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Design and implementation of intelligent accounting data analysis platform based on industrial cloud computing

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Abstract

In order to improve the ability of accounting data analysis and statistics, a method of constructing modern accounting data analysis platform based on industrial cloud computing is proposed. The time series model of modern accounting data analysis is constructed by using block bit sequence analysis method, and the association rule characteristic quantity of accounting data is extracted. Combined with cloud computing technology, the modern accounting data analysis platform is constructed, and the fuzzy C-means clustering algorithm is used to realize the clustering of modern accounting data, which can improve the ability of parallel computing and statistical analysis of accounting data. The simulation results show that the intelligent data analysis platform designed makes the statistical analysis ability of accounting data better and the parallel computing efficiency higher.

Keywords: Industrial cloud computing, Intelligent accounting data analysis, Fuzzy C-means clustering algorithm, Feature extraction

1 Introduction

Although the wireless sensor networks have been proposed, studied, and developed for more than a decade of years, there are still a lot of challenging issues especially in various industrial scenarios. Modern accounting intelligent analysis technology has gradually integrated with industrial wireless sensors and cloud computing. The development of modern accounting promotes the development of Chinese finance; with the rapid development of economy, it is necessary to introduce the method of modern accounting statistics and analysis, through the use of market economy and finance to carry out currency settlement and fund fusion. China's economy and finance are gradually moving towards the world; under the new fair value system, modern accounting data analysis platform based on cloud computing technology should be established to improve the ability of parallel computing and statistical analysis of modern accounting data [1].

Accounting data has its own characteristics; accounting data can be divided into many kinds. Generally speaking, there are external data that can be shared by external personnel of the enterprise, and also, data are reported internally. These data are often related to the business secrets of the enterprise. It cannot be shared by people outside the enterprise. These data often contain some laws and opportunities; with the development of big data and cloud computing, these data can be classified to calculate and analyze or to obtain the relevant information for the development of enterprises with comprehensive analysis [2], in order to better serve the enterprise's decision-making. In the daily activities of enterprises, there will be a large number of customer data, which reflect the customers in a period of time, the flow of funds, the size of the amount of funds, and so on. These data are often used in enterprises to evaluate the reputation of customers, to establish credit files for enterprises, and to screen customers [3]. Through the summary and analysis of the above data, we can provide a large amount of information for the enterprise's sales forecast, financial forecast, capital forecast, and so on and provide effective data support for the enterprise's

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business direction, customer evaluation, and other decisions; it has a certain predictive effect for the future development of enterprises.

In order to solve the problem of statistical analysis of modern accounting data, this paper proposes a method of constructing modern accounting data analysis platform based on cloud computing technology. The time series model of modern accounting data analysis is constructed by using block bit sequence analysis method, and the association rule characteristic quantity of accounting data is extracted. Combined with cloud computing technology, the modern accounting data analysis platform is constructed, and the fuzzy C-means clustering method is used to realize the clustering of modern accounting data, which can improve the ability of parallel computing and statistical analysis of accounting data. Finally, the performance test is carried out through the simulation experiment, which shows the superior performance of this method in improving the ability of accounting data analysis.

The rest of this paper is organized as follows. Section 2 discusses the idea and feature analysis of real-time database, followed by the proposed time series model of data analysis designed in Section 3. Section 4 is cloud computing fusion of modern accounting data. Section 5 shows the intelligent data analysis process and algorithm implementation. Section 6 is simulation experiment and result analysis, and Section 6 summarizes the whole paper.

2 The idea and feature analysis of real-time database

The accounting data analysis platform should serve the enterprise. This service involves many aspects. It employs thousands of people in the enterprise to design and develop new products until the sales management of the vast sales staff [4]. The economic activities of an enterprise are related to the interests of many sectors in the society, such as customers, supply units, workers, lenders, shareholders, and governments at all levels that have jurisdiction over their business directly. How modern enterprises can plan, coordinate, and control how many aspects of their economic activities provides information to the people and institutions concerned with its economic activities, which will affect the survival and development of the enterprise, and the accounting data analysis platform plays an extremely important role in the completion of these work [5].

