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Research on Combination Forecast Model of Language Development Trend Based on Grey Relational Degree – A Case Study of English

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***Abstract* – Due to the relative independence of various nationalities in the world and the differences in the natural and historical conditions of various countries, the development of the world's language and culture is not a relationship between simplification and systematization, but a trend of diversification and mutual integration. In order to study the development trends of various languages in the context of global diversity, the distribution of the number of native speakers and the total number of language users is predicted. This paper takes English as an example, randomly selects five factors for research, and from the perspective of grey modeling method, constructs a grey relational forecasting model based on grey relational degree, and grey correlation analysis of many factors that influence the language development trend, to find out the main factors affecting the distribution of English users. Comparing the prediction results with the prediction results of the regression model, the results show that the accuracy of the grey combination forecasting model proposed in this paper is very high.**

***Keywords* – Grey Correlation Degree, Combination Forecasting Model, Language Development Trend, English.**

I. Introduction

There are currently about 6,900 languages in the world. About half of the world's population uses one of the following ten languages as their mother tongue: Mandarin (including Standard Chinese), Spanish, English, Hindi, Arabic, Bengali, Portuguese, Russian, Punjabi, and Japanese. But many people in the world also speak a second language [1]. When considering the total number of people who use a particular language (mother tongue plus second, third, or more languages), the ranking of these languages differs from that of their mother tongue. Over time, the total number of people using one language may increase or decrease due to various factors [2]. From the perspective of grey modeling, we use grey relational analysis to analyze the factors that affect the language development trend. To facilitate the calculation [3], we randomly select five factors (including economic factors) to conduct studies to determine the main factors that affect the distribution of language users [4]. On this basis, a grey relational forecasting model based on grey relational degree is constructed to predict the distribution of languages [5] (number of native speakers or total number of users in a language).

II. Establishment of the Model

A. *Calculation of Grey Correlation Coefficient Series*

Set the sequence of language features $Y_i = \{x_i(1), x_i(2), \dots, x_i(n)\}$, I = 0, 1,When i = 0, we call Y_0 the number of native speakers in a certain language, Y_1 is the total number of users in a certain language. Suppose the sequence of related factors $X_i = \{x_i(1), x_i(2), \dots, x_i(n)\}$, i = 1, 2, 3,...,m; $\Delta_i(k)$ is the data increment of the sequence X_i at $(k-1) \to (k)$, k = 2, 3,...,n, that is:

$$\Delta_i(k) = x_i(k) - x_i(k-1) \quad (1)$$

E_i is the average value of the absolute value of the data increment $\Delta_i(k)$, that is:

$$E_i = \frac{1}{n-1}\sum_{k=2}^{n}|\Delta_i(k)|$$

$\partial_i(k)$ is the mean of the data increment $\Delta_i(k)$ for the sequence X_i at $(k-1) \to (k)$, that is:

$$\partial_i(k) = \frac{1}{E_i}|\Delta_i(k)| \quad (2)$$

$\gamma_{0i}(k)$ is the gray correlation coefficient of the sequence Y_0 and X_i from $(k-1) \to (k)$, that is,

$$\gamma_{0i}(k) = \frac{1}{1+|\partial_0(k)-\partial_i(k)|} \quad (3)$$

$\gamma_{1i}(k)$ is the gray correlation coefficient of the sequence Y_1 and X_i from $(k-1) \to (k)$, that is,

$$\gamma_{1i}(k) = \frac{1}{1+|\partial_1(k)-\partial_i(k)|}$$

γ_{0i} is the gray relational degree of sequence Y_0 and X_i, that is

$$\gamma_{0i} = \frac{1}{n-1}\sum_{k=2}^{n}\gamma_{0i}(k) \quad (4)$$

γ_{1i} is the gray relational degree of sequence Y_1 and X_i, that is

$$\gamma_{1i} = \frac{1}{n-1}\sum_{k=2}^{n}\gamma_{1i}(k)$$

It can be proved that the above gray relational degree model satisfies the characteristics of normality, even symmetry, proximity, preservation order, uniqueness and so on.

Gray correlation coefficient can reflect the relationship between the feature sequence of various language distribution and the sequence of influencing factors [6]. To predict the number of native speakers of a certain language and the total number of users of a certain language, We can first calculate the sequence of gray correlation coefficients between the linguistic distribution feature sequence and the related factor sequence, and then generate the predictive expression of the gray correlation coefficient sequence based on this.

