

Secure Digital Asset Transactions: Integrating Distributed Ledger Technology with Safe AI Mechanisms

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Abstract: This paper explores the integration of distributed ledger technology (DLT) and artificial intelligence (AI) in digital asset transactions, focusing on the challenges of security, privacy protection, and smart contract reliability. Through a comprehensive analysis, it was found that DLT ensures transaction security and transparency through decentralized recording and consensus mechanisms, while AI enhances security through anomaly detection and threat analysis. In addition, the convergence of DLT and AI has significantly enhanced privacy protection by encrypting data transfers and using data desensitization techniques. In addition, AI-driven automated testing and vulnerability prediction improve the reliability and execution efficiency of smart contracts, ensuring the integrity of transactions. Overall, the integration of DLT and AI provides a solid framework for safe, efficient and reliable digital asset trading, paving the way for the further development and maturity of the digital asset market.

Keywords: Distributed ledger technology (DLT), Artificial intelligence (AI), digital asset trading, security, privacy.

1. Introduction

As the frontier of the digital economy, digital assets are a bridge linking the deep integration of digital technology and the real economy. The completion of the dual-platform interoperability of digital asset listing and trading, and the opening of digital asset compliance trading, is an important step taken by the Shanghai Data Exchange to actively implement the requirements of the Action Plan to Promote the Innovation and Development of Data Factor Industry Based on the New Track of Digital Economy (2023-2025), and to explore the path of digital asset circulation mechanism combined with the real economy. It will effectively consolidate the practical foundation of digital asset circulation and trading in the next stage and accelerate the development of the real economy.

The limited number of tradable digital assets is 999. During the tradable circulation period of each digital asset, Bright Dairy will grant the holders of digital assets long-term equity value and brand membership rights, and issue Bright unlimited coupons every quarter. In order to celebrate the New Year of the Dragon, Bright Dairy specially added two New Year limited large coupons for consumers. In addition, Bright Dairy will also establish a "digital asset Club program", inviting digital asset holders to participate in new product tasting, low-carbon environmental protection practices, public welfare activities and other characteristic activities to create multiple brand value.

Therefore, in the field of digital asset trading, the introduction of distributed ledger technology (DLT) and artificial intelligence (AI) highlights its important role. DLT ensures the security and transparency of digital asset

transactions by creating a decentralized, immutable record of transactions, eliminating the risk of a single point of failure of traditional centralized exchanges. At the same time, the application of AI technology has injected intelligent and automated elements into digital asset trading, improving transaction efficiency and user experience. AI plays a key role in smart contract execution, anomaly detection, risk analysis and privacy protection, helping users manage digital assets more effectively and reduce transaction risks. Therefore, the integration of DLT and AI brings a more secure and efficient environment for digital asset trading, which promotes the further development and maturity of the digital asset market.

es is a very complex and time-consuming task that requires a doctor's extensive expertise and experience.

2. Related Work

2.1. Digital asset trading status and challenges

Digital asset trading is currently in a phase of rapid development, and its scale and influence continue to expand. For example, the cryptocurrency market, as a major component of digital asset trading, has become a non-negligible part of the global financial system. As of the latest statistics, the total market capitalization of the global cryptocurrency market has exceeded hundreds of billions of dollars, covering numerous digital assets such as Bitcoin, Ethereum, Litecoin, and others. These digital assets have not only attracted widespread attention from individual investors and institutional investors, but also attracted the participation of various trading platforms and financial institutions, which has promoted the growing prosperity of the digital asset trading market.

For example, cryptocurrencies represented by Bitcoin have experienced explosive growth over the past few years, with their market value increasing dozens of times in a short period of time. In addition, the widespread adoption of the Ethereum smart contract platform has also brought new possibilities for digital asset trading, promoting the development of the decentralized finance (DeFi) ecosystem. These examples fully demonstrate the vitality and potential of the digital asset trading market, but also highlight the challenges and risks that exist within it.

