

## Research Article

# Cloud Computing Resource Prediction Model Based on Time Convolutional Network

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With the continuous progress and development of modern science and technology, the research on cloud computing-related fields is constantly conducting more in-depth exploration. During the real-life use of cloud computing operations, as the number of tenants continues to increase, the resource usage load capacity of the relevant platform has also undergone tremendous changes. In order to enable the tenants to complete higher-level optimization of the relevant performance and indicators during the actual work of the platform, this article explains how to perform related network resource models on the premise of cloud computing operation management. The researchers used this cloud computing network operation forecasting system as the basic point of view for experimental research and explained and summarized all relevant research results and specific instructions on multivariable load sequences in detail. The multivariable load sequence is embedded in the dimension of the phase space in the calculation process, and the generalization operation from single variable to multivariable can be carried out. However, every time the expansion calculation is performed, the selection criteria available for the researcher to calculate will be reduced, making the result a reconstructed phase space with uncertainty. Therefore, in order to ensure the accuracy of the data of the research experiment results, the researchers must simplify the model, focus on further discussing the correlation between multivariable load sequences in the mechanism, and reduce the number of data calculations in the process. The redundant information generated can select more reasonable data information as input variables in the research process.

## 1. Introduction

With the continuous development of modern technology, the scale of many enterprises has also expanded rapidly. Many traditional enterprises have adopted a decentralized enterprise computing operation model, but as the scale of the enterprise continues to expand, the burden on servers has also continued to increase, reaching a considerable number [1, 2]. As a result, it also brings a series of difficult problems for enterprises, such as more complicated and difficult-to-operate operation management models, control of computing operating costs, and application of key functions [3]. These problems are forcing researchers to improve the existing systems and re-centralize the servers in large-scale use machines [4]. The processing method of cloud computing is the solution proposed by the researchers for enterprises. First, compared with the previous resource

management, cloud computing has significantly reduced the initial construction cost of resources, as well as the cost of resource operation and maintenance during use [5, 6]. This includes the server, platform storage equipment, network management tools provided by the platform, and a series of infrastructure required in the operation process; secondly, the main users of cloud computing are developers of application technologies in the Internet. The system platform simplifies and upgrades the system through operations such as the development of shielded software, such as the research and development of new distributed software systems, the testing of platform application systems, and the deployment of the system in use. Researchers doing system development can use cloud computing to improve the performance of the platform, the availability during actual operation, and the scalability of other related functions in the shortest time; the last point is the scalability and scalability of cloud computing

during use. The advantages of multi-tenant accommodation and platform configurability provide employees with a new and convenient way of thinking at work, as well as software operators, software developers and researchers, and the actual use of software. This brings more convenience and benefits.

## 2. Related Work

Some research mainly put forward the research results of researchers in the management of resource prediction models in the field of cloud computing. The ideas and viewpoints described in this article mainly come from the project "Cloud Computing and Its Supporting Network" [7]. This project is working to build a network communication service platform supported by a cloud computing system [8]. On this platform, the system can provide a series of related functions for operators using telecommunications, such as computing integration, storage aggregation, network protection, and other related functions to help enterprises carry out data management, and perform scientific and reasonable dynamic allocation of enterprise resources [9]. In addition, the platform can also provide related service management system equipment for telecom service providers. In order to better solve the problem of how to improve the efficiency and accuracy of the use of virtual machines in the cloud computing-related infrastructure, the researchers re-optimize the storage management methods of resources in the platform, and to better study this subject, the researchers also introduced an analysis and prediction system in the experiment [10]. Researchers have proposed a new type of prediction model in order to better model and predict the multi-variable load sequence generated during the study of the resource load sequence in the cloud computing platform [11]. This kind of forecasting model is still based on the multivariate load sequence as the main research foundation, and is mainly applied and suitable for cloud computing platform resource load sequence forecasting. The researchers summarized the data results obtained from the experiment, and comprehensively considered the multiple influence relationships of resources in the cloud computing platform. The researchers reasoned and deduced the data in the female experiment based on the principal component analysis method, and combined regarding the related theories of local forecasting method; a forecasting model of multi-variable load series is established. In the process of testing the effect of cloud platform use by researchers, the experimental results show that the multi-variable load sequence forecasting model proposed in this article is indeed currently predicting the direction of resources used by enterprises on cloud platforms as an effective method. And the prediction accuracy of this multivariate load sequence forecasting model is obviously different from that of the univariate load sequence forecasting model, and it has higher accuracy. Some research mainly studies the data and related processing and statistical methods of the resource load sequence in the cloud computing platform during use [12]. On the one hand, this new algorithm improves to a certain extent the identification of dirty data in the use of cloud computing platform resource

load sequences, as well as the research, improvement, and optimization of dirty data computing algorithms [13]. On the other hand, this new algorithm also realizes the wavelet denoising data preprocessing algorithm in the use of cloud computing resource platform. In the process of researching the cloud computing platform, the relevant experimental data showed the researchers that the related identification of dirty data and the correction and optimization of dirty data algorithms mentioned in this article can realize and search the relevant data and information in the computing process to a certain extent [14, 15].

