# Research on Hybrid Maintenance Cost Prediction of Smart Grid Based on Multi-dimensional Information

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**Abstract.** At present, the change of equipment state is not considered in the prediction of power grid maintenance cost, which leads to inaccurate prediction results. Based on multi-dimensional mixed information, a prediction method of power grid intelligent maintenance cost is proposed. According to the expenses of routine maintenance of various equipment, the intelligent maintenance cost of power grid is divided into routine maintenance and power supply loss cost. The CS algorithm is used to determine the maintenance strategy of power grid equipment, so as to obtain the maximum power grid income under the minimum maintenance cost. The multidimensional mixed information extracted from the daily operation of smart grid determines the maintenance status of equipment in the maintenance strategy. Through the methods of grey prediction and multiple linear regression prediction, the diversified prediction results are output, and then the weighted value of the prediction output results is assigned with the help of the combined prediction model to realize the cost prediction of multi-dimensional indicators. The experimental results show that the intelligent maintenance cost prediction of power grid based on multi-dimensional mixed information can improve the prediction accuracy and contribute to the lean management of power enterprises. Further improve the efficiency and benefit of the multi-dimensional index linkage budget method, promote the digital transformation of power grid enterprises, and provide reference for power supply enterprises.

**Keywords:** Multidimensional mixed information · Power grid maintenance · Intelligent maintenance · Grid information · Maintenance cost · Cost forecast

## 1 Introduction

Equipment maintenance is a key link in the planning and operation of power system. On the one hand, it is an important part of equipment asset management. On the other hand, under the planned power capacity and network topology, it largely determines the medium and long-term operation mode of power system. Therefore, equipment maintenance decision-making needs to comprehensively consider the above two aspects and carry out scientifically and carefully. The purpose of cost management of power grid


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enterprises is generally limited to how to reduce the cost, but not from the perspective of how much benefit the cost can bring to the enterprise. Therefore, the purpose of cost management should bring more benefits to the cost. Power grid enterprises use traditional means to manage costs, while advanced theories such as life cycle theory are not applied and popularized in power grid enterprises in time. These limitations greatly restrict the development and competitiveness of power grid enterprises [1]. The deepening power system reform has put more and more pressure on the cost management of power grid companies, which requires power grid enterprises to face up to the problems in cost control, carry out multi-dimensional lean analysis and inspection on the intelligent maintenance cost of power grid, and specifically analyze the rationality and irrationality of each maintenance cost, which can effectively improve the ability of cost control, meet the requirements of government supervision, improve quality and efficiency. This can help power supply companies solve the problems existing in the reform of multidimensional lean management system. The concept of cost management is relatively lacking in the management of power grid infrastructure projects. At present, the scope of cost management of power grid infrastructure projects is limited to the construction period, while the management of operation cost, maintenance cost and overhaul cost after completion is greatly ignored. The cost of power grid infrastructure projects is characterized by one-time investment (construction cost) accounting for only about 40% of the life cycle cost of power grid infrastructure projects, so the scope of cost management is limited [2, 3]. In today's environment of energy conservation and emission reduction, with the continuous progress of measurement, communication, computer and other technologies and the gradual deepening of the concept of building a smart grid, the equipment condition monitoring and evaluation technology for the purpose of real-time perception of equipment status has gradually developed and matured. At present, with the continuous construction of data acquisition and professional management system in power grid enterprises, the amount of structured and unstructured data related to assets, equipment, personnel, investment, cost, materials, electricity and business activities is increasing exponentially. At the same time, the maturity and application of big data value mining, artificial neural network, semantic recognition and other technologies have provided opportunities and laid a foundation for more multi-dimensional and lean management of maintenance cost prediction of power grid enterprises. Equipment maintenance has rapidly changed from regular maintenance to condition based maintenance, and has been gradually popularized and applied. Power system condition based maintenance decision-making can make full use of the actual equipment condition information from the system decision-making level, and fully tap the potential of equipment condition monitoring and evaluation technology in the decision-making application level. It has important theoretical and practical significance for improving the equipment asset management and operation reliability level of power system. Based on the above background, it is necessary and conditional to use big data technology to connect the industry and finance management link, study and innovate the methods and mechanisms of power grid enterprises in the core budget management links such as target calculation, implementation control, evaluation and incentive, so as to awaken data resources, optimize resource allocation and meet the demands of diversified management, And continuously improve the enterprise's value creation ability and cost lean management level. Reference [4] proposes a template update mechanism to improve the accuracy of visual tracking. First, when the background clutter is detected, the original template is saved. In the background clutter, we use the original template and the current template at the position of optical flow estimation, and select a better template. Then, the original template is reused after the background clutter ends. Finally, the mechanism is applied to KCF and BACF algorithms to verify the effectiveness of the mechanism. Reference [5] proposes a multi-layer template update mechanism to achieve effective monitoring in multimedia environments. In this strategy, the weighted template of the high confidence matching memory is used as the confidence memory, and the unweighted template of the low confidence matching memory is used as the cognitive memory. By alternately using confidence memory, matching memory and cognitive memory, it is ensured that the target will not be lost in the monitoring process. However, the above two literature methods do not consider the change of equipment status in the prediction of power grid maintenance costs, resulting in inaccurate prediction results. Based on multi-dimensional mixed information, this paper proposes an intelligent maintenance cost prediction method of power grid to realize the accurate accounting and control of maintenance information data, so as to promote the cost management level of power companies and provide guarantee for the stability of power system.

