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The Influence of Digital Currency Popularization and Application in Electronic Payment Based on Data Mining Technology

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ABSTRACT

The rapid development of science and technology has provided us with great convenience, and the payment methods are gradually enriched. On the basis of traditional electronic payment, digital currency has emerged as the times require. As a strategic currency, it is very necessary to supervise the market status during its whole life. In this paper, the authors propose a scenario payment identification model based on RNN network to identify different scenarios of electronic payment for the intelligent analysis of digital currency. On this basis, PSO is adopted to optimize the initial parameters of the model to improve the accuracy of model identification. Finally, the high-precision identification of different electronic payment means in multiple scenarios was completed, providing detailed data reference for the development of electronic payment market and digital currency, thus providing an objective basis for policy formulation and adjustment in the next stage.

KEYWORDS

Digital Currency, Electronic Payment, PSO-RNN

INTRODUCTION

A new round of scientific and technological revolution is coming, the global digital economy is growing, and digital currency has emerged as the times require (Daradkeh, 2022). The value of digital currencies issued by the private sector, represented by Bitcoin, Diem coin and USDT stable currency, fluctuates greatly and is highly speculative, which may impact a country's monetary sovereignty and financial stability (Sharif et al., 2020). In order to better adapt to new business types and models, build an efficient and safe payment and settlement system, and upgrade digital financial infrastructure, digital currency with credit endorsement, stable currency value, and universal acceptance has become an important choice for major central banks in the world. In recent years, major central banks around the world have accelerated the research and development of central bank digital currency, enabling the operation of a monetary system with blockchain technology, digital encryption technology, distributed bookkeeping technology and other technologies, and promoting the "digitalization" of payment means

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(Wu et al., 2021). As a new sovereign currency, it completes transactions through electronic payment, so it is crucial to study its relationship with the current electronic payment platform for the future impact on the existing monetary system, future monetary policy regulations, and the future trend of electronic payment (Mishara, 2020).

The operation modes are mainly divided into two types: independent gateway mode and credit intermediary mode (Alkhwaldi, 2022). The independent gateway model is the initial mode of electronic payment, and it is an independent enterprise. Such platforms connect users at the front end with banks at the back end. Based on online banking opened by banks, users conduct business transactions through online services provided by banks, thus enhancing the intermediary role of banks between buyers and sellers (Albastaki, 2022). Due to low-technology, relatively poor transaction security, and narrow profit space, this operation model has been gradually eliminated by the market, and replaced by the credit intermediary model, i.e., third-party payment (Lai et al., 2022). In the credit intermediary mode, after confirming the goods to be purchased, the buyer will use the account registered on the platform to make payment. The payment will be handed over to the electronic payment platform. After the platform confirms receipt, the seller will be informed that the buyer has paid for the transaction and asked to ship the goods as soon as possible. After the buyer receives the purchased goods, after checking the receipt, it indicates that it has confirmed the receipt notice or implied. When the logistics show that the goods have been received within the time limit determined acceptable according to the nature of the goods and the shipping method, it will notify the third party and then the payment for goods will finally reach the seller's account.

The most representative electronic payment platforms are Alipay and WeChat payment, both of which are widely used in everyday life (Ehiedu, 2023). At the same time, in order to break through the monopoly and blockade of developed countries in the international settlement system, help the renminbi (RMB) further move towards the international market, and improve the electronic payment system, the digital RMB process of the Central Bank was officially launched in 2014 (Al-Ammal, 2020). Although digital currency electronic payment (DCEP) is a new currency constructed by the blockchain and electronic encryption technologies for national credit endorsement, it is a payment instrument with value characteristics and legal compensation issued by the People's Bank of China, which is presented in a digital form and has the same functions and attributes as paper money. However, domestic issuance still faces many challenges, including legal, circulation, financial, and technical problems (Luna, 2019). Therefore, it is urgent to conduct a more accurate analysis of the current electronic payment market through intelligent means to complete the timely adjustment of monetary policy and ensure that it can move towards the expected goal (Alzoubi et al., 2022).

