Block Chain Technology

RSM338 - Machine learning in Finance

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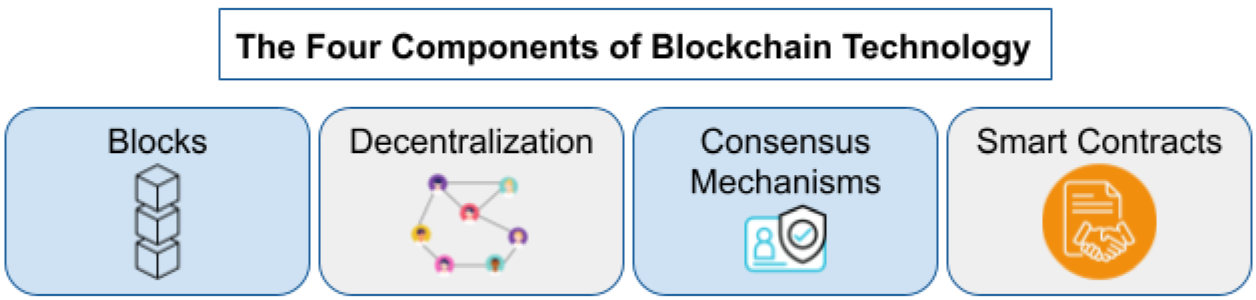
Blockchain Overview

Blockchain has emerged as a technology that could be the future of transaction and information sharing. While it's currently best known for its applications in cryptocurrency, blockchain is a powerful technology that has a wide array of uses. A blockchain is a shared, immutable database that runs across multiple computers instead of on a single computer (IBM). The word blockchain comes from the structure of the database, where data is structured into blocks and put into a chain whose shape and order are unchangeable.



Blocks: are holders of data with references to the previous block in the chain. Due to cryptographic hashing, the chain becomes nearly impossible to alter once a new block has been added (Frankenfield).
Decentralization: refers to the fact that the database is held in multiple locations on the network as opposed to relying on a central authority. The different nodes communicate with each other to confirm transactions, relinquishing the need for intermediaries. The way that the nodes communicate and confirm with each other is through consensus mechanisms.
Consensus Mechanisms: are protocols that certify agreement between nodes on the state of the blockchain, with the most popular mechanisms being Proof of Work and Proof of Stake (Haritonova).
Smart Contract: self-executing contracts have specific terms of agreement coded into them. Once the terms are met, the contracts execute the transaction, again eliminating the need for intermediaries and reducing fraud risk.

As mentioned previously, there are many different applications of blockchain technology. The first and most well-known is in cryptocurrencies. Blockchain minimizes some of the inherent risks of digital currencies through ensuring transparency, tamper-resistance, and censorship-resistance led by the decentralization factor. It allows for peer-to-peer transactions to be secure without intermediaries. Another application of blockchain is in supply chain management. The immutability and transparency of the chain allow for traceability and ensure the authenticity of products. Another avenue that blockchain is revolutionizing is through financial services. Transactions that have historically been expensive and time-consuming (for example, cross-border transactions) can be eased by blockchain technology. It also allows consumers access to financial instruments that may not be easily accessible in their countries or banks.

