The study of task allocation method based on blockchain node hash power

Fumin Deng[1] Qunxi Gong[2] Xuedong Liang[3]

[1,2,3] Sichuan University, Chengdu 610065, China

Abstract. Recently, the strong rise of digital encryption currency, making the block chain technology has gradually become a hot topic in academia and industry. However, most scholars' research focuses on the blockchain foundation and application, and rarely involves the task allocation method in the blockchain. For this, this paper proposes a task allocation method based on block chain-bus power. When assigning a task, the method considers the computing power of each node in the blockchain and the processing time of each task to be assigned at each node, and calculates the processing benefit of the task at the node.Then, the task is assigned to the node with the most efficient treatment for maximum benefit. The innovation of this paper is that not only considers the task processing time, but also considers the computing power of each node in the blockchain, and achieves resources that can save the task processing time and make full use of the node computing power. Finally, through the study of the example, the ideal task allocation scheme is obtained, which verifies the effectiveness of the method.

Keywords: Blockchain, Hash power, Task assignment

1 Introduction

Recently, blockchain, the underlying technology of Bitcoin, has received increasing attention, first mentioned by Nakamoto in his paper "Bitcoin: A Peer-to-Peer E-Cash System" [1], in this paper, he proposes a method for establishing a new, decentralized, trust-free peer-to-peer trading system, in which the birth of Bitcoin proves its achievability. Blockchain technology solves many problems in the centralized mode (low reliability, poor security, high cost, low efficiency, etc.) by decentralized design and encryption algorithms, time stamps, and consensus mechanisms [2]. In the 2016 McKinsey research report, the blockchain was highly rated, saying that it is the core technology that has the potential to trigger the fifth wave of disruptive revolutions after steam engine, power, information and Internet technology [3]. Governments and financial institutions have gradually increased their focus on blockchain technology. The People's Bank of China stated in early 2016 that it should actively promote the official digital currency [4]; The British government's blockchain research report "Distributed Ledger Technology: Beyond the Blockchain" [5] proposes to vigorously develop the application of blockchain in the government. Following this, more and more organizations and academics from different angles to study the block chain and its application scenarios.

With the widespread application of blockchain technology, a large number of blockchain networks have been established, which are mainly divided into three categories: common chain, private chain, and industry chain [6]. Thus, in so many blockchains, how rational allocation of tasks, to achieve high efficiency to complete the task, it becomes a problem to be resolved. In this paper, we consider the block-chain node hash power and the processing time of the task in the node, construct the task-node benefit matrix, and then assign the task according to the benefit matrix to get the maximum benefit. The architecture of this paper is shown in Fig. 1.

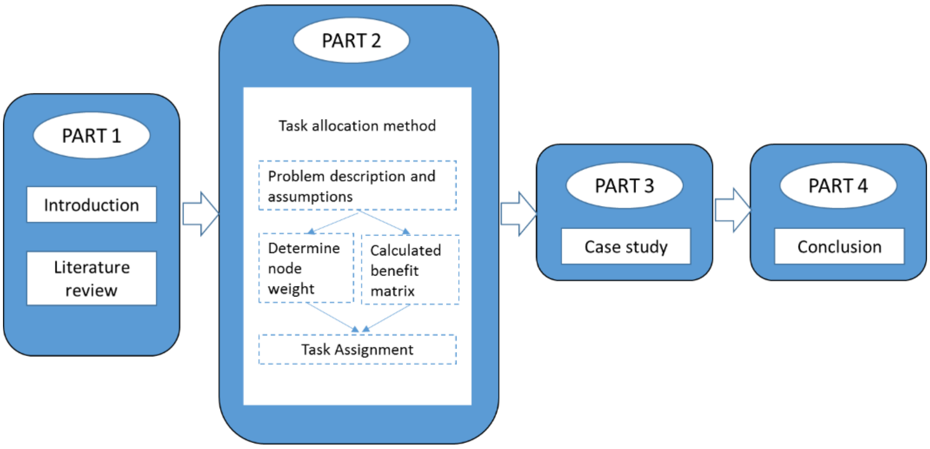

Fig. 1. The architecture of this paper

2 Literature review

In recent years, scholars have done a lot of research on blockchain. Their research mainly focuses on the following two directions: some scholars mainly study the basis of blockchain, and another part of scholars mainly study the application of blockchain.

