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Research on personal credit evaluation of internet finance based on blockchain and decision tree algorithm

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Abstract

With the development of Internet finance, existing financial platforms have gradually formed a large-scale, dynamic operating environment. How to ensure information security and realize personal credit evaluation is an urgent problem to be solved in the development of Internet financial platforms. The rise of blockchain technology has provided new solutions for the management of Internet financial platforms and information security. In view of the shortcomings of the current Internet financial credit evaluation, this article discusses the key standards of personal credit evaluation. With the help of blockchain, decision tree, and other technologies, this paper designs the credit evaluation process and establishes personal credit evaluation technology. Experiments and analyses show that this technology can effectively improve the transparency of personal credit information in Internet finance. This technology is used to study credit risk assessment factors and provide new solutions for the intelligent transformation and upgrading of Internet finance.

Keywords: Personal credit evaluation, Blockchain, Decision tree, Internet finance

RETRACTED ARTICLE

1 Introduction

With the development of the Internet, the position of Internet finance in the capital market is becoming more and more important. As the technical support of digital currency, the technology of blockchain has also received attention from various industries in my country [1, 2]. As a distributed accounting system, blockchain has security, low cost, and high efficiency. At the same time, since most Internet finance deals online, credit risk has become the most important risk in the internet finance market [3, 4].

The blockchain technology built on the P2P system can solve the credit risk of Internet finance. Since the twenty-first century, with the emergence of emerging technologies such as cloud computing and the Internet of Things, the research on personal credit evaluation has developed rapidly [5]. In recent years, many scholars have devoted themselves to the research in this area and have put forward many effective methods and models. From the perspective of social capital theory, Greiner emphasized the problem of information asymmetry in P2P online loan transactions and pointed out that due to the virtual nature of the network, the problem of information

asymmetry between borrowers and investors in the P2P loan model is more prone to problems [6]. Puro constructed a logistic regression model, based on the borrower's credit rating, loan amount and interest rate, to predict the borrower's likelihood of completing the loan [7]. Emekter uses the Fico scoring system to assess its credit risk and repayment performance based on Lending Club's credit data and finds that credit ratings and income to debt ratios have a significant impact on loan defaults.

But in the traditional personal credit evaluation research, there is no complete evaluation technology; especially, the Internet financial platform has the defects of low information transparency and centralization [8]. Blockchain technology can rely on distributed storage architecture, using consensus algorithms, smart contracts, and other technologies to solve the problem of information traceability in the process of information collection and circulation [9].

This article takes personal credit evaluation as the research object and uses blockchain, decision tree, and other technologies to design personal credit evaluation technology. By accessing the Internet financial information collection terminal, personal credit information is dynamically and accurately transmitted to the information blockchain, and real-time tracking and recording of information are realized [10]. This technology can improve the information transparency and data security of the injury information tracing process, realize the effective tracing of information, and provide effective and implementable solutions for promoting the development of the Internet financial cause.

2 Internet finance personal credit assessment

Internet finance is essentially a value exchange across time and space. However, unlike traditional finance, the main body of trust in traditional finance is the central bank, and the central bank will have the obligation of rigid payment, but it also has the power that can be abused. The credit records established on the Internet is searchable records [11, 12].

In a narrow sense, Internet finance tends to establish direct connections between peers, and there are mainly individual-to-person loans in my country. Broadly defined Internet finance includes not only the above, but also crowdfunding and third-party payment [13]. Internet finance can greatly reduce the threshold and improve efficiency. The structure diagram of the Internet finance development model is shown in Fig. 1.

With the development of technology, security, speed, and high yield have become a typical feature of Internet finance. So, in my country, the safety of P2P credit is mainly
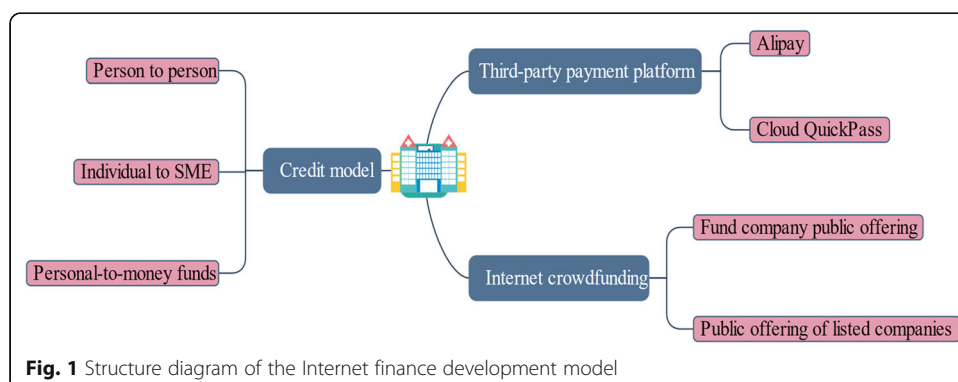

Fig. 1 Structure diagram of the Internet finance development model

guaranteed by three aspects: insurance companies, risk reserves, and fund supervision and fund custody [14, 15]. Insurance companies generally protect the risks of funds, not overdue and bad debts.