The influence of the development of information technology on the social and economic environment makes the transmission of information more fast; the price, exchange rate, and interest rate of the commodity are more intense, which makes the information users pay more attention to the future information, the uncertainty information, the partial information, and the emphasis on the relevance, consistency, and timeliness of information in the information quality. The traditional accounting information system

cannot meet the needs of the times and cannot meet the needs of decision-making [6]. The goal of the modern enterprise accounting data analysis platform which is to be rebuilt in this paper is to meet the needs of all kinds of information users, to realize multiple reports, and to use online real-time operation, active acquisition, and active provision. A man-machine interactive information use is complex, that is, first, comply with the development needs of the accounting theory and practice, give full play to the functions of the accounting information system in the enterprise management information system, and provide effective decision-making support for the internal and external information users; second, make full use of the results of information technology and related theories to improve the purpose of the integrated entity, the compatibility, complementarity, and hierarchy of the integrated unit, as well as the optimization of integration and the nonlinearity of the integrated function, and reflect the centralization, coordination, and separation of the system [7].

The application of the certificate of events and the application of advanced data collection greatly enriched the data source of the accounting information system with the help of advanced information technology [8]. How to achieve effective processing and application of these information has become an urgent problem. The database technology as the input and output of the process of data management technology will become a powerful tool for the storage and processing of the certificate.

To achieve a method of accounting information system is a time delay, a single breakthrough in the traditional accounting information disclosure, to provide diversified and timely management information for decision-making. The real-time database technology we proposed here is to comply with the following basic thought of the breakthrough time limit, breaking geographical boundaries, fast and accurate data collection, sorting, processing, and output information, taking into account the correlation between the reliability of the information and decision-making. The essential feature of real-time database technology is to break through time constraints [9].

Therefore, the time to sum up the characteristics of real-time database technology must meet the time of events' certificate data processing requirements to ensure the smooth operation of the real-time data in accounting information system.

We use the item voucher as the information source and the real-time database as the information carrier, and we store all the information in the daily economic activities of the enterprise (including the financial and non-financial information), establish the enterprise's accounting database, and complete the collection and storage of the source data. In this database, the accounting data can be stored in different information states (initial, initial processing, deep processing), different information levels

(management control, short-term planning and comprehensive control [10], management decision), and different measurement attributes (currency, non-money), in order to generate different information according to the needs of different decisions. In addition, with the characteristic time mechanism of the real-time database, we can realize the timely information collection, reflection, and processing, to the establishment and operation of accounting information system based on event approach to lay the foundation, and realize the core idea of event approach. This database in the certificate database is the main data source and is a combination of policies and regulations and other auxiliary and historical reference information, and it defines the rules of business affairs and its content and structure as shown in Fig. 1.

The accounting data, historical reference data, policies and regulations, and other auxiliary data are integrated in the database. It is the main data source for enterprise certificate library and, at the same time, the convergence of relevant information obtained through the Internet and other media and the accumulation of historical data [11]. Finally, through the definition of information processing rules, we export the business information needed, which is the core support for the construction of the accounting information system.

3 Methods

The time series model of modern accounting data analysis is constructed by using block bit sequence analysis method. The length of modern accounting data to be detected is defined as n , and the bit sequence is $E = \varepsilon_1, \varepsilon_2, \dots, \varepsilon_n$. By using the method of block bit analysis and combining with $x_i = 2\varepsilon_i - 1$ transformation, a new modern accounting data sequence $S_n = x_1 + x_2 + \dots + x_n$ is constructed, and the binomial and $\frac{S_n}{\sqrt{n}}$ of sequence X are statistically analyzed. Further, it carries out orthogonal transformation, while $\lim_{n \rightarrow \infty} P\left(\frac{S_n}{\sqrt{n}} \leq z\right) = \phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-u^2/2} du$ is close to the standard normal

distribution function [11]. The standard orthogonal items of accounting data meet the requirements of $S_{\text{obs}} = \frac{|S_n|}{\sqrt{n}}$. For statistical quantity $\frac{S_n}{\sqrt{n}}$, by adopting the standard normal distribution characteristic, the block prediction model of modern accounting data is expressed as follows:

$$\begin{aligned} \lim_{n \rightarrow \infty} P\left(S_{\text{obs}} = \frac{|S_n|}{\sqrt{n}} \leq z\right) &= 1 - \frac{1}{\sqrt{2\pi}} \left(\int_{-\infty}^{-z} e^{-u^2/2} du + \int_z^{+\infty} e^{-u^2/2} du \right) \\ &= 2\phi(z) - 1 \end{aligned} \tag{1}$$