With the continuous development of computer technology and artificial intelligence technology, as well as the improvement of electronic payment information, electronic payment scenarios are identified based on data mining technology. The proportion and related changes of different payment means under different payment scenarios in a certain region are analyzed, which can promote both the commercial development of the product itself and the prosperity of the local economy. According to the account information of internal merchants in the region and the electronic payment data mastered by local banks, the overall evaluation and analysis of electronic payment in the region can be conducted (Ozili, 2022). Digital payments have become an integral part of our daily lives. The emergence of new technologies and the increasing adoption of digital payments have opened up new opportunities for research in this area. To promote the development of the digital payment, companies can collaborate with industry partners, create research clusters, and offer training and workshops. The relevant payment data collected by merchants are generally time series data with a certain time correlation. It is a special time series to record the time point, merchant name, and consumption amount. Therefore, such data can be processed by machine learning methods. Traditional classification methods, such as k-Nearest Neighbor (KNN) and Support Vector Machines (SVM), are difficult to achieve ideal results for data with strong time correlation, while the calculation of statistical learning methods is also inconvenient for such multi-modal data processing problems

involving numerical quantification (Masini, 2023). Therefore, this paper chooses the mainstream and mature neural network method to process the regional internal data. BP neural network has strong nonlinear mapping ability, self-learning adaptive ability, and fault tolerance ability. When it is applied to multi-modal data classification analysis, it has the advantages of high prediction accuracy and fast training speed, among others (Jian, 2020). On this basis, given the time sequence regularity of data, recurrent neural network (RNN) has higher accuracy in the classification of such data (Rahhal, 2020). Compared with the traditional neural network, the cyclic neural network adds the input state of the last moment in the function input process, which allows it to remember the output state of the last moment, giving it advantages in processing time series. For the neural network related models, the selection of initial value is very important. Optimizing the initial value can avoid the problem that the model has difficulty reaching the optimal value due to the local optimal value in the back propagation process of weight calculation. Therefore, it is necessary to optimize the initial value through statistical methods to ensure the optimization of the model.

According to the intelligent analysis needs of digital currency and electronic payment in this region, this paper uses artificial intelligence RNN technology to classify and analyze the digital currency usage scenarios in the local electronic payment scenarios, so as to understand the current development status of digital currency. The contributions are as follows:

1. Based on historical data, this paper analyzes the use proportion and preferential conditions of various types of electronic payments in the region.
2. In order to improve the performance of the model and provide more accurate reference results, this paper uses particle swarm optimization (PSO) technology to optimize the initial parameters of the model in order to achieve the optimal effect.
3. We also compared the result with the traditional models and results show the proposed framework can achieve a higher recognition precision, which can provide a positive reference for exploring digital currency circulation.

METHOD

RNN-Based Payment Scene Recognition

The traditional neural network structure is illustrated in Figure 1. It can be regarded as a black box (Meng et al., 2012) that can be used for any function. With sufficient data, given a specific input value, multiple neurons in the hidden layer can be used to achieve the desired output fitting (Lou, 2012).

After the training of the neural network model, the corresponding output value can be obtained by giving a new input at the input layer according to the defined data format. However, for traditional neural networks, the input is all independent information, and there is no relationship between the input at the previous moment and the next moment. However, in practical applications, such as consumers' daily consumption data, the relevant information is highly related to time, and the input of the previous time has a certain impact on the next time. In order to solve this problem, RNN was proposed (Bai et al., 2020).

