Research and Application of Electricity Price Prediction Model Based on Big Data Analysis

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Abstract. Based on the analysis of big data price prediction model, refers to the big data technology, on the basis of using big data technology analysis ability, effectively improve the price prediction model is scientific and logical, to get more accurate price forecast structure, and applied to the electric power enterprise, realize the purpose of improving electric power enterprise economic efficiency and power supply efficiency. Due to the large amount of information of electricity price data, there is no management between most samples and characteristics. In the input process, such redundant data may lead to the prediction of low accuracy prediction, and may increase the actual prediction time. Then, the research and application of the electricity price prediction model based on big data analysis has high research value and application significance. It can start from the basis of big data analysis and effectively improve the electricity price prediction model on the basis of big data analysis, so as to achieve the purpose of promoting the development of the power industry and enterprises.

Keywords: big data analysis; electricity price forecast; improvement of DE-SVM

1 Introduction

In the electricity market, the price of electricity is one of the main factors that can affect the changes in the market, from the power generation countries, to the power supply enterprises, and consumers. Then in the developing and developed countries, the research and reform of electricity has always been an important basic content, it can be seen that the position of electricity price in the power industry will only become more and more important[1]. Therefore, the accuracy of electricity price forecast and the importance of related content are self-evident, especially for power generation enterprises, the use of the reasonable results of electricity price forecast can effectively develop a quotation strategy suitable for social and economic development, and further improve the economic benefits of enterprises[2].

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2 Characteristics and influencing factors of electricity price

2.1 Electricity price characteristics

In the electricity market, the price of electricity is mainly determined by the supply and demand relationship of the market. Then, and through the investigation of relevant literature, it can be seen that the characteristics of electricity price can be divided into three items, namely strong volatility, jump and peak, and periodicity[3]. As shown in Figure 1. Strong volatility means that the fluctuation of electricity price is much larger than the power load; jumping and peak means that the electricity price will appear abnormal change, the change is extreme change (extremely low or extremely high), compared with the stable electricity price by the relevant time units, such as hour, spring, summer, autumn and winter.

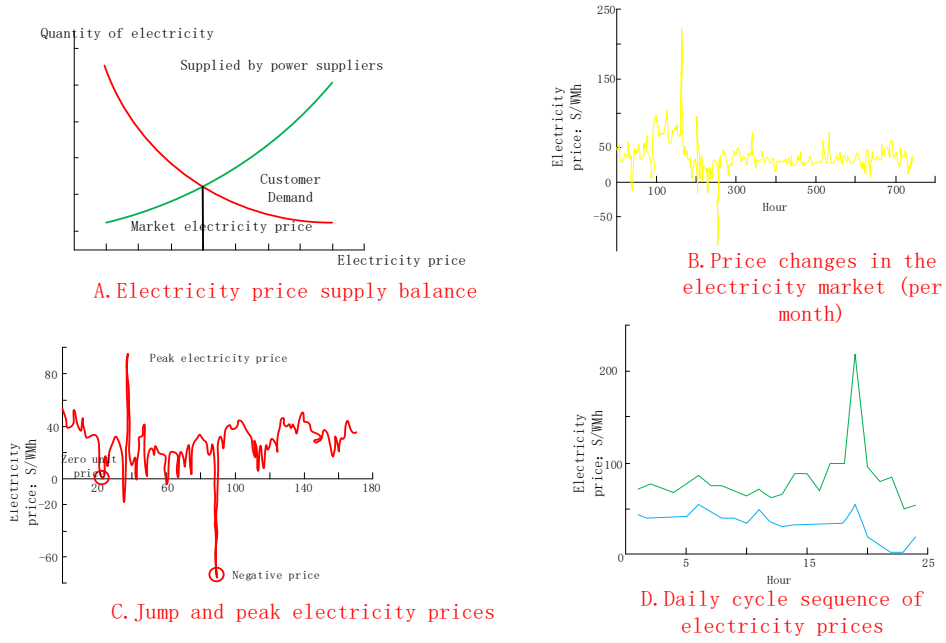

Figure 1 Plot of electricity price supply balance and characteristics

2.2 Factors affecting electricity price

According to the investigation, the factors affecting the electricity price are divided into four points, namely, the cost input of power generation, the historical electricity price, the power load, and others[4], content is as follows.