The risk deposit is to guarantee the risk of bad debts on the platform. And if the risk margin rate often cannot cover bad debts, it may also require free funds from the platform to advance. Fund supervision, custody, and custody. Supervision refers to earmarked funds, which are released after receiving transaction instructions. Custody refers to the separate management of P2P platform's own funds and client funds, custody refers to the investigation of the authenticity of platform investment projects. None of the above three guarantees can fully guarantee the safety of funds, nor can they avoid credit risk [16]. And it has rapidly evolved into an irreversible development trend. Internet finance has always been a new type of transaction model and more prominently the role of the Internet and computer information technology in the financial market. This model has weakened the position and role of traditional financial institutions in the financial market, and further weakened the role of financial intermediaries, forming a new development model and direction different from traditional finance.

3 Methods

Before delving into the details of our proposed method, we first review the existing methods, such as the blockchain and decision tree algorithm.

3.1 Decision tree algorithm

Decision tree algorithm is an algorithm with information classification capability. As an inductive induction algorithm, the decision tree has many advantages, such as the ability to independently select feature variables, fast classification speed, and the ability to effectively filter information. Therefore, the decision tree algorithm is also regarded as one of the statistically optimal algorithms. The decision tree algorithm is divided into two steps. The first step is to build a decision tree. The second step is the construction of decision trees. Generally speaking, the overall construction process of the decision tree is a process of continuously judging and classifying information. According to the characteristics of the decision tree algorithm, the feature variable with the largest difference is left after each construction [17, 18]. Differences between different decision trees are measured differently. Construction is also pruning. The purpose is to improve the fit of the decision tree to the information. The structure of the fusion model is shown in Fig. 2.

Gradient boosting decision tree (GBDT) is a machine learning method widely used in regression and classification tasks. It produces a prediction model in the form of a collection of weak learners. Iteratively weaker, the learner is combined into a stronger learner. The establishment of each decision tree is to reduce the residual of the previous model, so that the residual decreases toward the gradient, and the residual is continuously reduced in successive iterations [19]. In the GBDT iteration process, the goal of the next iteration is to find a weak learner of the CART regression tree model to fit the residuals of the previous model, so that the model generated by the previous iteration and the current model is obtained. The loss between the output value and the

Fig. 2 Structure diagram of fusion decision model based on gradient boosting decision tree
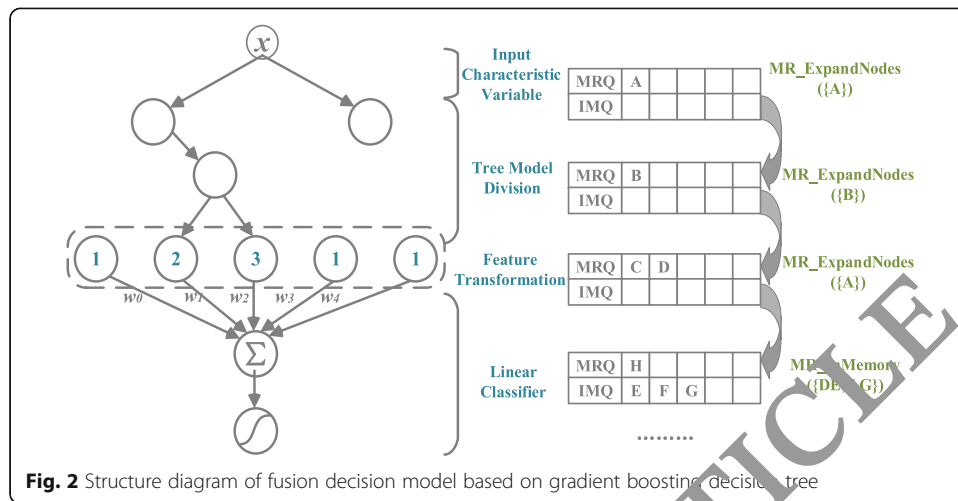
real value should be as small as possible, and finally, the models generated by all iterations are accumulated to obtain the final prediction model [20].