## 2 Intelligent Maintenance Cost Prediction Method of Power Grid Based on Multi-dimensional Mixed Information

### 2.1 Analysis on Cost Composition of Intelligent Maintenance of Power Grid

The maintenance of power grid infrastructure projects after completion and operation can be divided into two categories: one is routine maintenance, that is, planned periodic equipment maintenance. Such maintenance will not affect the use of power side and cost loss caused by power failure; One is the unconventional maintenance due to the loss of power failure on the power side caused by planned power failure and sudden failure. Routine maintenance cost refers to the cost of routine maintenance of various equipment in the project in order to ensure the stable and safe operation of the completed infrastructure project after the completion and operation of the power grid infrastructure project. The composition of routine maintenance cost is shown in Fig. 1.

The intelligent maintenance cost of power grid has changed from a single accounting subject carrying financial information to a multi-dimensional cross carrying financial information. The dimensions are obtained through the information link carrier, which transmits business and financial information. The accounting is more flexible. It can not only transmit business information in time, but also expand the management dimension according to its own management needs. Due to the large variety of equipment in power grid infrastructure projects and great differences in nature and characteristics, in order to simplify the prediction difficulty, the maintenance fee is regarded as the annual cost, and the ratio of the operation cost of the maintained equipment to its investment is used as the maintenance rate. The calculation formula of single maintenance cost of equipment is as follows:

$$W_1 = \sum_{a=1}^{s} w_a \frac{b(1+b)^{m_a}}{(1+b)^{m_a} - 1} c \tag{1}$$

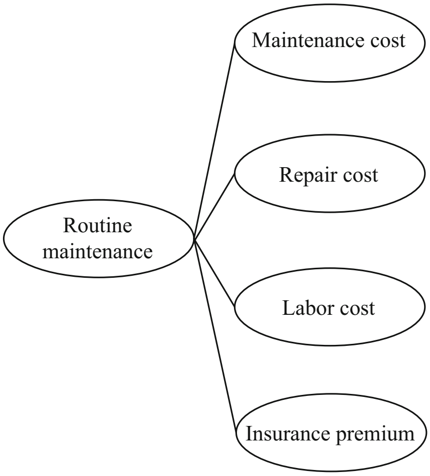


**Fig. 1.** Routine maintenance cost

In formula (1), $W_1$ represents the total annual maintenance cost of the project; $s$ represents the number of project equipment; $a$ represents the serial number of the equipment; $w_a$ represents the investment amount of the $a$ equipment; $b$ represents the rate of return on investment; $m_a$ represents the maintenance life of the $a$ equipment; C represents maintenance rate. Through cost collection and allocation, accurate distinction can be realized at the account level, and production costs and management expenses can be calculated. In order to standardize cost accounting, strengthen cost management, meet the needs of service transmission and distribution price and cost supervision, reflect the cost accounting elements in multiple dimensions according to business activities, voltage level, asset type and user category, clearly show the internal value flow of the enterprise, and effectively improve the cost management level of the company. When the power grid infrastructure project encounters an emergency and has a power outage, the power supply loss caused during the power outage should also be regarded as a kind of maintenance cost. For the cost estimation of power supply loss, this paper studies from the aspects of outage time, repair cost and average failure rate. The specific calculation formula is as follows:

$$W_2 = \sum_{a=1}^{s} \chi p_a \tau_a + q_a h_a x_a \tag{2}$$

In formula (2), $W_2$ represents the cost of power supply loss; $\chi$ represents the value coefficient of user's power consumption at the power consumption side; $p_a$ represents the interruption power of the equipment; $\tau_a$ represents the fault interruption time; $q_a$ represents the average repair cost; $h_a$ is the annual average failure rate; $x_a$ represents the average repair time. When calculating the single maintenance cost, we can see the maintenance expenditure on each business activity, each voltage level and each asset. According to the corresponding work order, we can analyze the rationality of the maintenance cost and the investment value of each project.