1) the cost of power generation input: the cost of power generation is one of the basic factors affecting the price, and then from the perspective of production and efficiency, the cost of power generation can be defined as " the greater the cost of power generation, power generators in order to ensure their economic benefits, will improve the electricity sales price, namely for the greater the cost, the higher the price."

2) historical price situation: historical price situation for the future development of the electricity price is direct influence, especially with historical price price change, to a certain extent, the change of the historical price, only a long history of price, less influence on the future change of electricity price exist, so the study on electricity price prediction, will be historical price as one of the important content of research.

3) Power load: The influence of power load is that the power supplier will reduce the electricity price when the electricity load exceeds the electricity user, the power supplier increases the electricity price, and the electricity user will reduce the use of the electricity.

4) Others: Other factors affecting the price of electricity are mainly environmental factors and indirect factors, such as climate (rain), natural conditions (wind speed), market structure (power), peak electricity consumption (holidays) and so on.

3 Research on electricity price prediction model based on big data analysis

Electricity price prediction model based on big data analysis, taking DE-SVM method as an example, the content is as follows[5-6].

3.1 Prediction method

Due to the many types of electricity price prediction models, there are some differences in the application effect and basic function of different prediction models. Therefore, the electricity price prediction model of DE-SVM method takes the basis of BP NN, RF and MLR to effectively improve the electricity price prediction model ability of DE-SVM method.

The first is the BPNN model, which not only has the basic characteristics of ANNs, but also is one of the more widely used basic models. With its own good mapping ability, it can effectively deal with different OR problems. The formula is expressed as:

$$y_h = f_1\left(\sum_i \left(\omega_{ih} X_i\right)\right) \text{ y} = f_2\left(\sum_h \left(\omega_{hj} X_i f_1\left(\sum_i \omega_{ih} X_i\right)\right)\right), \quad (1)$$

Where, xiFor the input layer; yhOutput for hidden layer; y is output for output layer; ωihIs the weight between the hidden layer and the input layer; ωhjIs the weight between the hidden layer and the output layer.

The second is the RF model, which is also one of the commonly used electricity price prediction models because of its simple algorithm application method and good training speed and error, so it is effective in the data with high dimensions. As shown in Figure 2.

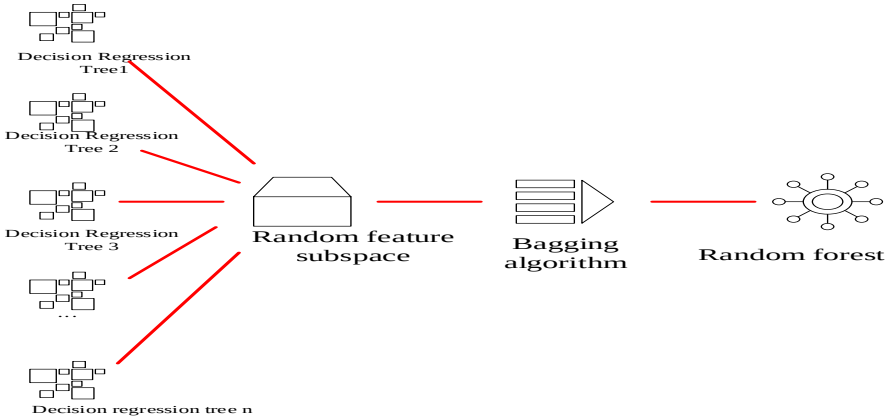

Figure 2. A Schematic diagram of the basic structure of the random forest model

Finally, the MR model. This model can not only calculate the results of electricity price prediction in the fastest time, but also present the interpretation of individual variables according to their own understanding. Then, the model is a commonly used electricity price prediction method in the past, and the formula is expressed as:

$$Y = b_0 + b_1 x_1 + b_2 x_2 + ... + b_n x_n \quad (2)$$

Where Y is the dependent variable, usually the assumed value; x1,x2,x3,...,xnFor independent variables; b0,b1,b2,b3,...,bnFor the characteristic weight of a single electricity price.

