

Application of Blockchain Technology in Cryptocurrency

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Abstract. This review focuses on blockchain technology, and its application and common problem with reference solution. The blockchain technology is nascent and complex and involves many different fields, which leads to the development of cryptocurrency. However, the cryptocurrency has high volatility that demands prompt solution. Deep learning technology is considered as a promising approach to address this issue. After research, this paper develops four models with high efficiency and accuracy, including NLANN, JNN, LSTM and GRN to realize prediction in cryptocurrency.

Keywords: Blockchain technology, cryptocurrency, volatility, deep learning technology.

1. Introduction

Blockchain technology is an innovative computer application based on the P2P (peer-to-peer) distributed database, cryptographic technique, timestamp technology and blockchain technology. The major development of blockchain is the application of cryptocurrency. As the traditional payment relies on the third party to process with limited amount, lacks in transparency and flexibility. While the cryptocurrencies can make online transactions more secure and faster without the third party involved. Among them, Bitcoin, Ethereum, Ripple and Litecoin. There's one main problem in cryptocurrency is high volatility. In order to solve this problem, deep learning technology is adopted with high accuracy in predicting time-series phenomenon and the four most promising models are put forward.

2. Main Body

2.1 Blockchain

2.1.1 Definition

Blockchain originated from Bitcoin that is brought up by Satoshi Nakamoto, which illustrates the concept of the electronic cash system based on the P2P (peer-to-peer) distributed database, cryptographic technique, timestamp technology and blockchain technology.

In a narrow sense, blockchain is a series of blocks arranged in chronological and uses cryptography to make sure once any element of blockchain cannot be modified after it has been added to the blockchain.

In a broad term, block chain data structure is developed to verify and store data, distributed node algorithm is called to achieve data generation and update, cryptography ensures the security of transmitting and accessing data, and using intelligent contract composed of automatic script code with the purpose of programming and manipulating data.

2.1.2 Architecture

As shown in Figure 1, the data layer, network layer, consensus layer, incentive layer, contract layer and application layer form a whole blockchain system.

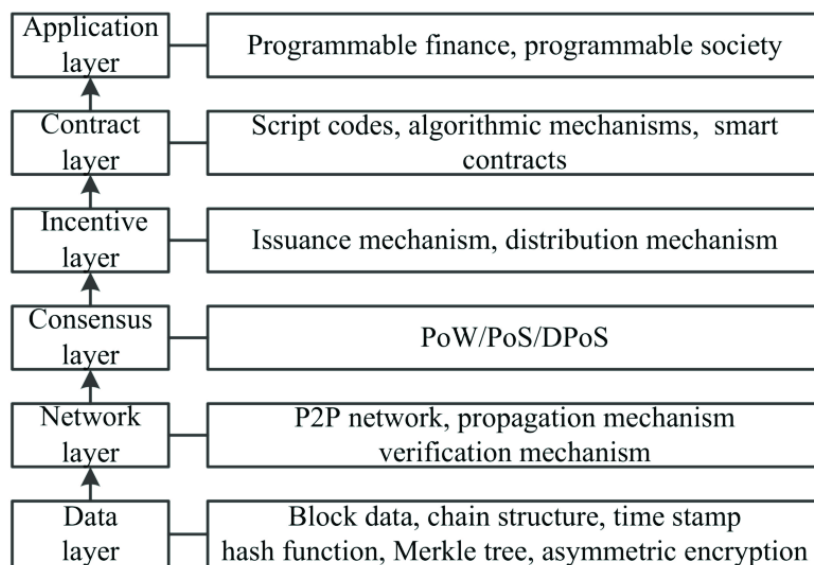


Figure 1. The architecture of blockchain

2.1.3 Characteristics of blockchain

The blockchain has five main characteristics, which will be shown in the Figure2 and the following. The first feature is decentralization. Since the blockchain utilizes the P2P network mode that means every node in the blockchain will play an equal role. The data is generated and stored by all of them. In addition, the destruction of any node within the system will not affect the operations of the blockchain system. Secondly, the openness as the data exchange in this system does not require mutual trust. Except for the encryption of private information of all parties, the data are open and available for all nodes, which is anyone can doubt the blockchain data information. While mutual trust is needed for information updating that makes it impossible to deceive other nodes and also makes the whole system open and transparent. Thirdly, the Immutability. Due to the technologies being used in blockchain, it cannot be forcibly cracked by cryptographic means unless more than 51% of nodes are controlled at the same time. Thus, even if one node's data is tampered, it will not affect data on other nodes, which ensure the systems' stability and credibility. The next feature is Integrity. The blockchain ledger cannot be edited or deleted once the data is added or the transaction is completed. Merkle tree is the essential data that ensures the integrity of data in the blockchain. Finally, the last characteristic is anonymity since there is fixed algorithm acting as the rules in the blockchain that means parties are not required to exchange their identities.