## 2.2 Formulate Economic Power Grid Maintenance Strategy

Power grid equipment life cycle cost management is based on reliability and life cycle management, which divides the power grid equipment cycle into procurement, installation, operation, maintenance and return. On the basis of ensuring reliability, the goal of this method is to maximize the benefit of power grid on the basis of minimizing the cost of equipment maintenance. In the daily patrol operation of power grid equipment, the operation status of substation equipment is monitored to determine the work content and time of equipment maintenance. This stage is also an important means to reduce equipment failure and improve equipment reliability. With the increase of operation time, the aging degree of transformer becomes more and more serious, and the operation uncertainty also increases. Therefore, during each maintenance, the maintenance cost will increase with the increase of operation time. Therefore, the maintenance cost is:

$$A = (W_1 + W_2)(1 + 0.00625R) \tag{3}$$

In formula (3), $A$ represents the maintenance cost; $R$ indicates the service age of the equipment. The recovery effect of power grid intelligent maintenance always depends on the type of equipment maintenance. According to engineering experience, when the failure rate is small, the equipment is in good condition, and the recovery effect of intelligent maintenance on the failure rate is small. Through a series of latest power technologies, through the collection and analysis of key indicators such as equipment current, voltage and temperature, we can find equipment defects in advance and reduce equipment power failure caused by post-processing methods such as fault power failure. With the aging of equipment insulation, the failure rate becomes larger than before, and its health condition becomes worse. The recovery effect of intelligent maintenance on the failure rate is greater than that in the case of small failure rate. At present, power enterprises have widely used live monitoring and on-line monitoring to replace routine tests to judge the operation state of equipment. The purpose of power grid intelligent maintenance is to ensure that the failure rate of equipment is within an acceptable range and obtain the maximum power grid income under the minimum maintenance cost. The goal of life cycle management in the maintenance stage is to improve the health level of equipment, prolong the equipment cycle and reduce the use cost. The first task of the intelligent maintenance selection model of power grid is to analyze and determine the benefit function and cost function of power grid equipment. The intelligent maintenance process of power grid can be regarded as the model solution of the minimum objective function optimization problem. If the maximum maintenance benefit is obtained, the best maintenance type and the best maintenance execution time can be determined. The traditional maintenance mode is planned maintenance. According to different models of equipment and previous maintenance experience, judge its operating conditions and carry out minor repair or overhaul. There are many types of equipment in the power grid, and the service life of most of them is not uniform. For example, the service life of electrical primary equipment is often long, while the integrated automation system and other secondary equipment are updated quickly and have a short service life due to the characteristics of more electronic components. Under the background of the increasing progress of condition monitoring technology, due to the lack or excessive maintenance of traditional regular maintenance and fault maintenance, the equipment maintenance and repair of power enterprises began to change to condition based maintenance. This paper uses CS algorithm to determine the maintenance strategy of power grid equipment, and its process is shown in Fig. 2.

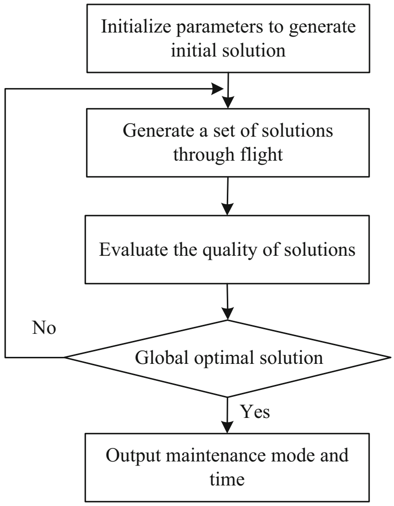


**Fig. 2.** Decision process of overhaul and maintenance strategy

According to the relationship between the health state, operation life and failure rate of power grid equipment, the influence of different maintenance states on failure rate is determined. According to the economic model, the unknown parameters are determined and the maintenance decision-making model is established. Initialize the parameters of CS algorithm, and set the population size, switching probability and step size. The calculation formula of step length is as follows:

$$D = \frac{\alpha_1}{|\alpha_2|^{\frac{1}{\delta}}} \tag{4}$$

In formula (4), $D$ represents the algorithm step size; $\alpha_1$ and $\alpha_2$ represent the parameters of flight search and random walk; $\delta$ represents the constant value of controlling random walk, which is taken as 1 in this paper. Arrange the best solutions to find the current optimal solution. Until the number of iterations is reached or the quality accuracy of the solution reaches 10–13, the optimal solution is output [4]. That is, the optimal maintenance mode and time are obtained. Repair sudden equipment faults and equipment defects found in operation, and transform various equipment in the substation at any time according to the latest electrical technology, so as to reduce equipment operation cost and improve safety and reliability [5].

### 2.3 Determination of Maintenance Status of Power Grid Equipment Based on Multi-dimensional Mixed Information

The maintenance plan in the current condition based maintenance decision model of power system is fixed, and does not consider how to deal with the changes of equipment status in the research cycle. For example, the equipment may fail before the maintenance plan, which will lead to the failure of the maintenance plan. In fact, under the background of on-line monitoring of equipment status, the change of equipment status is visible in the whole process. The data table Association view is represented as a visual data table association model on the front-end page. During the operation of the power grid system, the background of the power grid system will automatically record and precipitate the association information between various data tables and form an association view for automatic modeling [6]. At the same time, it can also provide reference for users when they conduct data analysis or manual modeling. It is not necessary to adjust the maintenance plan after the failure of the equipment. It is absolutely possible to adjust the maintenance plan ahead of time when the deterioration degree of the equipment is exceeded, so as to prevent failure. The multidimensional mixed information extracted in the daily operation of smart grid includes four dimensions: time, branch Item and location. Each dimension table is connected with the fact table to form a star like model. The fields used to describe quantitative analysis indicators in the fact table are called metrics. These fields are usually numerical and are used to perform the calculation of various analysis operators. The dimension table does not contain measures. Its fields are called dimensions. They are usually text, time, classification, geographical location and other types of data, and are the angle of observing data [7]. Therefore, this paper uses multi-dimensional mixed information to determine the maintenance status of power grid equipment. We divide the uncertainties observed in each period into two categories: the first is the combination of equipment states observed at the beginning of the period; The second category is the combination of equipment states observed during the period. In multi-stage decision-making, the gradual realization of uncertainty in multiple periods forms a scene tree, and each node in the scene tree needs to make corresponding decisions. After processing and analyzing the data, the state result of a characteristic quantity of power grid equipment can be obtained, forming a single characteristic quantity evaluation [8]. However, because only one characteristic quantity is used to evaluate the overall state of the transformer, there are some problems, such as the evaluation result is not accurate enough and the conclusion is too one-sided. For the above two types of random data, we need to make two types of maintenance status decisions accordingly. The first type of maintenance status is sequential decision-making, which is determined by the maintenance plan in the decision-making period. This process can be expressed as:

$$z_1 = g(v_t) \tag{5}$$

In formula (5), $z_1$ represents the maintenance state; $g$ represents the combination of equipment status; $v_t$ indicates the maintenance status of the equipment in period $t$, 0 indicates no maintenance, and 1 indicates maintenance. The second type is operation scheduling decision, which belongs to non sequential decision. It only appears in a node of the scene tree and will not affect the subsequent decision. This process can be expressed as:

$$z_2 = (\mu, \varphi, \gamma, \eta) \tag{6}$$

In formula (6), $z_2$ represents the operation scheduling decision; $\mu$ represents the output of power grid equipment unit; $\varphi$ represents the power flow of the branch; $\gamma$

represents the voltage phase angle of the equipment node; $\eta$ represents the load shedding amount at the load point. Taking the power transformer as an example, the health status of the transformer largely depends on the overall health status of its insulation system. In the insulation system of oil immersed transformer composed of paper and mineral oil, deterioration occurs in a complex multi factor process due to the interdependence between aging factors and their additive effect. The cumulative effect of temperature, moisture, acid and oxidation inside the transformer is the main cause of transformer aging. All state transition rates can be estimated by the average transition time between two states, and the state transition rate is constant. That is, the continuous availability on the time axis is discretized into the availability of the period, and its value is equal to the availability of the start time of the period. Assuming that the equipment does not reach the maintenance threshold state before the maintenance threshold time, but fails before the scheduled maintenance plan, in this case, it is necessary to perform post failure maintenance at the scheduled time and cancel the scheduled maintenance plan. Due to the large number of operation states of power grid equipment, the state level can be evaluated by fusing multi-dimensional mixed information, and finally a comprehensive state can be obtained.