3.2 DE- -SVM electricity price prediction model

Compared with the above two models, this model not only has a good generalization power, but also shows a high accuracy when dealing with nonlinear problems. Then, the formula of the electricity price prediction model is expressed as follows:

$$f(x) = w^T X + b \quad (3)$$

Where, w is the model parameter; b is also the model parameter; f (x) is the acceptable forecast value of electricity price, so the deviation of the electricity price is, then a double interval band can be established, so that the training sample enters the interval band is the correct prediction, and the problem of the model can be transformed. The formula is:

$$\min \frac{1}{2}\|w\|^2 + C\sum_{\substack{i=1 \\ w,b}}^{m} \ell_{\in}\left(f(X_i) - y_i\right) \quad (4)$$

$\ell_{\in}$ Where C is the regularization constant; it is the insensitive loss function; then the formula is:

$$\ell_{\in}(z) = \begin{cases} 0, if\,|z| \le \in \\ |z| - \in, otherwise \end{cases} \quad (5)$$

At the same time, the model requires that the kernel function is the RBF kernel function, and the formula is expressed as:

$$K(x,y)=\exp\left[-\frac{x-y^2}{2\sigma^2}\right](6)$$

σ Where the width coefficient; the final representation of the model is:

$$f(x)=\sum_{i=1}^{m}(\hat{\alpha}_i-\alpha_i)K(x,x_i)+y_i+\in-\sum_{i=1}^{m}(\hat{\alpha}_i-\alpha_i)K(x,x_i)(7)$$

3.3 Improve the DE- - -the SVM model

The first is the basic error function. The error function of the improved DE- -SVM model can be reflected from the mean square error, square root error, average absolute error and exponential function, the content is as follows;

1) Mean square error, mainly used for the error function of the electricity price prediction model. The smaller the value of the error, the higher the prediction accuracy. The formula is expressed as:

$$E_{MSE}=\frac{1}{n}\sum_{i=1}^{n}\left(Y_i-\hat{Y}_i\right)^2 (8)$$

Where, YiFor the true electrical value; Y ^iFor the predicted electrical value.

2) Square root error, as a judgment index of mapping the accuracy and dispersion degree of the prediction value. The smaller the value of the error, the better the actual prediction effect. The formula is expressed as:

$$E_{RMSE}=\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(Y_i-\hat{Y}_i\right)^2} (9)$$

3) Average absolute error, in the application process, the error value is mainly for the average module length of the predicted value, and then there is no upper limit on the value range of the error, the initial value is 0, and the smaller the error value is, the better the prediction result, the formula is expressed as:

$$E_{MAE}=\frac{1}{n}\sum_{i=1}^{n}\left|Y_i-\hat{Y}_i\right|(10)$$

4) Exponential function, as one of the important formulas in the application formula, mainly deals with the problem of large weight in the electricity price prediction and plays a certain convergence role. The formula is expressed as:

$$y=\exp(x)(11)$$

Secondly, the error unit based on formula (8-11), the comprehensive formula (8-11) is used to obtain the new formula, and the error feedback unit with strong convergence ability. The formula is expressed as:

$$E(x) = \alpha_1 E_{RMSE} + \alpha_2 E_{MAE} \quad (12)$$

$$f(x) = \exp(E(X)) \quad (13)$$

In formula (12), α is the weight coefficient of the function formula, with two terms.

In the final improved steps, the ten steps are as follows.

