Short-term forecasting of the power system

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Abstract: In order to predict the short-term load of the power system, we used regression analysis and time series analysis. Firstly, We plotted the annual load curve of a region and analysed the relationship between load and each meteorological factor. Secondly, the regression model is established and the regression equation is obtained. Through the analysis, we find that the average temperature has the most obvious influence on the load. Finally, using the time series model and considering the influence of the weather, the load forecasting model of the power system is established, and the good prediction results are obtained.

1. Background analysis

Short term load forecasting is the basis of power system operation and analysis, which is of great significance to unit commitment, economic dispatch, security check and so on. In order to ensure the scientific nature of power system optimization decision-making and improve the economy of power system, we need to forecast the short-term load of power system. In modern electric power system, the influence of meteorological factors on electric power system load becomes more and more prominent. Considering meteorological factors is one of the main methods to improve the accuracy of load forecasting.

2. Model hypothesis

(1) Assuming that during the forecast period, the local weather does not appear to be abnormally mutated.

(2) Suppose that during the forecast period, there will be no major natural disasters.

(3) Assuming that the power plant will not fail during the forecast period or cause a power outage due to damage to the transmission line.

3. Symbol Description

symbol	Description
P_1	Daily maximum load
P_2	Daily minimum load
P_3	Daily average load
X_1	Daily maximum temperature
X_2	Daily minimum temperature
X_3	Daily average temperature
X_4	Daily relative humidity
X_5	Daily rainfall

4. The Establishment and Solution of Model

First, we plot the scatter plot between the maximum daily load, the daily minimum load, the daily average load, and the meteorological factors. We found no relationship between load and relative humidity day. But there is a linear relationship between load and daily rainfall, daily maximum temperature, daily minimum temperature, daily average temperature. So we established a multiple linear regression model.

$$\begin{cases} P_1 = \beta_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{15}X_{15} + \varepsilon_1 \\ P_2 = \beta_{20} + \beta_{21}X_{21} + \beta_{22}X_{22} + \beta_{23}X_{23} + \beta_{25}X_{25} + \varepsilon_2 \\ P_3 = \beta_{30} + \beta_{31}X_{31} + \beta_{32}X_{32} + \beta_{33}X_{33} + \beta_{35}X_{35} + \varepsilon_3 \end{cases} \quad (1)$$

In this formula, $\varepsilon \sim N\left(0,\sigma^2\right)$, β and ε X and y are unknown parameters.

Assuming that $\left(x_{i1}, x_{i2}, \cdots, x_{ip}, y_i\right), i = 1, 2, \cdots, n\left(n = 1096\right)$ is the independent observation of $\left(X_1, X_2, \cdots, X_p, Y\right)$, the multivariate linear model can be expressed as

$$y_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon_i \qquad i = 1, 2, \cdots, n \quad (2)$$

In this formula, $\varepsilon_i \sim N\left(0,\sigma^2\right)$, independent distribution.

By solving the regression equation, we can conclude that the average temperature has the greatest effect on the load index. The effect of some factor on load index is small , such as daily rainfal , daily maximum temperature and daily minimum temperature. Daily relative humidity has no direct impact on the load index

Based on the above analysis, we consider the effect of daily mean temperature when predicting load changes. The accuracy of the predicted results is improved.

Second, we plot the load over time in a region for a few days.

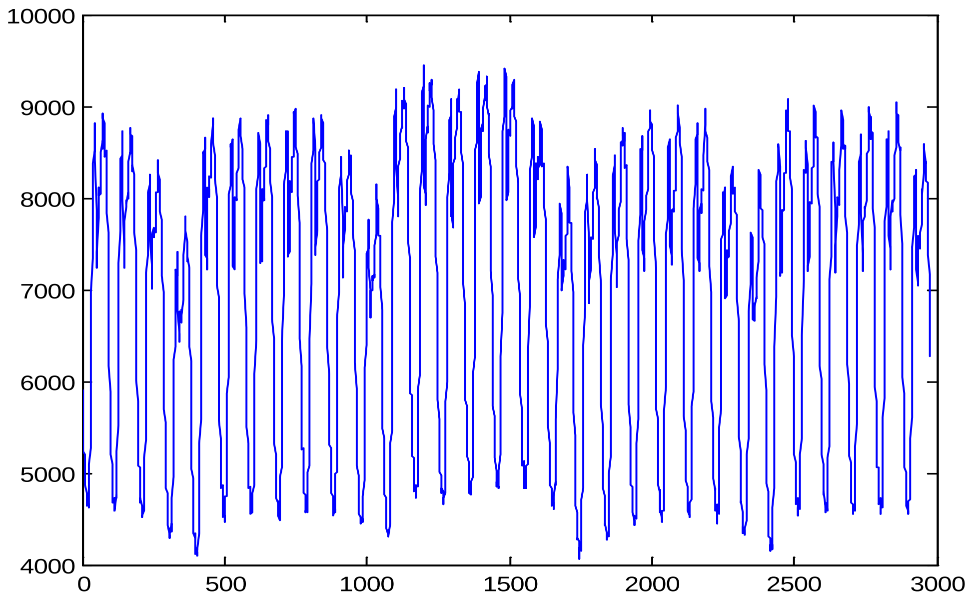

Fig. 1 The change of power load over time in a certain area

Through observation, we propose the following formula to predict the power load.