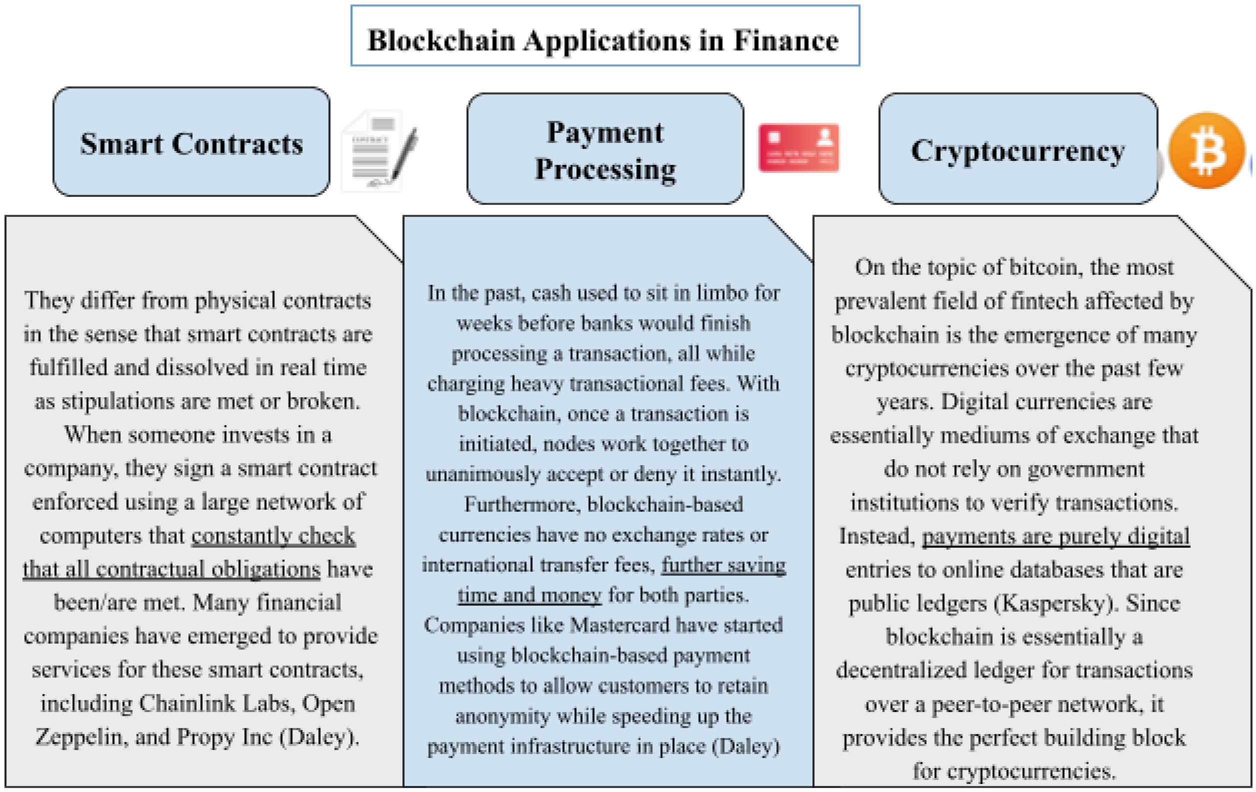
Different Kinds of Blockchain

Depending on the situation, various kinds of blockchain have their advantages and disadvantages (Jha):

Public Blockchain	**Private Blockchain**	**Hybrid Blockchain**	**Consortium Blockchain**
These are decentralized and open to anyone. Users have access to contemporary & historical records and can perform mining.	Far smaller than public blockchains, only runs on small networks and is accessible to specific individuals.	A mixture of both public and private systems. Specific individuals construct a permission-based system where some information is public.	Various organizational members work on one decentralized network. Participants often have a shared interest and collaborate to maintain the network.
Advantages			
- Trustable - Secure - Open & transparent	- Speed - Very scalable (effective across different sizes)	- Secure - Cost-effective (safeguards privacy while allowing 3rd-party contracts)	- Very secure - Scalable - Efficient - Has access controls (no unwanted users)
Disadvantages			
- Slower transactions - Scalability (larger ones aren't as good) - High energy consumption	- Lower security - Requires a central identity to manage	- Lack of transparency - Users have little incentive to contribute	- Limited decentralization - Trust dependency: members need to trust each other to some extent

Blockchain in Finance

Blockchains support the processes, infrastructure, and funding that uphold global supply chains with increased efficiency and security, such as lower fraud risks and human error. As it is an immutable and transparent ledger, different financial parties can easily collaborate, reach agreements, and manage data. Most importantly, digitization lowers capital requirements for all parties involved, making blockchain a desirable alternative (Blockchain).