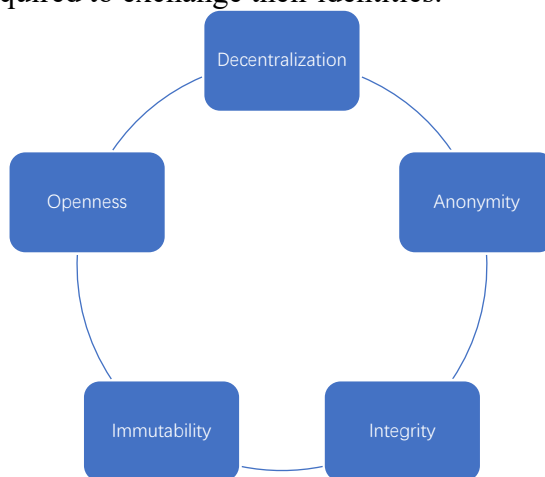


Figure 2. The key features of the blockchain

2.1.4 Development

The evolution of blockchain can be classified into three stages: Blockchain 1.0, Blockchain 2.0 and Blockchain 3.0. Firstly, Blockchain 1.0 is characterized as a digital currency system, which is mainly represented by Bitcoin. Except for Bitcoin, there are more than 600 types of cryptocurrencies have been established. After the development of crptocurrencies, Blockchain 2.0 focuses on financial sector and the emergence of smart contract is the hallmark of this generation. With smart contract, the other forms of assets are converted and related together that expand the applications of blockchain. Then, the major character of Blockchain 3.0 is programmable, which means blockchain can be utilized by government, medicine, culture, research and environment based on the internet technologies [1].

For blockchain, according to the prediction on blockchain, its global GDP will achieve by \$1.76 trillion by 2030, which is equivalent to 1.4% of global GDP and the blockchain market grew by 10.27% in 2020 [2]. Besides, blockchain technology has been applied to many aspects and it is getting adopted by more people. From the Figure 3 what can be obtained is the major use cases for blockchain worldwide, including digital currency (33%), data access and sharing (32%), and data reconciliation (31%). Other popular use cases are identity protection (31%), payments (30%), and tracking and tracing (27%) [3].