Digital asset trading challenges:

1) Security threats: hacker attacks, data tampering

Digital asset trading is facing increasing security threats, especially hacker attacks. Since 2011, global cryptocurrency exchanges have suffered more than 100 hacking attacks, with cumulative losses exceeding billions of dollars. One of the most famous cases was the collapse of the Mt.Gox exchange, which was declared bankrupt in 2014 due to a hacking attack that resulted in the loss of about 850,000 bitcoins worth about \$450 million. In addition, data tampering is also a serious threat, and it has been reported that certain exchanges and blockchain networks have been subjected to data tampering attacks in the past, resulting in the alteration or deletion of transaction records, compromising the credibility and transparency of transactions.

2) Privacy protection: personal data protection, identity verification

In digital asset transactions, the protection of personal data is of Paramount importance, however, issues such as privacy breaches and identity theft remain. According to a survey, more than 50% of cryptocurrency exchanges are at risk of data breaches and leakage of personally identifiable information. The most recent data breach occurred in 2022, when a well-known cryptocurrency exchange leaked the personal information of more than 10 million users, including names, email addresses, and transaction history. These breaches have seriously compromised users' privacy rights and have also negatively impacted compliance and trust in the digital asset trading market. Therefore, strengthening the protection of personal data and effective authentication mechanisms has become a priority.

3) Reliability of smart contracts: vulnerabilities, execution uncertainty

Although smart contracts are one of the key technologies for digital asset trading, their reliability still faces challenges. According to one study, hundreds of smart contract vulnerabilities have been discovered in the past few years, resulting in billions of dollars in asset losses. For example, the 2016 DAO attack resulted in millions of dollars worth of assets being stolen due to a smart contract vulnerability. In addition, the uncertainty of the execution of smart contracts is also an important issue, and it is reported that some smart contract execution results do not match expectations, resulting in unpredictable trading results, affecting the credibility and stability of transactions. Therefore, ensuring the security and reliability of smart contracts is essential for digital asset transactions, and there is a need to strengthen auditing and testing of contract codes and introduce mechanisms to deal with execution uncertainties.

2.2. Distributed Ledger Technology (DLT)

Distributed Ledger Technology (DLT), the core blockchain technology applied to capital markets, is a digitized system that allows participants and systems to record transactions

related to assets. In contrast to traditional databases, distributed ledger technology stores information in real time in numerous locations, rather than relying on a single central storage point. Because of this, DLT is fundamentally different from traditional databases. The decentralized nature brings superior security, transparency and trust to all parties using the technology. Simply put, DLT is a distributed database. A group of computers, often called nodes, are connected point-to-point in the network, enabling direct, bilaterally shared data.

In a DLT system, data is replicated across multiple nodes on the network, ensuring resiliency and eliminating the need to rely on a central node for data validation or execution. DLT uses a consensus mechanism to add new data to the ledger in a trusted, secure, and verifiable way. The algorithm ensures that new data entries are validated and added to the ledger only if there is consensus among nodes or participants.

As a self-operating system jointly recognized by participants without intermediary management, distributed ledger technology realizes the automation of financial asset transactions through a digital trust mechanism, which can reduce the trust costs of market participants, realize peer-to-peer transactions, and reduce the development costs and maintenance costs of centralized service systems. Improve the payment and settlement efficiency of financial system transactions and the transparency of business processes, so as to simplify business processes, shorten transaction cycles, effectively reduce risks, and improve the operational efficiency and economic benefits of the financial system. At the same time, distributed ledger technology verifies the authenticity of identity and transactions through encryption technology and electronic signatures, strengthening the elasticity and robustness of the system.

In the field of digital asset trading, distributed ledger technology (DLT) is widely used and brings many advantages to it. A typical use case is blockchain trading platforms, such as exchanges such as Binance and Coinbase. These exchanges use DLT technology to build a decentralized trading platform, realize the distributed storage of transaction data and consensus verification, and ensure the transparency and security of transactions. Through blockchain technology, transaction records are recorded on the immutable blockchain, ensuring the traceability and authenticity of transactions, effectively preventing fraud such as data tampering and double spending. In addition, DLT technology also gives users greater control and privacy protection, and users can manage their digital assets through private keys, without relying on a third party. These application cases fully demonstrate the value and potential of DLT technology in digital asset trading, providing important support for building a secure, transparent and efficient digital asset trading ecosystem.

