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UNIT- V
NEW IT INITIATIVES
5.6 Block Chain, Crypto currency, Quantum Computing

5.6.1 Block Chain:

A blockchain is a decentralized, distributed and public digital ledger that is used to record transactions across many computers so that the record cannot be altered retroactively without the alteration of all subsequent blocks and the consensus of the network.

5.6.1.1 Why is blockchain important?

Traditional database technologies present several challenges for recording financial transactions. For instance, consider the sale of a property. Once the money is exchanged, ownership of the property is transferred to the buyer. Individually, both the buyer and the seller can record the monetary transactions, but neither source can be trusted. The seller can easily claim they have not received the money even though they have, and the buyer can equally argue that they have paid the money even if they haven't.

To avoid potential legal issues, a trusted third party has to supervise and validate transactions. The presence of this central authority not only complicates the transaction but also creates a single point of vulnerability. If the central database was compromised, both parties could suffer.

Blockchain mitigates such issues by creating a decentralized, tamper-proof system to record transactions. In the property transaction scenario, blockchain creates one ledger each for the buyer and the seller. All transactions must be approved by both parties and are automatically updated in both of their ledgers in real time. Any corruption in historical transactions will corrupt the entire ledger. These properties of blockchain technology have led to its use in various sectors, including the creation of digital currency like Bitcoin.

5.6.1.2 Features of blockchain technology:

Blockchain technology has the following main features:

Decentralization

Decentralization in blockchain refers to transferring control and decision making from a centralized entity (individual, organization, or group) to a distributed network. Decentralized blockchain networks use transparency to reduce the need for trust among participants. These networks also deter participants from exerting authority or control over one another in ways that degrade the functionality of the network.

Immutability

Immutability means something cannot be changed or altered. No participant can tamper with a transaction once someone has recorded it to the shared ledger. If a transaction record includes an error, you must add a new transaction to reverse the mistake, and both transactions are visible to the network.

Consensus

A blockchain system establishes rules about participant consent for recording transactions. You can record new transactions only when the majority of participants in the network give their consent.

5.6.1.3 Key components of blockchain technology:

Blockchain architecture has the following main components:

A distributed ledger

A distributed ledger is the shared database in the blockchain network that stores the transactions, such as a shared file that everyone in the team can edit. In most shared text editors, anyone with editing rights can delete the entire file. However, distributed ledger technologies have strict rules about who can edit and how to edit. You cannot delete entries once they have been recorded.

Smart contracts :

Companies use smart contracts to self-manage business contracts without the need for an assisting third party. They are programs stored on the blockchain system that run automatically when predetermined conditions are met. They run if-then checks so that transactions can be completed confidently. For example, a logistics company can have a smart contract that automatically makes payment once goods have arrived at the port.

Public key cryptography:

Public key cryptography is a security feature to uniquely identify participants in the blockchain network. This mechanism generates two sets of keys for network members. One key is a public key that is common to everyone in the network. The other is a private key that is unique to every member. The private and public keys work together to unlock the data in the ledger.

For example, John and Jill are two members of the network. John records a transaction that is encrypted with his private key. Jill can decrypt it with her public key. This way, Jill is confident that John made the transaction. Jill's public key wouldn't have worked if John's private key had been tampered with.

5.6.1.4 Working of blockchain:

- Blockchain uses a multistep process that includes these five steps:
- An authorized participant inputs a transaction, which must be authenticated by the technology.
- That action creates a block that represents that specific transaction or data.
- The block is sent to every computer node in the network.
- Authorized nodes validate transactions and add the block to the existing blockchain.

- The update is distributed across the network, which finalizes the transaction.

- These steps take place in near real time and involve a range of elements. Nodes in public blockchain networks are referred to as miners; they're typically paid for this task -- often in processes called proof of work or proof of stake -- usually in the form of cryptocurrency.

- A blockchain ledger consists of two types of records, individual transactions and blocks. The first block has a header and data that pertain to transactions taking place within a set time period. The block's timestamp is used to help create an alphanumeric string called a hash. After the first block has been created, each subsequent block in the ledger uses the previous block's hash to calculate its own hash.