In basic research, scholars' research focuses on the efficiency, privacy, and security of blockchain technology. In terms of efficiency, Mei Haitao et al. [7] believe that the workload proof mechanism will limit the transaction rate of the blockchain and thus cannot compete with the current efficiency of the payment system. Moreover, the higher expansion speed of the blockchain will also seriously affect its read/write rate. In response to this problem, scholars explore optimization and improvement methods from different angles, such as implementing optional smart contracts [8], record integrity certification schemes [9], fusion of Internet of Things, AI, machine learning calculations, etc. [10]. In terms of privacy and security, Yin Guanqiao [11] found that under the existing rules, the user's personal identity information and private key cannot be recovered after being lost, which increases the risk of the user being stolen and stolen; Saxena et al. [12] proposed a method of composite signature to blur or eliminate the relationship between the two parties and enhance the anonymity of the transaction; Scholars have tried to solve the problem of privacy protection in the blockchain by using CoinJoin, ring and Zcash [13]. In addition, some scholars have studied the "three yuan paradox" problem [14, 15], resource waste problem [16], storage problem [17] and so on.

In applied research, scholars are mainly concentrated in the financial, energy and other industries. In the financial field, Xian Jingchen [18] pointed out that blockchain technology will re-allocate the rights and interests of various participants in the Internet finance sector, subverting some old situations in the traditional financial industry; Wang Shuo [19] analyzed the application and research status of blockchain in the financial field, and analyzed the difference between the blockchain payment model and the traditional payment model in international payment; In the financial field, the application of blockchain mainly involves credit information systems [20], bills [21], and supply chain finance [20]. In the field of energy, Zhang Ning [20] summarized and analyzed the application of blockchain technology in energy internet from three dimensions: function, subject and attribute. From the perspective of energy, information and value, this paper expounds the role of blockchain technology in different aspects of energy, Internet, source, network, Dutch, and storage in different aspects of measurement and certification, market transactions, and collaborative organization of energy finance; Wang Anping [22] studied and analyzed the application scenarios and business models of blockchains in the energy sector in the areas of transmission, transmission, distribution, utilization and storage, and proposed the problems and suggestions for the development of energy blockchain. At the same time, blockchain technology also has a good application in education [23], logistics [24] and other industries.

It can be seen that scholars have made great achievements in the blockchain, but there are few studies on the task allocation methods in the blockchain. Whether the task assignment in the blockchain is reasonable will directly affect the task processing time and resource utilization efficiency. Therefore, this paper attempts to achieve a maximum work benefit by constructing a task-node benefit matrix and rationally assigning tasks.

3 Task allocation method based on node hash power

3.1 Problem description and assumptions

Suppose there are sets of m independent processing tasks T={T_1, T_2, …, T_m}, where the i-th task is T_i; There are n nodes in the distributed block chain where the node set N={N_1, N_2, …, N_n}, wherein, j-th distributed nodes N_j. Tasks must be allotted to the node, and one task is processed independently by only one node

The following assumptions need to be met when solving the above problems: When a node status is "idle" or "busy" to "free", if there are still tasks waiting to be processed in the task queue, the processing task starts immediately, and there is no time lag; Tasks are independent of each other, regardless of priority; After a node starts task processing, it cannot be interrupted or terminated to process another task; The same node can only process one task at a time.

3.2 Determine node weight

Considering the hash power of each node in the blockchain to determine the weight of each node, the steps for determining the node weight are as follows:

1. Determine the hash power set. Set all the node hash power sets CF={cf_1, cf_2,…, cf_n} on the entire blockchain that can be used for task processing, where cf_j is the power of the j-node, then the total hash power of all nodes during this period is CF, CF=$\sum_{j=1}^{n}\mathrm{cf}_j$.
2. Determine the set of weights. Let the node weight set W=(w_1, w_2,…, w_n), and $\sum_{j=1}^{n}\mathrm{w}_j$=1. Where w_j represents the weight of the j-th node.
3. Calculate the weight. The ratio of the node power to the total computing power of all nodes is taken as the weight of the node in the task, $\mathrm{w}_j=\frac{\mathrm{cf}_j}{CF}$, where j=(1,2,3,...,n), then the node weight set is W= (w_1, w_2,…, w_n), Take task i at node j as w_{ij}=w_j