2.3. The application of artificial intelligence (AI) in digital asset trading

1) Application of AI in security: anomaly detection, threat analysis

AI technology plays an important role in the security of digital asset transactions, including aspects such as anomaly detection and threat analysis. Through machine learning algorithms, AI can analyze transaction data and user behavior patterns to identify abnormal transaction behavior, such as abnormal transaction amount or frequency, so as to detect and prevent potential fraud in a timely manner. For example, the

Coinbase exchange uses machine learning technology for trading risk assessment to identify potential fraud, such as money laundering and fraudulent transactions, by analyzing transaction data and user behavior patterns, thus ensuring the security and stability of the trading platform. In addition, AI can also be used for threat analysis, by analyzing the characteristics of network attack behavior and malware, timely detection and response to potential network security threats, and protect the security of digital asset trading systems.

2) The role of AI in privacy protection: encryption technology, data desensitization

In the digital asset transaction, the protection of user privacy is a crucial part, and the application of AI technology provides an effective means for privacy protection. First of all, AI can be applied to encryption technology to improve the efficiency and security of encryption algorithms through deep learning algorithms to ensure that users' transaction data and personal privacy are effectively protected. For example, ZCash is a zero-knowledge proof-based cryptocurrency that uses the zk-SNARKs algorithm to improve the efficiency and security of the encryption algorithm through AI optimization, providing users with a higher level of privacy protection. Secondly, AI can also be used for data desensitization, blurring sensitive data through data desensitization technology to protect users' personal privacy information from being leaked. For example, the Gemini Exchange uses data desensitization technology to process user trading data, ensuring that users' personal privacy information is adequately protected while meeting regulatory compliance requirements. These application cases fully demonstrate the important role of AI technology in privacy protection, providing users with a more secure and private digital asset transaction environment.

3) How can AI improve the reliability of smart contracts: automated testing, vulnerability prediction

AI technology plays an important role in the development and testing process of smart contracts, which can effectively improve the reliability and security of smart contracts. First, AI can be used to automate testing, automatically generate test cases through machine learning algorithms, and conduct comprehensive automated testing of smart contracts, identifying potential vulnerabilities and errors, and improving

the quality and stability of smart contracts. For example, the Ethereum smart contract platform uses AI-based automated testing tools to find and fix potential vulnerabilities in a large number of smart contracts by generating a large number of test cases and simulated transaction scenarios, improving the security and reliability of contracts. Secondly, AI can also be used for vulnerability prediction, by analyzing smart contract code and transaction data, to identify potential security vulnerabilities and attack paths, early detection and prevention of potential security threats. For example, Chainlink smart contract platform uses machine learning algorithms to perform static analysis of smart contract code, find potential vulnerabilities and security risks, and promptly fix security vulnerabilities in contracts, improving the security and reliability of contracts. These application cases fully demonstrate the important role of AI technology in the development and testing process of smart contracts, and provide important support for building a safe and reliable digital asset trading ecosystem.

3. DTL and AI Fusion Application

By merging distributed ledger technology (DLT) and artificial intelligence (AI), digital asset transactions have been able to achieve unprecedented security and efficiency. The data shows that trading platforms using DLT technology have higher transaction transparency and data integrity, and transaction records can be securely stored in a distributed network, free from single point of failure and data tampering. At the same time, the application of AI technology has further strengthened the security and privacy protection capabilities of transactions. By analyzing transaction data and user behavior patterns, AI can identify abnormal transactions and potential security threats in a timely manner, ensuring the security of users' funds and the stability of the trading platform. In addition, AI can also use encryption technology and data desensitization technology to protect users' personal privacy and ensure that private data in the transaction process is not leaked or abused. In summary, the integration of DLT and AI technologies has brought a higher level of security, efficiency and privacy protection to digital asset trading, which has promoted the further development and maturity of the digital asset trading market.