RNN is also composed of input layer, hidden layer, and output layer. A simple RNN is given in the left part of Figure 2. Compared with the traditional fully connected neural network, there is a recurrent layer in the hidden layer. In the hidden layer, its value s is not only determined by the input x at this moment, but also related to the s value of the last hidden layer. The additional w in the recurrent layer is the input weight of the last value of the hidden layer. By expanding it on the timeline, we can more clearly understand the input and output relationship at each time. From the right half of Figure 2, we can find when the network receives the information xt at time t, the status of the hidden layer is st and the output value is ot. It can be seen that the value of st depends on both xt and $st\text{-}1$. This process can be abstracted as formula (1) and (2) (Parl et al., 2019):

Figure 1. The structure of neural network

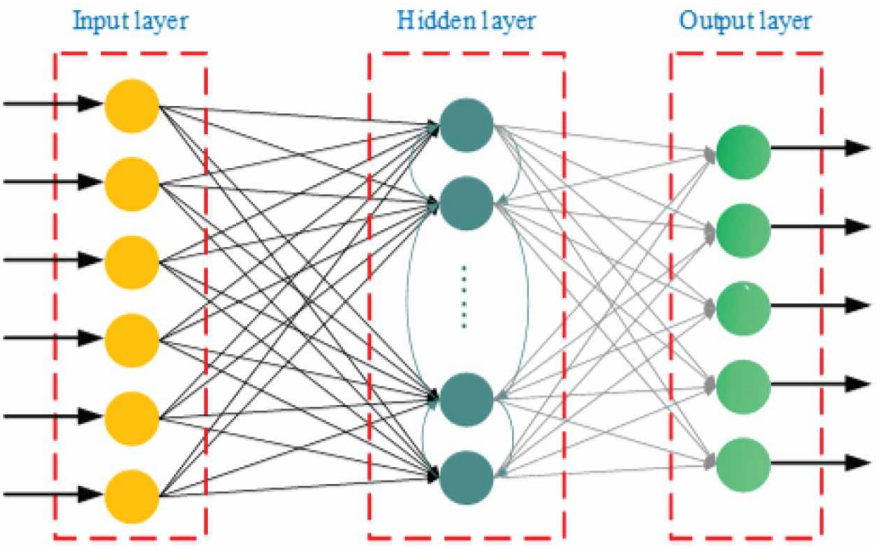
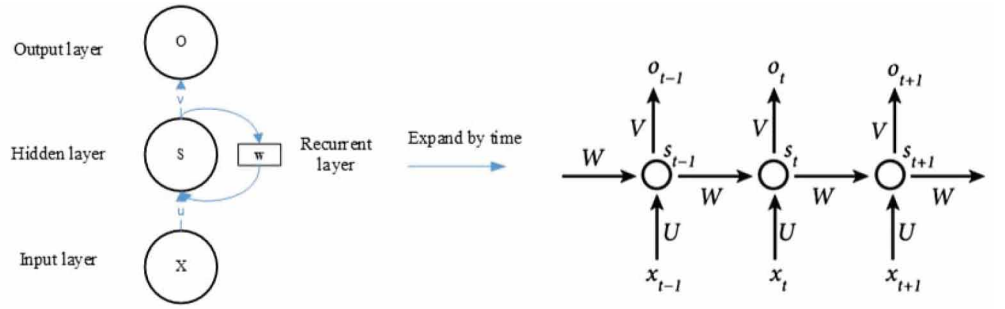


Figure 2. The framework of RNN in time sequence



$$O_t = g(V \cdot S_t) \tag{1}$$

$$S_t = f(U \cdot X_t + W \cdot S_{t-1}) \tag{2}$$

PSO-Based Model Optimization

The neural network related methods usually use the steepest descent method to learn and optimize the network weight when optimizing the model, so there is a certain sensitivity to its initial value. If the initial value is selected improperly, the algorithm will converge to the local extreme point, which will greatly reduce the performance of the model (Rokbani et al., 2013). Therefore, this paper intends to use the particle swarm optimization (PSO) method to globally optimize the initial value of RNN, so as to improve the network performance. The performance of particles is evaluated by fitness (Kefei et al., 2013).