## 3. Analysis of the Theoretical Basis of Cloud Computing and Time Convolutional Networks

*3.1. Time Data Concept and Related Theories.* Time data is usually called time series by scholars, which refers to the data series formed by a certain phenomenon occurring in different time environments. In our real life world, changes in data are often closely related to time. Researchers call the data observations obtained by the research object in the order of time as time series data. Among them, the most common ones are changes in weather and temperature, changes in stock and bond prices, and so on. At present, researchers have summarized many scientifically mature time series mining algorithms so that people can more conveniently capture the deeper information contained in time series data. Spatial data refers to data information with a definable spatial coordinate position. Spatial data can be described quantitatively by people, which is very useful for some things with positioning significance and can better explain this phenomenon. In the real life world, people often use spatial data to describe and express the relative geographic location of actual objects in some space, the distribution characteristics of surrounding objects and the environment, which clearly shows that due to the geographic location. The difference in location leads to the standardization process of the entity to be observed and studied or the target time under the influence of such different spatial conditions. Spatiotemporal data refers to data that includes the temporal attributes of time data and the spatial attributes of spatial data. For example, we often use the Internet to book data sheets for vehicles in our daily lives. The creation of this order contains not only time attributes, but also spatial attributes. Another example is the GPS positioning data frequently used on mobile phones and vehicles. The accurate positioning coordinates of the target location reflect the spatial attributes of this data, and the time value of the sample target to be studied when the position changes. The phenomenon of change is the time attribute embodied by this phenomenon. We can think that there are many pieces of time series data in our lives, and each of these pieces of data is generated by different spatial position coordinates.

With the continuous development of current information technology-related technologies, mining related to the field of spatiotemporal data has become a hot topic discussed by researchers in the current data mining research field, and

this topic has been awarded in academic fields at home and abroad. Regarding the new project of spatiotemporal data mining, researchers are focusing on information computing technology with practical applications. And through this technology, those high-dimensional, massive, and complex data are analyzed in detail to better find and use the part of the data that can create the value. In the modern society of human life, people's complex behaviors in life and work often bring about the accumulation of temporal and spatial data. Researchers have carried out a deeper digging of this spatiotemporal data to find some phenomena in human social life. For example: Researchers analyze and mine the research target and the route and trajectory and travel rules of the research target by studying the movement behavior of the target location, and provide the researcher with relevant predictions and location recommendations of the location of the tracking target services; through people's social behaviors, the cloud computing system platform will analyze and study the spatiotemporal information data of the research samples based on the social activities that people generate in life and work. At the same time, the platform can also make inferences and judgments based on the identity information of the tested sample and the relationship between people during social activities; the cloud computing system platform will use the cloud computing system platform through the migration behavior of the research target's population in and out, transfer, etc. Perform statistical calculations on the population flow in the city, and scientifically interpret and predict the cluster behavior generated by the research goal through the systematic scientific analysis of the cluster behavior. The relationship attributes between time and space in spatiotemporal data usually have more complex relationships, especially many of them that can be quantified, and some time attributes and space attributes that cannot be quantified are included in these data. According to the analysis of the spatiotemporal data attributes, whether the temporal and spatial attributes of the data will change under different circumstances. According to this, the researchers analyze and mine the spatiotemporal data and classify them into the following three categories: (1) Some data is in progress, in the process of research, the time and space attributes of the data will not change and remain at a relatively stable value. This kind of data is called static data by researchers. For example, an airport and a shopping mall can be used as static data for observation of interest. Such data has fixed coordinates, fixed addresses, and fixed names. Once established, its spatial position will not change. The data information of time and space has static properties and is a kind of point data. (2) During the research process of some data, the spatial attributes of the data will not change, but the temporal attributes will change. For example: electronic sensors and surveillance camera probes installed on the road, their spatial position will not change during the research process, but the information that can be collected will change over time. This kind of data information has the characteristics of unchanged spatial attributes and changing temporal attributes. (3) There is a kind of data that both the temporal and spatial attributes studied during the research process will change. For example, simple and

environmentally friendly shared bicycles, and currently popular online ride-hailing platforms, the user's data is scattered data in terms of time effect. For example, at a certain moment, a user is about to start from A and sends a request to the platform. After a period of time, a user sends a request again in place B. At this time, these two kinds of data belong to changes in both temporal attributes and spatial attributes. Spatiotemporal data are shown in Figure 1.

*3.2. Theoretical Basis of Convolutional Neural Networks.* Convolutional Neural Network (CNN) refers to a feedforward neural network that contains both convolutional computing power and deep learning structure characteristics. It is developed by researchers specifically for neural networks containing data similar to a grid structure. In recent years, as researchers continue to explore and improve the theoretical basis of deep learning, and the data computing equipment for research has also been improved and perfected to a certain extent, convolutional neural networks have been able to develop so quickly. And it is currently widely used in the fields of visual processing and natural language processing in the related use of computers. Convolution operation on a two-dimensional tensor is shown in Figure 2.