## 2.4 Establish the Prediction Model of Power Grid Intelligent Maintenance Cost

The cost prediction of intelligent maintenance of power grid needs to consider the cost of operation and maintenance period, maintenance period and scrapping period. Some of the costs are determined, some fluctuate with the changes of market and other factors, and most of the factors are uncertain. Human subjective factors are inevitably added in the estimation, which greatly reduces the objectivity of the whole project life cycle cost estimation. The diversity of demands of power grid intelligent maintenance management determines the necessity of multi-dimensional linkage prediction of cost indicators. In the actual operation process, it is necessary to take the historical budget data, final settlement data, price verification data, business activity data, etc. as the basis, and take the business assumption parameters such as electricity, electricity price and investment as the input content. There is a certain correlation between costs and between costs and power generation. Among them, the initial investment cost has a great impact on the cost and power generation in the subsequent stages. Therefore, when calculating the kWh cost, we must consider various parameters of the cost in each stage, and substitute the weight value into the intelligent maintenance cost prediction model of the power grid. This paper uses cloud model to deal with the uncertainty of power grid project cost. A concept within the scope of the universe is a mapping from the universe to the membership [0,1], and it is a one to many mapping, that is, a value in the universe represents the concept, and the membership of accuracy is a one to many relationship, rather than a single membership relationship of other methods [9]. The cloud model can express the concept with randomness, and give the membership degree of each specific implementation to the concept. It reflects the uncertainty of the concept by reaching the shape composed of a certain number of cloud droplets. The total contribution of all elements in the universe to the concept can be expressed as:

$$\vartheta = \frac{\int \sigma(x)dx}{\sqrt{2\pi}\varpi} \tag{7}$$

In formula (7), $\vartheta$ represents the contribution degree; $\varpi$ represents the entropy of power information characteristics; $\sigma$ represents qualitative probability; $x$ represents the information element between any cell. Thus, the randomness of membership can be determined. Through the use of grey prediction, multiple linear regression prediction and other methods, the diversified prediction results are output, and then the weighted value of the prediction output results is assigned with the help of the combined prediction model to calculate the budget scale of multi-dimensional indicators. The statistical data of failure rate has great volatility, so that the data sequence is not a strict exponential form, and because the parameter a in the traditional GM (1,1) model is constant, it will produce a lot of errors. In other words, GM (1,1) model is a linear time invariant system. In this paper, the linear time term is considered to replace the traditional constant parameters, and then the GM (1,1) model with time-varying parameters is constructed. The grey prediction model first assembles the original data into the original sequence, and then uses the accumulation generation method to generate the sequence that can be operated. After revising the residual, the difference differential equation is established for the transformed sequence. Then, based on the analysis of correlation degree and convergence degree, constantly supplement new information, clean up meaningless old information, and solve repeatedly until the purpose of qualitative analysis of system characteristics or quantitative analysis according to correlation factors is achieved. Parameter assumptions in the field of power grid engineering mainly include two items: one is the assumption of project design life, and the other is the assumption of project actual service life; The parameter assumptions in the economic field mainly include discount rate, project residual value, inflation, operation period, etc. Whether the project cost composition analysis is in-depth and whether the kWh cost estimation model is reasonable and accurate will directly determine whether the calculation results are correct, and will also affect the effect of kWh cost management in the intelligent detection cycle of power grid [10–12]. The weight of different combinations of various output results is mainly determined according to the variance covariance method. The prediction combination weight formula can be expressed as:

$$\varepsilon = \frac{\psi_2 - \phi}{\psi_1 + \psi_2 - 2\phi} \tag{8}$$

In formula (8), $\varepsilon$ represents the combination weight; $\psi$ represents variance; $\phi$ represents covariance. Output diversified prediction results, and then use the weighted assignment of the prediction output results with the help of the combined prediction model to calculate the budget scale of multi-dimensional indicators. According to the above process, the design of power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information is completed.

