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# Blockchain and AI Meet in the Metaverse

*Hyun-joo Jeon, Ho-chang Youn, Sang-mi Ko and Tae-heon Kim*

## Abstract

With new technologies related to the development of computers, graphics, and hardware, the virtual world has become a reality. As COVID-19 spreads around the world, the demand for virtual reality increases, and the industry represented by the Metaverse is developing. In the Metaverse, a virtual world that transcends reality, artificial intelligence and blockchain technology are being combined. This chapter explains how artificial intelligence and blockchain can affect the Metaverse.

**Keywords:** AI, Blockchain, Virtual Reality, Metaverse, NFT

## 1. Introduction

The term “Metaverse” is a combination of ‘meta’ meaning ‘virtual, transcendence’ and ‘verse’ a backformation from ‘universe’. The Acceleration Studies Foundation (ASF), a non-profit technology research organization, classified the Metaverse into the following four categories: a virtual world that experiences a flawless virtual story, a mirror world that reflects the current real world, an augmented reality that shows a mixture of augmented information in the real world and life logging, which captures and stores everyday information about people and things [1]. With the development of technology, the number of people who use the Metaverse increases, and as activities at the same level as reality are performed, various and a lot of data are being generated. Data generated in the metaverse has value in itself. In the Metaverse, the amount of data increases, the value increases, and the importance of reliability and security is increasing. Blockchain technology is required to guarantee the reliability of data in the Metaverse, and artificial intelligence is used to secure the diversity and rich content of the Metaverse. The contents will be developed in the following order.

In this chapter, under the theme of the Metaverse, we will look into the issues of human instinct for creation in the virtual world, the phenomenon in which the real and the virtual are combined in the virtual world, and the reliability of data in this virtual world. Blockchain and NFT technologies are described as trust technologies. And the Metaverse platform built on the basis of this technology will be described. Basically, we will understand the interface between blockchain and artificial intelligence, and look at how a better world is created by combining blockchain and artificial intelligence in Metaverse.

## 2. Virtual world and desire of creation

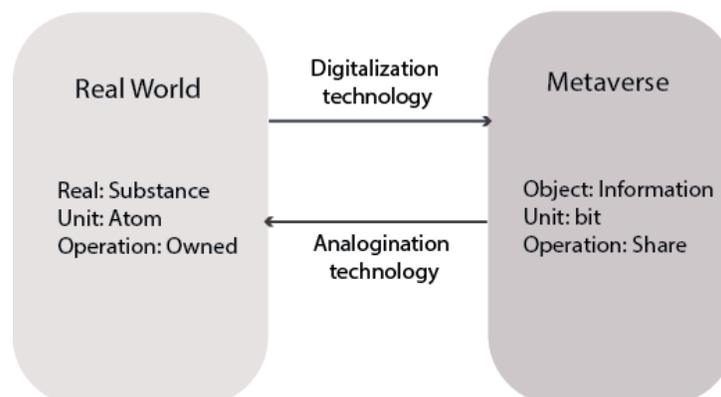
### 2.1 Human desire for creation

Humans have an instinct for creation, and this creativity is an important factor that distinguishes humans from other animals. The creativity of human beings has been creating the culture. The paper published in 2004 described the SeaCircle as the new concept of the culture, and it regarded the SeaCircle as human cultural activities for creating. In the concept of the SeaCircle, humans are the spiritual beings, and only humans constitute a culture. It explains the elements of insight of culture [2]. According to the SeaCircle theory, creativity is explained as an element of Open Mind and Spirit [3].

On the SeaCircle concept, the Metaverse can be interpreted as a space that allows people to be more immersed in creative activities by resolving some of the constraints on space and resources.