*3.3. Cloud Computing Resource Prediction Model Foundation.* The project based on the prototype of the cloud computing platform mentioned in this article is the project "Cloud Computing and Its Supporting Network", a collaboration between Northwest University and Huawei. The infrastructure facilities of this type of cloud computing platform are composed of two system structures. The two structures are the service management system and the operation monitoring system in the platform management as shown in Figure 3.

The analysis and prediction system used in the cloud computing platform mainly implements functions such as mining and analyzing data in the current state, analyzing the current operating state and future development trends, and providing alerts on user behavior. The data analysis performed in the cloud computing platform is mainly to predict and process the raw data that has not been processed in the platform; the trend prediction is mainly for the data after analysis and processing, and the platform will analyze and process the data according to the specific algorithm summarized by the researcher. The prediction model and prediction algorithm are improved and perfected, and the future development direction is scientifically predicted based on the results of data analysis. The prediction alarm in the cloud computing platform is mainly managed in the form of network communication. When the system is abnormal, the service system will reflect the abnormal state data of trend prediction by sending communication to the user, so that the user can make a response.

The cloud computing platform architecture diagram is shown in Figure 4.

The cloud computing platform prediction system architecture of this paper is shown in Figure 5.

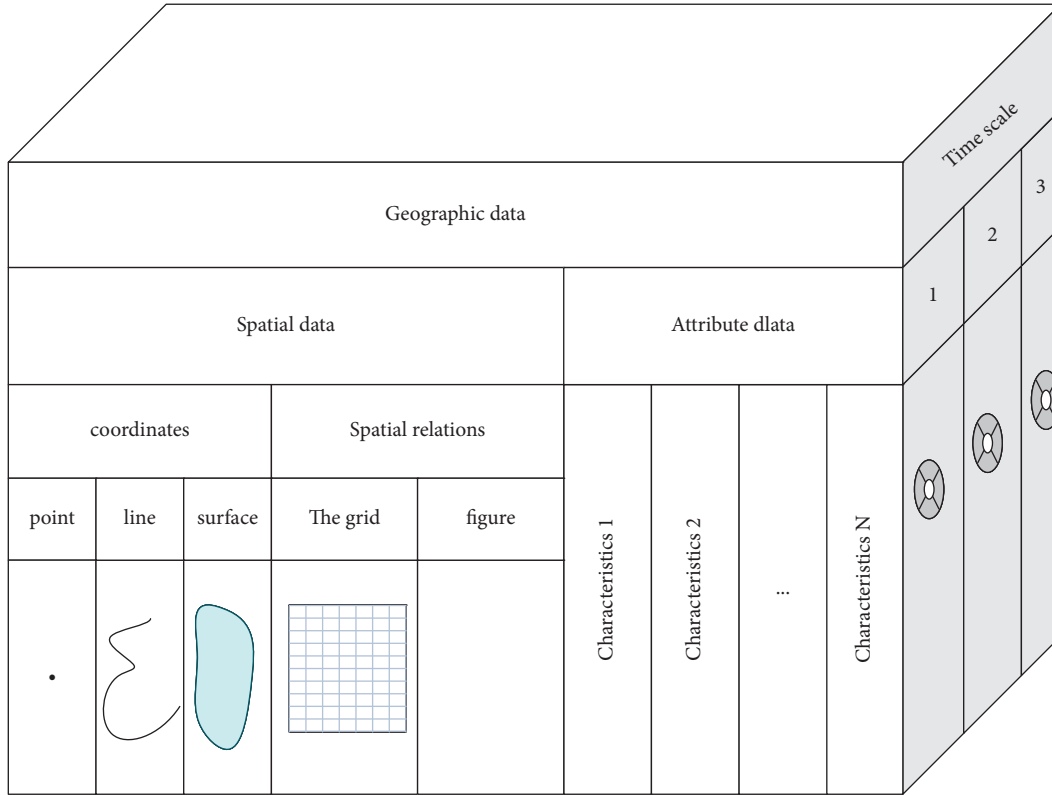


FIGURE 1: Spatiotemporal data.