In the process of economic operation, it is very important for enterprises to carry out credit rating [12]. By using SP800-22 rev1a standard, the detection threshold P value of accounting data is defined as:

$$\begin{aligned} P \text{ value} &= 2[1 - \phi(S_{\text{obs}})] = 2 \left(1 - \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{S_{\text{obs}}} e^{-u^2/2} du \right) \\ &= \frac{2}{\sqrt{2\pi}} \int_{S_{\text{obs}}}^{+\infty} e^{-u^2/2} du = \frac{2}{\sqrt{\pi}} \int_{\frac{S_{\text{obs}}}{\sqrt{2}}}^{+\infty} e^{-t^2} dt = \text{erfc}\left(\frac{S_{\text{obs}}}{\sqrt{2}}\right) \end{aligned} \tag{2}$$

If P value ≥ 0.01 , the measured accounting data are considered to be random. The association rule characteristic quantity of accounting data is extracted, and the fusion of accounting data and classification is carried out by using the methods of block analysis and test statistical analysis [13].

4 Cloud computing fusion of modern accounting data

On the cloud computing platform, purchase the analyzed data through the data platform and combine the sales data of the enterprise itself to effectively analyze the sales prospects of the enterprise products [14]. A non-overlapping block pattern is used to divide the sequence of bits n into $N = \lfloor \frac{n}{M} \rfloor$ bits. The statistical value of accounting data is

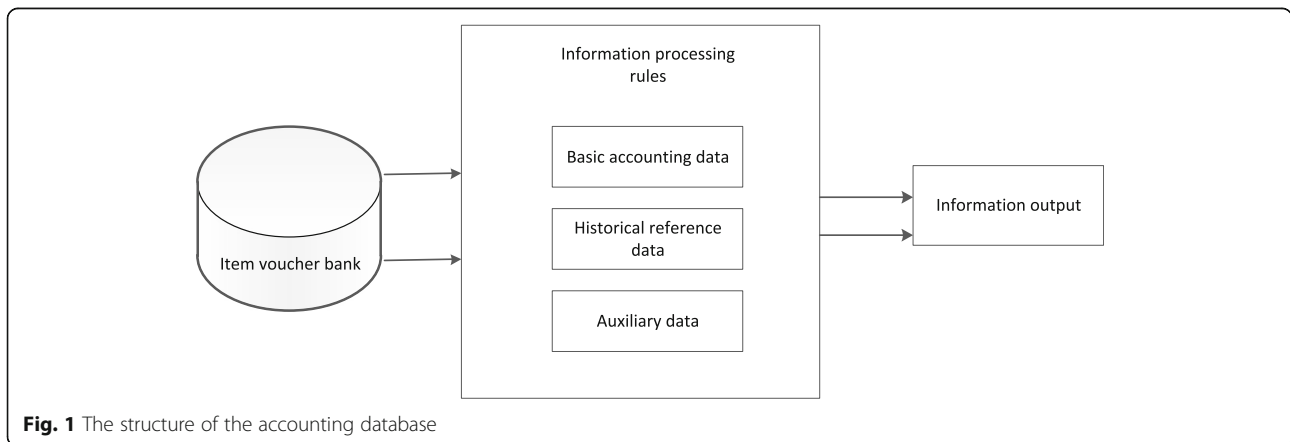


Fig. 1 The structure of the accounting database

satisfied with $\chi^2(\text{obs}) = 4M \sum_{i=1}^N (\pi_i - 1/2)^2$, and the degree of freedom of $\chi^2(\text{obs})$ service is χ^2 of $N/2$. A singular value decomposition method is used to decompose the P value values of the modern accounting data eigenvector matrix rows involved in the operation as follows:

$$P\text{value} = \text{igamc}(N/2, \chi^2(\text{obs})/2) = \frac{1}{\Gamma(N/2)} \int_{\chi^2(\text{obs})/2}^{\infty} e^{-t} t^{N/2-1} dt \quad (3)$$

In which, $\Gamma(N/2) = \int_0^{\infty} t^{N/2-1} e^{-t} dt$.

First, the range detection is based on the code frequency detection and turns the large-scale modern accounting data analysis and calculation problem into a series of small scale parallel computing problems [15, 16]. The binomial S_n of the accounting data can be expressed as $S_n = n\pi - n(1 - \pi)$, the test statistics $\frac{S_n}{\sqrt{n}} = \frac{n\pi - n(1-\pi)}{\sqrt{n}}$ is close to the standard normal distribution function, and the detection of modern accounting data is obtained [17–19]. The results of statistical analysis meet the sparse matrix $\lim_{n \rightarrow \infty} P(\frac{n\pi - n(1-\pi)}{\sqrt{n}} \leq z)$ $= \phi(z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^z e^{-u^2/2} du$ for the analysis of modern accounting data by L , the singular value decomposition $L = U * S * C$ is carried out, and the correlation fusion method is used to obtain the frequency of the detection range of the accounting data:

$$\begin{cases} r_1 = \frac{n}{8} \\ r_2 = \frac{n}{16} \\ r_3 = \frac{n}{32} \\ \dots \\ r_{i \max} = \frac{n}{2^{i \max+2}} \end{cases} \quad (4)$$

