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What benefits might we be able to achieve using Quantum Computing that we cannot achieve with conventional computers?

In this presentation, I will pay attention to the different sides of quantum computing and its comparison with Classical computers.

Comparing these two might not be the right thing to do because these two are not much the same, in a simple word we can describe a Quantum computer As:

A quantum computer uses a quantum property called superposition or qubits to store data. Unlike a classical computer whose bits of data can exist as either a zero or a 1, a qubit can be a zero, 1, or both simultaneously.

“Quantum computers aren’t faster than classical processing, they are a different way of programming,” said Le Bars. “They deliver far greater efficiencies than classical computing for some optimization algorithms. For instance, being able to simulate climate change models with granularity all at once across millions of industry variables that impact CO2 emissions would result in more informed predictions to better guide sustainable strategies long term.”

There are 8 possible three-bit combinations: 000, 001, 010, 011, 100, 101, 110, 111. The number 8 comes from  $2^3$ . There are two choices for the first bit, two for the second and two for the third, and we multiply these three 2s together. If instead of bits we switch to qubits, each of these 8 three-bit strings is associated with a basis vector, so the vector space is 8-dimensional.

The same analysis tells us that if we have  $n$  qubits, then we will have the Impact of Quantum Computing  $2^n$  basis vectors and the space will be  $2^n$ -dimensional. As the number of qubits grows, the number of basis vectors grows exponentially, and things quickly get big. For instance, If we have 72 qubits, the number of basis elements is 272. This is about 4,000,000,000,000,000,000. It is a large number and is considered to be around the point at which classical computers cannot simulate quantum computers.

1- Quantum computing can simulate interactions between molecules more authentically, enabling us to predict the activity and safety of drug molecules more precisely during the drug design stage.

Traditional computers have played a role in this regard, but simulating large, complex biomolecular systems, especially when involving quantum effects, dramatically increases the difficulty and complexity of computations. This is because the behaviour of biomolecules is largely driven by quantum mechanical principles, and conventional computational methods often require approximations, which may lead to a loss of accuracy.

Quantum computers provide a new computational paradigm that allows us to simulate quantum systems directly and efficiently. This means it can capture the details of intermolecular interactions more authentically, providing more accurate data and insights for drug design. For complex molecular systems that conventional computing cannot efficiently handle, quantum computing might be the key.

2- Using Quantum computers to simulate wormholes between two black hole which has the same properties as quantum mechanics, means we can transfer qubits for now between two black hole in simulation which has been done by Google Quantum computer.(this experiment proved ER = EPR) For conventional computers, this calculation might take years.

Scientists couldn't produce results with all of the factors in the black hole included in the calculation but they could include gravity which provided them with evidence which prove quantum gravitation.

"The relationship between quantum entanglement, spacetime, and quantum gravity is one of the most important questions in fundamental physics and an active area of theoretical research," says Spiropulu. "We are excited to take this small step toward testing these ideas on quantum hardware and will keep going."

3- Quantum computing boosts the potential of AI by amplifying its velocity, efficacy, and precision. It transcends the limitations imposed on traditional computers by utilising qubits and capitalising on non-linear operations.

Let's explore the impact of quantum computing on different industries and the transformative effects it brings to AI-driven processes

Machine learning (ML) relies on computers' ability to acquire knowledge from data and generate or recognise patterns, similar to how the human brain functions.

However, the effectiveness of **machine learning** can be hindered by subpar data quality and the sluggish availability of data. This is where quantum computing comes into play, offering the potential to rapidly process large volumes of data rapidly, thus granting machine learning the same advantage. Published findings reveal the exceptional performance of their quantum computer, Sycamore, compared to classical learning agents, demonstrating exponential superiority across a diverse range of tasks, highlighting the remarkable capabilities of quantum learning agents.

in particular, hold significant promise in addressing complex issues like climate change and healthcare.

Apart from the incredible speed and the ability to handle complex data sets, quantum computing brings several other benefits to AI.

**Optimising Solutions:**

Quantum computing empowers us to make optimal decisions in portfolio analysis, delivery routes, and **personalised treatment**.

As big data shapes our computer architecture, we require a different approach to effectively handle it. Quantum computers excel at solving sequential problems, offering better decision-making capabilities for businesses and consumers. This encourages investments in this emerging technology.

**Spotting Patterns in Large Data Sets:**

Quantum computing can rapidly search for patterns or anomalies in vast, unsorted data sets. It has the ability to simultaneously access all items in a database, identifying similarities within seconds.

Current technologies rely on sequential examination, which is time-consuming and impractical for large data sets.

**Facilitating Integration of Diverse Data Sets:**

Quantum computers will enable breakthroughs by integrating vastly different data sets. Initially, human intervention may be necessary to guide the integration process.

When we analyse raw data from diverse sources with distinct structures, it is crucial to understand how these structures are related to each other.

Advancements in natural language analysis, a significant challenge in artificial intelligence, are required for this task. Human input plays a vital role in training the system for future integration

In conclusion, quantum computing represents a paradigm shift in computational capabilities, offering benefits that extend far beyond the reach of conventional computers. As this transformative technology continues to evolve, it holds the promise of addressing some of the most pressing challenges facing humanity while unlocking new opportunities for innovation and discovery. By harnessing the power of quantum mechanics, we are entering an era where the boundaries of computation are limited only by the bounds of our imagination.

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