3.3 Calculated benefit matrix

Get the processing time set. Obtain the processing time set P_{1j}={P_{1j}, P_{1j}, …, P_{1j}}, P_{2j}={P_{2j}, P_{2j}, …, P_{2j}}, …, P_{ij}={P_{ij}, P_{ij}, …, P_{ij}}, j=1,2, …, n. Then the processing time matrix is:

$$P_{ij}=\begin{Bmatrix} P_{11} & P_{12} & \cdots & P_{1n} \\ P_{21} & P_{22} & \cdots & P_{2n} \\ \vdots & \vdots & & \vdots \\ P_{m1} & P_{m2} & \cdots & P_{mn} \end{Bmatrix}$$

Find the benefit matrix E_{ij} according to E=$\frac{1}{\mathrm{WP}}$.

$$E_{ij}=\begin{bmatrix} E_{11} & E_{12} & \dots & E_{1n} \\ E_{21} & E_{22} & \dots & E_{2n} \\ \dots & \dots & & \dots \\ E_{m1} & E_{m2} & \dots & E_{mn} \end{bmatrix}$$

3.4 Task Assignment

According to the characteristics of the above problem, the decision variable can be represented by an m×n 0-l matrix x_{ij}, where $x_{ij} \in$ {0, 1}.

$$x_{ij} = \begin{cases} 0, & \text{Task i is not processed in node j} \\ 1, & \text{Task i is processed at node j} \end{cases}$$

For the processing state x_{ij} of the task, considering that each task requires only one node for processing, and each task is processed once, the following constraints must be met:

$$\begin{cases} \sum_{j=1}^{n} x_{ij} = 1, \; j = 1, 2, ..., n \\ \sum_{i=1}^{m} \sum_{j=1}^{n} x_{ij} = m \\ x_{ij} \in \{0,1\}, i = 1, 2, ..., m; \; j = 1, 2, ..., n \end{cases}$$

Then, according to the benefit matrix, the "idle" node with the most benefit is selected as the node for processing the task, that is, when the node with the most benefit is in the "busy" state, the node with the most benefit is selected among the nodes in the "idle" state.

$$\max E(x) = \sum_{i=1}^{m} \sum_{j=1}^{n} E_{ij} x_{ij} \quad (1)$$

4 Case study

In order to test the practicability and effectiveness of the proposed method, a case study is used to illustrate the task assignment. Suppose that in a blockchain system, there are six distributed nodes consisting of node sets N={N_1, N_2, …, N_6},there are 10 independent tasks in the task set T={T_1, T_2, …, T_{10}} that require node processing.

4.1 Computation node weight

The hash power of each node HP={2.1, 3.2, 2.3, 3.5, 2.8, 3.4, 1.5, 2.9, 1.8, 3.0}, and the unit is PH/s, then the node weight matrix can be calculated as:

$$W_{ij} = \left\{ \begin{matrix} 0.08 & 0.12 & 0.09 & 0.13 & 0.11 & 0.13 & 0.06 & 0.11 & 0.07 & 0.11 \\ 0.08 & 0.12 & 0.09 & 0.13 & 0.11 & 0.13 & 0.06 & 0.11 & 0.07 & 0.11 \\ 0.08 & 0.12 & 0.09 & 0.13 & 0.11 & 0.13 & 0.06 & 0.11 & 0.07 & 0.11 \\ 0.08 & 0.12 & 0.09 & 0.13 & 0.11 & 0.13 & 0.06 & 0.11 & 0.07 & 0.11 \\ 0.08 & 0.12 & 0.09 & 0.13 & 0.11 & 0.13 & 0.06 & 0.11 & 0.07 & 0.11 \\ 0.08 & 0.12 & 0.09 & 0.13 & 0.11 & 0.13 & 0.06 & 0.11 & 0.07 & 0.11 \end{matrix} \right\}$$

4.2 Computational task - node benefit

Task i processes the required time matrix at node j, where the unit is: min.

