The quantum computer works on qubits, that is by using the electrons in the atom and by knowing their position we decide the value to be given. The atom is set in a magnetic field and a wave of electromagnetic radiation is focused on it to set the

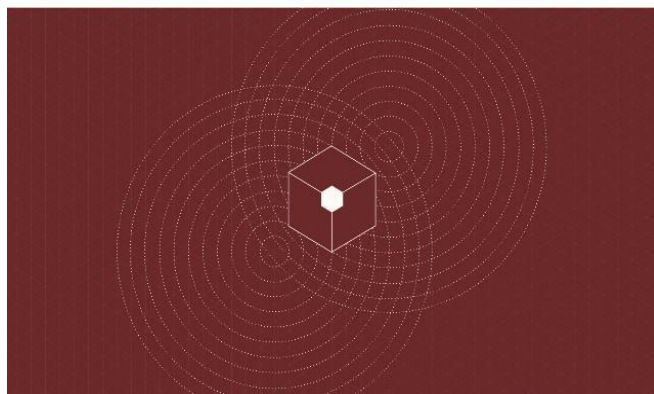


Fig 3 Quantum Interference

position, Signals can be sent to the qubits using a variety of methods, including microwaves, laser, and voltage and that position is analyzed and output is given. For some tactics of qubit storage, the unit that houses the qubits is kept at a temperature just above absolute zero to maximize their constancy and reduce interference. The quantum computer is not fast than classical computer but the speed of getting the output to the output terminal is extremely fast.

V. Applications of QUANTUM COMPUTING:

- **Cryptography**

Quantum cryptography could possibly achieve some of the purposes of public key cryptography. Quantum-based cryptographic systems could, therefore, be more secure than traditional systems against quantum hacking.

- **Search Problems**

The most well-known example of a problem admitting a multinomial quantum speedup is unstructured search, finding a marked item out of a list of items in a database.

- **Artificial Intelligence**

We all know how powerful AI is and we often think with embedded AI in it and use them for our better functionality. AI is a set of programs which

takes input and processes it and gives output and learns from it, just like the human mind. AI still have lots of complexity which we cannot process and what we use AI with quantum computing, as the structure of AI is very easy to understand for quantum computing so it will work more effectively and we can get the most out of it. Also if you are thinking that then AI would have its own big brain and can be a threat to human life then don't worry it has lots of time till we still have the potential of quantum computing.

- **Drug Development, Better Batteries, Traffic Optimization, Cleaner Fertilization, etc.**

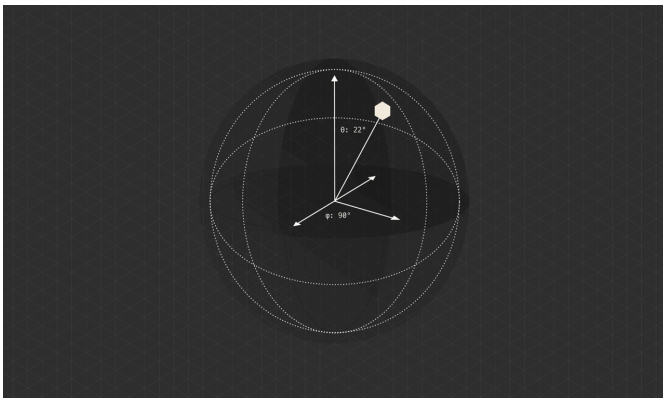


Fig 4 Quantum computer working

VI. ADVANTAGES & DISADVANTAGES

○ ADVANTAGES:

- The main advantage of quantum computing is that it is even classical algorithm calculations. They are also performed easily which is similar to the classical computer.

- If we add the qubits to the register, we increase its storage capacity exponentially.
- In this computing qubit is the conventional superposition state. So there are advantages of exponential speedup to the results by handling the number of calculations and methods.
- Quantum computing required less power.

○ DISADVANTAGES:

- The research for this problem is still continuing the effort applied to identify a solution for this problem that has no positive progress.
- Qubits are not digital bits of the day thus they cannot be used as conventional error correction.
- The main disadvantage of Quantum computing is the technology required to
- implementing a quantum computer is not available at present.
- The minimum energy requirement for quantum logical operations is five times that of classical computers.
- Quantum CPU will have efficiency and heating problems of its own.

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