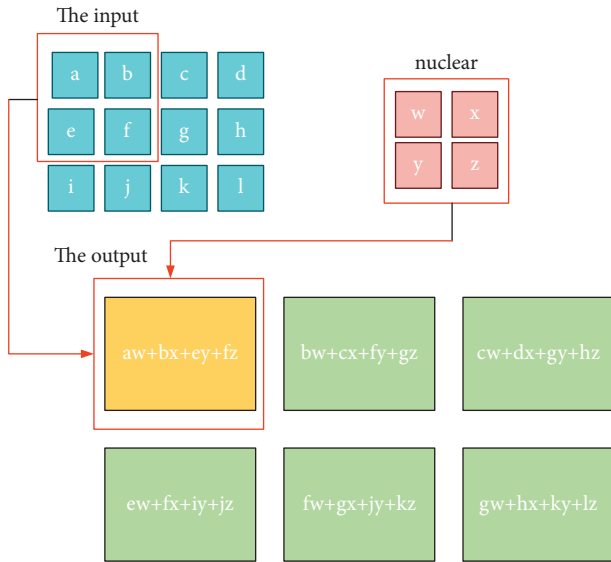


FIGURE 2: Convolution operation on a two-dimensional tensor.

3.3.1. *Data Preprocessing Algorithm.* Researchers consider that the cloud computing platform prediction system is likely to encounter data missing, data integrity problems, noise during the collection process, or inconsistencies in the data collection process during the process of research data collection. These factors often cause the cloud computing platform prediction system to produce great errors when calculating data, which will have a serious impact on the accuracy of the cloud computing platform

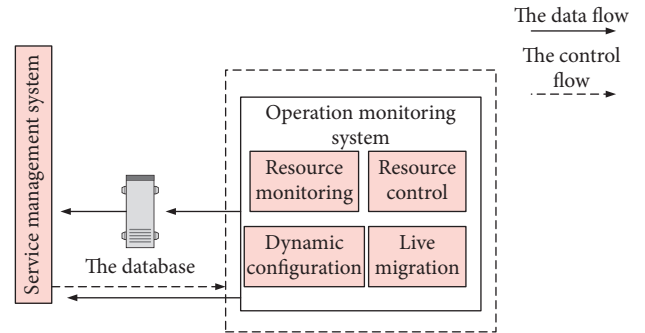


FIGURE 3: Cloud computing infrastructure architecture diagram.

prediction system platform. In order for researchers to better solve the above problems, this article will be divided into two parts to perform data preprocessing on the resource load sequence of the cloud computing platform prediction system.

3.3.2. *Single Prediction Model.* In order to better understand the resource load sequence in the cloud computing platform forecasting system, the author chose three single forecasting models in this article. The main reasons for choosing these three prediction models are as follows: Researchers can analyze and propose the relevant laws of holidays hidden in the resource load of the cloud computing platform prediction system through the phase space reconstruction prediction model, making the cloud computing platform

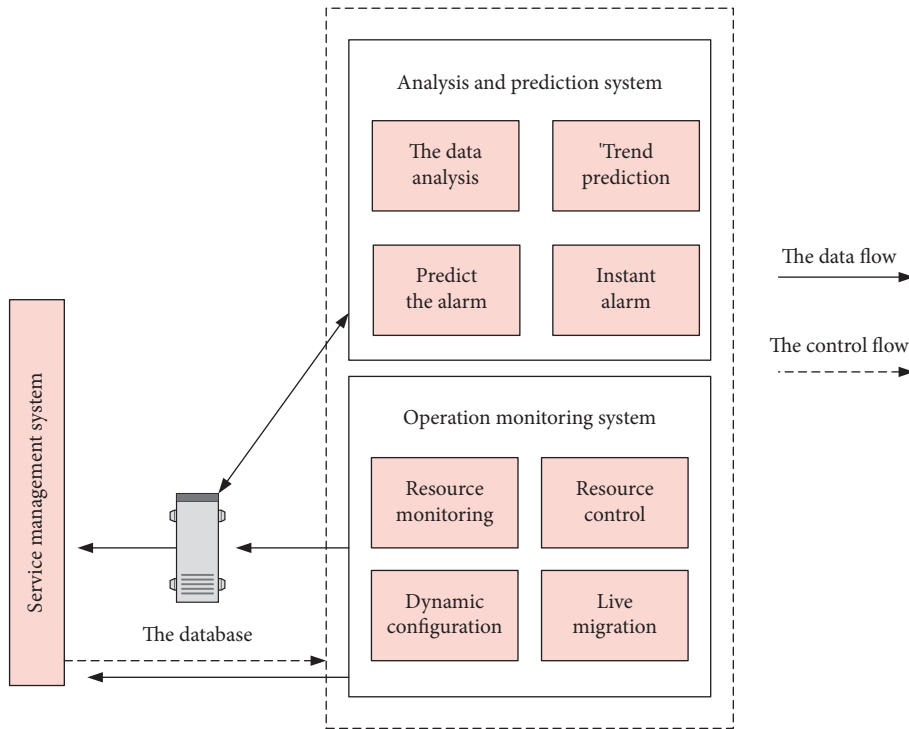


FIGURE 4: Cloud computing platform architecture diagram.