- Before a new block can be added to the chain, its authenticity must be verified by a computational process called validation or consensus. At this point in the blockchain process, a majority of nodes in the network must agree the new block's hash has been calculated correctly. Consensus ensures that all copies of the blockchain distributed ledger share the same state.

- Once a block has been added, it can be referenced in subsequent blocks, but it can't be changed. If someone attempts to swap out a block, the hashes for previous and subsequent blocks will also change and disrupt the ledger's shared state.

- When consensus is no longer possible, other computers in the network are aware that a problem has occurred, and no new blocks will be added to the chain until the problem is solved. Typically, the block causing the error will be discarded and the consensus process will be repeated. This eliminates a single point of failure.

While underlying blockchain mechanisms are complex, we give a brief overview in the following steps. Blockchain software can automate most of these steps:

Step 1 – Record the transaction

A blockchain transaction shows the movement of physical or digital assets from one party to another in the blockchain network. It is recorded as a data block and can include details like these:

Who was involved in the transaction?

What happened during the transaction?

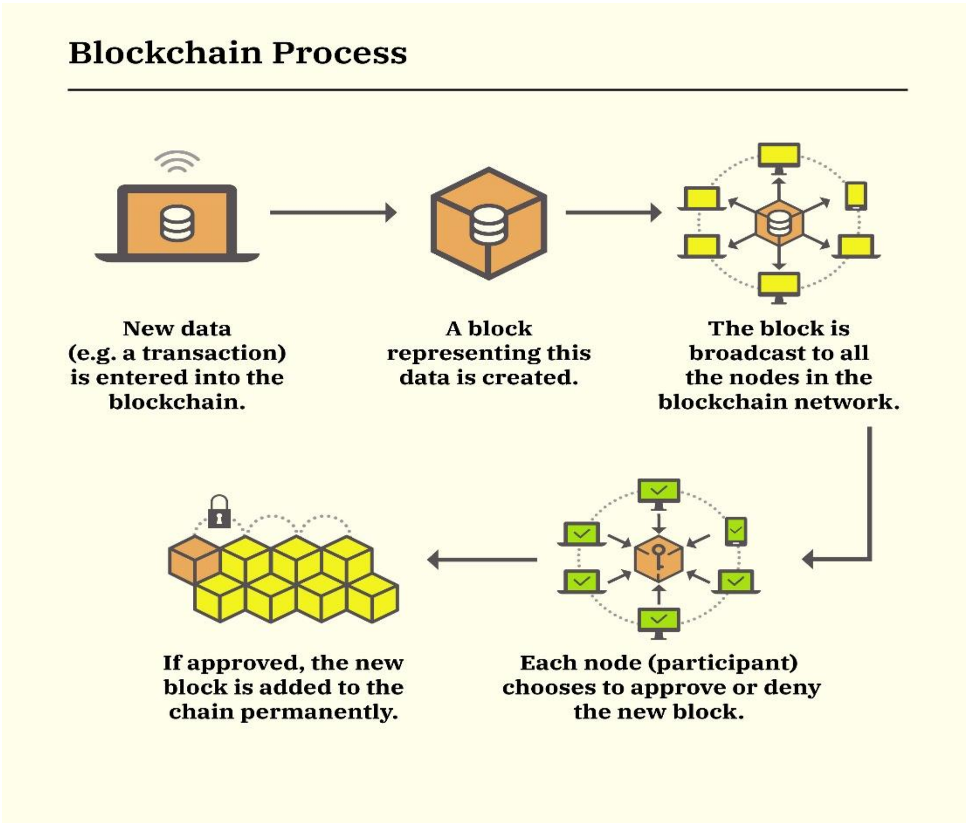
When did the transaction occur?

Where did the transaction occur?

Why did the transaction occur?

How much of the asset was exchanged?

How many pre-conditions were met during the transaction?



Step 2 – Gain consensus

Most participants on the distributed blockchain network must agree that the recorded transaction is valid. Depending on the type of network, rules of agreement can vary but are typically established at the start of the network.

Step 3 – Link the blocks

Once the participants have reached a consensus, transactions on the blockchain are written into blocks equivalent to the pages of a ledger book. Along with the transactions, a cryptographic hash is also appended to the new block. The hash acts as a chain that links the blocks together. If the contents of the block are intentionally or unintentionally modified, the hash value changes, providing a way to detect data tampering.