Therefore, in the linear subspace of finite field, using 0 or 1 run detection, in the cloud computing platform, the cost of parallel computing of accounting data can be expressed as $\text{Sum}_r = \frac{n}{4} - \frac{n}{2^{i \max+2}}$, i_{\max} is the length of the longest run, and modern accounting number is the length of the longest run [20, 21]. According to the total number of runs to meet the $\frac{n}{8} = 2^{i \max-1} r_{i \max}$, the longest run length is i_{\max} , modern accounting data detection frequency is $r_{i \max}$, and sequence length n should meet $\frac{n}{8} = 2^{i \max-1} r_{i \max}$, $r_{i \max} = 1$, or $r_{i \max} = 2$. The total cost of modern accounting data cloud computing is $V_{\text{idea}} = \text{Sum}_{\text{idea}} = 2 \text{Sum}_r = \frac{n}{2} - \frac{n}{2^{i \max+1}} \approx \frac{n}{2} - 2 \approx \frac{n}{2}$. The modern accounting data test statistics $\frac{n\pi - n(1-\pi)}{\sqrt{n}}$ have the following forms:

$$\begin{aligned} \frac{n\pi - n(1-\pi)}{\sqrt{n}} &= \frac{2\pi(1-\pi)[n\pi - n(1-\pi)]}{2\sqrt{n}\pi(1-\pi)} \\ &= \frac{4n\pi^2(1-\pi) - 2n\pi(1-\pi)}{2\sqrt{n}\pi(1-\pi)} \approx \frac{V_n - 2n\pi(1-\pi)}{2\sqrt{n}\pi(1-\pi)} \end{aligned} \quad (5)$$