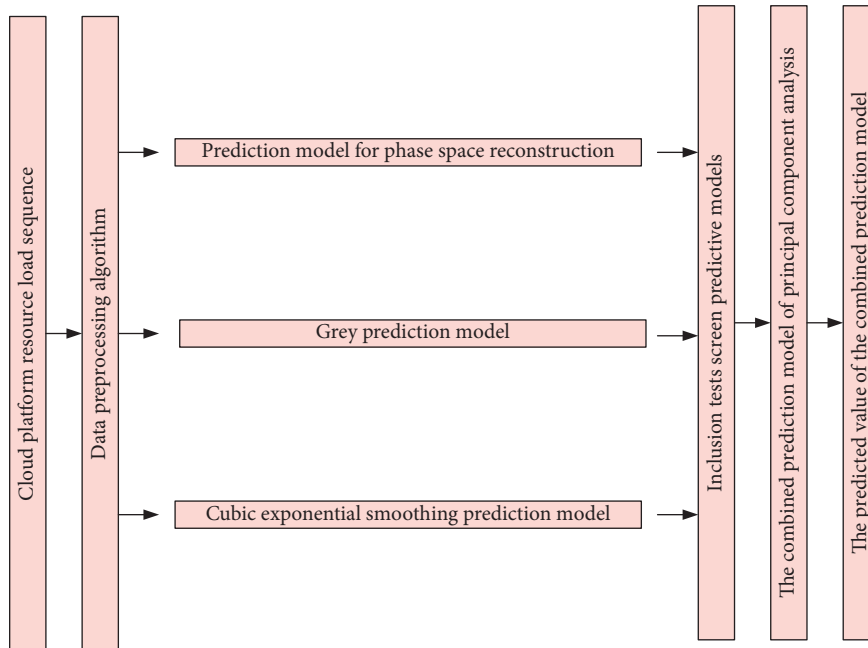


FIGURE 5: Cloud computing platform prediction system architecture.

prediction system the original characteristic state is analyzed and restored.

3.3.3. *Inclusive Test.* The existing combined forecasting model of the cloud computing platform forecasting system is just a relatively simple single forecasting model used by researchers to assign weights to the data obtained by the

analysis of the cloud computing platform forecasting system. Because this type of prediction model is relatively simple, the operation process does not consider whether there will be some data effects that are not conducive to the experiment if the data of a single prediction model is only used in the process of combined prediction. On the one hand, the combined forecasting model in the cloud computing platform forecasting system will not necessarily improve when it

is used. Therefore, researchers have adopted the means of increasing the number of single forecasting models; on the other hand, there are likely to be some interrelated characteristics between each single prediction model in the cloud computing platform prediction system. This phenomenon will cause the phenomenon of information overlap in the combined prediction model when the input information is studied in the experiment, leading to the accuracy of the prediction reduce.

**3.3.4. Combined Forecasting Model.** When researchers conduct computational research on the cloud computing platform forecasting system, they use a single forecasting model, which to a certain extent cannot integrate the characteristics of the cloud computing platform resource load sequence, and the cloud calculated from the data results the prediction error of computing platform resource load is extremely large. Therefore, the combined forecasting model will become a key research area in the field of scientific research for the development of cloud computing platform resource load forecasting. Compared with a single prediction model, the combined prediction model in the cloud computing platform takes into account the various factors that may occur in reality. This model has more comprehensive information and more accurate calculation data. Compared with a single prediction model, it has obvious superiority.

## 4. Data Preprocessing Method and Prediction Model Design

### 4.1. Data Preprocessing Method and Correction Algorithm

**4.1.1. Laida Criterion.** The expression is as follows:

$$|x_i - \bar{x}| > 3\sigma. \quad (1)$$

Among them,

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i, \quad (2)$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^n x_i^2 - (1/n)(\sum_{i=1}^n x_i)^2}{n-1}}.$$

**4.1.2. Shawville Criterion.** The expression is as follows:

$$|x_i - \bar{x}| > Z_c \sigma. \quad (3)$$

**4.1.3. Gadabus Criterion.** The expression is as follows:

$$g_i \geq g(a, n). \quad (4)$$

Among them,

$$g_i = \frac{|x_i - \bar{x}|}{\sigma}. \quad (5)$$

**4.1.4. T-Test Criteria.** The expression is as follows:

$$|x_i - \bar{x}| > K\sigma. \quad (6)$$

In the process of data research and processing in this article, the researchers found that some data was not recorded under this processing method, and it is necessary to supplement and retrieve these unrecorded values.

In order to retrieve the lost data, the researchers studied the following methods:

- (1) Retrieve the lost value manually: The advantage of this retrieval method is that it is simple to operate and easy to learn. However, the shortcomings of this approach are also very obvious. This method is not suitable for data sets that do have a higher ratio. If manual filling is used in this kind of data, the resulting data will be distorted easily. Among them, the mode imputation method and the mean imputation rule are the most commonly used methods when manually filling in missing values in the data.
- (2) Fill in the missing values with constants: this method is to replace all missing positions in the whole article with a fixed constant when the researchers find that the missing data is found in the data consolidation process. This mode of operation is very simple and can be easily achieved. But the disadvantage is that the accuracy rate is very low. If the operator replaces all the missing values in the data with "Constant", the prediction model is likely to make judgment errors. Therefore, this method is not reliable.
- (3) Replace the missing values in the data with the average value of the remaining data: When there is a data loss phenomenon in a set of samples, the researcher can add the remaining data and average again, using the average value in the data as a standard value is used to supplement the missing part of the data.
- (4) Fill the most probable value with the most data based on scientific inference: Researchers can make inference predictions on the required data information based on the mathematical model derived from inference. For example: linear regression model, decision tree induction and other methods, the missing values of the sample data will be supplemented by the calculated prediction results.