Thus, the blocks and chains link securely, and you cannot edit them. Each additional block strengthens the verification of the previous block and therefore the entire blockchain. This is like stacking wooden blocks to make a tower. You can only stack blocks on top, and if you remove a block from the middle of the tower, the whole tower breaks.

Step 4 – Share the ledger

The system distributes the latest copy of the central ledger to all participants.

4.6.1.5 Types of blockchain networks?

There are four main types of decentralized or distributed networks in the blockchain:

Public blockchain networks

Public blockchains are permissionless and allow everyone to join them. All members of the blockchain have equal rights to read, edit, and validate the blockchain. People primarily use public blockchains to exchange and mine cryptocurrencies like Bitcoin, Ethereum, and Litecoin.

Private blockchain networks

A single organization controls private blockchains, also called managed blockchains. The authority determines who can be a member and what rights they have in the network. Private blockchains are only partially decentralized because they have access restrictions. Ripple, a digital currency exchange network for businesses, is an example of a private blockchain.

Hybrid blockchain networks

Hybrid blockchains combine elements from both private and public networks. Companies can set up private, permission-based systems alongside a public system. In this way, they control access to specific data stored in the blockchain while keeping the rest of the data public. They use smart contracts to allow public members to check if private transactions have been completed. For example, hybrid blockchains can grant public access to digital currency while keeping bank-owned currency private.

Consortium blockchain networks

A group of organizations governs consortium blockchain networks. Preselected organizations share the responsibility of maintaining the blockchain and determining data access rights. Industries in which many organizations have common goals and benefit from shared responsibility often prefer consortium blockchain networks. For example, the Global Shipping Business Network Consortium is a not-for-profit blockchain consortium that aims to digitize the shipping industry and increase collaboration between maritime industry operators.

5.6.1.6 Advantages of Block Chain:

Blockchain technology brings many benefits to asset transaction management. We list a few of them in the following subsections:

Advanced security

Blockchain systems provide the high level of security and trust that modern digital transactions require. There is always a fear that someone will manipulate underlying software to generate fake money for themselves. But blockchain uses the three principles of cryptography, decentralization, and consensus to create a highly secure underlying software system that is nearly impossible to tamper with. There is no single point of failure, and a single user cannot change the transaction records.

Improved efficiency

Business-to-business transactions can take a lot of time and create operational bottlenecks, especially when compliance and third-party regulatory bodies are involved. Transparency and smart contracts in blockchain make such business transactions faster and more efficient.

Faster auditing

Enterprises must be able to securely generate, exchange, archive, and reconstruct e-transactions in an auditable manner. Blockchain records are chronologically immutable, which means that all records are always ordered by time. This data transparency makes audit processing much faster.

5.6.1.7 Applications of Blockchain:

Blockchain technology has a wide range of applications across various industries due to its decentralized, secure, and transparent nature. Here are some notable applications of blockchain:

i. Cryptocurrencies:

Bitcoin, Ethereum, and Altcoins: Blockchain is most well-known for its role in enabling cryptocurrencies, providing a decentralized and secure way to conduct financial transactions without the need for intermediaries like banks.

ii. **Smart Contracts**:

Automated Contracts: Smart contracts are self-executing contracts with the terms of the agreement directly written into code. They automatically enforce and execute the terms of the contract when predefined conditions are met, eliminating the need for intermediaries and reducing the risk of fraud.

iii. Supply Chain Management:

Traceability and Transparency: Blockchain helps enhance transparency and traceability in supply chains by recording every transaction or movement of goods. This can reduce fraud, errors, and inefficiencies in supply chain processes.

iv. **Identity Management**:

Secure Identity Verification: Blockchain can be used for secure and decentralized identity management, allowing individuals to have control over their personal information. This can help in reducing identity theft and ensuring privacy.

v. Healthcare:

Patient Data Management: Blockchain can be used to securely store and manage patient data, providing a tamper-proof record of medical history. This can improve data accuracy, interoperability, and patient privacy.