According to (3) shows, If $\gamma_{0i}(k)$ is the gray correlation coefficient of the sequence Y_0 and X_i from $(k-1) \rightarrow (k)$, then

$$\gamma_{0i}(k) = \frac{1}{1+|\partial_0(k)-\partial_i(k)|}$$

Similarly, according to (3) shows, If $\gamma_{1i}(k)$ is the gray correlation coefficient of the sequence Y_1 and X_i from $(k-1) \rightarrow (k)$, then

$$\gamma_{1i}(k) = \frac{1}{1+|\partial_1(k)-\partial_i(k)|}$$

Calculating the gray correlation coefficient of the corresponding element between the feature sequence $Y_0 = (x_0(1), x_0(2), \cdots, x_0(n))$ of a language native speaker and the user's total feature sequence $Y_1 = (x_1(1), x_1(2), \cdots, x_1(n))$ of a certain language and the related factor sequence $X_i = (x_i(1), x_i(2), \cdots, x_i(n))$ to form a gray correlation coefficient sequence $R_{0i} = (\gamma_{0i}(2), \gamma_{0i}(3), \cdots, \gamma_{0i}(n))$ and $R_{1i} = (\gamma_{1i}(2), \gamma_{1i}(3), \cdots, \gamma_{1i}(n))$, as shown in Fig . 1 and Fig. 2 :

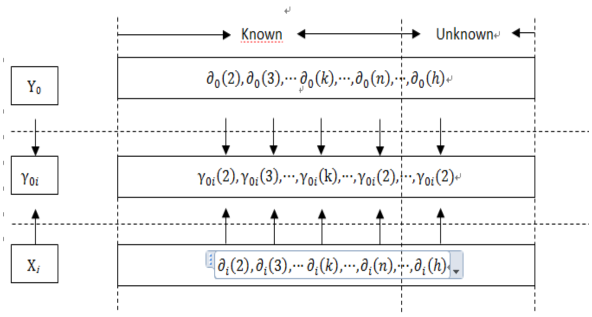

Fig. 1 The gray correlation coefficient of the element corresponding to sequence Y_0 and sequence X_i.

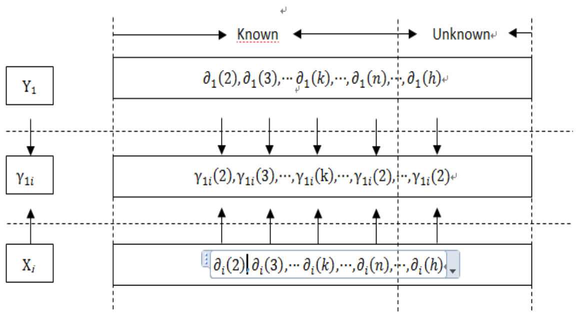

Fig. 2. The gray correlation coefficient of the element corresponding to sequence $\mathbf{Y_1}$ and sequence X_i.

B. *Calculation of Grey Correlation Coefficient*

How to use the known gray correlation coefficient sequence $R_{0i} = (\gamma_{0i}(2), \gamma_{0i}(3), \cdots, \gamma_{0i}(n))$ and $R_{1i} = (\gamma_{1i}(2), \gamma_{1i}(3), \cdots, \gamma_{1i}(n))$ to generate the gray correlation coefficient $\gamma_{0i}(h)$ and $\gamma_{1i}(h)$? We first calculate $\gamma_{0i}(h)$. Usually, there are 3 ways to generate the gray correlation coefficient $\gamma_{0i}(h)$:

1) Generation of gray correlation coefficient based on mean method [2]

When the values of $\gamma_{0i}(2), \gamma_{0i}(3), \cdots, \gamma_{0i}(n)$ are relatively close, the average value of the gray correlation coefficient is calculated as the value of the gray correlation coefficient $\gamma_{0i}(h)$, that is,

$$\gamma_{0i}(h) = \frac{1}{n-1}\sum_{k=2}^{n}\gamma_{0i}(k)$$

According to definition, $\gamma_{0i}(h)$ is actually the gray relational degree of the native speaker Y_0 and the related factor sequence X_i in a certain language, that is, $\gamma_{0i}(h) = \gamma_{0i}$. Therefore, the gray relational number generated by the mean value method is:

$$\gamma_{0i}(h) = \gamma_{0i} = \frac{1}{n-1}\sum_{k=2}^{n}\gamma_{0i}(k)$$

2) Generation of Gray Correlation Coefficient of $NGM(1,1,k)$ Model Based on Direct Estimation