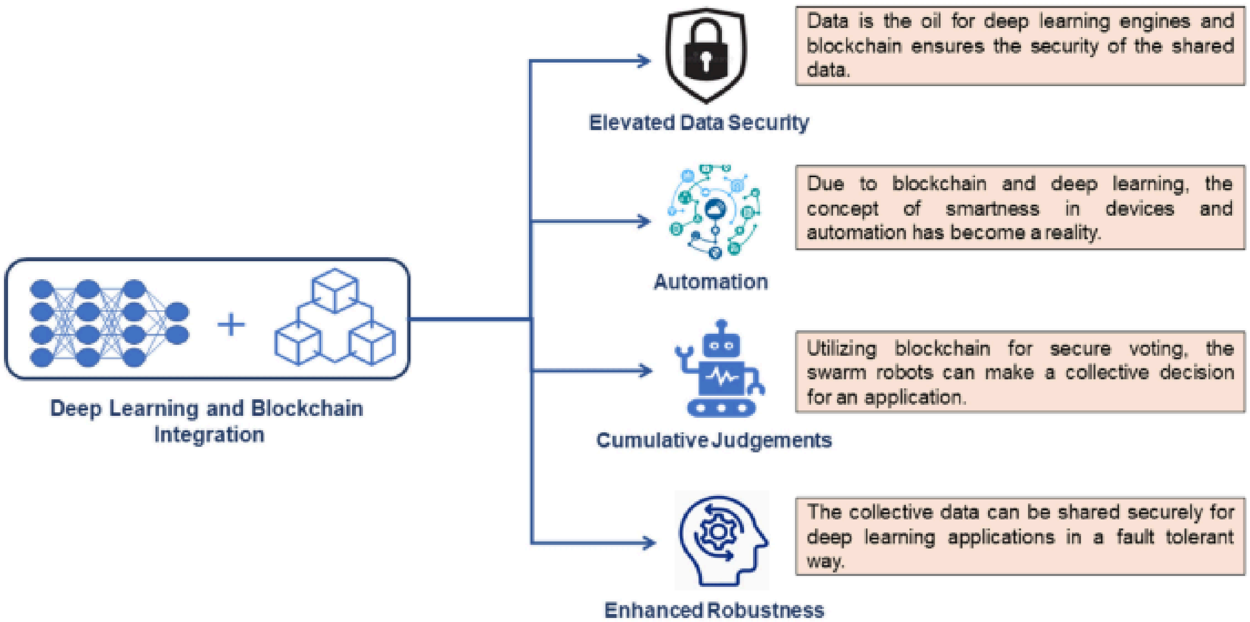


On top of the aforementioned applications, in the stock market, where costs are high and security risks higher, blockchain helps mitigate and lower costs. Typically, a stock market has multiple players- brokers, investors, regulatory departments, and an institution that processes investments. This causes investments to take up to three days to process. Using smart contracts, blockchain provides a decentralized process that increases the efficiency of investing compared to more traditional routes as investment contracts can be fulfilled immediately. Many trading companies like Robinhood and Cash App have enabled users to trade blockchain-based currencies like Bitcoin instantly (Daley).

Cryptocurrencies require far fewer maintenance costs and are extremely resistant to fraud and tampering, making them relatively safe. To generate new coins, people use powerful machines to solve mathematical problems in a process called ‘mining’. Miners essentially try to decrypt blocks containing transactional information, which verifies and provides the miner with transaction information. Once a block is fully decrypted, it is authenticated and added to the blockchain (GeeksforGeeks).

Blockchain & Machine Learning

We can apply the concepts of machine learning to make blockchains more efficient. This is because Blockchain is a means of managing data, while machine learning analyzes it. The learning potential of machine learning is also unlocked by a large amount of quantifiable data, which can be stored in blockchain networks. Furthermore, the data in these networks are free from noise, duplicates, and missing values, making it far easier for machines to learn from them. This allows for a wide variety of usages across different industries (Combining blockchain).



In fintech, for example, we can use machine learning to develop and analyze cryptocurrency trading strategies. Many trading bots have machine learning algorithms embedded in their system. Machine learning can also help with the mining process, as the process involves randomly guessing sets of differing values to solve blockchain functions, as well as optimizing energy consumption since mining is a very energy-consuming activity. Machine learning can optimize mining strategies using different algorithms and supervised learning (Javatpoint).

Case Study: Ronin Network Hack - A Blockchain and Cybersecurity Analysis

Case Overview:

Ronin Network - associated with a blockchain game called Axie Infinity - lost $615 million due to a hacker who took approximately 173,000 Ethereum and $25.5 million. Axie Infinity is a game that incorporates elements of blockchain technology. In this case, Ronin Network had in-game digital currency Ethereum which goes for approximately $3,000 in real-world CAD. The hackers were attributed to North Korean hackers and led to sanctions created by the U.S. Treasury Department against cryptocurrency wallets linked to the attackers.