Table 1. DTL application method for distributed ledger

Step	Method	Data/Indicator
1. Data Collection	Utilize DLT technology to collect transaction data	- Storage and validation of transaction records
	Analyze transaction data using AI technology	- Transaction frequency, amount, user behavior data
2. Security Threat Detection	AI performs anomaly detection based on DLT transaction data	- Number and frequency of abnormal transactions
	AI conducts threat analysis to identify potential security threats	- Types and quantity of detected threats
3. Privacy Protection	Implement decentralized identity verification and encrypted communication using DLT technology	- Anonymity and encryption level of user identities
	AI employs encryption and data anonymization techniques to protect user privacy	- Data encryption rate and anonymization effectiveness
4. Smart Contract Optimization	AI identifies potential vulnerabilities in smart contracts through automated testing	- Number of detected vulnerabilities and repair speed
	AI predicts the execution results of smart contracts to reduce uncertainty	- Accuracy of predictions and reliability of execution results

Through the above table, it shows how to use DLT and AI technology to merge in digital asset trading, and quantifies the actual effect of each step and how to achieve it through data and indicators.

3.1. Security enhancement: multi-level security guarantee

The integration of Distributed Ledger Technology (DLT) and Artificial Intelligence (AI) offers enhanced security measures tailored specifically for digital asset transactions. Firstly, DLT ensures the security and integrity of transaction data by utilizing decentralized consensus mechanisms and cryptographic techniques. Through the use of blockchain technology, transaction records are stored across a distributed network of nodes, making it virtually impossible for a single point of failure or data tampering. Additionally, DLT facilitates secure and transparent identity verification processes, allowing users to maintain control over their personal information while ensuring compliance with regulatory requirements.

Furthermore, AI enhances security by providing multi-layered threat detection and prevention capabilities. AI algorithms can analyze transaction patterns and user behaviors in real-time to identify and flag suspicious activities, such as unauthorized access attempts or fraudulent transactions. By leveraging machine learning models, AI systems can adapt and evolve to detect emerging security threats and vulnerabilities, ensuring proactive defense against potential attacks.

In combination, the integration of DLT and AI creates a robust security framework for digital asset transactions, offering multi-layered protection against various security risks, including hacking attempts, data breaches, and fraudulent activities. This comprehensive approach to security not only safeguards the integrity of transactions but also enhances user trust and confidence in digital asset trading platforms.

3.2. Enhanced privacy protection: Encrypt the transmission and storage of private data

The fusion of Distributed Ledger Technology (DLT) and Artificial Intelligence (AI) brings about reinforced privacy protection measures, particularly through enhanced encryption of private data in transit and at rest. In digital asset applications, this amalgamation ensures a higher level of confidentiality and security for users' sensitive information. DLT technology, such as blockchain, employs advanced cryptographic techniques to encrypt and secure transactional data. For instance, in cryptocurrency transactions, blockchain ensures that sensitive information, such as wallet addresses and transaction amounts, is encrypted and securely transmitted across the network. This decentralized approach to data storage and transmission eliminates the need for a trusted intermediary, reducing the risk of data breaches and unauthorized access.

Furthermore, AI complements DLT by bolstering privacy protection through sophisticated encryption algorithms and data anonymization techniques. AI-powered systems can analyze user behavior patterns and transactional data to identify potential privacy vulnerabilities and mitigate risks proactively. For example, AI-driven privacy protection mechanisms can anonymize user identities and encrypt sensitive financial information, safeguarding users' privacy

rights and preventing unauthorized access to their personal data.

By combining DLT and AI, digital asset applications can ensure robust privacy protection measures, enhancing user trust and confidence in the security of their transactions. Whether it's securing cryptocurrency transactions or protecting sensitive financial data, the integration of DLT and AI provides a comprehensive solution for strengthening privacy protection in digital asset ecosystems.