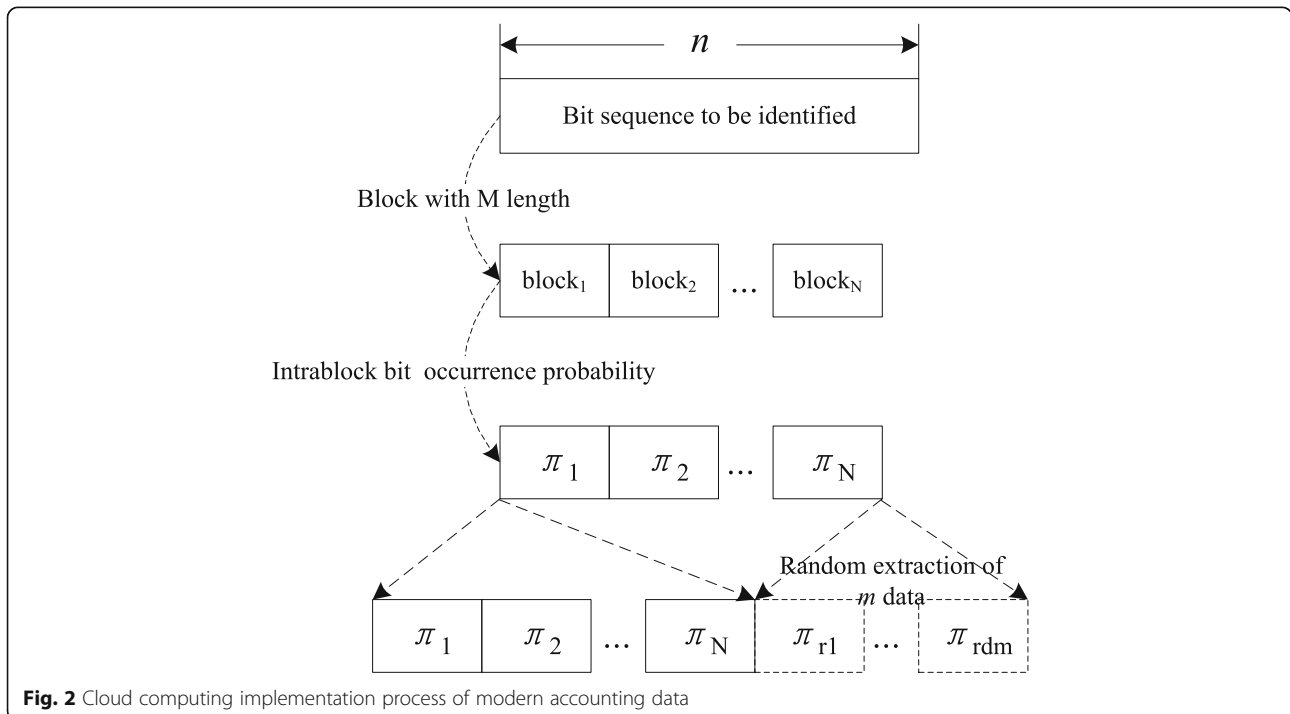


Fig. 2 Cloud computing implementation process of modern accounting data

Table 1 Experimental data

Modern accounting data sample	n	m	Type
Sample 1	10,000	20	Double
Sample 2	20,000	40	Double
Sample 3	30,000	60	Double
Sample 4	50,000	70	Double
Sample 5	80,000	90	Double
Sample 6	100,000	100	Double

To sum up, the statistics of modern accounting data $Run_n = \frac{V_n - 2n\pi(1-\pi)}{2\sqrt{n\pi(1-\pi)}}$ from the standard normal distribution function [22, 23]. The statistical threshold values P value for modern accounting data are:

$$\begin{aligned}
 P \text{ value} &= 2[1 - \phi(Run_n)] = \text{erfc}\left(\frac{Run_n}{\sqrt{2}}\right) \\
 &= \text{erfc}\left(\frac{V_n - 2n\pi(1-\pi)}{2\sqrt{2n\pi(1-\pi)}}\right) \tag{6}
 \end{aligned}$$

In order to solve the problem of block length value selection, the information entropy theory is introduced into the block length candidate value of modern accounting data. In the process of characteristic decomposition of modern accounting data, the matrix $X(i)$ is divided into $p(i)$ submatrices with $N_{ij} \times m$ size, and the probability distribution can be expressed as $\begin{bmatrix} X \\ P \end{bmatrix} = \begin{bmatrix} x_1 & x_2 & \dots & x_N \\ p_1 & p_2 & \dots & p_N \end{bmatrix}$, from this realization to the modern accounting data cloud computing fusion processing.

5 Intelligent data analysis process and algorithm implementation

Consider the case of rank loss, if the block set $(N(i) \bmod L) < m$, conversely, $p(i) = \lfloor \frac{N(i)}{L} \rfloor$. Under the condition that the parallel computation of modern accounting numbers satisfies the condition of uniform convergence, there are:

$$\begin{aligned}
 N_{i1} &= N_{i2} = \dots = N_{i,p(i)-1} = L; \\
 N_{ip_i} &= N(i) - (p(i) - 1)L.
 \end{aligned}$$

A singular value decomposition method is adopted to perform fuzzy C-means clustering processing on modern session count data, cloud computing analysis of modern accounting data is realized, and the realization steps are obtained as follows:

- Step 0: Initializing statistical characteristics of modern accounting data $M = 20$;
- Step 1: The length of R modern accounting data sequence is obtained as L_{\min} , and the maximum length of block length of modern accounting data is defined as: $M_{\max} = \lfloor \frac{L_{\min}}{2} \rfloor$.
- Step 2: While $M \leq M_{\max}$, then $BLOCK_{iM} = (\text{block}_{i1}, \text{block}_{i2}, \text{block}_{i3}, \dots, \text{block}_{i, \lfloor \frac{L_{\min}}{M} \rfloor})$.
- Step 3: The occurrence probability of bit $BLOCK_{1M}, BLOCK_{2M}, BLOCK_{3M}, \dots, BLOCK_{RM}$ in each block of modern accounting data sequence S is calculated separately, and the probability of occurrence of bit $\pi_{1M}, \pi_{2M}, \pi_{3M}, \dots, \pi_{RM}$ in each block of modern accounting data sequence of item i is obtained [22, 23].
- Step 4: The probability of occurrence of the elements in the statistical time series $X = (x_1, x_2, x_3, \dots, x_{M+1}) = (0, \frac{1}{M}, \frac{2}{M}, \dots, 1)$ of modern accounting data is calculated and as $\pi_{1M}, \pi_{2M}, \pi_{3M}, \dots, \pi_{RM}$; the detection statistic is $\begin{bmatrix} X \\ P_i \end{bmatrix} = \begin{bmatrix} 0 & \frac{1}{M} & \dots & 1 \\ p_{i1} & p_{i2} & \dots & p_{i(M+1)} \end{bmatrix}$.
- Step 5: Calculate the statistics of modern accounting data under the condition that the block length is M , and make $\tilde{H}_M(X) = \frac{-\sum_{i=1}^R \sum_{j=1}^{M+1} p_{ij} \cdot \log(p_{ij})}{R}$.
- Step 6: Go back to step 2, get the output entropy $\tilde{H}_{20}(X), \tilde{H}_{21}(X), \dots, \tilde{H}_{M_{\max}}(X)$.