The particles in the particle swarm are defined as follows:

$$P_j = \left[C_j \varepsilon_j \sigma_j\right] j = 1,2,\ldots,Q \tag{3}$$

where Q is the particles number totally, C, ε, and σ are the particle properties.

First, initialize the particles randomly and then update particles iteratively. Each particle in iteration *k* is defined by three characters: (1) location in search space $P_j(k)$; (2) the best position $P_{jbest}(k)$ at *k* iteration; and (3) flight speed $V_j(k)$.

In addition, global optimal position of the entire particle swarm is defined as $P_{jbest}(k)$, so the function of velocity V_j and position P_j updated iteratively by each particle during flight is defined as:

$$\alpha(k) = (\alpha_{\max} - \alpha_{\min})(k / K)^2 + \alpha_{\min} \tag{4}$$

$$c_1(k) = (c_{1\max} - c_{1\min})(k / K)^2 + c_{1\min} \tag{5}$$

$$c_2(k) = (c_{2\min} - c_{2\max})(k / K)^2 + c_{2\max} \tag{6}$$

$$v(k+1) = \alpha(k)v_j(k) + c_1(k)r_1\left[P_j(k) - P_{jbest}(k)\right] + c_2(k)r_2\left[P_j(k) - P_{gbest}(k)\right] \tag{7}$$

$$P_j(k+1) = P_j(k) + v_j(k+1) \tag{8}$$

where $\alpha(k)$ is the inertial weight of velocity, $c_1(k)$ and $c_2(k)$ is the acceleration coefficient, r_1 and r_2 are independent random numbers located at 0~1, and *K* is the max iteration number. Velocity and position of particles are determined by the optimal position P_{jbest} of individuals and the global optimal position P_{gbest} of the entire particle swarm. In addition, in order to prevent PSO divergence caused by randomness of r_1 and r_2, the particles position should be limited by $\left[P_{\min}, P_{\max}\right]$. PSO is adopted to optimize the parameters in RNN and the specific process is shown in Figure 3.

EXPERIMENT RESULTS AND ANALYSIS

The Recognition of the Electronic Payment Using Digital Currency

This paper selects the electronic payment data of this region in recent years and inputs the data in the form of time series into the RNN model proposed in Section 2 for identification. First, the identification of different scenarios under the use of currency payment is completed. The results are shown in Figure 4.

As illustrated in Figure 4, the RNN model used in this paper has a high recognition rate for the use of digital currency scenarios, which exceeds 90%, and the highest recognition rate appears in the shopping scene. This is because among the merchants in this region, the shopping area is relatively centralized, and the large shopping malls can greatly reduce the training process of the model and improve the accuracy rate through centralized collection. However, the recognition rate of transportation scenarios using electronic currency payment is low because, compared with traditional advanced methods and other well-known electronic payments, there are fewer people using electronic currency in this scenario, resulting in fewer samples. However, since transportation scenarios often overlap with other scenarios, some of them are recognized as other scenarios, which reduces the accuracy of recognition.

The Payment Comparison Among Digital Currency and Others

According to the data provided, after the division of digital currency in different scenarios is realized according to the RNN model, this paper also uses the RNN model to conduct statistical analysis on different electronic payment means in different scenarios. The results are given in Figure 5.

It can be found from Figure 5 that in all electronic payment scenarios, the proportion of WeChat payment is the highest in most scenarios, which is closely related to its huge user numbers, followed by Alipay, also because its development occupies a certain number of customers earlier. From the