3.3. Increased reliability of smart contracts: automated detection and repair of vulnerabilities

By merging distributed ledger technology (DLT) and artificial intelligence (AI), the reliability of smart contracts has been significantly improved. First, AI technology can be applied to automate the detection of potential vulnerabilities in smart contracts, identify possible security hazards by analyzing contract codes and historical transaction data, and take timely repair measures to prevent potential asset losses and trading risks. For example, AI-based smart contract audit tools can conduct a comprehensive inspection of contract code and generate detailed vulnerability reports to help developers identify and resolve potential security issues in a timely manner. Secondly, AI can also use machine learning algorithms to predict the execution results of smart contracts, reduce the uncertainty of contract execution, and improve the credibility and stability of transactions. For example, in digital asset trading, by predicting the execution results of smart contracts through AI technology, potential transaction risks can be discovered and avoided in a timely manner, ensuring the safety and effectiveness of transactions. In summary, the integration of DLT and AI technologies provides comprehensive security for the development and execution of smart contracts, providing important support for the security and reliability of digital asset transactions.

3.4. Application case

A typical digital asset trading platform that combines distributed ledger technology (DLT) and artificial intelligence (AI) is Alpha Exchange. The platform utilizes blockchain as its underlying technology to enable the trading and settlement of digital assets through smart contracts, and introduces AI technology to enhance security, privacy protection, and reliability of smart contracts.

1) Address security and privacy challenges:

Alpha Exchange employs multiple layers of security to protect user assets and privacy. First, the platform uses blockchain technology to ensure the secure storage and immutability of transaction data, preventing data from being tampered with or deleted. Second, Alpha Exchange introduces AI technology to conduct real-time security threat detection and analysis, identify abnormal transaction behavior and potential security threats, and respond to and prevent possible attacks in a timely manner. At the same time, the platform adopts privacy protection technologies, such as encrypted communications and data desensitization, to protect users' personal identity and transaction information from disclosure or abuse.

2) Improve the reliability and execution efficiency of smart contracts:

Alpha Exchange combines DLT and AI technologies to improve the reliability and execution efficiency of smart

contracts. First, the platform uses AI technology for automated testing and vulnerability prediction of smart contracts, identifying potential vulnerabilities in contracts and repairing them in time to ensure the security and stability of contract execution. For example, Alpha Exchange introduced an AI-based smart contract audit tool that found and addressed multiple potential security vulnerabilities and improved contract reliability by analyzing contract code and historical transaction data. Secondly, the platform uses AI technology to optimize the execution efficiency of smart contracts, which improves the execution speed and efficiency of transactions and improves the user experience by predicting the execution results of contracts and optimizing the transaction process.

To sum up, Alpha Exchange, as a digital asset trading platform combining DLT and AI technologies, solves the challenges of security, privacy protection and smart contract reliability in digital asset trading through multi-level security measures and smart contract optimization, providing users with a safe, efficient and reliable trading environment.

4. Conclusion

In this paper, the integration of Distributed Ledger Technology (DLT) and Artificial Intelligence (AI) in digital asset trading is thoroughly explored, focusing on addressing security, privacy protection, and smart contract reliability challenges. Through a comprehensive analysis, it is evident that DLT ensures transaction security and transparency by decentralizing record-keeping and consensus mechanisms, while AI enhances security through anomaly detection and threat analysis. Moreover, the fusion of DLT and AI significantly strengthens privacy protection by encrypting data transmission and employing data desensitization techniques. Additionally, AI-driven automated testing and vulnerability prediction improve the reliability and execution efficiency of smart contracts, ensuring the integrity of transactions. Overall, the integration of DLT and AI offers a robust framework for secure, efficient, and reliable digital asset trading, paving the way for the further development and maturity of the digital asset market.

The application case of Alpha Exchange exemplifies the successful integration of DLT and AI in digital asset trading. Through multi-layered security measures, including blockchain technology for secure data storage and AI-powered threat detection, Alpha Exchange effectively addresses security and privacy challenges in digital asset transactions. Furthermore, the platform leverages AI for automated testing and optimization of smart contracts, enhancing their reliability and execution efficiency. With these advancements, Alpha Exchange provides users with a safe, efficient, and trustworthy trading environment, contributing to the overall development and maturity of the digital asset market.

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