Blockchain Technology Analysis of Gaming:

Tokenization of Assets	Transparent and Immutable Gaming History	Provable Scarcity and Authenticity:
In-game items like characters, equipment, or virtual land are often tokenized as non-fungible tokens (NFTs). Each NFT is unique and exists on the blockchain, providing verifiable ownership and scarcity. This allows players to truly own, buy, sell, or trade their in-game assets outside the game on various marketplaces.	These are self-executing contracts with the terms of the agreement between buyer and seller directly written into lines of code. In gaming, smart contracts automate in-game transactions and rules. For example, a smart contract could automatically transfer an NFT to a player once they achieve a certain milestone, ensuring fairness and transparency	Player achievements, asset histories, and transaction records are stored on the blockchain, creating a transparent and immutable history. This can be used to prevent cheating, verify high scores, and maintain a fair gaming environment. Each player is a "block" in the database that the system uses in order to give out currency.

Blockchain Technology Analysis of the Attack:

The hackers managed to use Ronin Networks validator nodes to approve the fraudulent transactions. The validator nodes are a part of the consensus mechanism in Blockchain technology, which are protocols that enable transactions of digital currency with real-world currency in the blockchain technology used by Ronin Network.

Key Findings and Responses:

Security Improvements and Industry Wide Implications: Ronin Network increased their consensus mechanism, by increasing validator thresholds. The incident made it evident that companies need to increase their measures of security for their blockchain networks.

Cryptocurrency and Law Enforcement Dynamics: Law Enforcement Advantages: Authorities can trace digital assignments, makes it difficult for criminals to convert digital currency easily

Concluding Insights:

The Ronin Network incident serves as a stark reminder of the inherent susceptibilities within blockchain frameworks, particularly in the context of safeguarding digital assets. This case exemplifies the critical importance of robust security protocols in blockchain networks, especially those handling digital currencies. It highlights the potential risks associated with consensus mechanisms in systems where validator nodes are few and can become points of vulnerability. Additionally, the episode stresses the significance of advanced blockchain analytics for tracing and recovering stolen assets. As a key takeaway, the Ronin case accentuates the imperative for the blockchain industry to continually enhance its security measures and maintain heightened vigilance to safeguard against such sophisticated exploits

Real-Life Application of Blockchain in Finance

ripple

Ripple was developed to create a more efficient, transparent system for real-time gross settlements (RTGS) across borders, aiming to reduce costs and transaction times. The creation of the Ripple Transaction Protocol (RTXP) was a significant step in this direction, enabling quick monetary transfers. Unlike other platforms that sought to disrupt the banking system, Ripple's approach was to enhance and streamline it, making it an attractive solution for financial businesses' transaction needs.

<u>Key Processes of Ripple</u>

RippleNet: RippleNet is a digital payment network that enables seamless, real-time international money transfers. It's used by various financial institutions to provide a faster, more cost-effective alternative to traditional payment systems like SWIFT

XRP Cryptocurrency: XRP is the native digital currency of the Ripple network. It's used within RippleNet for liquidity management and as a bridge currency for cross-border transactions, which allows for quick and cost-effective conversion between different currencies.

Advantages of Ripple	
<u>Fast Transaction Speed:</u> 	Ripple's standout feature is its rapid transaction processing time. XRP transactions typically complete within 3-5 seconds, a stark contrast to Bitcoin's slower confirmation times, which can exceed 20 minutes. This efficiency in processing speed makes Ripple highly attractive for users and applications requiring quick transaction confirmations.
<u>Economical Transaction Cost</u> 	Ripple's use of 'drops' to manage transactions results in lower costs, making XRP trading more economical compared to some other cryptocurrencies. A 'drop' is the smallest unit of XRP. By using drops for transaction fees, Ripple allows for precise and small transaction costs
<u>Scalability:</u> 	One of Ripple's key strengths is its scalability. It can process up to 1,500 transactions per second, nearly on par with major payment processors like VISA, which handles about 1,700 transactions per second. This capability positions Ripple as an ideal platform for fintech companies and other

	applications that demand high transaction volume handling.
<u>High Uptime and Low Power Consumption:</u> 	Ripple's distributed ledger is supported by a global network of 150 validators on RippleNet, ensuring high uptime and stability. Additionally, XRP doesn't require mining, which is a process that consumes significant computing resources and energy. As a result, Ripple's network is more energy-efficient compared to traditional blockchain networks like Bitcoin

Risks and Drawbacks

Although blockchain technology has an incredible potential to benefit many industries, there are risks associated with it nonetheless.