### 2.2 Connection between the virtual world and the real world

Recently, the virtual world and the real world have been developed in convergence. The First and Second Industrial Revolutions were the process of maximizing efficiency through division of labor, so the production of materials and the consumption of materials were separated. In the Third Industrial Revolution, as online transactions are actively conducted, data has become an important commodity, and offline transactions are gradually being replaced by online. In the Firth Industrial Revolution, an intelligent revolution is occurring as things and humans become hyper-connected. There is a convergence phenomenon in which production and consumption occur at the same time, such as social customization or digital DIY(Design It Yourself). The offline world composed of materials is dominated by Pareto's law, which attempts to own and concentrate on the core of 20% due to limited resources. On the other hand, in the online world of information, the Long Tail theory is applied to share and find opportunities from the marginalized 80% of customers. The Forth Industrial Revolution is creating a convergence world where offline and online meet. This convergence is being created in manufacturing, logistics, finance, automotive, sports, healthcare, education, food and everyday life. In addition, as the problems of material production and supply were solved in the First, Second, and the Third Industrial Revolutions, and interest in human personal desire and spirit increased in the Forth Industrial Revolution stage, a new convergence between offline world and online world are being created [4].



**Figure 1.**  
*Relationship between the real world and the Metaverse.*

### 2.3 Combination of virtual and real in Metaverse

Political, economic, social, and cultural interactions appear in the Metaverse, which seems to mimic the real world. **Figure 1** shows the process of interworking and convergence between the real world and the Metaverse [4]. The Metaverse expresses an alternative world that cannot be achieved well in the real world.

In Minecraft, a virtual reality game platform representing Metaverse, as it became difficult to go to school due to COVID-19, UC Berkeley students created a campus inside the Minecraft game and held an event to hold a virtual graduation ceremony [5]. The president, guest speakers, and graduates all participated as Minecraft characters, and even the tradition of throwing hats after graduation was reenacted in Minecraft.

Roblox allows game developers to create games on the Roblox virtual platform instead of commuting to an offline office [6]. In Roblox, tokens are obtained in return for labor, and the tokens obtained in the game can be brought to the outside to be cashed.

In Metaverse, numerous users can freely trade goods and services according to the currency and transaction method provided by the platform. Both the virtual asset SAND of The Sandbox and the virtual asset MANA in Digital Land are listed on the exchange and are actively traded [7, 8]. This means that money in the virtual world in units of bits can replace money in the real world. Co-creating a game in the space of the virtual world means replacing the space in the space of the real world. This means that activities in the real world are data in bits in the virtual space, and the importance and reliability of these data are emphasized.

### 3. Data trust in the virtual world

After the 4th industrial revolution, the virtual world has grown rapidly. The real thing has been converted into data from the virtual world, and the virtual world has even played a role in leading the real world. Here, we have a question about the reliability of data about whether the real thing is becoming data accurately in the virtual world. In the virtual world, trust technology is emerging as an important issue. We can think of blockchain as one of these trust technologies.

Blockchain was first proposed in 2008 in Satoshi Nakamoto's paper "Bitcoin: P2P Electronic Money System". Blockchain can be said to be a technology that gives trust in transactions between individuals. A blockchain consists of blocks containing data and a chain that connects them. It is a blockchain to create and connect blocks, and consensus algorithms are used in this process. Any of the nodes participating in the network can create blocks, but not all generated blocks are connected, and only one block is recognized and connected. Since only one block among many blocks is connected to the previous block and the remaining blocks are discarded, consensus among participating nodes to select one block is essential. As a method of reaching consensus, consensus algorithms such as Proof of Work (PoW) and Proof of Stake (PoS) are used. If it is recognized as a unique block by all nodes, the node that created the block will receive cryptocurrency as a reward. This action is called mining, and a blockchain connected only with blocks created by mining is called a Canonical Chain.

Blockchain is developing and evolving as shown in **Table 1** [9]. Blockchain 1.0 was a period of innovation in the financial system with the advent of Bitcoin. Bitcoin is meaningful in that it attempts a single global financial system based on decentralization and decentralization, which are the core values of blockchain.

Blockchain 1.0	Blockchain 2.0	Blockchain 3.0
Crypto currency, Currency transfer, Remittance. Digital payment system	Smart contract, Decentralized autonomous organization(DAO), Stock, Bonds, Loans, Mortgages, Smart property	Government, Public, Science, Health, Culture, Art, IoT, Big Data, AI

**Table 1.**  
*Blockchain paradigm evolution direction.*

Blockchain 2.0 is a period of contract automation centered on Ethereum smart contracts. It made it possible to execute contracts with legal effect online only with computer code without a transaction intermediary. It is a period that showed the potential for development as an online trading platform. Blockchain 3.0 is the stage in which blockchain technology is spread and applied to various industries. In order to solve the problems of the previous blockchain, technological improvements such as changes in consensus algorithms, improvement of transaction processing speed, and in-house decision-making functions are being made [10]. While it is expected that artificial intelligence will be applied to more expanded fields in Blockchain 3.0, more various applications of blockchain and artificial intelligence are expected to appear in the Metaverse environment.