vi. Voting Systems:

Secure Voting: Blockchain technology can enhance the security and transparency of voting systems. It can help prevent fraud, ensure the integrity of the electoral process, and provide a transparent audit trail.

vii. Cross-Border Payments:

Faster and Cheaper Transactions: Blockchain can facilitate faster and more cost-effective cross-border payments by eliminating the need for multiple intermediaries and reducing transaction times.

viii. Real Estate:

Property Transactions: Blockchain can streamline and secure real estate transactions by providing a transparent and unchangeable ledger for property ownership records, reducing fraud and ensuring accurate ownership history.

ix. **Intellectual Property Protection**:

x. **Digital Rights Management**: Blockchain can be used to protect intellectual property rights by providing a secure and transparent system for tracking ownership and licensing of digital content.

xi. Energy Trading:

Decentralized Energy Markets: Blockchain enables peer-to-peer energy trading, allowing individuals or organizations to buy and sell excess renewable energy directly, without the **need for intermediaries**.

xii. **Legal and Notary Services**:

Immutable Contracts and Documents: Blockchain can be used to create immutable and tamper-proof records for legal documents, reducing the risk of fraud and providing a secure way to verify the authenticity of contracts.

These are just a few examples, and the potential applications of blockchain technology continue to evolve as the technology matures and industries explore new ways to leverage its benefits.

5.6.2 Crypto Currency:

A cryptocurrency is a digital currency, which is an alternative form of payment created using encryption algorithms. The use of encryption technologies means that cryptocurrencies function both as a currency and as a virtual accounting system. To use cryptocurrencies, you need a cryptocurrency wallet.

5.6.2.1 Working of cryptocurrency :

- Cryptocurrencies run on a distributed public ledger called blockchain, a record of all transactions updated and held by currency holders.
- Units of cryptocurrency are created through a process called mining, which involves using computer power to solve complicated mathematical problems that generate coins. Users can also buy the currencies from brokers, then store and spend them using cryptographic wallets.
- If you own cryptocurrency, you don’t own anything tangible. What you own is a key that allows you to move a record or a unit of measure from one person to another without a trusted third party.
- Although Bitcoin has been around since 2009, cryptocurrencies and applications of blockchain technology are still emerging in financial terms, and more uses are expected in the future. Transactions including bonds, stocks, and other financial assets could eventually be traded using the technology.

5.6.2.2 Types of Cryptocurrency:

There are thousands of cryptocurrencies. Some of the best known include:

Bitcoin:

Founded in 2009, Bitcoin was the first cryptocurrency and is still the most commonly traded. The currency was developed by Satoshi Nakamoto – widely believed to be a pseudonym for an individual or group of people whose precise identity remains unknown.

Ethereum:

Developed in 2015, Ethereum is a blockchain platform with its own cryptocurrency, called Ether (ETH) or Ethereum. It is the most popular cryptocurrency after Bitcoin.

Litecoin:

This currency is most similar to bitcoin but has moved more quickly to develop new innovations, including faster payments and processes to allow more transactions.

Ripple:

Ripple is a distributed ledger system that was founded in 2012. Ripple can be used to track different kinds of transactions, not just cryptocurrency. The company behind it has worked with various banks and financial institutions.

Non-Bitcoin cryptocurrencies are collectively known as “altcoins” to distinguish them from the original.

5.6.2.3 Disadvantages of Cryptocurrency:

Investing in cryptocurrency might look appealing and profitable but investors should also consider a few downsides to it.

1. Cryptocurrency claims to be an anonymous form of transaction, but they are actually pseudonymous which means they leave a digital trail that the Federal Bureau of Investigation can decode. So, there's a possibility of interference from federal or government authorities to track the financial transactions of normal people.
2. On a blockchain, there is a constant risk of a 51% attack which means It is a situation when a miner or group of them gets more than 50% of the network's mining hash rate control. While in control, an ill-natured group can reverse the transaction that is completed, pause the transaction in process, double spend coins, prevent new transactions from getting validation and much more. Nevertheless, this attack is only a risk to recently hard-forked networks and new blockchains.
3. The majority of blockchains work on the proof-of-work consensus mechanism. Network participants are required to use powerful ASIC computers and the right hash to make a block added to the network. Due to this, there is excessive power consumption and countries are taking majors to lower its impact on the environment.
4. The lack of key policies related to transactions serves as a major drawback of cryptocurrencies. The no refund or cancellation policy can be considered the default stance for transactions wrongly made across crypto wallets and each crypto stock exchange or app has its own rules.