Logistic regression (LR) is a binary classification model widely used in the industrial field. On the basis of linear regression, a layer of sigmoid function mapping is added to the mapping of features to results to predict the value. Limited to [0, 1], you can output probabilities of different categories. The probability $p\ (y = 1|\ x, \theta)$ represents the probability that y belongs to 1 given the characteristic variable x, and $h_\theta(x) = p\ (y = 1|\ x, \theta)$, then there is a logistic regression model.

$$h_\theta(x) = \left[1 + \exp\left(-\theta^T x\right)\right]^{-1} \tag{1}$$

In which, $\theta = \{\theta_0, \theta_1, \cdots \theta_\beta\}$ represents the coefficient value corresponding to each feature, θ value. It can be obtained by solving the maximum likelihood estimation function. Assuming that each sample in the data set is independent of each other, the likelihood function:

$$L(\theta) = \prod_{i=1}^{n} [h_\theta(x)]^{y_i} \cdot [1 - h_\theta(x)]^{1 - y_i} \tag{2}$$

Let x be the input n-dimensional feature variable, the set $y \in \{c_1, c_2, \cdots, c_n\}$ is the input category, X is the random variable on the input space, Y is the random variable on the output space, the combination of X and Y. The probability distribution is $P\ (X, Y)$, and $P\ (X, Y)$ independently and identically generates the training data set:

$$T = \{(x_1, y_1), (x_2, y_2), \cdots (x_N, y_N)\} \tag{3}$$

So available:

$$P(Y = c_k / X = x) = \frac{P(X = x/Y = c_k)P(Y = c_k)}{\sum_{k=1}^{K} P(X = x/Y = c_k)P(Y = c_k)} \tag{4}$$

The conditional probability has made the construction of conditional independence, namely:

$$P(X = x/Y = c_k) = P\left(X^{(1)} = x^{(1)}, X^{(2)} = x^{(2)}, \cdots X^{(n)} = x^{(n)}\right)/Y = c_k$$
$$= \Pi_{j=1}^{n} P\left(X^{(j)} = x^{(j)}/Y = c_k\right) \tag{5}$$

Bring Eq. 5 into Eq. 6 to get the basic formula, which means the probability of the output category *A* given the instance *Y* [21].

$$P(Y = c_k/X = x) = \frac{\displaystyle\prod_{j=1}^{n} P\left(X^{(j)} = x^{(j)}/Y = c_k\right) P\left(Y = c_k\right)}{\displaystyle\sum_{k=1}^{K}(Y = c_k)\prod_{j=1}^{n} P\left(X^{(j)} = x^{(j)}/Y = c_k\right)} \tag{6}$$

In practical application, when classifying feature instances, we choose the one with the largest probability value as the final category, which can be formalized as formula 7.

$$y = f(x) = \text{argmax}\, \frac{\displaystyle\prod_{j=1}^{n} P\left(X^{(j)} = x^{(j)}/Y = c_k\right) P\left(Y = c_k\right)}{\displaystyle\sum_{k=1}^{K}(Y = c_k)\prod_{j=1}^{n} P\left(X^{(j)} = x^{(j)}/Y = c_k\right)} \tag{7}$$

The gradient descent method is often used to obtain the parameter θ, but due to the limited learning ability of the LR model, a large amount of artificial feature engineering is usually required to improve the learning ability of the model. How to automatically mine effective features and feature combinations has become an urgent problem to be solved, and using models to explore the combined relationship between features has become an effective way to solve this problem [22]. This paper considers combining the fusion model structure after the conversion of GBDT's features with the LR model and applying it to financial personal credit evaluation research. The feature combination is performed by GBDT and then combined into the LR model for training and combined into the fusion decision model.

3.2 Blockchain intelligent technology

Blockchain is a disruptive technology that is leading a new round of technological and industrial changes in the world and is driving the transition from "Internet of Information" to "Internet of Value." Blockchain technology uses a chain structure to record the entire transaction information and cannot be tampered with, which has a strong role in increasing trust [23, 24]. This technology has a natural match for the transaction-based financial characteristics of the supply chain. Since the introduction of blockchain technology, the application of blockchain technology to the supply chain has accounted for the highest proportion of various financial transaction studies [25]. Related research mainly believes that the blockchain will expand the coverage of the supply chain, reduce the financing burden of SMEs, and promote the securitization of financial assets in the supply chain. The schematic diagram of the combination of Internet finance and blockchain is shown in Fig. 3.
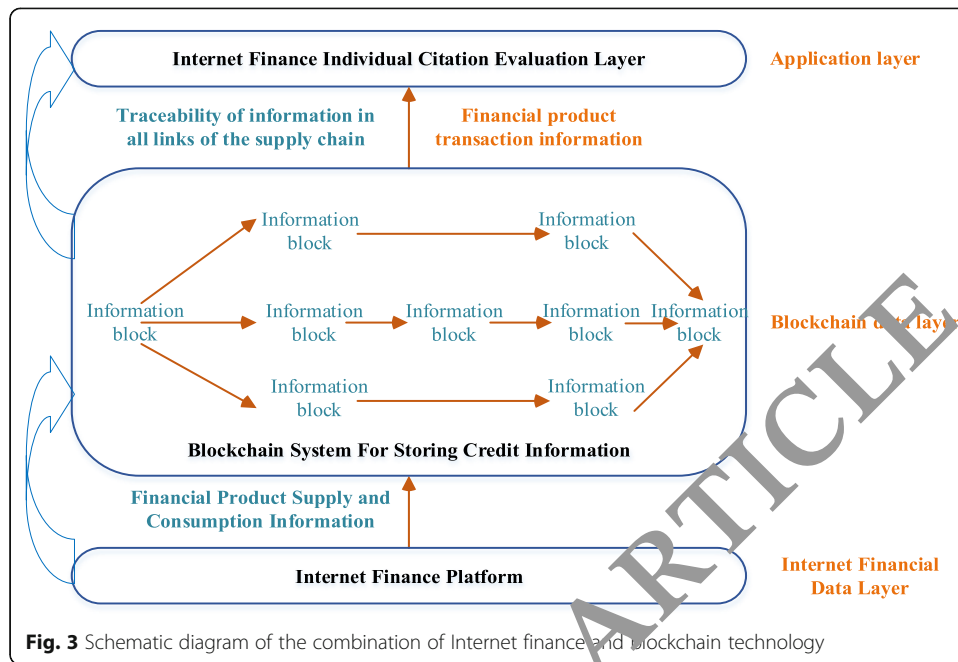
Fig. 3 Schematic diagram of the combination of Internet finance and blockchain technology