## 4. Blockchain-based Metaverse

### 4.1 Ethereum code

Ethereum is a platform network designed to operate various decentralized applications (DApps), based on its own blockchain. Just as the basic framework and details of Internet standards were documented as RFCs, Ethereum Request for Comment (ERC) documents the details of Ethereum. In DApps using the Ethereum network, the basic protocol for issuing tokens is expressed as ERC-number as shown in **Table 2**. ERC-number is a protocol to follow when issuing tokens from DApps using the Ethereum network. Ethereum standard documents start with ERC-20, ERC-165, ERC-223, ERC-621, ERC-721, ERC-777, ERC-827, ERC-884, ERC-998, ERC-1155, ERC-1404 etc. [11].

Among them, ERC-20 is a protocol related to replaceable tokens, and ERC-20 tokens have the same value and function and can be exchanged with each other. The Ethereum project is issuing tokens based on ERC-20 and allowing investment and various businesses to take place.

ERC-721 is a protocol for NFT (Non-Fungible Tokens). NFT guarantees uniqueness by keeping encrypted transaction history permanently on the blockchain. Each token has a unique recognition value, authenticating the ownership of digital assets and assigning a value to the transaction. NFT has been mainly used to commemorate special moments or to collect digital assets, and recently it is creating a new digital content business by combining it with Metaverse.

ERC-20	ERC-165	ERC-233
ERC-621	ERC-721	ERC-777
ERC-827	ERC-884	ERC-1155

**Table 2.**  
*ERC(Ethereum request for comment)-number.*

## **4.2 Ethereum-based Metaverse**

The Metaverse is a three-dimensional virtual space where social and economic activities are commonly used just like the real world. NFT plays a role of mediating interaction and proving private property within the Metaverse world. An example of NFT application is the CryptoKitties. It is a blockchain-based cat reproduction game. CryptoKitties is an Ethereum ERC-721 token-based DApp [11]. Game users are given only one cat in the world in CryptoKitties. Cat digital assets have a rarity because they contain a separate unique recognition value, unlike existing virtual assets. In general online games, when the service is terminated, there is a problem that the character developed in the game can no longer be owned. However, digital assets with NFT technology can be distributed and stored by individual participants connected to the network to prove ownership.

Decentraland implemented the concept of real estate in the Metaverse by combining virtual reality and blockchain technology [12]. Decentraland made it possible to purchase land, a virtual real estate, using MANA, an ERC-20 token. Users can freely place buildings on land purchased from Decentraland, earn income by attaching billboards to buildings, or open exhibitions by collecting rare digital content. Land ownership and other collectible items are ERC-721 non-fungible tokens. These unique assets are made through Ethereum smart contracts and allow owners to prove ownership on the blockchain ledger. Cryptocurrency MANA can be purchased on exchanges and can also be used to purchase digital goods and services around the world.

Enjin Coin is a cryptocurrency project created for game item trading, and is an integrated platform for creating blockchain-based games. Enjin is a smart contract platform based on the Ethereum blockchain, and is a protocol and cryptocurrency that supports the crypto needed to create, manage, and implement virtual goods for game developers, content creators, and game communities. Ethereum-based ERC-20, ERC-721, and ERC-1155 token items can be stored and managed in a mobile cryptocurrency wallet. Enjin Coin guarantees the ownership and currency value of game items used in all games. When Enjincoin is applied as a currency in Metaverse, it can be used not only as a currency in Metaverse, but also in the real world with the value of currency.

## **5. Complementary point of Blockchain and artificial intelligence**

### **5.1 Artificial intelligence and blockchain**

Through the cognitive revolution, the agricultural revolution, and the scientific revolution, humans have entered the stage of connected intelligence, which uses the combined intelligence of humans and machines. As in the movie *The Matrix*, a symbiotic relationship between humans and machines has begun, and artificial intelligence and blockchain technology are accelerating this.