The most common strategy used by researchers in academia is method (4), because in method (4) the missing data values in the sample are not obtained out of thin air, but researchers use scientific algorithms to analyze and calculate the remaining information inferred. This article analyzes and contrasts various methods for supplementing missing values of sample data in the current academic community, and finally chooses method (4) as the supplement of missing values of resource load sequence in the cloud computing platform.

What needs to be emphasized in this article is that in some specific cases, just as certain words and paragraphs in

the data information database must be allowed to be afraid, the occasional missing value in the data does not necessarily mean that the data is in progress. An error occurred during the collection process. Researchers use to determine the elimination method of numerical noise. This article conducts a more in-depth study on the following methods.

- (1) Binning: researchers smoothly process the ordered value data by “neighboring” (that is, the values around the missing data). First, the researcher will put some “buckets” in the sample data, or ordered values in “bins”. Based on this, the neighboring value of missing data was investigated and researched, so the smoothing strategy was chosen. The main smoothing strategies currently used by researchers are: box mean smoothing method, box median smoothing method, box boundary value smoothing method, and so on.
- (2) Regression: the researcher eliminates the method of using the noise fitting function to give a certain value. The main method of this fitting function elimination can be divided into linear regression elimination method and multiple linear regression elimination method. Linear regression elimination method refers to the accurate value of an attribute in the known sample data, and on this basis, the fitting curve between two different attributes is known. And bring the known attribute value into the calculated fitting curve to predict the value of another attribute. The multiple linear regression forecasting method often involves multiple attributes in the sample data when data forecasting, and the other steps are generally the same as the linear regression forecasting method.
- (3) Clustering: researchers classify data objects with similar properties and characteristics in the sample data information, and arrange them into groups. Then group these classified data information into a specific set, which is defined as a cluster. The researchers then perform information detection based on the similar characteristics of these information clusters. If the data is not in the form set, the researchers define it as an outlier.

In this article, based on the analysis information proposed above, the researchers will divide the data information into two major groups to discuss the closed value: If the value of  $i$  selected by the researcher is too large and exceeds a certain range, then the noise will be removed. The range is wider, and a lot of useful information will be eliminated and eliminated by the system; if the researcher selects a threshold smaller than a certain range when conducting the experiment, the noise removal will not have a particularly obvious effect, and there will be a lot of noise in the load sequence. It will continue to survive and cannot be eliminated.

Select the closed value as

$$n_i = M(j + 2 - i)^\beta. \quad (7)$$

The action mode of the hard threshold is

$$a_i = \begin{cases} d_i |d_i| \geq \lambda, \\ 0 |d_i| < \lambda. \end{cases} \quad (8)$$

The soft threshold function is as follows:

$$\alpha_i = \begin{cases} \text{sign}(d_i)(|d_i| - \lambda) |d_i| \geq \lambda, \\ 0 |d_i| < \lambda. \end{cases} \quad (9)$$

Among them,

$$\text{sign}(t) = \begin{cases} 1, t \geq 0, \\ -1, t < 0. \end{cases} \quad (10)$$

#### 4.2. Forecasting Model Design of Multivariate Load Series.

This article draws on the method of univariate reconstruction phase space to determine delay time  $\tau$  and embedding dimension  $m$ .

Reconstruct the phase space as follows:

$$X(n) = [x(n), \dots, x(n - (m - 1)\tau)]^T \in R \quad (11)$$

$$(n = N, \dots, (m - 1)\tau + 1).$$

Reconstruct the multivariate phase space as follows:

$$Y(n) = [x_1(n), x_1(n - \tau_1), \dots, x_1(n - (m_1 - 1)\tau_1)]$$

$$x_2(n), x_2(n - \tau_2), \dots, x_2(n - (m_2 - 1)\tau_2)$$

$$\dots \dots$$

$$x_k(n), x_k(n - \tau_k), \dots, x_k(n - (m_k - 1)\tau_k)^T \in R^{m_1 + \dots + m_k}$$