3.2.1 Decentralized and consensus mechanism

Decentralization is the most significant feature of blockchain technology. There is no strong central node in the blockchain to formulate rules, unify accounting, and maintain books. The accounting rules are public (i.e., consensus mechanism); all members can participate in bookkeeping. As long as the bookkeeping rules follow the system rules and are verified by other members, they will be successfully booked by the system without the need for endorsement by the system center or third-party intermediaries.

3.2.2 Tamper proof and easy to check

The blockchain uses a hash function to encrypt data. Each data block contains information such as the last block data, the transaction information, and the transaction time. Based on this, a new block is formed; as long as the function of the last block is verified, the value is equivalent to all the books before verification; and the blockchain formed in this way is relatively easy to verify. And each input data change will generate a new data block, so verifying the last data block of the longest data chain is equivalent to verifying all transaction information of the entire data chain, thereby ensuring that all transaction record information is not tampering to ensure that information is safe [26].

3.2.3 Smart contract

A smart contract is different from a traditional contract. A smart contract is simply a program that can be automatically executed. As long as the conditions agreed by the program are triggered and met, the related transactions of the contract will be automatically executed without manual intervention. Smart contracts are an important feature of blockchain technology. Because the system avoids the center's interference with

transactions, the data can only be increased, not tampered with, or deleted. Once the fraud is made, the records can never be eliminated and the cost is higher. Smart contracts make transactions transparent, transaction costs are significantly lower, and are protected from outside interference [27].

4 Experiment

When measuring the potential impact of Internet finance personal credit, this article considers that there are a variety of factors that affect the measurement of potential impact, but in practice, each element cannot be considered equally. Therefore, this paper uses AHP to divide the weight of the influencing factors, and finally obtain the impact score of each measure.

4.1 Matrix consistency check

In the consistency check of the judgment matrix, when the judgment matrix cannot guarantee complete consistency, the characteristic root of the corresponding judgment matrix will also change, so this paper can use the change of the characteristic root of the judgment matrix to check the degree of consistency of judgment [28]. Therefore, in this paper, the negative averages of the feature roots other than the largest feature root are used as indicators to measure the consistency of the judgment matrix deviation [29, 30].

$$
A = \begin{bmatrix}
1 & 1/3 & 1/3 & 1/3 & 1/4 & 1/5 & 1/3 & 1/4 \\
3 & 1 & 2 & 1/3 & 1/4 & 1/4 & 1/3 & 1/3 \\
3 & 1/2 & 1 & 1/3 & 1/4 & 1/5 & 1/2 & 1/3 \\
3 & 3 & 3 & 1 & 1/3 & 1/4 & 3 & 3 \\
4 & 4 & 4 & 3 & 1 & 1/3 & 3 & 3 \\
5 & 5 & 3 & 4 & 3 & 1 & 3 & 3 \\
3 & 3 & 2 & 1/3 & 1/3 & 1/3 & 1 & 3 \\
4 & 3 & 3 & 1/3 & 1/3 & 1/3 & 1/3 & 1
\end{bmatrix}
\tag{8}
$$

The ratio of the consistency index CI of the judgment matrix to the average random consistency index CI of the same order is called the random consistency ratio, which is recorded as CR.

4.2 Hierarchical single sort

Calculate the product M_i of each row element of the judgment matrix. By calculating the single ranking of each level of the judgment matrix, the final result of the judgment matrix is finally shown in Table 1.

5 Results

5.1 System function realization

The Internet financial personal credit evaluation system is oriented to multiple types of units and requires a certain degree of decentralization and a certain degree of openness, so the alliance chain model is adopted. This model not only allows the supervisory authority to have supervisory powers, but also allows access to inquiry for all members. In the choice of development platform, from the currently popular Bitcoin, Ethereum, Hyperledger, and Hyperledger's Sawtooth platform to build a retrospective prototype system, this platform is the first distributed platform for enterprise scenarios. The partial data structure relationship of personal credit evaluation is shown in Fig. 4.