## 3 Experimental Study

### 3.1 Experimental Preparation

In order to test the effectiveness of the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information proposed in this paper, four examples are used to verify it. Select the 2015–2020 power grid maintenance appropriation data as the data source, use matlab simulation to first optimize the initial weight by using CS algorithm, set the population size to 50, the number of iterations to 500, the crossover probability to 0.2, and the mutation probability to 0.01, and then train. The network learning rate is set to 0.05, and the training error is selected as $1 \times 10^{-5}$, the maximum number of training is $10^5$.The specific settings of each example are shown in Table 1.

**Table 1.** Example description

| Numerical example | System | Constitute | Maintenance period | Safe operation constraints |
|---|---|---|---|---|
| 1 | Single bus system | 2 units | 5 | N-0 |
| 2 | Two node system | 3 units and 3 lines | 5 | N-1 |
| 3 | Two node system | 5 units and 3 lines | 10 | N-2 |
| 4 | Rts79 system | 30 units, 5 transformers and 50 lines | 25 | N-3 |

In these examples, it is assumed that each device contains two elements in series, and each element contains four states: normal, mild deterioration, severe deterioration and failure. The unbalanced power penalty factor is set to 1000 and the convergence gap is set to 10–6. The maintenance cost is calculated by 2% of the purchase cost of transformer every year, and the environmental maintenance cost is calculated by 0.25% of the purchase cost. The service life of the unit is 30 years. When the transformer is scrapped, the residual value is calculated by 10% of the purchase cost and the discount rate is calculated by 8%. According to the selection requirements of the number of transformers, firstly, it can meet the long-term planning load. Secondly, when one main transformer is shut down, the other transformers can meet 70% of the load.

### 3.2 Results and Analysis

In the above four examples, the accuracy of the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information is calculated, and the results are compared with the maintenance cost prediction methods based on BP neural network and GA-SVM, so as to verify the superiority of the design method in this paper. The maintenance cost prediction results of each example are shown in Tables 1, 2, 3, and 4 respectively.

In the single bus system of example 1, the accuracy of the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information is 95.64%, which is 6.11% and 7.56% higher than the maintenance cost prediction

**Table 2.** Comparison of accuracy rate of example 1 (%)

| Number of tests | Intelligent maintenance cost prediction method of power grid based on multi-dimensional mixed information | Prediction method of power grid intelligent maintenance cost based on BP neural network | Prediction method of power grid intelligent maintenance cost based on GA-SVM |
|---|---|---|---|
| 1 | 95.47 | 88.09 | 88.24 |
| 2 | 96.58 | 89.17 | 87.67 |
| 3 | 94.29 | 89.48 | 89.55 |
| 4 | 95.06 | 90.86 | 87.86 |
| 5 | 96.32 | 89.65 | 86.43 |
| 6 | 96.63 | 88.23 | 87.52 |
| 7 | 95.95 | 90.32 | 88.20 |
| 8 | 96.28 | 91.65 | 87.39 |
| 9 | 94.59 | 89.54 | 87.66 |
| 10 | 95.22 | 88.28 | 90.23 |

method based on BP neural network and GA-SVM. Compared with the two traditional maintenance cost prediction methods, the intelligent maintenance cost prediction method based on multi-dimensional mixed information has higher accuracy.

**Table 3.** Comparison of accuracy rate of example 2 (%)

| Number of tests | Intelligent maintenance cost prediction method of power grid based on multi-dimensional mixed information | Prediction method of power grid intelligent maintenance cost based on BP neural network | Prediction method of power grid intelligent maintenance cost based on GA-SVM |
|---|---|---|---|
| 1 | 92.29 | 86.04 | 85.49 |
| 2 | 91.56 | 85.68 | 84.86 |
| 3 | 92.85 | 86.21 | 83.68 |
| 4 | 91.62 | 87.55 | 84.25 |
| 5 | 93.23 | 86.36 | 83.54 |
| 6 | 92.56 | 85.22 | 82.31 |
| 7 | 93.34 | 86.65 | 84.25 |
| 8 | 94.65 | 86.27 | 82.12 |
| 9 | 92.27 | 85.51 | 83.86 |
| 10 | 93.54 | 86.92 | 82.43 |

In the two node system of example 2, the accuracy of the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information is 92.79%, which is 6.55% and 9.11% higher than the maintenance cost prediction method based on BP neural network and GA-SVM. This is because the method in this paper outputs a variety of prediction results through the methods of grey prediction and multiple linear regression prediction, and then uses the combined prediction model to allocate the weight of the prediction results to achieve the cost prediction of multi-dimensional indicators.