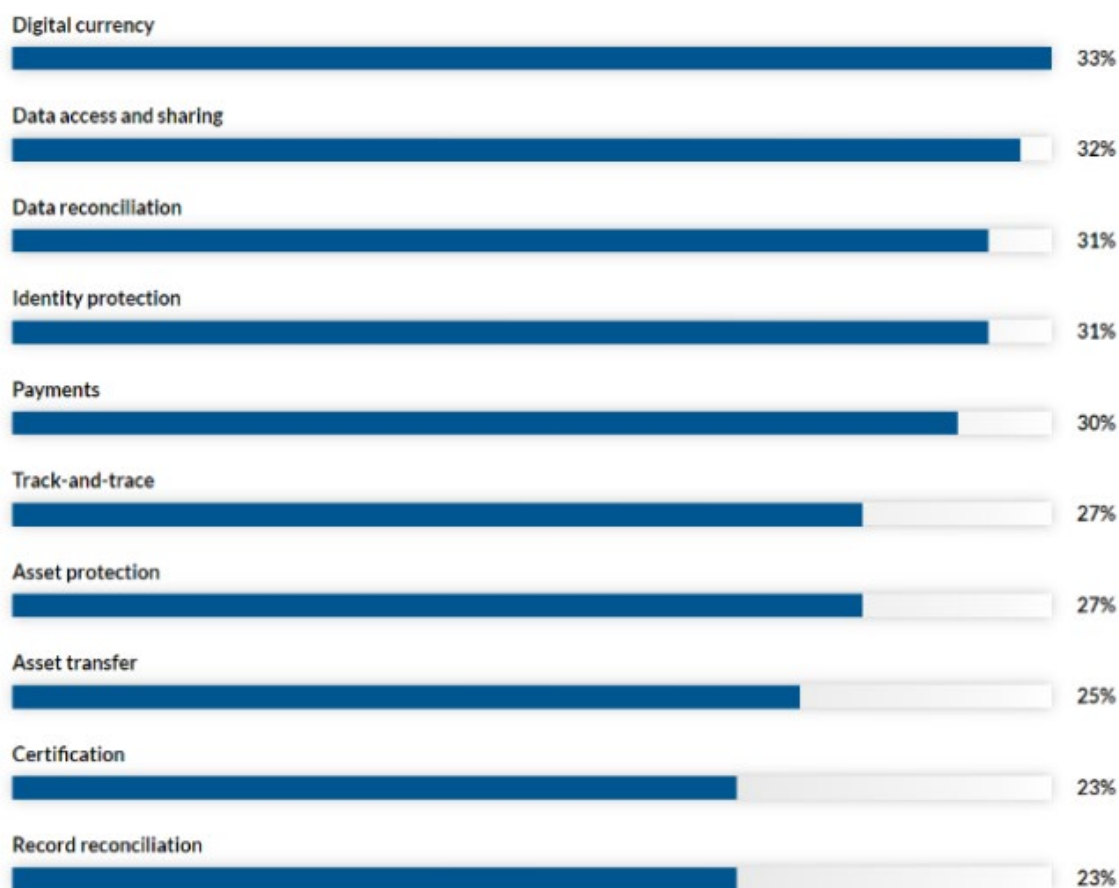


Figure 3. The top 10 uses of blockchain technology

Among these uses, cryptocurrency is a part of digital currency that is developed based on blockchain technology and contributes to 33% which is the biggest ratio of blockchain's application. To be more specific, 63 million unique Blockchain.com wallets were created by 2020. The increasing trend of blockchain wallets continues since 2015 [4].

Blockchain technology is considered as the "next-generation Internet" with the ability to restructure financial transactions, effect individuals' interrelation, and make a difference in economy [5]. Within this, the cryptocurrency is the top priority.

2.2 Major currency

In 2020, Bitcoin takes up 66% in market capitalization, Ethereum (8%), Ripple (4%), Litecoin (1%) and Monero (0.5%) are the following major currencies in market capitalization. Additionally, other cryptocurrencies only occupies the share of 7% in total [6]. As the Bitcoin, Ether and Ripple are the most essential currencies, these will be specified in the following

2.2.1 Bitcoin

Bitcoin is the original cryptocurrency that was established by Satoshi Nakamoto in 2009 to confront with the 2008 financial crisis. Bitcoin is employed to act as a reward for users who starts financial transactions on the blockchain. The significance of Bitcoin is to help decentralize peer-to-peer financial transactions.

2.2.2 Ethereum

Ethereum is the brainchild of Russian-Canadian computer programmer and co-founder of Bitcoin Magazine Vitalik Buterin in 2015. A platform promoting peer-to-peer transaction is conceived which has similarities with Bitcoin, while has additional decentralized applications apps that operate independent of anyone's authority [7]. Thus, it can be applied in Decentralized applications (DApps), smart contract, Decentralized finance (DeFi) and Non-Fungible Tokens (NFTs). And many fields including decentralized gaming, advertisement, metaverse and movies have benefited from it. When comes its hallmarks different from other cryptocurrencies, ethereum is firstly programmable that likes a global computer enables individuals to code it. And the ethereum has faster block time than other cryptocurrencies. What's more, there's no fixed supply for ethereum so that it can produce amounts of currencies as long as it will not cause inflation.

2.2.3 Ripple

Ripple functions like a trusted agency in transactions between parties that can provide convenience for other cryptocurrencies like Bitcoin. When this system is used for transaction, XRP, a kind of cryptocurrency launched in 2021, is utilized to transfer transactions from central database controlled by governments or financial institutions to more open infrastructure. XRP has advantages in cross-border movements with characteristics of trustless, cheap and fast.

2.2.4 Litecoin

In 2011 Litecoin was developed using Bitcoin's source code which also is the first batch of altcoins to be created. It has been the second-most popular cryptocurrency for a long time, and is still widely traded today, with a market cap of over \$6 billion. Compared with Bitcoin, Litecoin is processes with faster transactions processing nearly four times faster than Bitcoin. A finite supply with four times larger than Bitcoin provided is another advantage [8]. While Litecoin still has less utility and social adoption than Bitcoin.

2.3 Cryptocurrency

2.3.1 Definition

Since the first cryptocurrency was invented in 2009, a variety of cryptocurrencies were initiated to satisfy diverse requirements and applications. Cryptocurrencies are digital or virtual currencies underpinned by cryptographic systems, which make online payment more secure without the third party getting involved. Digital payments can be utilized in business transactions, remittances and micropayments that can function securely within the time of an hour or even a few seconds by employing certain cryptocurrencies [9].