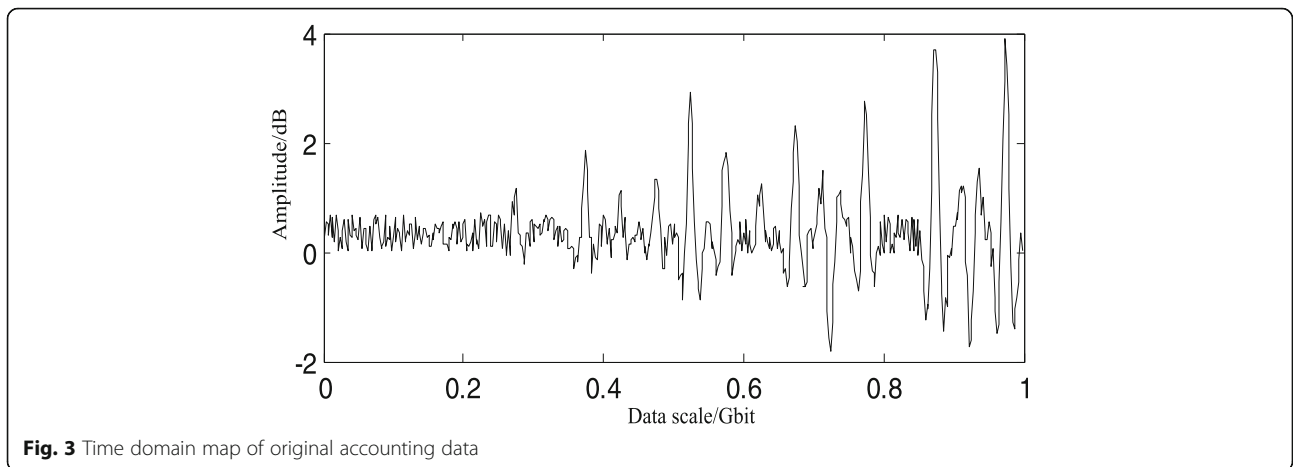


Fig. 3 Time domain map of original accounting data

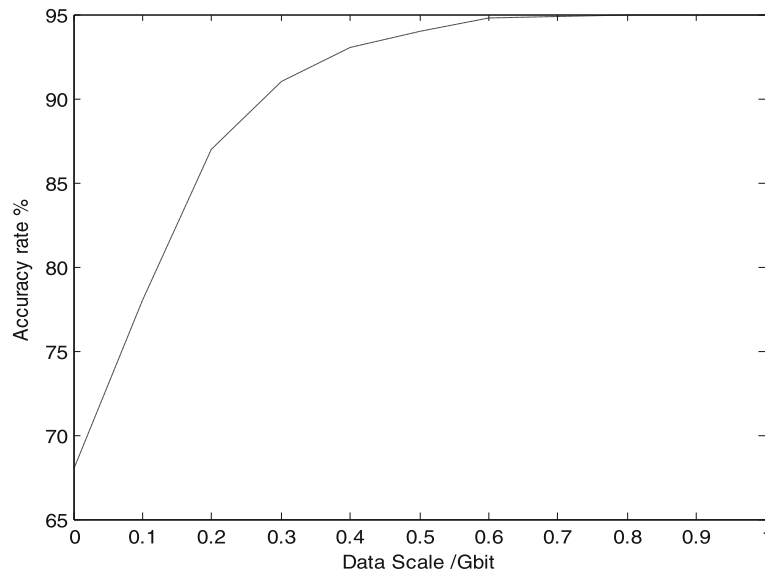


Fig. 4 Accuracy rate

Step 7: If $\Delta H_i(X) \geq \theta$, determine the threshold of the block length candidate.

The fuzzy C-means clustering method is used to realize the clustering of modern accounting data [24], and the parallel computing and statistical analysis ability of accounting data is improved. The flow chart is shown in Fig. 2.

6 Results and discussion

In order to test the performance of this method in the implementation of cloud computing and statistical analysis of

modern accounting data, the simulation experiment was carried out. The experiment was designed with Matlab 7, the CPU was Intel Core™ i7-2600 @ 3.40 GHz, the statistical sample set of accounting data was 2000, and the test sample was tested. The scale is 100, the block length is 2.15, and the detection threshold is 0.23. The scale statistics of the experimental data are shown in Table 1.