$$P_{ij} = \left\{ \begin{matrix} 2 & 1 & 3 & 2 & 2.5 & 3 & 3 & 2.5 & 3.5 & 1.5 \\ 4 & 3 & 4 & 4 & 4 & 3 & 4.5 & 4 & 3.5 & 2 \\ 3 & 4 & 4 & 3 & 3 & 2 & 3 & 2 & 4 & 2 \\ 3 & 3 & 3 & 2 & 2 & 4 & 4 & 3 & 3.5 & 4 \\ 5 & 3 & 3 & 6 & 4 & 3 & 4 & 5 & 3 & 2 \\ 2 & 1 & 1 & 1 & 3 & 2 & 2.5 & 4 & 3 & 1 \end{matrix} \right\}$$

Find the benefit matrix E_{ij} according to E= $\frac{1}{\mathrm{WP}}$.

$$E_{ij} = \left\{ \begin{matrix} 6.31 & 8.28 & 3.84 & 3.79 & 3.79 & 2.60 & 5.89 & 3.66 & 4.21 & 5.89 \\ 3.15 & 2.76 & 2.88 & 1.89 & 2.37 & 2.60 & 3.93 & 2.28 & 4.21 & 4.42 \\ 4.21 & 2.07 & 2.88 & 2.52 & 3.15 & 3.90 & 5.89 & 4.57 & 3.68 & 4.42 \\ 4.21 & 2.76 & 3.84 & 3.79 & 4.73 & 1.95 & 4.42 & 3.05 & 4.21 & 2.21 \\ 2.52 & 2.76 & 3.84 & 1.26 & 2.37 & 2.60 & 4.42 & 1.83 & 4.91 & 4.42 \\ 6.31 & 8.28 & 11.52 & 7.57 & 3.15 & 3.90 & 7.07 & 2.28 & 4.91 & 8.83 \end{matrix} \right\}$$

4.3 Result analysis

After obtaining the task-node benefit, all task-node state matrices are:

$$x_{ij}=\begin{Bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{Bmatrix}$$

Using formula (1), the total benefit of the task-node can be calculated as E=39.75, the total processing time is P=12min, and the total computing power required is HP=14.6PH/s. If the minimum time is 10 min based on the minimum time, the required minimum total force is 17.2 PH/s; if the minimum total force is 13.4 PH/s based on the required total force, the minimum time required is 20.5 min. It can be seen that the task-node benefit matrix assignment task based on the node power can obtain better comprehensive results. In order to make the results more intuitive, the results of the three schemes are shown in Figure 2.

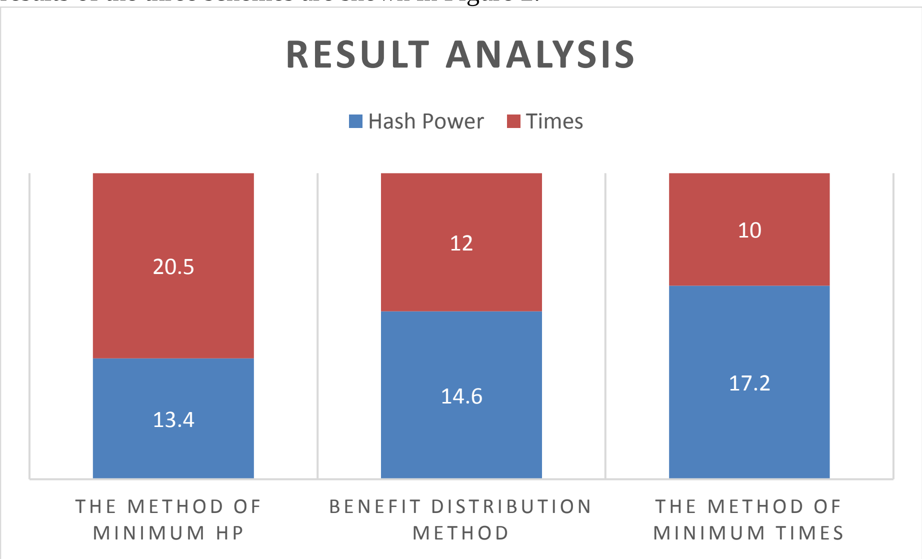

Fig. 2. Comparative analysis of the results of the three distribution schemes

5 Conclusion

A reasonable allocation scheme can not only save the task processing time, but also make full use of the resources of the node hash power, and study the task allocation method based on the blockchain node hash power, which has certain theoretical and engineering significance. Through the research of this paper, the conclusions drawn are as follows:

1. Based on the blockchain node computing power to obtain the weight set of the node, combined with the task-node processing time matrix, calculate the benefit matrix of the task-node, and assign the task through the benefit matrix, providing a new solution to the problem of task allocation for blockchain systems
2. The method is verified by case, and a reasonable task allocation scheme is obtained to prove the effectiveness of the method.