Figure 3. Flow chart of PSO optimization

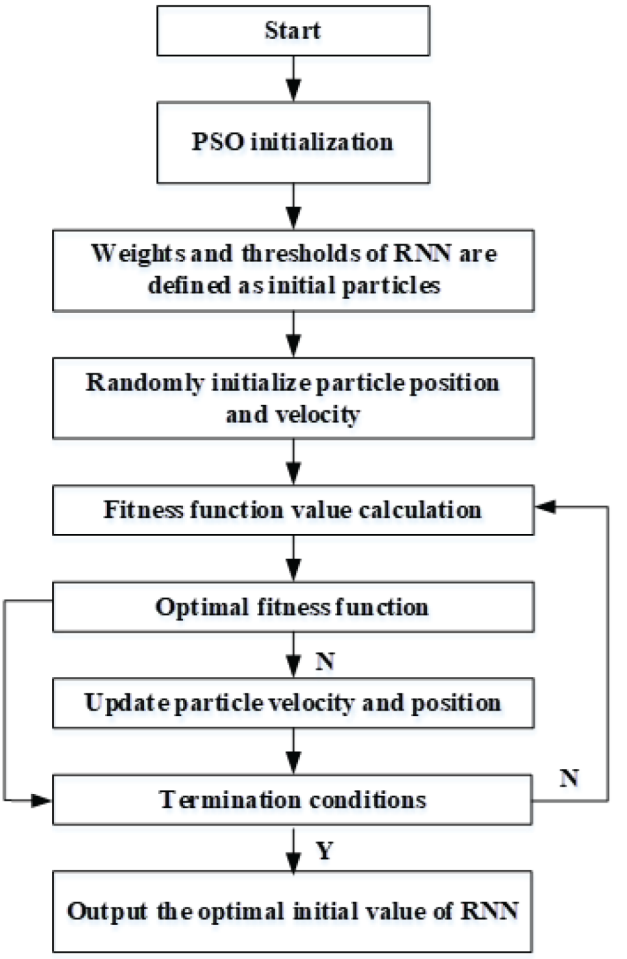


Figure 4. Payment identification result using digital currency

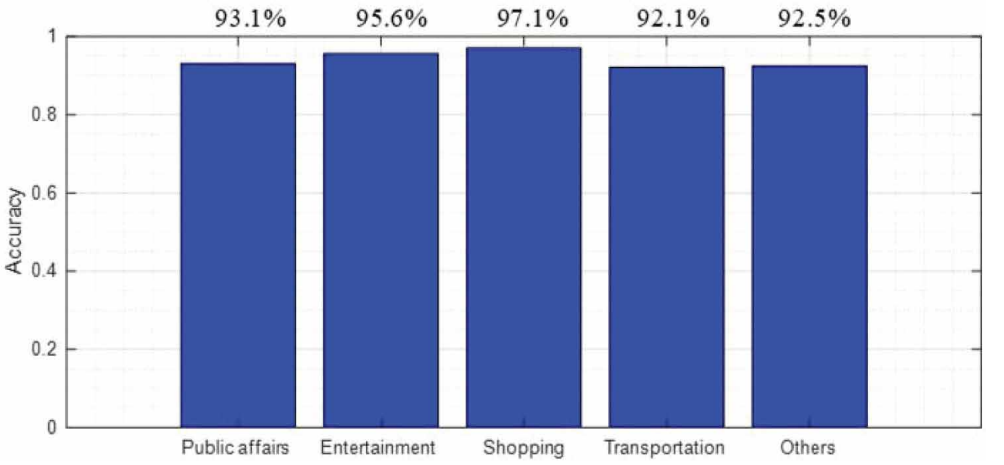
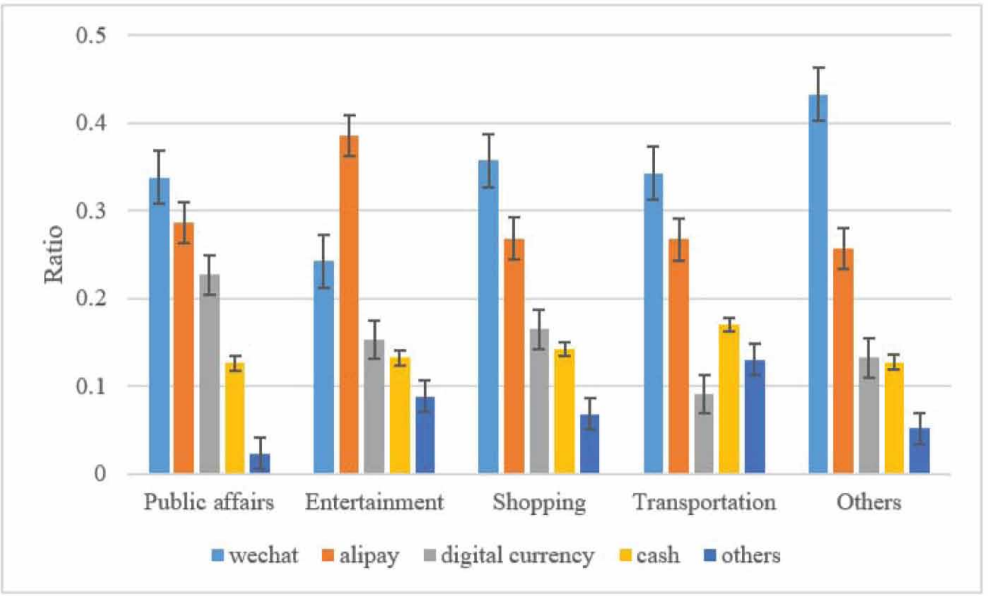