5.6.2.4 Applications of Crypto currency:

1. **Cryptocurrencies,** powered by blockchain technology, have various applications across different sectors. Here are some notable applications:
2. **Digital Payments:**

   Cryptocurrencies can be used for online and offline transactions, allowing for faster and more secure payments without the need for traditional banking systems.

Bitcoin, Ethereum, and other cryptocurrencies can facilitate peer-to-peer transactions globally.

3. Remittances

Cryptocurrencies provide an efficient and cost-effective solution for cross-border remittances. Users can send and receive funds without the delays and high fees associated with traditional banking system.

4. Smart Contracts:

Smart contracts, built on blockchain platforms like Ethereum, enable self-executing contracts with predefined rules and conditions. They automate and enforce contract terms, reducing the need for intermediaries and minimizing the risk of fraud.

5. Decentralized Finance (DeFi):

DeFi platforms leverage blockchain and smart contracts to recreate traditional financial services such as lending, borrowing, and trading in a decentralized manner. Users can access financial services without relying on traditional banks.

6. Tokenization of Assets:

Cryptocurrencies allow for the tokenization of various assets, including real estate, art, and commodities. This process involves representing ownership of these assets through digital tokens on a blockchain, making them more accessible for trading and investment.

7. **Cross-Border Trade**:

Cryptocurrencies facilitate cross-border trade by providing a faster and more efficient way to settle transactions. They reduce the need for intermediaries and streamline the payment process between parties in different countries.

8. Privacy Coins:

Certain cryptocurrencies, like Monero and Zcash, are designed to provide enhanced privacy and anonymity for users. These privacy features can be appealing in situations where individuals desire increased confidentiality in their transactions.

9. Micropayments:

Cryptocurrencies make micropayments more feasible by enabling transactions of very small amounts. This is particularly useful for content creators, allowing them to receive small payments for their work without being burdened by high transaction fees.

10. **Gaming and Virtual Assets**:
    Cryptocurrencies are used in the gaming industry for in-game purchases and the creation of digital assets. Non-fungible tokens (NFTs) on blockchain platforms like Ethereum enable ownership and trading of unique virtual items.
11. **Identity Verification**:
    Blockchain-based identity solutions provide a secure and decentralized way to manage and verify identity information. Users have greater control over their personal data, reducing the risk of identity theft.
12. **Charitable Donations**:
    Cryptocurrencies facilitate transparent and traceable charitable donations. Blockchain technology ensures that funds are directed to the intended recipients, and donors can track the use of their contributions.
13. **Hedging Against Economic Instability**:
    Cryptocurrencies, particularly Bitcoin, are sometimes considered a store of value and a hedge against economic instability. Some investors view cryptocurrencies as a digital alternative to traditional safe-haven assets like gold.
    As the cryptocurrency space continues to evolve, new applications and use cases may emerge, expanding the role of digital currencies in various aspects of our daily lives and the global economy.

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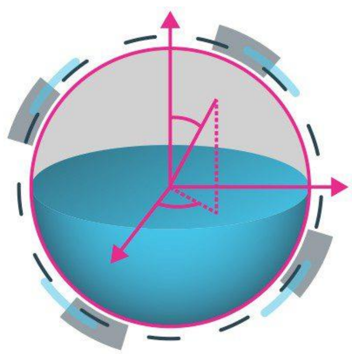
5.6.3 Quantum Computing :

Quantum computing is a multidisciplinary field comprising aspects of computer science, physics, and mathematics that utilizes quantum mechanics to solve complex problems faster than on classical computers. Quantum algorithms take a new approach to these sorts of complex problems — creating multidimensional computational spaces. This turns out to be a much more efficient way of solving complex problems like chemical simulations.