$$n = N, N - 1, \dots, \max_{1 \leq i \leq k} (m_i - 1)\tau_i + 1. \quad (12)$$

Suppose there are currently  $K$  resource load sequence types, which are included by the cloud computing platform  $Y_1, Y_2, \dots, Y_k$  are the first vectors of the  $K$  underlying resource phase spaces, and the first vector  $Y_q = [x_{q1}, x_{q2}, \dots, x_{qm}]^T$  of the phase space is used as a variable Exist in different underlying resources, there are  $q = 1, \dots, K; m = \min_{1 \leq h \leq K} (m_h)$ , which represents the variable  $y_{i,j}$  ( $i = 1, 2, \dots, m; j = 1, 2, \dots, K$ ) at the corresponding position in the matrix, and the matrix is obtained:

$$R = (r_{ij}), i = 1, 2, \dots, m, j = 1, 2, \dots, K. \quad (13)$$

Among them,

$$\bar{y}_j = \frac{1}{n} \sum_{i=1}^n y_{ij},$$

$$r_{ij} = \frac{S_{ij}}{\sqrt{S_{ii}S_{jj}}}, \quad (14)$$

$$S_{ij} = \frac{1}{n-1} \sum_{k=1}^n (y_{ki} - \bar{y}_i)(y_{kj} - \bar{y}_j).$$

Description of the number of neighborhood points in the phase space reconstruction process is as follows:

$$H = X(X^T X)^{-1} X^T,$$

$$D(K) = \text{tr}(H),$$

$$\sigma^2(K) = \frac{\left[ y - yX^T(XX^T)^{-1}X \right] \left[ y - yX^T(XX^T)^{-1}X \right]^T}{K - D(K)}. \quad (15)$$

The weight of point  $X_{mi}$  is defined as follows:

$$P_i = \frac{\exp(-c(d_i - d_m))}{\sum_{i=1}^q \exp(-c(d_i - d_m))}. \quad (16)$$

The first-order local linear prediction model is constructed as follows:

$$X_{Mi+k} = a_k e + b_k X_{Mi}, \quad i = 1, 2, \dots, q. \quad (17)$$

Apply the weighted least squares theory, then

$$\min \sum_{i=1}^q P_i \left[ \sum_{j=1}^m (x_{Mi+k}^j - a_k - b_k x_{Mi}^j)^2 \right], \quad (18)$$

where  $x_{Mi}^j$  (18) is the  $j$ th element in the reference vector  $X_{Mi}$ . After simplification, we can get

$$\begin{cases} a_k \sum_{i=1}^q P_i \sum_{j=1}^m x_{Mi}^j + b_k \sum_{i=1}^q P_i \sum_{j=1}^m (x_{Mi}^j)^2 = \sum_{i=1}^q P_i \sum_{j=1}^m x_{Mi+k}^j x_{Mi}^j, \\ a_k m + b_k \sum_{i=1}^q P_i \sum_{n=1}^m x_{Mi}^j = \sum_{i=1}^q P_i \sum_{n=1}^m x_{Mi+k}^j. \end{cases} \quad (19)$$

The matrix form is written as

$$\begin{pmatrix} \alpha & \beta \\ m & \alpha \end{pmatrix} \begin{pmatrix} a_k \\ b_k \end{pmatrix} = \begin{pmatrix} e_k \\ f_k \end{pmatrix}. \quad (20)$$

Among them,

$$\begin{aligned} \alpha &= \sum_{i=1}^q P_i \sum_{j=1}^m x_{Mi}^j, \\ \beta &= \sum_{i=1}^q P_i \sum_{j=1}^m (x_{Mi}^j)^2, \\ e_k &= \sum_{i=1}^q P_i \sum_{j=1}^m x_{Mi+k}^j x_{Mi}^j, \\ f_k &= \sum_{i=1}^q P_i \sum_{n=1}^m x_{Mi+k}^j, \\ \begin{pmatrix} a_k \\ b_k \end{pmatrix} &= \begin{pmatrix} \alpha & \beta \\ m & \alpha \end{pmatrix}^{-1} \begin{pmatrix} e_k \\ f_k \end{pmatrix}. \end{aligned} \quad (21)$$

Substitute the obtained  $a_k$  and  $b_k$  into the prediction formula as follows:

$$X_{M+K} = a_k e + b_k X_M. \quad (22)$$

The predicted value after  $k$ -step evolution is  $X_{M+K}$  is as follows:

$$X_{M+k} = (x_{M+k}, x_{M+k+r}, \dots, x_{M+k+(m-1)r}). \quad (23)$$

In  $X_{M+k} = (x_{M+k}, x_{M+k+r}, \dots, x_{M+k+(m-1)r})$ , the  $m$ -th element  $x_{M+k+(m-1)r}$  is the  $k$ -step predicted value of the original load sequence.

**4.3. System Analysis and Implementation.** The prototype of the cloud computing platform mentioned in this article is actually a project "cloud computing and its supporting network" that Northwest University cooperates with Huawei. The main purpose of this project is to better test and evaluate the effect of the prediction model of the cloud computing platform resource load sequence. Denoising effects under different wavelet bases and different decomposition layers are shown in Table 1.

