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An Empirical Study on Machine Learning for Enterprise Cloud Computing Service Management

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

A machine learning method is proposed to aim at the problems of large data processing, complex data, and limited system resources in cloud computing service management. First, multi-department analysis is carried out on cloud service management data, and relevant management data is standardized to form a standardized management data collection; Machine learning is used to classify, mine, and extract service management data, and corresponding management measures are taken promptly to improve the management level of cloud computing services. MATLAB simulation shows that machine learning can improve the level of cloud computing service management, simplify the process of cloud computing service management, shorten the management time of cloud computing services, and meet the actual needs of service management.

Keywords: Cloud computing; service management; machine learning; empirical.

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1. INTRODUCTION

SMEs are a crucial part of China's current market economy and have played a significant role in the country's economic development in recent years. According to statistics, Chinese SMEs now account for nearly 99.7% of the total number of enterprises in China, generating 60% of GDP and paying 40% of tax revenue. SMEs also play an active role in promoting employment and protecting people's livelihoods. These SMEs create 75% of the jobs in society, especially in the economic development of local towns and cities, where they employ more than 90% of the local workforce. However, in recent years, despite the gradual development and expansion of their relative size, the profit level of SMEs has not improved accordingly. Moreover, along with economic globalization, the increasingly severe downward pressure on domestic and foreign economies and the increasingly fierce competition in domestic and foreign markets, SMEs are facing higher and higher thresholds for market research and innovation, and their advantages in rapid response to the market are beginning to weaken gradually, coupled with the internal management problems that have come to the fore and the lack of corresponding rapid innovation mechanisms to compete with large enterprises, the resources available to SMEs, including the use of IT technology, are not comparable to those of large enterprises. These factors are beginning to become bottlenecks that hinder the development and growth of enterprises.

The continuous in-depth development of cloud computing service management has greatly improved the efficiency of enterprise management [1]. However, cloud computing service management data is complex and involves many departments, which will cause the decline of cloud computing service level and increase the probability of cloud computing latency. How to process cloud computing service data, reduce the complexity of data [2], and improve service management is a problem that enterprises need to solve [3]. Some scholars believe that using intelligent algorithms in cloud computing server management can effectively simplify the amount of data in cloud computing and reduce the complexity of data [4]. Some scholars believe that applying intelligent algorithms in cloud computing server management can better conduct data analysis [5], identify characteristic data from multiple angles [6], and improve the accuracy of management [7]. For the above analysis, some scholars believe that cloud computing service management needs to screen data and reduce the proportion of redundant data to optimize the analysis results [8]. Based on the above research, this paper uses machine learning algorithms to analyze cloud computing service management, optimize the data structure in the management process, reduce the complexity of data, and aim to improve the level of cloud computing service management.

2. DESCRIPTION OF THE PROCESS OF CLOUD COMPUTING SERVICE MANAGEMENT

2.1 Selection of Distributed Computers

Distributed computer selection is the idle computer selection in the cloud computing services management process, such as server selection [9], logical computer selection, transmission mode selection, cloud processing platform selection, and auxiliary computing selection. To better select distributed computers, it is necessary to set selection criteria [10], eliminate distributed computers that do not meet the requirements, and form a distributed computer selection list. The empirical research of machine learning on the optimization of cloud computing service management not only increases the number of service management per unit of time [11] but also reduces the channel occupancy rate and improves the accuracy of service management. To meet the needs of different departments and fields for cloud computing service management [12], it is necessary to quantify the content of cloud computing service management and put forward the following assumptions.

Hypothesis 1: Service management data is $I^2 = (x_1, \cdots x_n)$, service management content is I_i, cloud computing constraints is m_i, distributed computer selection function $w({I^2}_i, x_n)$ is shown in equation (1)

$$w({I^2}_i, x_n) = m_i \cdot \sum \xi_i \cdot \frac{(I_i, x_n)}{\sum \lambda_i} \tag{1}$$

Where λ is the adjustment factor between service management indicators?