Artificial intelligence is reaching a stage where prediction and creation are possible through pattern recognition and learning using large amounts of data. And artificial intelligence is helping people to reduce repetitive tasks and human errors. Blockchain technology has deeply entered our society as a digital asset and is developing into a safe and reliable transaction through decentralization. Artificial intelligence is the core of the Fourth industrial revolution, and it can be integrated with blockchain technology to make both artificial intelligence and blockchain more powerful [13]. Artificial intelligence and blockchain can change business models and have a transformative impact on society.

## **5.2 Blockchain for artificial intelligence**

Artificial intelligence has a centralized nature where data is centrally managed and stored, making it a target for hacking and manipulation, which can lead to data tampering. In addition, since the source and reliability of the source for generating data are not guaranteed, there are many errors and risks. The blockchain capabilities of immutability, origin and control mechanisms have the potential to address the shortcomings of artificial intelligence and improve the accountability of trust, privacy issues and decisions. The combination of blockchain and artificial intelligence can help enable trusted digital analysis and decision-making on vast amounts of data. And it can be used to create secure data sharing and make artificial intelligence explainable, as well as regulating trust between devices that cannot trust each other [13].

## **5.3 Artificial intelligence for blockchain**

Integrity of blockchain data is guaranteed. However, the security of applications built on top of the blockchain platform is not secure. Also, when a new block is added to the blockchain and consensus of all nodes is required, a problem arises that it cannot be used efficiently in fields that require high speed. When an error or vulnerability is found in the script of a smart contract and needs to be corrected, the irreversibility of the blockchain can hinder it. The case of hacking tens of millions of dollars in crypto currencies using vulnerabilities in smart contract algorithms reminds us of the need for agents that can immediately compensate for imperfect algorithms [14]. In such cases, machine learning systems of artificial intelligence can improve the security of blockchain applications, adjust dynamic parameters for scalability, and provide effective personalization and governance mechanisms.

Netflix provides a list of related movies related to your favorite movies, but this is the result of Netflix's central server analyzing personal information. If you do not provide personal information to Netflix, your personal information will be protected, but you will not be provided with personal taste analysis. Instead of collecting data on a central server, you might consider making use of data stored on a decentralized blockchain. However, in the case of a public blockchain, anyone can look into the transaction ledger, so there may be a risk of invasion of privacy as well. Although it is possible to allow individuals to directly control personal information in the blockchain, there is a risk of incurring a lot of cost. Artificial intelligence can provide customized services to individuals without violating personal information. Artificial intelligence can perform analysis on the user's local device and not perform analysis that is not permitted in advance. Artificial intelligence can realize decentralization so that real individuals have control over personal information [15, 16].

## **6. Blockchain and artificial intelligence encounter in the Metaverse**

Blockchain plays an important role in implementing the economic system in Metaverse. The economy of Metaverse without blockchain will eventually be controlled by someone. If the blockchain is not supported, it is difficult for resources or goods used in the Metaverse world to be recognized for their value or to have economic interactions equivalent to the real economy. NFT-based blockchain technology further activated the Metaverse. With the advent of WEB 3.0 and Blockchain 3.0, Metaverse becomes the world to realize it.

In the Metaverse, people appear by scanning themselves in 3D or transforming them into avatar characters. Characters in the Metaverse are recognized as beings

like clones in real life, not just game characters. In the Metaverse, besides their own avatars, they create things that can express their uniqueness. And to prove this, the NFT technology of the blockchain is used.

### **6.1 High quality learning data**

In the real world, the problem of people's time, labor, and cost is easily replaced by using artificial intelligence in Metaverse. In the real world, when delivering news, you have to go through a lot of work, such as recruiting an announcer, shooting in a studio, and editing video. However, in the virtual space, by utilizing an artificial intelligence announcer, it is possible to deliver urgent and important news quickly and continuously for a long time. In order to deliver news in the Metaverse, it is necessary to learn the facial expressions, muscle movements, voices, nuances, and gestures of real announcers. When learning by receiving a long-time news video from a broadcaster to make an artificial intelligence announcer video, we extract only the part where the voice of another reporter and noise-free data, and the announcer's face and voice come out clearly toward the camera, and only detect a specific person techniques must be applied. If you use blockchain meta-information when searching for various data like this, you can select only the pure data necessary for learning and induce high-quality learning. Metadata stored within the blockchain block makes the necessary high-quality data selectively available. It is created as reliable data in the Metaverse, which increases the number of users who use the Metaverse.