1. Have you ever heard of a computer that can do things regular computers can't? These special computers are called quantum computers. They are different from the computer you use at home or school because they use something called "qubits" instead of regular "bits".
2. A bit is like a light switch that can only be on or off, like a zero or a one. But a qubit can be both zero and one at the same time! This means quantum computers can do many things at once and work much faster than regular computers. It's like having many helpers working on a task together instead of just one.
3. Scientists first thought about quantum computers a long time ago, but it wasn't until recently that they were able to build working models. Now, companies and researchers are working on making bigger and better quantum computers.
4. Regular computers use bits, which are either ones or zeros, to process information. These bits are passed through logic gates, like AND, OR, NOT, and XOR, that manipulate the data and produce the desired output. These gates are made using transistors and are based on the properties of silicon semiconductors. While classical computers are efficient and fast, they struggle with problems that involve exponential complexity, such as factoring large numbers.
5. On the other hand, quantum computers use a unit called a qubit to process information. A qubit is similar to a bit, but it has unique quantum properties such as superposition and entanglement. This means that a qubit can exist in both the one and zero states at the same time. This allows quantum computers to perform certain calculations much faster than classical computers.

6. In a real quantum computer, qubits can be represented by various physical systems, such as electrons with spin, photons with polarization, trapped ions, and semiconducting circuits. With the ability to perform complex operations exponentially faster, quantum computers have the potential to revolutionize many industries and solve problems that were previously thought impossible.

5.6.3.1 The mechanics of quantum computing:



Quantum computing is a unique technology because it isn't built on bits that are binary in nature, meaning that they're either zero or one. Instead, the technology is based on qubits. These are two-state quantum mechanical systems that can be part zero and part one at the same time. The quantum property of "superposition" when combined with "entanglement" allows N qubits to act as a group rather than exist in isolation, and therefore achieve exponentially higher information density (2^N) than the information density of a classical computer (N).

Although quantum computers have a significant performance advantage, system fidelity remains a weak point. Qubits are highly susceptible to disturbances in their environment, making them prone to error. Correcting these errors requires redundant qubits for error correction and extensive correction codes, however useful applications of so-called Noisy Intermediate Scale Quantum devices, or "NISQ's" is proceeding very rapidly. Improving the fidelity of qubit operations is key to increasing the number of gates and the usefulness of quantum algorithms, as well as for implementing error correction schemes with reasonable qubit overhead.

5.6.3.2 Advantages:

Speed: Quantum computers can perform certain calculations much faster than classical computers, making them well-suited for tasks that involve a large amount of data or complex mathematical calculations.

Parallelism: Quantum computing allows for the parallel processing of information, which means that multiple computations can be performed simultaneously. This can significantly speed up certain tasks, such as searching large databases.

Cryptography: Quantum computing has the potential to break many of the encryption methods currently used to secure data. However, it also has the potential to develop new and more secure encryption methods, which could be more resistant to attacks by hackers.

Chemistry: Quantum computing can simulate the behavior of molecules at a level of detail that is not possible with classical computing. This could lead to new discoveries in drug design, materials science, and other areas.

5.6.3.3 Disadvantages of Quantum Computers

Quantum computers have the potential to revolutionize the field of computing, but they also come with a number of disadvantages. Some of the main challenges and limitations of quantum computing include:

1. **Noise and decoherence:** One of the biggest challenges in building a quantum computer is the problem of noise and decoherence. Quantum systems are extremely sensitive to their environment, and any noise or disturbance can cause errors in the computation. This makes it difficult to maintain the delicate quantum state of the qubits and to perform accurate and reliable computations.
2. **Scalability**: Another major challenge is scalability. Building a large-scale quantum computer with a large number of qubits is extremely difficult, as it requires the precise control of a large number of quantum systems. Currently, the number of qubits that

can be controlled and manipulated in a laboratory setting is still quite small, which limits the potential of quantum computing.