Hypothesis 2: The importance of different service management contents is $\frac{\sum d_i}{\bar{d}}$ [13], and the service list handler function is $f(d_i)$. The importance determines the priority of the content of cloud computing management services, and the judgment of the importance of the content is shown in equation (2).

$$f(d_i) = \sum w_i \cdot f(I_i \cup T)' \tag{2}$$

Where is the w correlation coefficient of different service content?

2.2 Mathematical Description of Machine Learning

2.2.1 Machine learning

Machine learning is an intelligent algorithm that can iteratively analyze service management, including the construction of service management data collections, the elimination of management attributes, and the judgment of data independence, etc., to achieve comprehensive calculation of service management [14]. Determine the appropriate improvement indicators for the resource situation of cloud computing and service management standards [15]. First, determine the threshold and conditions of service management according to the service management standards, and then select distributed computers according to the resources of cloud computing [16]. Optimize cloud computing service management by self-learning and give corresponding weight to the results. Finally, the data and attributes that do not meet the requirements are removed [17], and machine learning is performed on other data to achieve multi-angle and multi-dimensional comprehensive analysis [18].

Hypothesis 3: The content of machine learning is *n*, and the deep mining function is $de(d_i)$, x_i, y_i represents the distribution of computer and service management data, then, the machine learning function is shown in equation (3).

$$de(d_i) = rand(0,1) \cdot f(\frac{I_i}{x_i} | \lambda) \tag{3}$$

Among them, s_n are the adjusted service management level, x_i machine learning content, and $s(x_i)$ cluster data.

The distributed computer and service management data is cross-analyzed, and under the constraints, the service management level function $Le(x_i)$ is calculated as shown in equation (4).

$$Le(x_i) = \frac{1}{w_i} \cdot \sum I_i \cdot \sum s_n \cdot \lambda \tag{4}$$

2.2.2 Parameter adjustment of service management

In the process of service management, machine learning needs to continuously adjust parameters to achieve the integration of cloud computing and service management data and improve the level of service management. In different service management processes, it is necessary to increase the number of parameters and perform large-scale data analysis of service management results. Among them, the parameter regulation factor v needs to be set between distributed computers and between computers and service management data, and the calculation of this factor is shown in equation (5).

$$v_i = \frac{\sum w_i}{\sum f(d_i)} \tag{5}$$

After obtaining the service management results, it is necessary to verify the rationality of the service management results, so you need to set the depth adjustment factor of the parameters to obtain the final calculation results, as shown in equation (6).

$$Le(x_i) = \frac{p_i}{w_i} \cdot I_i \cdot f(x_i) \tag{6}$$

In summary, in the early stage of cloud computing service management analysis, it is necessary to expand the scope of parameter adaptation as much as possible and incorporate more service management data into the system. In the later stage of cloud computing service management, it is necessary to dig deep into the parameters to verify each parameter's rationality