2.3.2 Advantages

Cryptocurrencies have six major advantages. Crptocurrencies have no need for financial intermediaries or Money Transfer Operators to complete transaction as the cryptocurrencies can

achieve transactions all by themselves. It provides benefits for regions and countries of reducing cost on bank transactions, like El Salvador became the first country adopt Bitcoin as a legal tender as the remittances make up 23% of its GDP and only 30 percent citizens own individual bank account [10]. Cryptocurrency is also an International currency. Cryptocurrencies are nationally and internationally available and do not belong to any country or organization. Compared with traditional payments, not only can payments be processed and settled faster, but individuals do not need to physically go to financial institutions, no matter what kind of deal is going to be made or what the amount of capital is. Moreover, cryptocurrencies have high security. As the cryptocurrencies are based on cryptographic technologies that make duplication or counterfeit cryptocurrencies impossible. Cryptocurrencies have built-in inflation protection. Inflation is always a significant problem in current financial systems. While cryptocurrencies are distributed with standard circulation supplies which makes it immune to inflation. The last advantage of cryptocurrency is transparency. The cryptocurrencies are based on blockchain to function, which stores data in multiple computers and every user has a key that provide them with transparency and security.

2.3.3 Disadvantages

Cryptocurrencies also have three disadvantages. The main one is lack of supervision. Since the blockchain and cryptographic technology is so complex that requires amount of technical knowledge which may increase the difficulty for government and market to supervise. The transaction between cryptocurrencies are irreversible. Once the transactions are completed, there's no refund or cancellation which may provide chance for outlaws to cheat others' money. Illegal behavior may occur if cryptocurrencies are employed. Since the user's information cannot be tracked down by government, cryptocurrencies can generate a dark web or black market to do illegal deals [9].

2.3.4 Cryptocurrency volatility

All assets will experience price fluctuation during valuation which is called volatility. Volatility is one of the most essential and common risk measure in finance. To be more specific, high volatility means high risk in investment. The price can fluctuate dramatically in a short term which may bring more probabilities of high interest and also high loss. In this case, the assets with high volatility is more difficult to predict.

According to Figure 4, 5 and 6, the market price of Bitcoin, Ethereum and XRP has changed approximately \$2500, \$200 and \$0.07 respectively which reflect heightened volatility with high frequency and size of price jumps. Thus, it is more than urgent to predict cryptocurrencies' price to some extent to mitigate threats for traditional economy and deter the market from collapsing as more and more users step in cryptocurrency market.

In order to solve this issue, the deep learning technology is adopted in this paper.



