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Artificial Intelligence and Blockchain technology importance in today's World

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Blockchain constructs a distributed point-to-point system, which is a secure and verifiable mechanism for decentralized transaction validation and is widely used in financial economy, Internet of Things, large data, cloud computing, and edge computing. On the other hand, artificial intelligence technology is gradually promoting the intelligent development of various industries. As two promising technologies today, there is a natural advantage in the convergence between blockchain and artificial intelligence technologies. Blockchain makes artificial intelligence more autonomous and credible, and artificial intelligence can prompt blockchain toward intelligence. In this paper, we analyze the combination of blockchain and artificial intelligence from a more comprehensive and three-dimensional point of view. We first introduce the background of artificial intelligence and the concept, characteristics, and key technologies of blockchain and subsequently analyze the feasibility of combining blockchain with artificial intelligence. Next, we summarize the research work on the convergence of blockchain and artificial intelligence in home and overseas within this category. After that, we list some related application scenarios about the convergence of both technologies and also point out existing problems and challenges. Finally, we discuss the future work.

1.Introduction

Among the 21st century's various disruptive technologies, artificial intelligence (AI) and blockchain belong to those that stand out in terms of the attention and hype they have received (Salah et al. 2019). However, bringing together AI and blockchain is a combination of two completely different technologies. The blockchain is still a very young technology and research field. It was first described in the white paper Bitcoin: A Peer-to-Peer Electronic Cash System in 2008, although the term "blockchain" was not yet mentioned (Nakamoto 2008). In comparison, AI has been a well-researched area for several decades, beginning with the proposal of a first artificial neuron model (McCulloch and Pitts 1943) and Alan Turing's highly regarded essay Computing Machinery and Intelligence (1950). Until recently, researchers only studied blockchain and AI applications in isolation, focusing on their individual application in different vertical domains and businesses. Nevertheless, connecting AI and blockchain harbors a great deal of potential. Such a combination is rarely a question of developing completely new applications. Most of the academic work in this area investigates how one of the two technologies can support the other. For instance, the blockchain can enable an increase in the transparency of AI systems, which often have the character

of a black box (Castelvecchi 2016). Against this background, the explainable artificial intelligence (XAI) research field has increasingly become an area of interest for the research community (Došilović et al. 2018). As an exemplary application, the blockchain can therefore provide new potentials for increasing transparency (Dillenberger et al. 2019; Sarpatwar et al. 2019). On the other hand, AI can help overcome some challenges with which that the blockchain, as a new technology, still struggles. Finally, there is a third category of use cases whose focus is not primarily on one technology supporting the other. Instead, AI and blockchain are used side by side and unfold their effect through their respective strengths. Examples include a platform for global employability (Keršič et al. 2020), or an approach that utilizes blockchain and automated machine learning to provide an automated customer service (Li et al. 2019).

As the cutting-edge technologies nowadays, blockchain and artificial intelligence have attracted increasing attention due to the irreplaceable role that they play in technological innovation and industrial transformation [1–3]. The concept of artificial intelligence technology originated from the Dartmouth Society in 1956. As an essential branch of computer science, artificial intelligence technology is dedicated to the research and development of technical sciences used to simulate, extend, and expand human intelligence. In recent years, thanks to the tremendous breakthroughs made in machine learning (especially deep learning) [4] and the exponential growth of data, artificial intelligence has ushered in an explosive period. Due to its advantages in analysis, prediction, judgment, and decision-making, artificial intelligence can fundamentally empower industries such as security, finance, retail, transportation, and education [5–8]. Blockchain technology started relatively late, firstly starting with Bitcoin proposed by Satoshi Nakamoto in 2008. The blockchain is essentially a distributed ledger [9, 10]. It can use a decentralized consensus mechanism in an environment where different entities participate, without the intervention of a third trusted party. Blockchain also realizes the generation and verification of transactions in an untrusted distributed system, building trust at a lower cost [11]. It is precisely because of this that more and more researchers have concentrated on blockchain technology [12, 13]

2. Artificial Intelligence

Although mankind has long tried to understand the functioning of intelligence, the term AI was first coined in 1956 (Russell and Norvig 2016). In recent years, there has been a reemergence of interest in the field of artificial intelligence among managers and academics (Brock and Wangenheim 2019). Currently, AI is a broad and thriving field with many practical applications and active research topics (Goodfellow et al. 2016). Machine learning (ML) technology powers many aspects of modern society: from web searches to content filtering on social networks, to recommendations on e-commerce websites, and it is increasingly present in consumer products, such as cameras and smartphones (LeCun et al. 2015). Deep learning is also among the current trending technologies. Owing to larger datasets and more powerful computers, deep learning has seen tremendous growth over the last years (Goodfellow et al. 2016). The architecture of deep learning comprises different modules arranged in multiple layers. Each of these layers can transform input data and is able to learn. Deep learning has improved the state of the art in several areas, such as speech recognition, visual object recognition, and object detection (LeCun et al. 2015). Swarm intelligence is another AI discipline concerned with intelligent multi-agent systems' design (Blum and Li 2008). This field of research is inspired by swarms from nature like ants or termites, which have formed a collective

behavior. Nowadays, there is a wide range of possible practical applications of swarm systems. Examples include the transport of large and heavy objects by means of a swarm of mobile miniature robots (Chen et al. 2013), various applications of swarm robots in the agricultural sector (Emmi et al. 2014; Yaghoubi et al. 2013), and potential applications for entertainment purposes or toy robots (Alonso-Mora et al. 2014)

3. Blockchain Technology

3.1. Concept of Blockchain

Blockchain technology is a kind of distributed ledger technology that stores data in a chain data structure. It is a new distributed infrastructure and computing paradigm, which employs the distributed node consensus algorithm to verify the transaction data and further synchronize the entire network, as well as uses cryptography to ensure data security and credibility [28].