According to the above simulation environment and parameter setting, the cloud computing and statistical analysis of modern accounting data are carried out, and the original accounting data sampling time domain

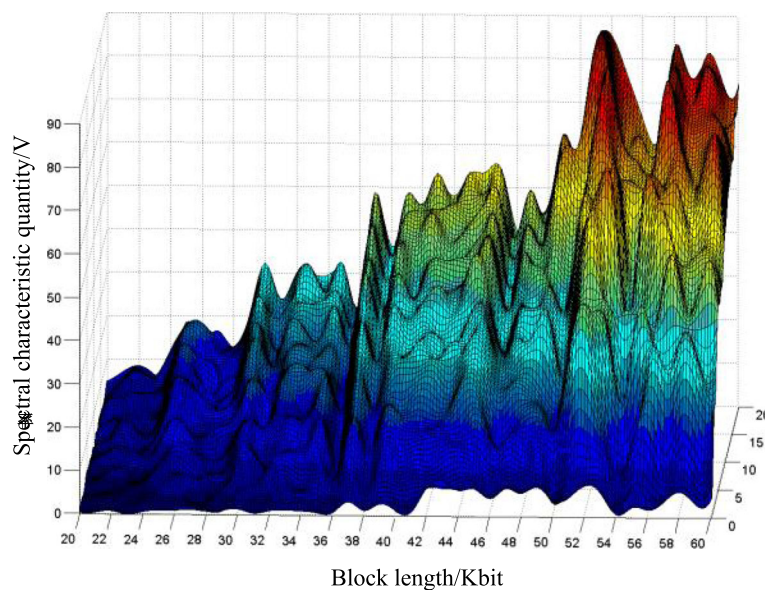
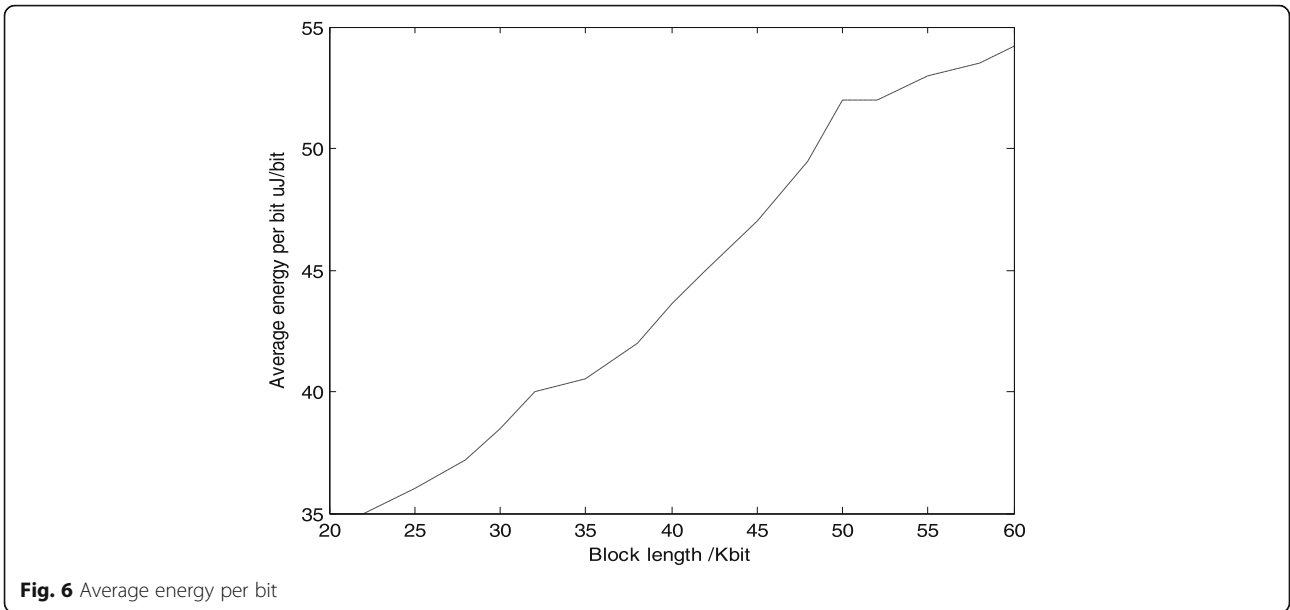


Fig. 5 Cloud computing fusion of accounting data



waveform is shown in Fig. 3. The accuracy rate of intelligent data analysis based on industrial cloud computing platform is shown in Fig. 4.