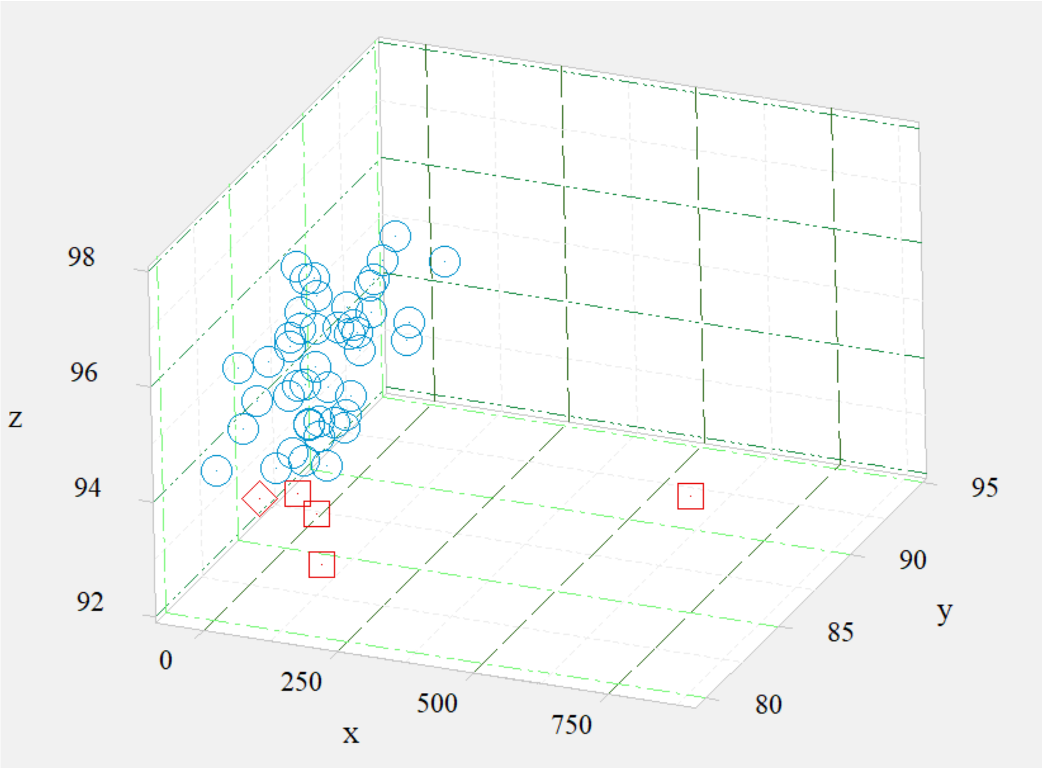

Fig. 1. Parameter adjustment process of service management

and practical significance. The changes in parameters during the machine learning process are shown in Fig. 1.

The parameter distribution of cloud computing service management is relatively stable, and the change range of each parameter is small, showing a uniform distribution. This shows that the parameter adjustment process of enterprise cloud computing service management by machine learning method is more reasonable and meets the analysis requirements.

2.3 Machine Learning Strategies for Cloud Computing Service Management

2.3.1 Different machine learning strategies

Machine learning has many optimization solutions for cloud computing service management, which can adapt to cloud computing service management at different stages and contents. First of all, we must determine the content of cloud computing service management and adopt corresponding machine learning strategies according to different contents. At present, there are many machine learning strategies, mainly as follows.

1) Service management strategy for a single indicator, as shown in equation (7).

$$C(x_i) = \frac{Le(x_i)}{\sum x_i} \tag{7}$$

2) Multi-indicator service management strategy as shown in equation (8).

$$A(x_i) = \sum_i L(d_i) \cdot rand(x_i) \tag{8}$$

3) Single-dimensional service management strategy as shown in equation (9).

$$E(x_i) = \frac{\max f(d_i)}{1 - \bar{x}} \tag{9}$$

4) Multi-dimensional service management strategy as shown in equation (10).

$$F(x_i) = \frac{\min f(d_i)}{\sqrt{\bar{x}^2 - 4w_i} \cdot \lambda} \tag{10}$$

Among them, *K* is the distributed computing capacity managed by cloud computing services.

The strategy of cloud computing service management is as follows: on the one hand, it can realize machine learning of different service management contents and provide the pertinence of service management. At the same time, single-indicator and multi-indicator service management strategies can realize comprehensive service management judgment, accurately discover problems in service management, and facilitate the formulation of service management strategies in the future. On the other hand, the multi-dimensional service management strategy can dig deep into the management problems, find the causes of different problems, and facilitate the selection of future indicators. In short, the cloud computing service management strategy is analyzed from multiple angles, aiming to improve the accuracy of service management analysis.

2.3.2 Multi-indicator and multi-dimensional synergy

Multi-indicator and multi-dimensional analysis is the key to improving the accuracy of cloud computing service management, and the effect of deep learning can be achieved through the collaborative analysis of distributed computers and service management data. Multi-metric and multi-dimensional collaboration can better handle different service management content and better select machine learning strategies. For each service management content, multiple iterative analysis is carried out, and the threshold of each content is constrained to ensure the validity of the calculation results.