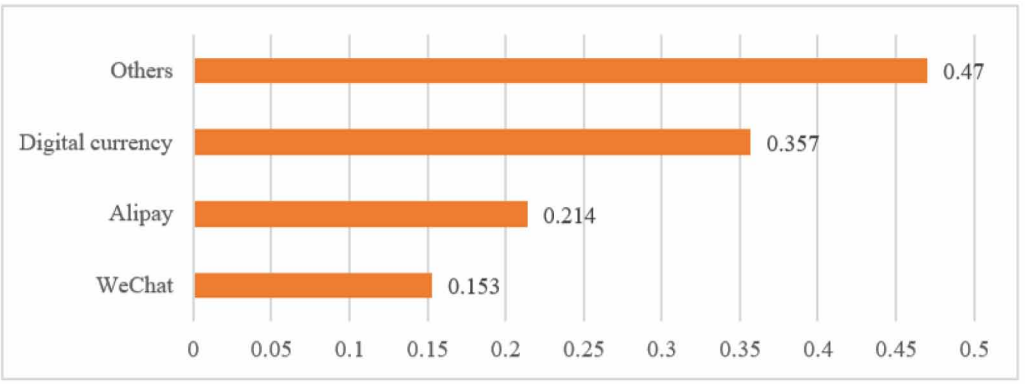
Figure 5. Payment ration in different scenes



entertainment scenarios, Alipay has the highest utilization rate, which may be due to the fact that Alipay provides convenience and a large number of discounts in this scenario. The enormous discounts make merchants vigorously promote this payment method. At the same time, although digital currency has been introduced for a period of time, its market utilization rate in various scenarios is almost the same as that of cash, and it has obvious advantages only in public affairs. It is not ruled out that the influence of the deliberate requirements of the public service unit on the results of payment use can make its digital currency payment ratio higher in such scenarios. On this basis, this paper calculates the proportion of preferences used by different payment methods when using electronic payment according to the identification results. The result is shown in Figure 6.

It can be found that among the electronic payments classified into other categories, the proportion of payment with discount is the largest. This is because these relatively small or professional electronic payment channels will attract people to use them through large discounts to improve their

Figure 6. Ratio of discount use in payment



own use probability. For digital currency, its principle is similar, and its utilization rate will increase when compared with a large discount, which can be illustrated by combining Figure 5 and Figure 6. Although WeChat payment and Alipay offer few discounts, their huge user numbers ensure their leading position in the electronic payment field. At the same time, to better explain the development of digital currency and share, this paper analyzes the market share and activity in each quarter of the digital currency data collected in this region in recent years based on the RNN scenario classification. The results are shown in Table 1.