3.2. Characteristics of Blockchain

3.2.1. Multicenter

The blockchain adopts distributed decentralized storage, so the distributed recording, storage, and update of data can be realized without a single central point. Since there is no centralized hardware or management organization, any node can operate on the data on the blockchain according to the established rules.

3.2.2. Transparency

The system data of the blockchain is open and transparent, and any node can have a general ledger of the entire network. Except for the private information of the directly related parties of the data being encrypted through asymmetric encryption technology, the blockchain data are open to all nodes, so the entire system information is highly open and transparent.

3.2.3. Autonomy

The blockchain system has multiple participants, and they have formulated automatically negotiated specifications and protocols based on open rules and algorithms. Each node in the system always follows these specifications and protocols during operation. This ensures that every transaction in a trustless environment can guarantee its correctness and authenticity. The nodes can securely exchange, record, and update data, and operations that do not follow the specifications and protocols will not take effect.

3.2.4. Immutability

After the transaction information of the blockchain passes the consensus of all nodes and is recorded in the block, there is a complete backup locally on each node. At the same time, the correlation between blocks is carried out by the hash algorithm. If you want to tamper with a piece of data, you need to modify all subsequent blocks, which is very costly.

3.2.5. Traceability

Each node in the blockchain saves all the records in the history. Any piece of data can be found by traversing the local blockchain data, which makes all the data on the blockchain chain traceable.

3.2.6. Programmability

The nature of the blockchain provides a trusted application environment for the execution of smart contracts, so the blockchain can provide users with programmable data manipulation capabilities. Users can customize smart contract rules that meet their needs. At the same time, due to its open and automatic execution characteristics, it also guarantees the security of assets and data on the chain.

3.3. Concept of Blockchain

The rich application scenarios of blockchain are basically based on the four core technologies of blockchain, namely, consensus mechanism, data structure, cryptography, and distributed storage. As the key future research direction of blockchain technology, cross-training technology has gradually become one of the core technologies of blockchain.

3.3.1. Consensus Mechanism

To ensure that nodes are willing to take the initiative to keep accounts, the blockchain has formed an important consensus mechanism. Common consensus mechanisms are as follows: (1) The proof of work mechanism (PoW) is the original consensus mechanism, and all participating nodes compete for bookkeeping rights by comparing computing power. Since everyone participates, but only one node can be selected, many resources and time costs will be wasted. (2) For the proof-of-stake (PoS) mechanism, the longer you hold the digital currency and the more assets you hold, the more likely this mechanism is to obtain the right to bookkeeping and rewards, which saves time but easily causes the Matthew effect. (3) The delegated proof-of-stake mechanism (DPoS) selects representative nodes for proxy verification and accounting, which is simpler and more efficient, but it also sacrifices some decentralization to a certain extent.

3.3.2. Data Structure

The blockchain is similar to an iron chain in form, consisting of one block after another to form a complete chain. Each block includes a block header and a block body. The blocks are linked back and forth through the hash pointer in the block header. The hash value contained in each block header is similar to a digital fingerprint of all the data in the previous block, so there is an interlocking connection between each block. This relationship forms a chain. When any data in the block are modified, all subsequent hash values will change. Such a structure and content constitute the entire blockchain.

3.3.3. Cryptography

Blockchain uses killer feature-cryptography. The symmetric encryption is equivalent to using the same key to open and lock the door. Asymmetric encryption is equivalent to using a pair of different keys to open and lock the door, namely, public key and private key. If you use the public-key encryption, you can use the private key to decrypt; if you use private-key encryption, you can use the public key to decrypt. These two keys are generally stored in the user's personal wallet. Once the private key is lost, the assets are gone. It is relatively safe in the blockchain in which the public key and private key are formed through multiple transformations, and the characters are relatively long and complex [29].

3.3.4. Distributed Storage

The most attractive thing about blockchain is its distributed storage mechanism. The information record on each block in the blockchain is recorded by each node participating in the bookkeeping competition. To prevent some malicious nodes from doing damage, the new data in the blockchain that adopts the PoW consensus mechanism need to be unanimously confirmed and agreed upon by most nodes, and at least 51% of the nodes must agree. Therefore, it is difficult to tamper with data.

3.3.5. Cross-Chain Technology

Cross-chain technology is an important technical means for blockchain to realize interconnection and improve scalability. In terms of network morphology, blockchain is different from the Internet. The latter supports one network to connect to global nodes, while the former forms multiple isolated parallel networks. In addition to the extensive coexistence of public chains, private chains and consortium chains allow different organizations to have their own blockchains and even allow multiple blockchains to run simultaneously within the same organization. The number of global blockchains is increasing, and the isolation of different blockchain networks makes it impossible to effectively carry out operations, such as digital asset transfer and cross-chain communication between chains. In the cross-chain process, the two most important things are: The first is to recognize atomicity, that is, cross-chain transactions either happen or do not happen, so that honest nodes will not be damaged; the second is to ensure that the total assets on each chain will not decrease.