2.4 Computational Steps of Machine Learning

The basic idea of machine learning is to use service management content to set the initial value of the cloud computing platform and obtain a more reasonable service management strategy, the specific steps are as follows.

- Step 1: Determine the service management data, standardize the content of service management data, and record the service management results.
- Step 2: Select the metrics, thresholds, and synergy coefficients for service management, and standardize the management data to map it to a one-dimensional space.
- Step 3: The final service management scheme is obtained through multi-index and multi-dimensional analysis of distributed computers and service management content.
- Step 5: Verify the service management solution based on the synergy coefficient between indicators and dimensions, and output the final cloud computing service management results.
- Step 6: If all service management data is calculated, stop machine learning and output the final result, otherwise repeat steps 1~5.

3. PRACTICAL CASES OF CLOUD COMPUTING SERVICE MANAGEMENT

3.1 Cloud Computing Service Management

Three small and medium-sized enterprises carried out cloud computing service management research, the survey data was 5 4.3 M, qualitative information accounted for 3 2.6%, quantitative information accounted for 5 6.3%, other information accounted for 1 1.1%, and the information of cloud computing service management is shown in Table 1.

From Table 1, it can be seen that the basic information of cloud computing service management can be obtained, the dispersion degree of relevant data is greater than 70%, the fitting degree is greater than 8 0%, the channel communication rate is greater than 9 0%, the volatility is less than 1 1%, and the distributed computer is at 5 0% Above, machine learning analysis can be carried out. Moreover, the service management information of different management departments and industries has not been abnormal after standardized processing to more intuitively understand the distribution of cloud computing service management data, and compare different dimensions, as shown in Fig. 2.

It can be seen from Fig. 2 that the distribution of cloud computing service management data by machine learning is more discrete and stable, which is in line with the actual enterprise analysis needs.

3.2 Analysis Results of Cloud Computing Service Management

(1) The compliance rate of actual requirements

According to the constraint standards of cloud computing service management, the service management data is analyzed and compared with the actual service requirements, and the results are shown in Table 2.

Table 2 shows that the compliance rate of actual service management is relatively high, both higher than 90%, and the compliance rate in the early stage is higher than that in the later stage, showing volatility changes, mainly because the machine learning method mainly expands the analysis scope in the early stage and improves the analysis accuracy in the later stage. To further verify the effectiveness of service management, the service management data should be judged continuously, and the results are shown in Fig. 3.

Table 1. Cloud computing service management information

Index	Dispersion	Degree of fit	Distributed computer volume	Channel communication rate	Volatility
Quantitative information	78.49	87.26	54~62	98.76	10.32
Qualitative information	76.82	89.24	34~113	97.97	9.13
Semi-structural information	79.92	89.74	64~89	98.97	7.92
Non-structural information	76.10	88.16	63~92	98.06	4.10
Information redundancy rate	76.97	87.97	46~103	97.22	3.97
Standardized information	78.35	87.98	52~46	98.12	2.35