To more clearly show the market share trend of digital currency in each quarter and year, the statistical chart of each year is shown in Figure 7.

According to Figure 7, the market utilization rate of digital currency does not show an overall trend of increasing year by year. In the first year, we vigorously pushed forward the obsolescence, showing an increase quarter by quarter, and ensured a relatively stable situation in subsequent years. This is because in the first year of use, through various publicity efforts and policy guidance, it has occupied a high market at the initial stage, and with the deepening of preferences and policy guidance, the use rate is guaranteed. However, it can be seen that there was a significant decline in the third quarter of 2021. According to the survey, the electronic currency of a bank was adjusted in this year, leading to a significant decline in its market share. This information has important reference significance for the future development of electronic currency and electronic payment.

Model Comparison Among the Proposed Methods and Others

To verify the superiority of the model proposed in this paper, the scene recognition in the payment scenario analysis proposed above is compared with other algorithms, so as to better promote the accurate analysis and subsequent development of digital currency. Figure 8 shows that, because the selected data is a certain time sequence, the RNN method has certain advantages over traditional classification methods. Even if PSO is not used to optimize the initial parameters, it can achieve good results. After PSO optimization, the advantages of the results are further revealed, and its overall recognition rate is nearly 5% higher than that of traditional methods, which is a great advantage in recognition algorithms.

Table 1. Ratio of digital currency use trend in electronic payment

	Q1	Q2	Q3	Q4
2019	13%	10%	11%	16%
2020	14%	12%	12%	14%
2021	12%	11%	8%	13%

Figure 7. Ratio of digital currency use trend in electronic payment

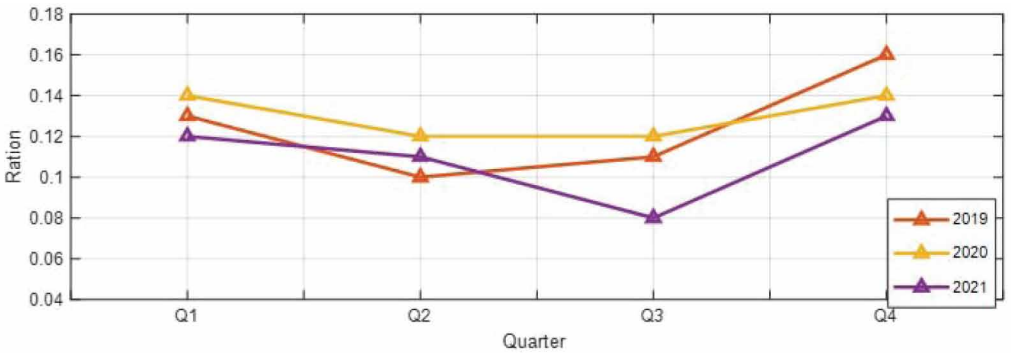
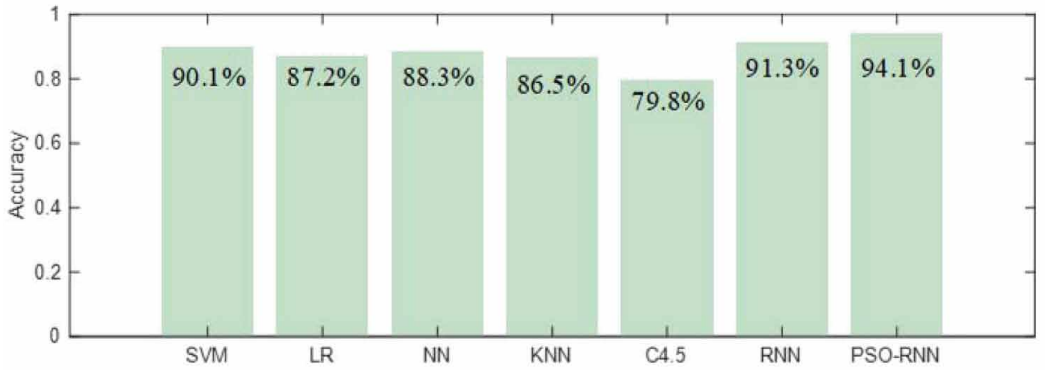