Monday to Saturday at a certain moment the size of the load:

$$x(t) = k_1 x(t-6) + k_2 x(t-5) + k_3 x(t-4) + k_4 x(t-3) + k_5 x(t-2) + k_6 x(t-1) \quad (3)$$

The size of the load on a certain day on Sunday:

$$y(t) = ky(t-14) + ky(t-7) \quad (4)$$

According to the above formula, we get the comparison chart between predicted results and the actual results as shown below.

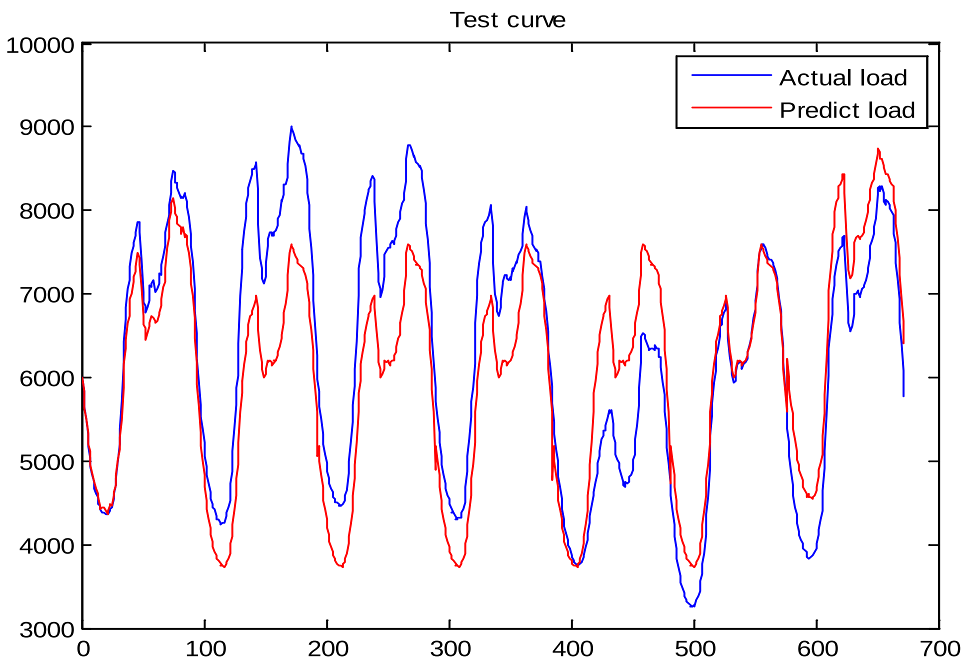

Fig. 2 A comparison of the predicted results with the actual results

After considering the effect of daily mean temperature on the load, we obtained the following predictions.

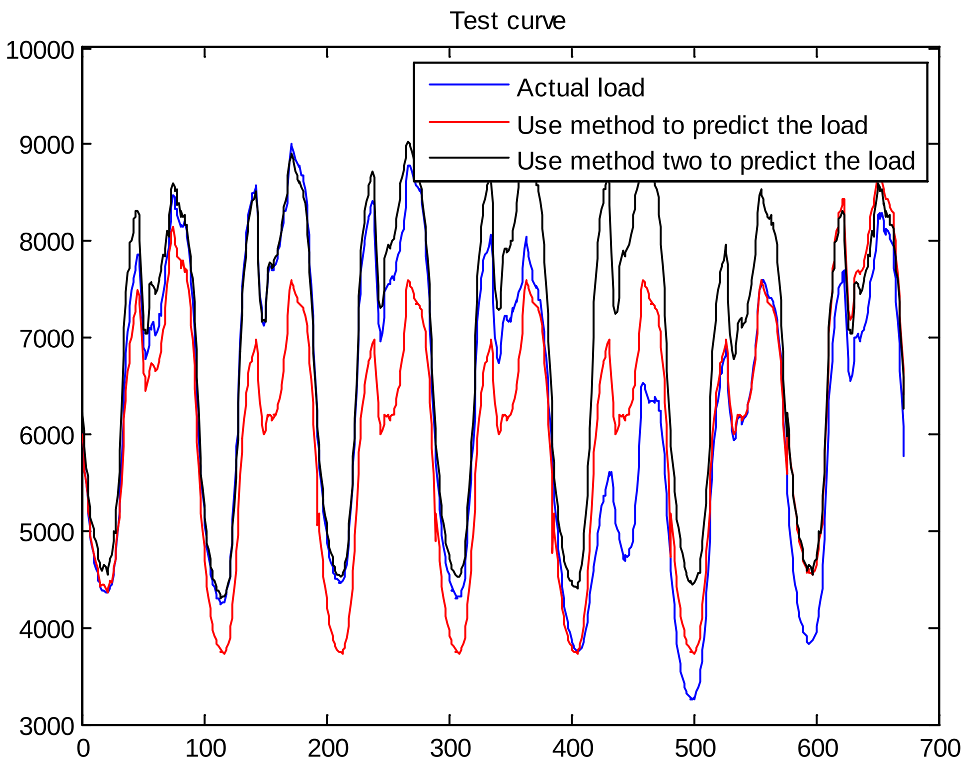

Fig. 3 Comparison of two methods to predict the load

5. Model conclusion

Considering the influence of weather factors, the accuracy of the predicted results of the power system load is improved.

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