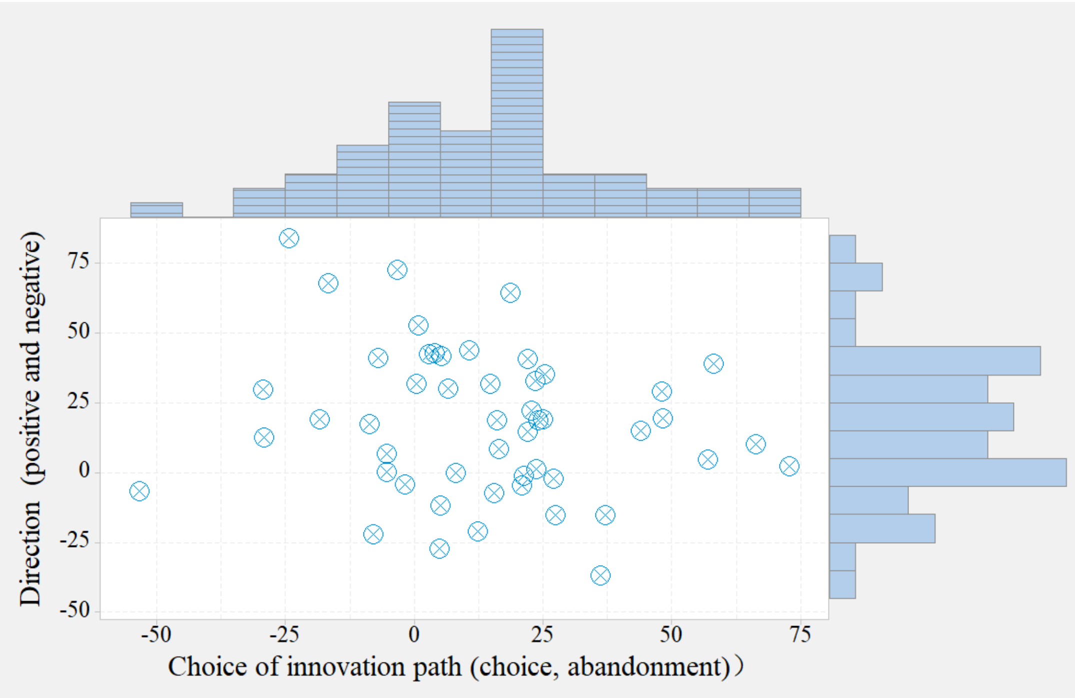

Fig. 2. Distribution of cloud computing service management data

Table 2. Compliance rate of actual service management

Data type	Compliance rate	Analysis phase		*T/P*
		Prophase	Anaphase	
Structure data	95.36	98.52	94.22	14.23/0.032
Unstructured data	92.36	99.6	90.36	10.65/0.015
Semi-structured data	96.85	99.7	94.3	16.35/0.042