Lack Of Regulation

Another negative aspect of blockchain technology is the current lack of standardization between blockchains. The different frameworks that blockchains can adopt make it harder for certain blockchains to communicate with one another.

Scalability

As the number of transaction increases, the speed of transactions can decrease significantly and fees may be driven up by consumers wishing to speed their transactions up

Environmental Impact

Running blockchains uses an enormous amount of energy through the need for computing power. Thus, the environmental aspect of blockchain technology is one of the biggest drawbacks of this powerful tool.

Lack of Standardization

Another negative aspect of blockchain technology is the current lack of standardization between blockchains.

Error Correction

Due to the almost irreversible nature of blockchains, if an error occurs during a transaction, corrections or reversals are nearly impossible.

Complexities in Expanding Blockchain Capacity:

Increased Transaction Delays and Network Overloads: The surge in transaction volume can overwhelm many blockchain networks, causing delays in processing and confirmation.

Exploring Scalable Solutions: Innovations like layer-two solutions, larger block sizes, or alternative consensus models are being considered to mitigate these scaling issues.

Impact of Cryptocurrencies on the Environment:

Contribution to Carbon Emissions: Cryptocurrencies using Proof of Work, such as Bitcoin and Ethereum, demand significant computational resources, leading to extensive energy use. The reliance on energy-intensive processes contributes to an increased carbon footprint.

Transitioning to Greener Alternatives: Newer digital currencies are opting for less energy-intensive mechanisms like Proof of Stake, and significant updates like Ethereum 2.0 aim to reduce the overall energy footprint.

Regulatory Dilemmas in Blockchain Applications:

Discrepancies Between Global Operations and Local Laws: The worldwide reach of blockchain clashes with region-specific regulatory frameworks.The anonymous or semi-anonymous nature of many blockchain transactions complicates adherence to legal standards, especially in areas concerning financial regulations.

Progressive Regulatory Efforts: Efforts are underway globally to establish regulatory guidelines that accommodate the unique aspects of blockchain technology.

Challenges with Blockchain Interoperability:

Diverse Protocols and Standards: The variety of unique protocols across blockchain networks makes seamless interaction challenging.

Barriers to Cross-Chain Interactions: This lack of a unified standard impedes transactions or information sharing across different blockchains.

Interoperability Enhancements: Projects are underway to develop standards and technologies that facilitate interoperability among diverse blockchain networks.

Risks Related to Blockchain's Fixed Nature:

Immutable Transaction Records: Altering or undoing transactions on a blockchain is notoriously difficult. This permanence means mistakes or fraudulent activities are not easily correctable.

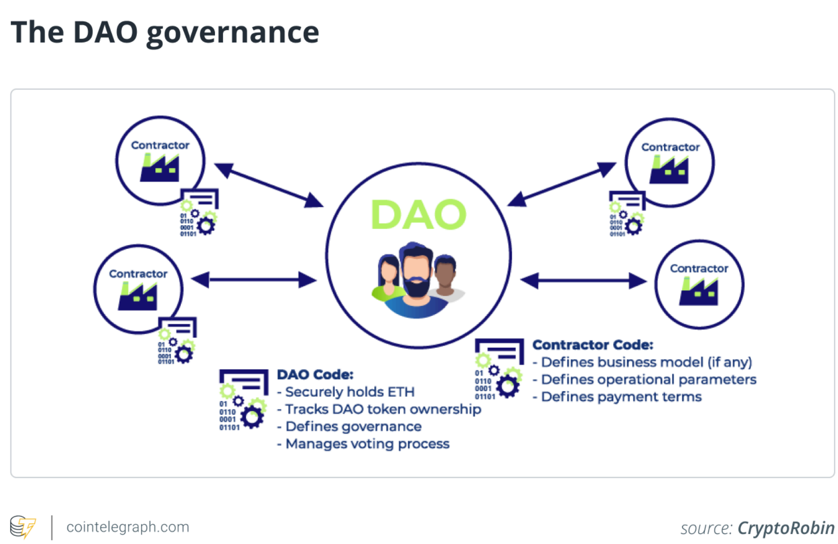
Need for Vigilance in Transactions: This necessitates a high level of caution and verification processes before executing blockchain transactions.