Figure 8. Result of the payment scene recognition using different methods



DISCUSSION

As an emerging currency, digital currency has been met with controversy since its birth. However, as a part of the national financial strategy, the evaluation of the development status of the digital RMB issued by the central bank has important reference significance for future policy guidance. As an electronic payment, digital RMB can be analyzed in detail by means of artificial intelligence, and the whole market context can be grasped by comparing with the development path of traditional electronic payment methods. In this paper, RNN is used for intelligent analysis of local electronic payment data to realize intelligent identification of digital currency usage scenarios, and relevant data analysis is also carried out. From the recognition results, it can be found that the RNN method can better process the electronic payment data every day due to the time series nature, and its recognition accuracy is higher than that of the NN method and the traditional statistical learning method. In the process of establishing the model, because the NN-related method often fails to skip the local optimal value and thus cannot complete the establishment of the optimal model, this paper selects the PSO method to optimize its initial value and has achieved good recognition effect. In addition to using the PSO method, we can try to use Genetic algorithms (GA), Ant Colony, and other methods to gradually optimize the parameters in future research.

Through data analysis, it can be found that, although the current use of digital currency is relatively low and its use frequency fluctuates significantly with the adjustment of policies, its original intention is not only to facilitate people's lives like other electronic payment means, but also to bypass the hegemony of the US dollar and improve the status of the RMB around the world through digital currency (Xu, 2022) . At the same time, digital currency can solve the trust problem of all parties in the payment business (Cheng, 2022). The core issue of payment business is the trust of all parties to the transaction under the environment of asymmetric information and uncertainty. The blockchain technology is the basis of digital currency. Its transaction data exists in a wide range of networks, which eliminates the possibility of forgery and tampering, can effectively ensure the authenticity of transaction information, and achieve mutual trust between all parties to the transaction.

Digital currency can solve the security problem in payment business. Blockchains are chains composed of blocks in a specific order. Each block contains transaction information and a timestamp within a certain period of time, and each block retains the summary information of the previous block. Each block of the blockchain can verify the others to ensure the integrity and non-repudiation of transaction data (Zhang, 2022).

Digital currency can also improve payment efficiency. Through sophisticated structural design, digital currency does not rely on centralized institutions or an intermediary guarantee but is directly

paid by one party to the other in the form of point-to-point. Since institutions are not required to act as independent third parties, efficient transfer of online funds can be achieved.

Digital currency can improve the efficiency of payment supervision. Due to the existence of blockchain, digital currency transactions have a significant chronological order. In addition, it is difficult to forge or tamper with the blockchain, and the regulatory authorities can obtain data such as capital flow and trading partners of digital currency to achieve efficient supervision. Therefore, vigorously developing digital currency plays an important role in both the electronic payment field itself and the improvement of the national financial industry.

CONCLUSION

In light of the demand for market analysis during the current development of digital currency, this paper uses big data on electronic payment in the region for a period to distinguish digital currency and related electronic payment and to identify scenarios through RNN. Based on the results, we analyzed and summarized its current market share, potential challenges, and problems to ensure its sound development. In order to improve the model performance at initialization stage, this paper used the PSO method to optimize the initial parameters to achieve the optimization of the initial value of the model and improve the identification effect. As a new product in recent years, the development path of digital currency is bound to be tortuous. In future research, only by combining more market data to achieve more detailed flow analysis and full cycle path monitoring of digital currency can we ensure its maximum value.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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