Further, the assignment of tasks in the blockchain system will be further studied from the three dimensions of resource-task-node.

References

1. Nakamoto, S., Bitcoin: A peer-to-peer electronic cash system. Consulted, 2008.
2. Shen, X., Q.Q. Pei, and X.F. Liu, Survey of block chain. Chinese Journal of Network & Information Security, 2016.
3. MCKINSEY COMPANY． Blockchain in insurance--opportunity or threat?[EB／OL]．[2016 07]．http：//fwww．mckinsey．com／industries／financial-services／our-insights／blockchin -in-surance-opportunity-or-threat．．
4. PILKINGTON M．Blockctmin technology：Priciplesand applications[OL]．http：／／ideas．repec．org／p／hal／journl／halshs-01231205．html．．
5. HANaXK M． VAIZEY E Distributed ledger technology：beyond block chain ER]．UK：Government Office for Science，2016．．
6. ANTONOPOULOSH A M.Mastering Biteoin[M]．USA：O'Reilly Media，2014．．
7. Mei, H. and J. Liu, Industry present situation, existing problems and strategy suggestion of blockchain. Telecommunications Science, 2016.
8. Swan, M. Blockchain Temporality: Smart Contract Time Specifiability with Blocktime. in International Symposium on Rules and Rule Markup Languages for the Semantic Web. 2016.
9. Cucurull, J. and J. Puiggalí, Distributed Immutabilization of Secure Logs. 2016: p. 122-137.
10. Outchakoucht, A., H. Es-Samaali, and J. Philippe, Dynamic Access Control Policy based on Blockchain and Machine Learning for the Internet of Things. International Journal of Advanced Computer Science & Applications, 2017. 8(7).
11. Yin, G., A Summary of the Status Quo of the Development of Blockchain Technology and Its Potential Problems. Times Finance, 2017(6).
12. Saxena, A., J. Misra, and A. Dhar. Increasing Anonymity in Bitcoin. in International Conference on Financial Cryptography and Data Security. 2014.
13. Yuan, C., M.X. Xu, and X.M. Si, Research on a New Signature Scheme on Blockchain. 2017. 2017(2): p. 1-10.
14. Chen，Yixi, Research on the"Impossible Trinity"of Block Chain technology and theproblems should pay attention to. Zhejiang Finance, 2016(2): p. 17-20.
15. A summary of Blockchain Technology. Financial Market Research, 2016.
16. 16. Yu, L. and Y. Jin, Research on splitting technology of blockchain data. Chinese High Technology Letters, 2017.

17. Yuan, Y. and F.Y. Wang, Blockchain: The State of the Art and Future Trends. Acta Automatica Sinica, 2016.
18. Jingchen, X., The development and prospect of "blockchain + internet finance". Finance and accounting monthly, 2017(14): p. 79-83.
19. Wang, S., Research Status and Innovation Trend of Blockchain Technology in Financial Field. Shanghai Finance, 2016(2): p. 26-29.
20. Wang, Q., Q. Sude, and B.A. Jieru, Discussion on block chain application in credit investigation industry. Telecommunications Network Technology, 2017.
21. Song, H., The Application of Block-chain in Digital Paper. China Finance, 2018(10).
22. Wang, A.P., J.G. Fan, and Y.L. Guo, Application of Blockchain in Energy Interconnection. Electric Power Information & Communication Technology, 2016.
23. Li, Q. and X. Zhang, Blockchain: A Technology to Win Open and Trust in Education. Journal of Distance Education, 2017.
24. A Model of Logistics Information Ecosphere of Supply Chain Based on Block Chain. Information Studies Theory & Application, 2017.