3. **Error correction**: Error correction is another major challenge in quantum computing. In classical computing, errors can be corrected using error-correcting codes, but in quantum computing, the errors are much more difficult to detect and correct, due to the nature of quantum systems.
4. **Lack of robust quantum algorithms**: Even though some quantum algorithms have been developed, their number is still limited, and many problems that can be solved using classical computers have no known quantum algorithm.
5. **High cost**: Building and maintaining a quantum computer is extremely expensive, due to the need for specialized equipment and highly trained personnel. The cost of building a large-scale quantum computer is also likely to be quite high, which could limit the availability of quantum computing to certain groups or organizations.
6. **Power consumption**: Quantum computers are extremely power-hungry, due to the need to maintain the delicate quantum state of the qubits. This makes it difficult to scale up quantum computing to larger systems, as the power requirements become prohibitively high.

5.6.3.4 Applications of Quantum Computing:

1. Artificial Intelligence & Machine Learning

Artificial intelligence and machine learning are some of the prominent areas right now, as the emerging technologies have penetrated almost every aspect of humans' lives. Some of the widespread applications we see every day are in voice, image and handwriting recognition. However, as the number of applications increased, it becomes a challenging task for traditional computers, to match up the accuracy and speed. And, that's where quantum computing can help in processing through complex problems in very less time, which would have taken traditional computers thousand of years.

2. Computational Chemistry:

IBM, once said, one of the most promising quantum computing applications will be in the field of computational chemistry. It is believed that the number of quantum states, even in a tiniest of a molecule, is extremely vast, and therefore difficult for conventional computing memory to process that. The ability for quantum computers to focus on the existence of both 1 and 0 simultaneously could provide immense power to the machine to successfully map the molecules which, in turn, potentially opens opportunities for pharmaceutical research. Some of the critical problems that could be solved via quantum computing are — improving the nitrogen-fixation process for creating ammonia-based fertilizer; creating a room-temperature superconductor; removing carbon dioxide for a better climate; and creating solid-state batteries.

3. Drug Design & Development

Designing and developing a drug is the most challenging problem in quantum computing. Usually, drugs are being developed via the trial and error method, which is not only very expensive but also a risky and challenging task to complete. Researchers believe quantum computing can be an effective way of understanding the drugs and its reactions on humans which, in turn, can save a ton of money and time for drug companies. These advancements in computing could enhance efficiency dramatically, by allowing companies to carry out more drug discoveries to uncover new medical treatments for the better pharmaceutical industry.

4. Cybersecurity & Cryptography

The online security space currently has been quite vulnerable due to the increasing number of cyber-attacks occurring across the globe, on a daily basis. Although companies are establishing necessary security framework in their organisations, the process becomes daunting and impractical for classical digital computers. And, therefore, cybersecurity has continued to be an essential concern around the world. With our increasing dependency on digitisation, we are becoming even more vulnerable to these threats. Quantum computing with the help of machine learning can help in developing various techniques to combat these cybersecurity threats. Additionally, quantum computing can help in creating encryption methods, also known as, quantum cryptography.

5. Financial Modelling

For a finance industry to find the right mix for fruitful investments based on expected returns, the risk associated, and other factors are important to survive in the market. To achieve that, the technique of 'Monte Carlo' simulations is continually being run on conventional computers, which, in turn, consume an enormous amount of computer time. However, by applying quantum technology to perform these massive and complex calculations, companies can not only improve the quality of the solutions but also reduce the time to develop them. Because financial leaders are in a business of handling billions of dollars, even a tiny improvement in the expected return can be worth a lot for them. Algorithmic trading is another potential application where the machine uses complex algorithms to automatically trigger share dealings analysing the market variables, which is an advantage, especially for high-volume transactions.

6. Weather Forecasting

Currently, the process of analysing weather conditions by traditional computers can sometimes take longer than the weather itself does to change. But a quantum computer's ability to crunch vast amounts of data, in a short period, could indeed lead to enhancing weather system modelling allowing scientists to predict the changing weather patterns in no time and with excellent accuracy — something which can be essential for the current time when the world is going under a climate change.

Weather forecasting includes several variables to consider, such as air pressure, temperature and air density, which makes it difficult for it to be predicted accurately. Application of quantum machine learning can help in improving pattern recognition, which, in turn, will make it easier for scientists to predict extreme weather events and potentially save thousands of lives a year. With quantum computers, meteorologists will also be able to generate and analyse more detailed climate models, which will provide greater insight into climate change and ways to mitigate it.

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