To summarize, blockchain technology, while innovative, faces hurdles like scalability problems, environmental impacts, regulatory challenges, interoperability issues, and the risks associated with its unchangeable nature. Overcoming these obstacles is essential for the broader acceptance and advancement of blockchain technology.

Future Outlook

Blockchain has repeatedly been referred to as the 'future of finance' - moving forward, in navigating the intersection of blockchain and machine learning, we see finance at the crossroads between the two, and it is clear that this partnership holds great promise for the future of finance. This future presents both innovative opportunities and complex challenges, both of which will have to be addressed in the application of blockchain and machine learning

The partnership between blockchain and machine learning in finance will lead to several innovative approaches to finance, chief of which is how decentralized autonomous organizations will integrate adaptive governance (Gan et al., 2021). This refers to a model where organizations operate in a decentralized manner, using autonomous processes to make decisions, and in doing so, incorporate adaptive governance methods. In this model, decentralized autonomous organizations - DAOs - work without a central governing body - essentially, decision-making and the control and execution of operations are distributed over a network of participants, using smart contracts (which is where autonomy comes into play), to execute predefined rules without human intervention or interference (Makridakis et al., 2019). Adaptive governance, in this case, refers to the integration of the governance structure and rule adapting to external stimuli or changing conditions - within a financial context, this model can have many notable implications like enhanced resilience (as there is no longer a single point of contact), improved efficiency through automation, and quicker and stronger flexibility in reacting to changing market conditions.



We will also see the evolution of smart contracts using reinforcement learning (RL), with smart contracts being embedded with RL algorithms, allowing for the automation and optimization of trading strategies (Gan et al., 2021). RL would use historical market data in order to adapt to changing market conditions to autonomously execute trades. Smart contracts adapted with RL can also be applied to adaptive risk models, in order to autonomously adjust risk parameters in real-time market data and therefore develop more accurate and robust models that reflect the risk landscape (Davarakis et al., 2023). This, combined with the potential for enhanced market predictions to help in pricing assets, the development of more dynamic pricing, and the potential for improved security measures within smart contracts (wherein the contract can autonomously detect potential fraud patterns) (Davarakis et al., 2023), shows us that there is significant potential for blockchain applications in the evolution of the future of finance.

The evolution of decentralized governance in DAOs, aided by machine learning analytics, signals a shift towards more adaptive and efficient decision-making structures. Privacy-preserving machine learning directly on the blockchain allows the secure processing of confidential financial data, opening the door to confidential and collaborative model training (Gang et al., 2021). The integration of machine learning into consensus algorithms and smart contracts has the potential to address existing scalability concerns and creates the opportunity for self-optimizing responsive financial processes - as we can see, there are several advantages associated with the integration of blockchain, machine learning, and finance, and in moving forward, we need to be able to leverage the efficiencies and competencies associated with the three in order to maximize synergies.

However, it is important to note that numerous challenges may present obstacles in this transformative journey. For one, issues with cross-chain interoperability still exist, given that the industry requires standardized protocols for the efficient deployment of machine learning models across different blockchain networks (Gan et al., 2019). Moving forward, the need for more robust and comprehensive standards across the board is clear and will aid in the integration of smart contracts and reinforcement learning algorithms across the different blockchain ecosystems. The establishment of industry-wide standards will help facilitate interoperability and, in doing so, will improve the security and transparency associated with financial technologies. We cannot ignore the resource-intensive nature of running complex machine-learning algorithms on decentralized networks, and the inefficiency of this process raises justifiable concerns about scalability and computational efficiency (Shi et al., 2023). Environmental concerns will play a large role in the regulation of this industry, and so we need to be aware of potential regulatory constraints and move towards the development of risk and emission mitigation strategies. This, combined with the algorithmic biases in financial processes on the blockchain (Jagati, 2023), indicates that there are challenges in this field that will require innovative solutions and the establishment of regulatory standards.

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