Table 1 Results of the AHP judgment matrix

Calculation of the result of judgment matrix					λ_{max}	CI	RI	CR
A $W = \begin{bmatrix} 0.0328 \\ 0.0542 \\ 0.0478 \\ 0.1465 \\ 0.2142 \\ 0.3071 \\ 0.1083 \\ 0.0891 \end{bmatrix}$ $\lambda_{max} = 8.8120$ $CI = 0.1160$ $RI = 1.409$ $CR = 0.0823$	$B_1\ W = \begin{bmatrix} 0.6144 \\ 0.2684 \\ 0.1172 \end{bmatrix}$	$B_5\ W = \begin{bmatrix} 0.1365 \\ 0.6250 \\ 0.2385 \end{bmatrix}$			B_1 3.0735	0.0368	0.5200	0.0707
	$B_2\ W = \begin{bmatrix} 0.5278 \\ 0.3325 \\ 0.1396 \end{bmatrix}$	$B_6\ W = \begin{bmatrix} 0.1168 \\ 0.6833 \\ 0.1998 \end{bmatrix}$			B_2 3.0536	0.0268	0.52	0.0515
					B_3 3.0618	0.0197	0.100	0.0478
	$B_3\ W = \begin{bmatrix} 0.5469 \\ 0.3445 \\ 0.1085 \end{bmatrix}$	$B_7\ W = \begin{bmatrix} 0.1220 \\ 0.3296 \\ 0.5584 \end{bmatrix}$			B_4 3.0037	0.0018	0.5000	0.0036
					B_5 3.0183	0.0091	0.5300	0.0176
	$B_4\ W = \begin{bmatrix} 0.1095 \\ 0.5816 \\ 0.3090 \end{bmatrix}$	$B_8\ W = \begin{bmatrix} 0.0936 \\ 0.2797 \\ 0.6267 \end{bmatrix}$			B_6 3.0246	0.0123	0.52	0.0236
					B_7 3.0183	0.0091	0.4900	0.0178
					B_8 3.0857	0.0428	0.5200	0.0825

It can be seen that the values of CR are all less than 0.10, so the judgment matrix is considered to have satisfactory consistency

According to the system architecture, the entire process of personal information data flow is integrated into the blockchain. In terms of platform functions, it can realize member identity authentication, data identification, information integration, product traceability, and other functions. Among them, member certification is that after a member submits an application through a smart contract, the relevant regulatory agency conducts a qualification review, and after passing, grants the corresponding authority and digital certification. When tracing the product, each piece of information of the product carries its own unique digital label and information writing timestamp. The digital encryption technology of the blockchain can ensure that the relevant information of the product in the circulation process can maintain the integrity and prevent tampering and other functions.

5.2 System application effect analysis

The electronic data information of personal credit evaluation is added to the blockchain for protection within the set block generation time and timeout period. Carry out the security verification load on the system, set the block generation time to 60s, and select the security data of different periods respectively. During the testing process, the evaluation indicators adopt average response time (Ave), minimum response time
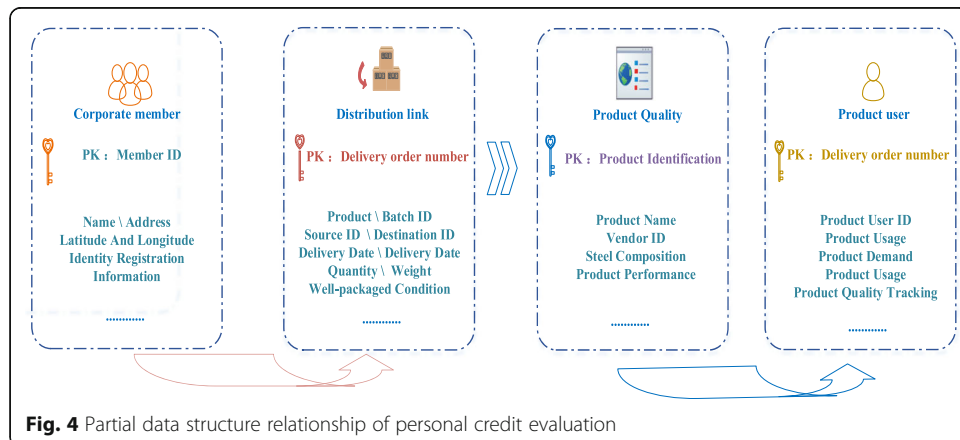

Fig. 4 Partial data structure relationship of personal credit evaluation

(Min), and maximum response time (Max). During the verification, 1000 virtual users were simulated and tested, and the test parameters were recorded. The test results are shown in Figs. 5 and 6.

Through the system security verification load test results, it can be seen that the system can respond to user requests without any difference between 200 and 1000 users, and the system response time is still less than 10 ms at 1000 users, and the system efficiency is high.