Step 1: Conduct α1,2, F and CR, etc., while clear f (x);

Step 2: Using the DE algorithm to randomly generate the initial population (xi(0))；

Step 3: Use formula (13) to calculate the target value of an individual error function;

Step 4: Use the DE algorithm to carry out a single individual variation operation to obtain the mutation individual;

Step 5: Using DE algorithm, single individual cross operation to obtain the experimental individual;

Step 6: Using formula (13), evaluate the initial population obtained in step 2 to obtain the fitness of a single individual;

Step 7: Use the DE algorithm to conduct an iterative operation to obtain the offspring individuals;

Step 8: distinguish the maximum number of iterations and the termination condition, the iteration termination to the next step, otherwise back to step 3;

Step 9: Take the best individual of the iteration as the best solution of the output;

Step 10: Use SVM to predict the electricity price.

4 Application of electricity price prediction model based on big data analysis

The application of the electricity price prediction model based on big data analysis, taking the application of the above model as an example, predicts the electricity price of a certain month in a certain area, so as to verify the practical application value of the above model[7], content is as follows.

Take the daily electricity price of a certain region as the basic data to integrate the DE-SVM model and improve the DE-SVM model, as shown in Figure 3; compare the error results of the two models, then analyze the prediction effect of the DE-SVM model is better and the higher the accuracy, as shown in Table 1 and Table 2.

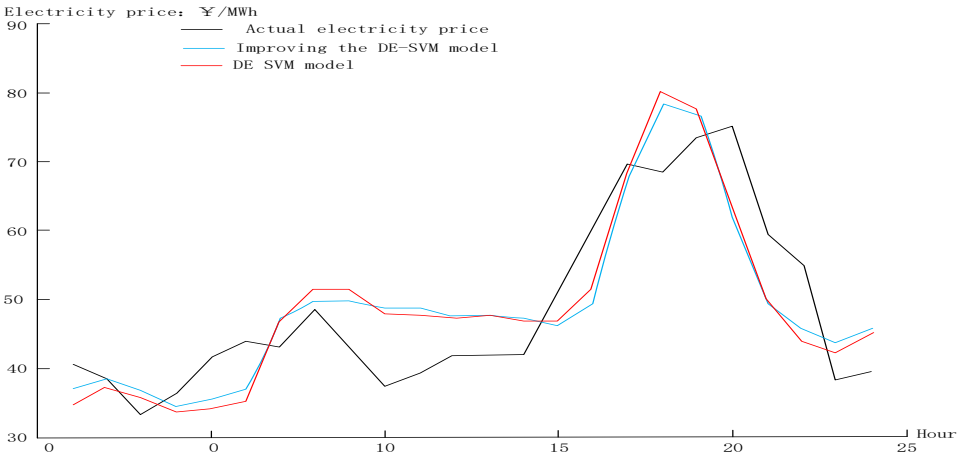

Figure 3. Forecast results of the daily electricity price of a certain month in an area

Table 1. Comparison of error results between improved DE-SVM model and DE-SVM model

method	Absolute percentage error, median	root-mean-square error	time
Improve the DE- - - SVM model	13.3%	7.1	2.4s
DE—SVM model	13.0%	7.0	2.0s

Table 2. Comparison of electricity price forecast results of non-consecutive days in the improved DE- - SVM model

date	Error index	DE—SVM model	Improve the DE- - - SVM model
X month Y day	Absolute percentage error, median	26.7%	20.4%
	root-mean-square error	22.0	20.5
	time	1.4s	1.2s
X month, Y + 15th	Absolute percentage error, median	12.9%	12.4%
	root-mean-square error	5.2	5.2
	time	1.0s	0.8s

From the above figure 3, table 1, table 2, DE-SVM model price prediction accuracy compared to improve the DE-SVM model price forecast progress, relatively weak, but also has the ability of price prediction, and improve the DE-SVM model price prediction accuracy is higher, so the price prediction model based on large data analysis, can use improved DE-SVM model.

5 Conclusion

In conclusion, the research and application of electricity price prediction model based on big data analysis firstly summarizes the characteristics and influencing factors of electricity price to provide the research direction; secondly introduces the research of electricity price

prediction model based on big data analysis, refine the main contents and provide theoretical support for the study; finally expounds the application of electricity price prediction model based on big data analysis to improve the study, making the study has certain practical value and significance.

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