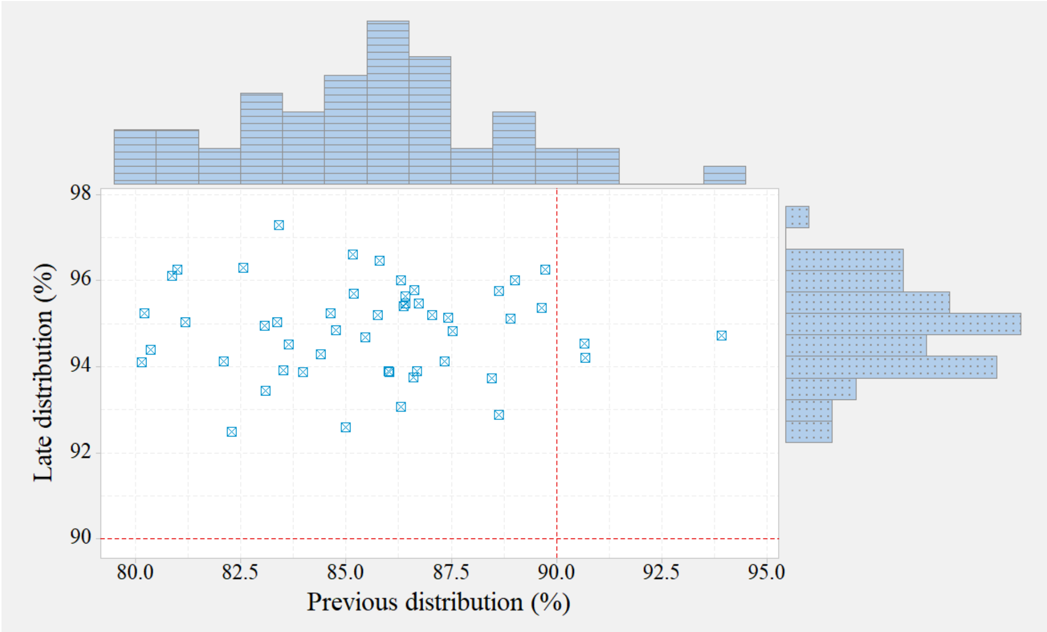

Fig. 3. Distribution of service management results after processing

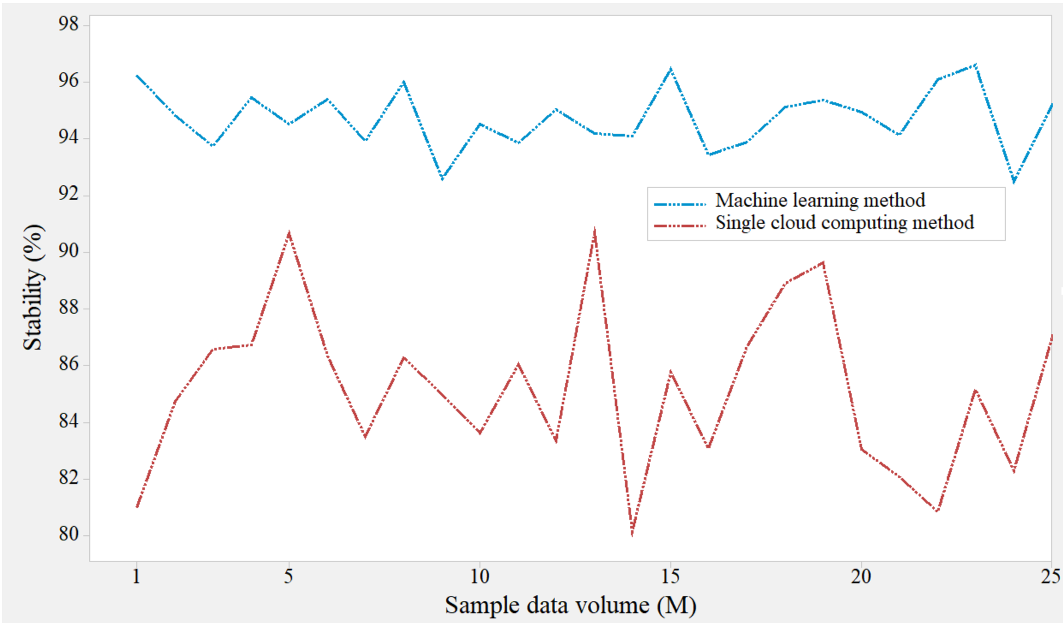

Fig. 4. Service management analysis stability by different methods

Comparative analysis shows that the service management results processed by machine learning are evenly distributed, consistent with the actual service management department. Among them, the machine learning method treats service management data more concisely, has a higher correlation between data, and better processing results in the later stage. In addition, the data processed by machine learning did not fluctuate significantly. This is because machine learning adds synergies between management metrics and dimensions.

(2) Stability of service management analysis

To further verify the effect of machine learning, it is necessary to compare with a single cloud computing method, including stage stability, overall stability, bias, and redundancy rate, the result is shown in Fig. 4.

It can be seen from Fig. 4 that in the data range of 0~25M, the results of machine learning methods fluctuate less and have high stability, which is better than that of a single cloud computing method. Under the constraints of service management, machine learning has a lower deviation rate. The reason is that the machine learning method adopts policy selection and performs targeted policy analysis on different service management contents to ensure the stability of machine learning results.

(3) The computational accuracy of service management

Accuracy is an important indicator of service management, and high accuracy performance better guides the implementation of service management measures. Table 3 shows the service management accuracy results of the machine learning method.