A large-scale Internet financial unit that tried the personal credit evaluation technology was used as an example to analyze the effect, and the personal credit evaluation information of the unit was collected, including data such as changes in information integrity and information delay changes. The change of personal credit information delay is shown in Fig. 7.

As shown in Fig. 7, after the unit tried out personal credit evaluation technology, since the information of the main test cases in the occurrence and transmission of credit events was effectively shared, there was a significant change in the delay of credit information between the Internet financial units and individuals. The number of dispute cases has been effectively reduced. After the unit tried the personal credit information evaluation technology, the integrity of the information of the main test cases in the occurrence and transmission of credit events was effectively improved, and all kinds of test cases reached within 1 month The degree of completeness or near completeness of the information. In recent years, the P2P online credit industry has experienced "blowout" growth, and the borrower's default risk assessment and control cannot be ignored. Many statistics show that a large part of the problematic platform is due to the default of the platform due to the borrower's default. Only on the basis of a reasonable personal credit system strengthen the management of investors and borrowers in online loan transactions. In order to effectively control credit risk, we can promote the healthy development of online loan platforms and even the entire industry. Here, the establishment of a borrower credit evaluation system can help the industry to establish a more effective and accurate borrower credit risk evaluation system.
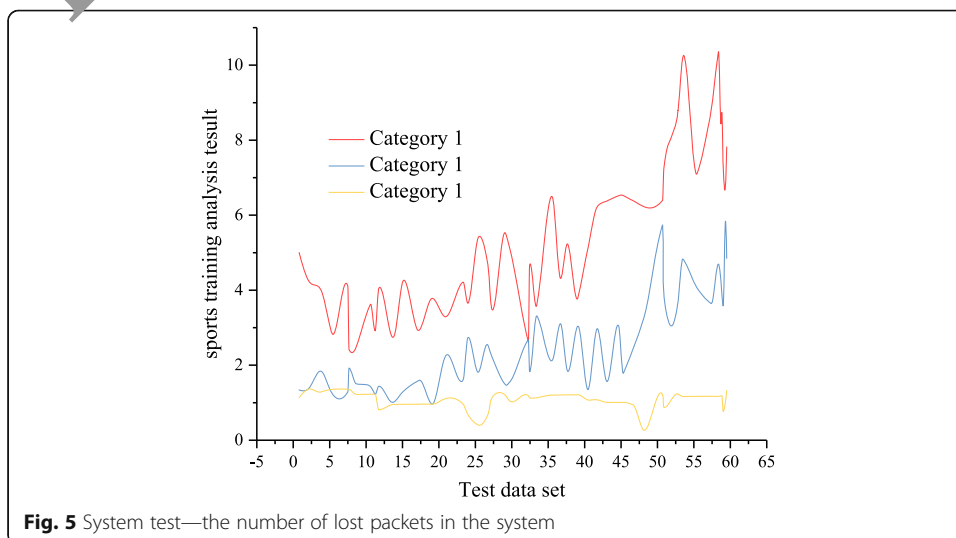

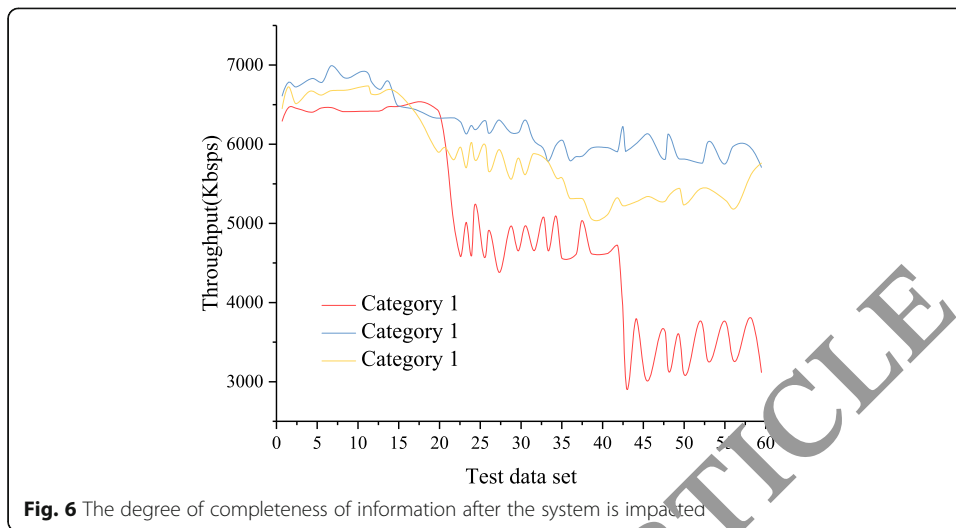**Fig. 5** System test—the number of lost packets in the system