The feature extraction and statistical analysis of the modern accounting data shown in Fig. 3 are carried out, the maximum association rule exponent spectrum of the modern accounting data flow model is calculated, and the feature statistical analysis is carried out. The result of cloud computing fusion of accounting data is shown in Fig. 5.

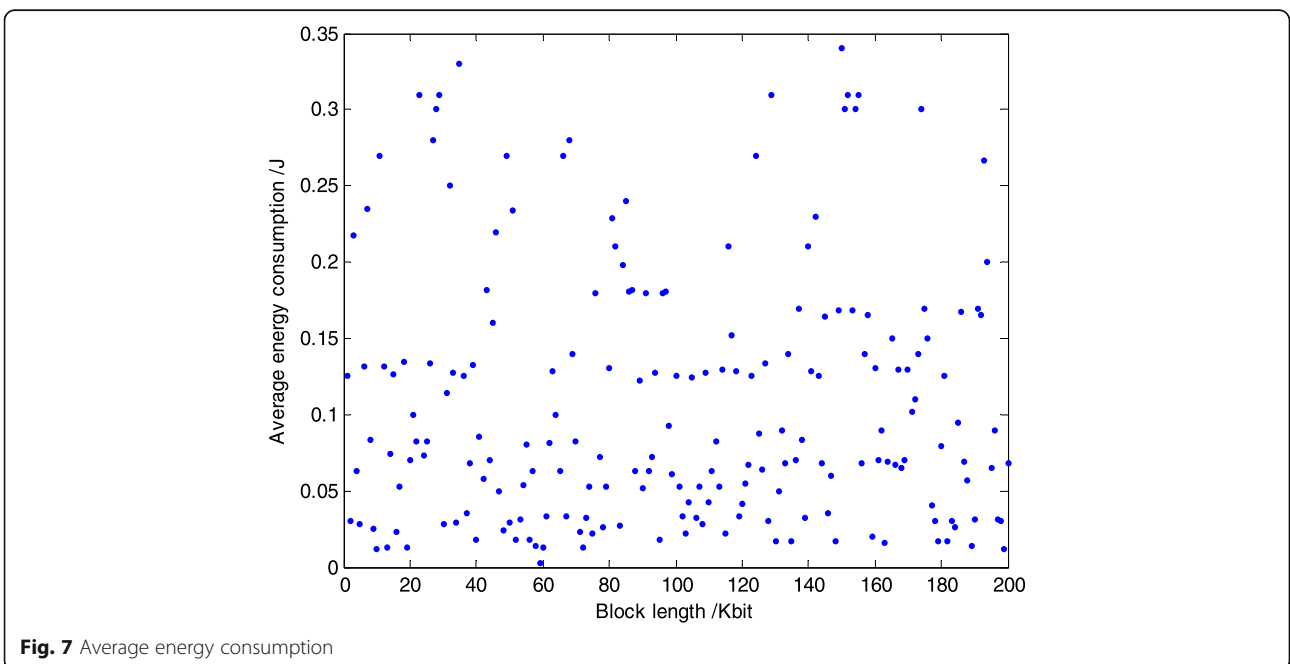
Figure 6 shows the average energy consumption per bit for different block lengths. Figure 7 is the average

energy consumption for different block lengths. It is clearly evident from Fig. 6 that the average energy per bit increases with the increase of block length.

Through the above experimental results, it can be observed that the parallel computing ability is better and the computing efficiency is higher by using the method of this paper to process the accounting data in cloud computing.

7 Conclusions

In this paper, a method of constructing modern accounting data analysis platform based on cloud computing technology



is proposed. The time series model of modern accounting data analysis is constructed by using block bit sequence analysis method, and the association rule characteristic quantity of accounting data is extracted. Combined with cloud computing technology, the modern accounting data analysis platform is constructed, and the fuzzy C-means clustering method is used to realize the clustering of modern accounting data, which can improve the ability of parallel computing and statistical analysis of accounting data. The simulation results show that the intelligent data analysis platform designed makes the statistical analysis ability of accounting data better and the parallel computing efficiency higher.

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Authors' contributions

WT proposed the innovation ideas and theoretical analysis. YL conceived of the study, participated in its design and coordination, and helped to draft the manuscript. Both authors read and approved the final manuscript.

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Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Competing interests

The authors declare that they have no competing interests.

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