Figure 4. The price volatility of Bitcoin

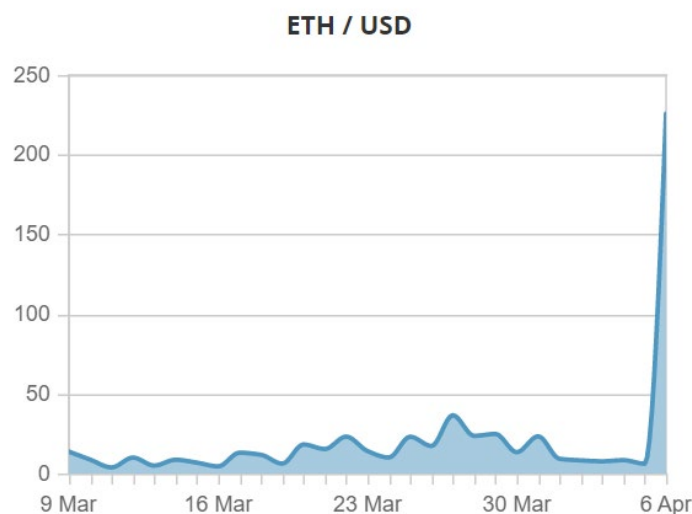


Figure 5. The price volatility of Ethereum

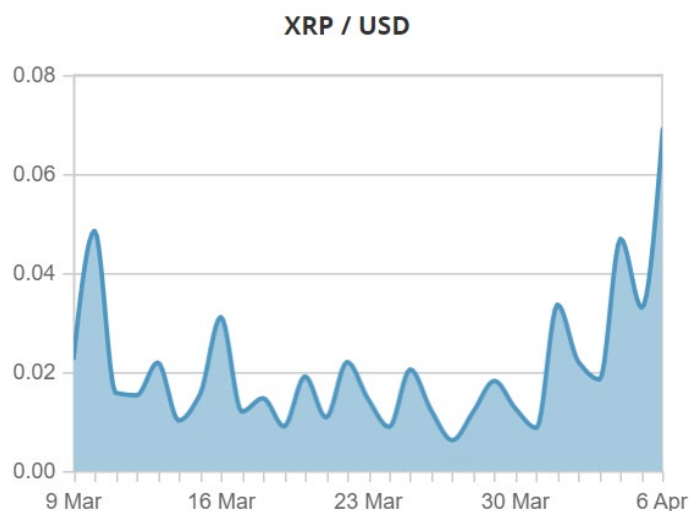


Figure 6. The price volatility of XRP

3. Deep Learning Techniques

Deep learning (DL) originating from the concept of artificial neuron network (ANN) is a branch of artificial intelligence (AI) and machine learning (ML), which is considered as the core technology under the background of the Fourth Industrial Revolution. Deep learning technique is consisted of neuron network which is a nascent and booming technology that is applied in healthcare, visual recognition, text analytics, cybersecurity and other areas. The major task is to find appropriate function to operate the process of deep learning from the dynamic reality, while compared with traditional approaches, it has high accuracy in predicting time-series phenomenon without excessive presumptions which is very promising in the finance field involving large data sets. Thus, this technology is more than optimal to focus on this problem.

3.1 Neuron network architecture

The simplest form of machine learning is consisted of a predator of output (y) under the condition of given input (x).

Deep learning belongs to the machine learning and the special about it is it can learn features from data in different layers of abstraction. The architecture of this approach is founded on L layers and each layer will be given a univariate activation function, f . Then the univariate functions can be conneted together by high-dimensional mapping, F .

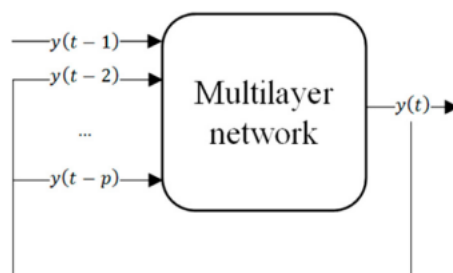


Figure 7. The architecture of the Autoregressive Neural Network

3.2 Model

The efficient models to predict the volatility of cryptocurrencies are the Non-Linear Autoregressive Neural Network (NLANN) and the Jordan Neural Network (JNN) according to D'Amato, and Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) according to Patel, which will be explained further.

3.2.1 The Non-Linear Autoregressive Neural Network (NLANN)

The NLANN constructs a discrete non-linear autoregressive model based on multilayer feed forward network. For feed forward structure, the amount of hidden layers and neurons can be adjusted and improved by a trial and error procedure with the function of the mean of the squared errors.

3.2.2 The Jordan Neural Network (JNN)

The JNN is a kind of Recurrent Neuron Network brought up with Jordan with provided feedback from output to input. These recurrent networks associate static patterns with output patterns that are sequentially ordered. Hidden nodes visualize their own previous output to serve as a guide for subsequent behavior [11]. That makes it suitable for modeling time series.

3.2.3 Long Short-Term Memory (LSTM)

The LSTM is a deep learning technology based on RNN and LSTM can be seen as an improved RNN with unlimited stored information. And a standard LSTM cell is consisted of an input gate, an output gate, and a forget gate that control the flow rate of information.

3.2.4 Gated Recurrent Unit (GRN)

The GRN is a gating mechanism in RNN that assembles LSTM with a single nuance of the absence of output gate. Thus, GRU has the ability to solve the vanishing gradient problem by only using two gates, including an update gate and a reset gate. The information flowing into memory is managed by the update gate, and the information flowing out of the memory is under control of the reset gate. The update gate and reset gate are two vectors that decide which information will get passed on to the output.

4. Conclusion

In this paper, the prediction of cryptocurrency volatility dynamic is addressed. The price of cryptocurrency shows dramatically high volatility due to speculative behaviors in market. Thus, deep learning technology which is suitable for time-series analysis is adopted in this paper and four efficient methods are put forward, including NLANN, JNN, LSTM and GRN. Both NLANN and JNN are provided with feedback to previous layers. And LSTM and GRN performs well under this problem due to its ability to remember and extract the temporal features of data.

Deep learning is quite potential in predicting volatility of cryptocurrency which offers direction for future research.

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