Fig. 6 The degree of completeness of information after the system is impacted

6 Discussion

In order to carry out real-time management and personal credit monitoring of Internet financial information anytime, anywhere, a personal credit evaluation technology based on blockchain and decision tree algorithm is designed and implemented. This article takes Internet finance as the research object and adopts blockchain, decision tree, and other technologies to design credit evaluation technology. By accessing the Internet financial information collection terminal, personal credit information is dynamically and accurately transmitted to the information blockchain, and real-time tracking and recording of information are realized. The trial results show that the system has strong real-time, high efficiency, and ease of use. This technology can improve the information transparency and data security of the credit information tracing process, realize the effective tracing of information, and provide an effective and implementable solution for promoting the development of Internet finance. The next step will be to expand the participating projects and sample library construction.
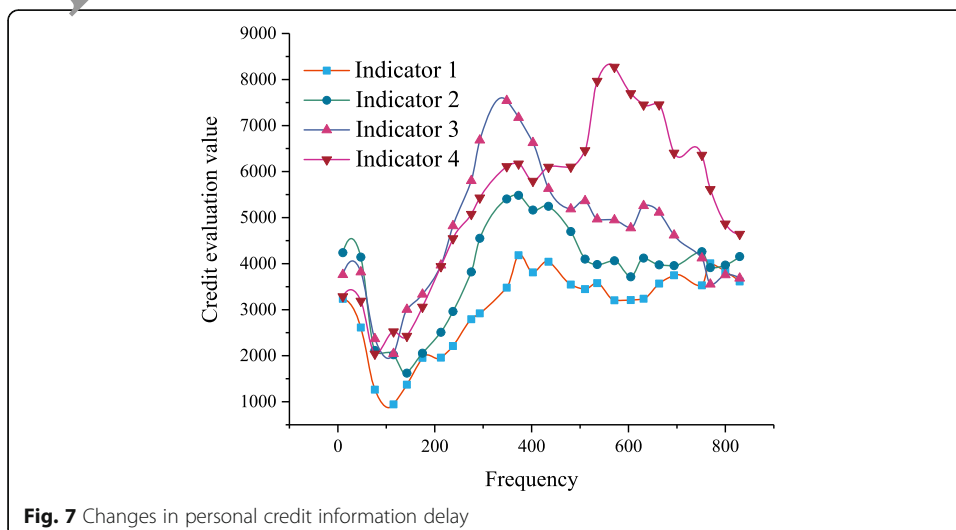