Table 3 shows that machine learning methods are superior to single cloud computing methods in the analysis of unstructured, semi-structured, and qualitative data, and the accuracy does not change with the change of data structure. The main reason is that the machine learning method sets thresholds for distributed computers and service management content, continuously expands the adaptation range of parameters in the early processing process, and conducts an in-depth analysis of parameters in the later stage. Therefore, machine learning can reduce the impact of data results on results and improve the analysis accuracy of service management. The analysis process of the two algorithms is shown in Fig. 5.

Table 3. Comparison of the accuracy of service management processing by different methods

Data structure	Processing scope	Machine learning		A single approach to cloud computing	
		Accuracy	**Time**	**Blend in depth**	**Time**
Semi-structured	part	96.26	11.00	85.23	23.87
	overall	94.84	14.75	85.13	25.04
	Multidimensional	93.75	16.60	80.15	24.20
Non-structured	Multi-indicator	95.46	16.73	86.12	24.11
	Multidimensional	94.53	10.65	83.95	26.46
Qualitative data	part	95.41	16.35	86.55	23.43
	overall	93.91	13.50	88.47	23.90
	Multidimensional	96.00	16.29	81.86	25.12

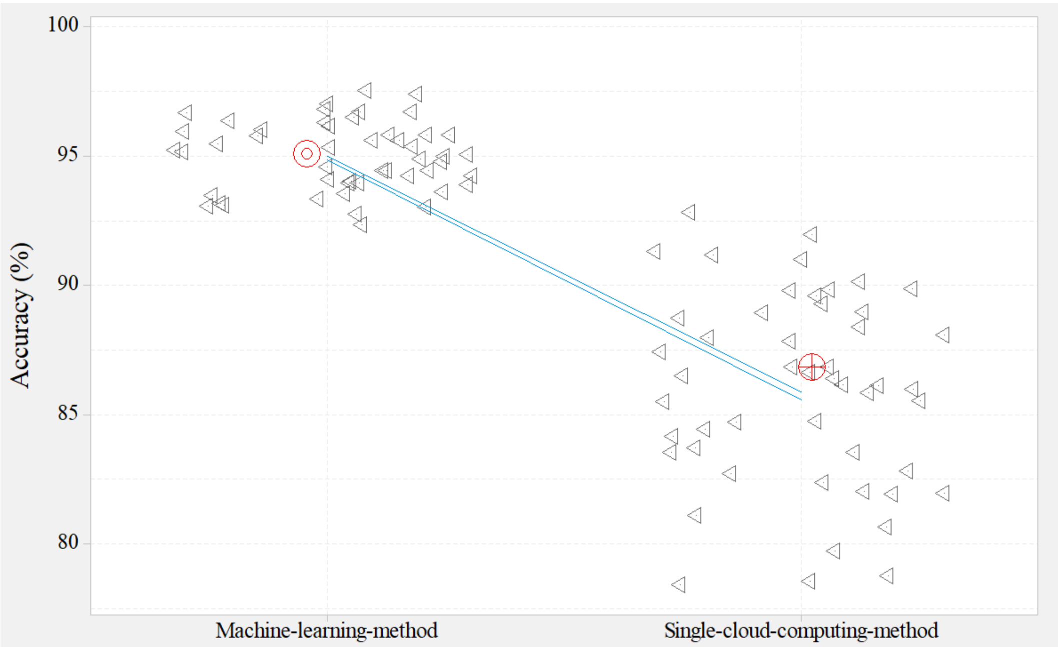

Fig. 5. Comparison of analytical accuracy of different methods

4. CONCLUSION

This paper proposes a machine learning method to analyze cloud computing service management to improve the service management level. The accuracy and stability of service management are calculated by setting the threshold of service management content and distributed computers and increasing the synergy coefficient of multi-dimensional and multi-index. The results show that machine learning can conduct in-depth management data analysis through the standardized processing of service management data, which has high stability and accuracy and is significantly better than a single cloud computing method. However, the algorithm in this paper also has its shortcomings, and the data and indicators of each dimension are not uniformly standardized, so there may be certain deviations in the processed data, which affects the accuracy of the results. In future studies, data processing between dimensions will be carried out.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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