This article establishes a predictive model based on the CPU utilization load sequence of a cloud computing platform as an example. Among them, the load sequence of CPU utilization uses wavelet denoising theory to denoise these four types of resource load sequences. Denoising processing is shown in Figure 6. Main component characteristic root and contribution rate are as shown in Table 2. Principal component feature vector is shown in Table 3.

The main component table is

$$\begin{aligned} Z_1 &= 0.4753Y_1 + 0.4031Y_2 + 0.1216Y_3, \\ Z_2 &= 0.0058Y_1 + 0.1722Y_2 + 0.8219Y_3. \end{aligned} \quad (24)$$

The weight is the contribution rate of each principal component:

$$\begin{aligned} Y &= \frac{1.8394}{1.8394 + 0.9285} \times Z_1 + \frac{0.9285}{1.8394 + 0.9285} \times Z_2 \\ &= 0.6645 \times Z_1 + 0.3355 \times Z_2 \\ &= 0.3178Y_1 + 0.3256Y_2 + 0.3566Y_3. \end{aligned} \quad (25)$$

The multi-variable phase space embedding dimension of the virtual machine utilization rate is a multi-variable prediction model. Comparison of test results of the grey prediction model is shown in Table 4. The prediction results and accuracy comparison of the CPU utilization load sequence of the cloud computing platform are as shown in Table 5.

$$m = m_1 + m_2 + m_3 + m_4 = 8 + 2 + 2 + 2 = 14. \quad (26)$$

**4.4. Combined Forecasting Model.** MAPS is defined as follows:

$$\text{MAPE} = \frac{1}{N} \sum_{i=1}^N \left| \frac{f_i - y_i}{y_i} \right| \times 100\%. \quad (27)$$



TABLE 1: Denoising effects under different wavelet bases and different decomposition layers.

Wavelet base	Decomposition layer	Root mean square error (RMSE)	Signal to noise ratio (SNR)
db4	3	0.1993	32.2564
db4	4	0.2163	30.6250
db4	5	0.2335	29.0929

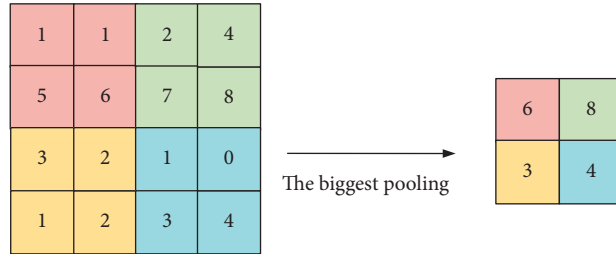


FIGURE 6: Denoising processing.

TABLE 2: Main component characteristic root and contribution rate.

Main ingredient	Eigenvalues	Contribution rate (%)	Cumulative contribution rate (%)
Z1	1.8394	61.31	61.31
Z2	0.9285	30.95	92.26
Z3	0.2320	7.74	100.00

TABLE 3: Principal component feature vector.

Resource category	Z1	Z2
Memory utilization	-0.6894	0.0764
Disk utilization	-0.6349	0.4150
Network load utilization	0.3487	0.9066

TABLE 4: Comparison of test results of grey prediction model.

Grey prediction model	Without denoising	Wavelet denoising processing
Posterior variance ratio C	0.2332	0.1476
Probability of small error	85.66%	92.38%

TABLE 5: The prediction results and accuracy comparison of the CPU utilization load sequence of the cloud computing platform.

Time series/day	CPU utilization actual value/%	Predicted value of phase space prediction model	Grey prediction model predicted value	Three times exponential smoothing model prediction value	Combination forecast model forecast value
1091	38.520	38.917	38.733	39.728	39.323
1092	38.760	38.945	38.735	39.763	39.354
1093	39.380	38.993	38.737	39.799	39.396
1094	39.636	38.956	38.739	39.836	39.396
1095	39.720	38.955	38.741	39.872	39.414
	MAPE (%)	1.23	1.39	1.54	1.01

## 5. Conclusion

This article mainly carried out specific research on the resource prediction model in the cloud computing platform. Researchers realized the resource prediction function of the cloud computing platform through continuous in-depth research on the original system. Although the cloud computing platform has been greatly developed, there is still a lot of work that needs to be further studied on the system

platform. Researchers will continue to conduct in-depth research and mining on the existing data and will summarize the algorithm applied to cloud computing resource load sequence. In this article, the researchers analyzed and studied the algorithms in the data processing function of data prediction, and have obtained considerable results of data prediction processing on the cloud computing platform. However, these methods are relatively simple and basic. In real life, in order to better remove the noise in the

data, researchers often use different methods of data generation, different sources of data, etc., and these collected data often contain some additional information. How to eliminate the redundant additional information contained in these data and the impact of this information on the prediction results requires researchers to conduct further research on the prediction processing methods of system data and combining various types of combined prediction models.

### Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

### Conflicts of Interest

The author(s) declare that they have no conflicts of interest.

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