**Table 4.** Comparison of accuracy rate of example 3 (%)

| Number of tests | Intelligent maintenance cost prediction method of power grid based on multi-dimensional mixed information | Prediction method of power grid intelligent maintenance cost based on BP neural network | Prediction method of power grid intelligent maintenance cost based on GA-SVM |
|---|---|---|---|
| 1 | 90.46 | 82.47 | 80.94 |
| 2 | 91.87 | 81.18 | 82.58 |
| 3 | 92.54 | 83.09 | 83.69 |
| 4 | 90.21 | 82.66 | 82.26 |
| 5 | 91.62 | 83.25 | 81.05 |
| 6 | 92.28 | 84.54 | 82.12 |
| 7 | 90.33 | 82.91 | 83.53 |
| 8 | 90.56 | 83.32 | 82.26 |
| 9 | 90.20 | 82.20 | 82.39 |
| 10 | 92.92 | 84.63 | 81.22 |

In the two node system of example 3, the accuracy of the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information is 91.30%, which is 8.27% and 9.10% higher than the maintenance cost prediction method based on BP neural network and GA-SVM. This is because the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information uses CS algorithm to determine the maintenance strategy of power grid equipment, so as to obtain the maximum power grid income under the lowest maintenance cost. The multi-dimensional mixed information extracted from the daily operation of smart grid determines the maintenance status of equipment in the maintenance strategy (Table 5).

In the rts79 system of example 4, the accuracy of the power grid intelligent maintenance cost prediction method based on multi-dimensional mixed information is 88.02%, which is 8.62% and 10.32% higher than the maintenance cost prediction method based on BP neural network and GA-SVM. Therefore, the power grid intelligent maintenance cost prediction method proposed in this paper can identify the equipment maintenance status by making full use of the multi-dimensional mixed information of power grid

**Table 5.** Comparison of accuracy rate of example 4 (%)

| Number of tests | Intelligent maintenance cost prediction method of power grid based on multi-dimensional mixed information | Prediction method of power grid intelligent maintenance cost based on BP neural network | Prediction method of power grid intelligent maintenance cost based on GA-SVM |
|---|---|---|---|
| 1 | 87.67 | 79.74 | 79.40 |
| 2 | 88.24 | 80.66 | 78.16 |
| 3 | 89.58 | 79.35 | 77.85 |
| 4 | 88.46 | 78.22 | 76.62 |
| 5 | 89.13 | 78.03 | 77.33 |
| 6 | 87.82 | 77.19 | 76.52 |
| 7 | 88.29 | 79.55 | 78.2 |
| 8 | 86.65 | 80.28 | 78.91 |
| 9 | 87.36 | 80.36 | 76.74 |
| 10 | 87.01 | 80.62 | 77.28 |

operation and maintenance according to the different characteristics of costs in different stages, so as to accurately predict the maintenance cost, which can provide reference for power supply network enterprises.

## 4 Conclusion

The cost prediction of intelligent detection of power grid is studied, and the optimization of maintenance strategy is effectively supported by multi-dimensional mixed information. The CS algorithm is used to determine the maintenance strategy of power grid equipment, so as to obtain the maximum power grid profit under the lowest maintenance cost. The multi-dimensional mixed information extracted from the daily operation of smart grid determines the maintenance status of equipment in the maintenance strategy. Through the methods of grey prediction and multiple linear regression prediction, a variety of prediction results are output, and then the weight of the prediction results is allocated by using the combined prediction model to achieve the cost prediction of multi-dimensional indicators. In the case of limited human, material and financial resources, priority maintenance projects and resources can be selected according to the urgency of maintenance and the value of line or substation equipment. Using multi-dimensional mixed information to forecast maintenance costs is conducive to the fine management of operation and maintenance costs. In combination with the mature "big cloud intelligent transfer" technology, timely carry out informatization and intelligent application research, further improve the efficiency and efficiency of multi-dimensional indicator linkage budget method, promote the digital transformation of power grid enterprises, and create a world-class enterprise. In the future development, we will introduce advanced information technology and science and technology, integrate various technologies, predict the cost of intelligent detection of power grid, and improve the prediction accuracy.

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