### **6.2 Reusable data**

Recently, creative activities in Metaverse are often developed using artificial intelligence instead of real people. When artificial intelligence artists creates works, they learn about the trends and styles of the works, and then express what they learned for creation. In the past, a lot of data was used for style analysis. Now, artificial intelligence artists store the data in the distributed ledger so that it can be easily selected and reused. Acquiring more data and practicing iteratively reduces the chance of selecting the wrong data and shortens validation time.

### **6.3 Stable decentralized network**

Metaverse is a virtual 3D environment that requires a large amount of data and server capacity. However, controlling through a central server can incur a lot of cost. By utilizing the distributed environment system of blockchain, it is necessary to have a network system that can use the Metaverse environment with each individual's PC computing. When individuals control the Metaverse environment they want to use or view, the burden of centrally managing vast amounts of data can be reduced. It can also prevent some big tech companies from monopolizing the Metaverse environment.

### **6.4 Privacy**

There is a need for a system that can govern so that ethical problems do not arise with respect to persons belonging to the Metaverse. Only the publicly available information about real and virtual people should be made known. And a personal information security system should be applied to prevent any damage to privacy. However, digital virtual people have no legal basis, so they are easier to manipulate or transform photos than real people, and there is a concern that the wrong algorithm

may be applied, which may lead to serious racial and gender discrimination. With regard to personal information, it can be safely protected with blockchain to prevent external attacks. If personal information is erroneously altered, it can be managed responsibly with a clear path that can be traced based on the time of occurrence.

### **6.5 Distinguishing between virtual and real**

In order to create a stable environment in which users are not confused in the Metaverse, a device that can distinguish between artificial intelligence and real people is needed. The fictional characters used in the Metaverse have now reached a level where it is difficult to distinguish the real from the fake from the human point of view. A reliable data construction system is needed to inform the comparison and judgment between real and fictional people. Data should be transparent and descriptive so that fake news and fake photos can be identified. Data content should be stored in a blockchain so that people can accurately know and understand the data generated by artificial intelligence and know the detailed history if desired. Blockchain technology can be used as a data to explain the data generated by artificial intelligence.

### **6.6 Rich content**

We are using artificial intelligence technology as a way to imitate human behavior and replace it. Artificial intelligence analyzes the user's behavioral patterns such as words and messages in the Metaverse to predict the user's personality, intellectual level, and economic level. Metaverse uses artificial intelligence to create human-like voices and unique content. These data can be automatically converted into games, YouTube, news, advertisements, and lecture materials by simply inputting simple information. It is possible to create vast pattern content that imitates human behavior by using artificial intelligence technology with the vast data needed for the Metaverse world. With blockchain, personal information can be safely protected and various types of content can be created more abundantly.

### **6.7 Economic virtuous cycle**

In investment and business, artificial intelligence can be used to make decisions about which data to use. It is important to have more reliable data in changing forecasts. If blockchain data is used, more reliability can be guaranteed through history management, thereby increasing the reliability of business predictions. In addition, the Metaverse Marketplace can be further activated through the payment of tokens and coins based on blockchain technology.

## **7. Conclusion**

In the Metaverse, various and large amounts of secondary and tertiary data are generated due to the activities of many users. In the blockchain-based Metaverse, this data has a unique identification tag and is used as traceable data. Such data is becoming a good material for artificial intelligence in the Metaverse. Metaverse uses artificial intelligence and blockchain technology to create a digital virtual world where you can safely and freely engage in social and economic activities that transcend the limits of the real world, and the application of these latest technologies will be accelerated. Artificial intelligence and blockchain technology are expected to play an essential role in the ever-expanding world of the Metaverse.

## **Conflict of interest**

The authors declare no conflict of interest.

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