Fig. 7 Changes in personal credit information delay

References
1. B. Zhao, L. P. Leichman, S. Horgan, M. Bouvet, K. J. Kelly, Evaluation of treatment and outcomes for Hispanic patients with gastric cancer at commission on cancer credited centers in the United States. J. Surg. Oncol. **83**(5), 1-15 (2019).
2. Y. Zhang, Y. Lu, X. Huang, K. Zhang, S. Maharjan, Blockchain empowered asynchronous federated learning for secure data sharing in internet of vehicles. IEEE Trans. Veh. Technol. **99**, 11–21 (2020)
3. R. Zhang, F. R. Yu, J. Liu, T. Huang, Y. Liu, Deep reinforcement learning (DRL)-based device-to-device (D2D) caching with blockchain and mobile edge computing. IEEE Trans Wireless Communications, 112-121 (2020).
4. Z. C. Yang, H. Kuang, J. S. Xu, H. Sun, Artificial immune algorithm-based credit evaluation for mobile telephone customers. J Operational Res Soc, 1–4 (2015).
5. K. Yamamoto, H. Akie, K. Suyama, R. Kanamada, Criticality safety evaluation for the direct disposal of used nuclear fuel. Preparation of data for burnup credit evaluation (contract research). Bull. World Health Organ. **83**(5), 369–377 (2015)
6. J. Xu, K. Xue, H. Tian, J. Hong, P. Hong, An identity management and authentication scheme based on redactable blockchain for mobile networks. IEEE Trans. Veh. Technol. **12**, 1–1 (2020)
7. J. Wang, From aperture satellite to 'internet finance': Institutionalization of ICTs in China's financial sector since 1991. Telecommun. Policy **42**, 566–574 (2018)
8. J. Wang, From aperture satellite to "internet finance": Institutionalization of ICTs in China's financial sector since 1991. Telecommun. Policy **33**(5), 312–321 (2018)
9. S.N. Sarin, A. Makunin, A.S. Dora, T.K. Barik, SNP barcoding based on decision tree algorithm: A new tool for identification of mosquito species with special reference to anopheles. Acta Trop. **199**(10), 51–62 (2019)
10. A. Schweizer, P. Knoll, N. Urbach, von der Gracht HA, T. Hardjono, To what extent will blockchain drive the machine economy? Perspectives from a prospective study. IEEE Trans. Eng. Manag. 7 (12), 1-15 (2020).
11. S. Schneider, M. Leyer, M. Tate, The transformational impact of blockchain technology on business models and ecosystems: A symbiosis of human and technology agents. IEEE Trans. Eng. Manag. **11**(9), 1–12 (2020)
12. O.P. Sangoro, T. Gavana, M. Finda, W. Mponzi, F.O. Okumu, Evaluation of personal protection afforded by repellent-treated sandals against mosquito bites in South-Eastern Tanzania. Malaria J **7**(13), 111–123 (2020)
13. F. Rifaldy, J. Prihantini, Prediction of chronic of kidney failure based on artificial intelligence system using the fuzzy decision tree algorithm. Nephrol Dialysis Transplant Suppl **11**(9), 1–12 (2020)
14. P.H. Wang, Y.-S. Tu, J.Y. Tseng, PgpRules: A decision tree based prediction server for P-glycoprotein substrates and inhibitors. Bioinformatics **123**(12), 156–165 (2019)
15. D.C. Owen, M.T. Bensi, A.P. Davis, A.H. Aydilek, Measuring soil coverage using image feature descriptors and the decision tree learning algorithm. Biosyst. Eng. **196**(1), 112–126 (2020)
16. H. Narayanan, M. Sokolov, A. Butté, M. Morbidelli, Decision tree-PLS (DT-PLS) algorithm for the development of process: Specific local prediction models. Biotechnol. Prog. **35**(4), 224–(2019)
17. R. Lugari, L. Scoccianti, P. Tagliavini, D. Pancotti, G. Barbaglio, M. Tirelli, G. Chierici, M.L. De Franco, A. Gnudi, Evaluation of urinary albumin excretion rate in different conditions of severe diabetic retinopathy1. Oncology **7**(6), 413–424 (2015)
18. A. Kumari, R. Gupta, S. Tanwar, N. Kumar, Blockchain and AI amalgamation for energy cloud management: Challenges, solutions, and future directions. J Parall Distribut Comput **22**(6), 322–334 (2020)
19. M. Ibrani, E. Hamiti, L. Ahma, R. Halili, V. Shala, D. Berisha, Narrowband frequency-selective up-link and down-link evaluation of daily personal-exposure induced by wireless operating networks. Wirel. Netw **23**(4), 1–10 (2017)
20. S. Hall, B. Poller, C. Bailey, S. Gregory, R. Clark, P. Roberts, A. Tunbridge, V. Poran, C. Evans, B. Crook, Use of UV fluorescence-based simulation in evaluation of personal protective equipment worn for first assessment and care of a patient with suspected high consequence infectious disease. J. Hosp. Infect. **23**(6), 13–24 (2018)
21. R. Gupta, A. Kumari, S. Tanwar, N. Kumar, Blockchain-envisioned softwarized multi-swarming UAVs to tackle COVID-19 situations. IEEE Netw. **12**(9), 215–225 (2020)

22. S. Elena, G. Olga, S. Vasiliy, S. Alexey, Developing of the decision tree algorithm using biomarkers panel for the differential diagnosis of primary glomerulonephritis. Nephrol Dialysis Transplant **212**(18), 123–134 (2019)

23. C. Chen, J. Wu, H. Lin, W. Chen, Z. Zheng, A secure and efficient blockchain-based data trading approach for internet of vehicles. IEEE Trans. Veh. Technol. **229**(12), 1–12 (2019)

24. Z. Bo, W. Xuan, Z. Dongbo, S. Chanan, Z. Jianhua, Hybrid probabilistic-possibilistic approach for capacity credit evaluation of demand response considering both exogenous and endogenous uncertainties. Appl. Energy **229**(12), 186–200 (2018)

25. F. Long, N. Xiong, A.V. Vasilakos, L.T. Yang, F. Sun, A sustainable heuristic QoS routing algorithm for pervasive multi-layered satellite wireless networks. Wirel. Netw **16**(6), 1657–1673 (2010)

26. C. Lin, N. Xiong, J.H. Park, T. Kim, Dynamic power management in new architecture of wireless sensor networks. Int. J. Commun. Syst. **22**(6), 671–693 (2009)

27. H. Liang, J. Zou, K. Zuo, M.J. Khan, An improved genetic algorithm optimization fuzzy controller applied to the wellhead back pressure control system. Mech. Syst. Signal Process. **142**(1), 106–114 (2020)

28. H. Liang, J. Zou, Z. Li, M.J. Khan, Y. Lu, Dynamic evaluation of drilling leakage risk based on fuzzy theory and PSO-SVR algorithm. Futur. Gener. Comput. Syst. **95**(4), 454–466 (2019)

29. J. Li, N. Xiong, J.H. Park, C. Liu, M.A. Shihua, S. Cho, Intelligent model design of cluster supply chain with horizontal cooperation. J. Intel. Manuf. **23**(4), 917–931 (2012)

30. W. Guo, N. Xiong, A.V. Vasilakos, G. Chen, C. Yu, Distributed k-connected fault-tolerant topology control algorithms with PSO in future autonomic sensor systems. Int J Sensor Networks **12**(1), 53–62 (2012)

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