According to the gray correlation coefficient calculation formula (3)

$$\gamma_{0i}(k) = \frac{1}{1+|\partial_0(k)-\partial_i(k)|}$$

It can be seen that $\gamma_{0i}(k) > 0$, that is, the gray related sequence $R_{0i} = (\gamma_{0i}(2), \gamma_{0i}(3), \cdots, \gamma_{0i}(n))$ is a nonnegative sequence, which satisfies the modeling condition of the gray $NGM(1,1,k)$ model. The following is based on the R sequence to establish the $NGM(1,1,k)$ model, to build a gray $NGM(1,1,k)$ gray prediction model of the relationship between the feature sequence Y_0 of the number of people in a native language and the relevant factor sequence X_i, to achieve the prediction of the gray associated sequence.

$R_{0i}^{(1)} = \left(\gamma_{0i}^{(1)}(2), \gamma_{0i}^{(1)}(3), \cdots, \gamma_{0i}^{(1)}(n)\right)$ is a cumulative sequence of $R_{0i} = (\gamma_{0i}(2), \gamma_{0i}(3), \cdots, \gamma_{0i}(n))$, and a $NGM(1,1,k)$ gray prediction model based on direct parameter estimation is constructed. Then the simulation and prediction model of $\hat{\gamma}_{0i}(h)$ is:

$$\hat{\gamma}_{0i}(h) = (1-e^{a})\left(\gamma_{0i}(2) - \frac{b}{a} + \frac{b}{a^2} - \frac{c}{a}\right)e^{-a(h-1)} + \frac{b}{a}$$

Similarly, using the mean method and $NGM(1,1,k)$ gray model, the simulation and prediction model of $\hat{\gamma}_{1i}(h)$ can be obtained as

$$\hat{\gamma}_{1i}(h) = (1-e^{a})\left(\gamma_{1i}(2) - \frac{b}{a} + \frac{b}{a^2} - \frac{c}{a}\right)e^{-a(h-1)} + \frac{b}{a}$$

The parameters a, b are estimated based on the direct parameter estimation $NGM(1,1,k)$ gray prediction model.

C. Generate Comprehensive Correlation Coefficient

The gray correlation coefficient is predicted based on the $NGM(1,1,k)$ model of direct estimation [7]. The prediction results reflect the development trend of the correlation between the language feature sequence and the related factor sequence. The value of the gray correlation coefficient based on the mean value method reflects the feature sequence of the language distribution and the correlation the traditional relationship between factor sequences on the gray correlation coefficient calculation results; the traditional relationship and the development trend of both weighted gray correlation coefficient [8], resulting in a more reasonable gray correlation coefficient. The gray correlation coefficient obtained by the weighted method is called the integrated gray correlation coefficient. Using $\gamma'_{0i}(h)$ to represent the number of people in a language native gray correlation coefficient, which is calculated as:

$$\gamma'_{0i}(h) = \theta\gamma_{0i}(h) + (1-\theta)\hat{\gamma}_{0i}(h) \qquad (5)$$

Using $\gamma'_{1i}(h)$ to represent the number of people in a language native gray correlation coefficient, which is calculated as:

$$\gamma'_{1i}(h) = \theta\gamma_{1i}(h) + (1-\theta)\hat{\gamma}_{1i}(h)$$

θ is the weighting coefficient, $\theta \in [0,1]$. The integrated gray correlation coefficient not only reflects the traditional correlation between sequences but also reflects the influence of its development tendency [9]. It reflects the distribution of feature sequences and Correlation between the sequences of the factors. The general take $\theta = 0.5$.

D. Calculation of Prediction Value Based on Grey Correlation Coefficient

If there is a correlation between the feature sequence of population Y_0 and the sequence X_i in a native language, according to (3), there is

$$|\partial_0(h) - \partial_i(h)| = \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)} \qquad (6)$$

The relationship between $\partial_0(h)$ and $\partial_i(h)$ in Eq. (6) can not be directly determined. Since there is a correlation between the sequence Y_0 and the sequence X_i, the curves are similar and can be expressed by $\partial_0(h-1)$ and $\partial_i(h-1)$ the size of the relationship between approximate judgment $\partial_0(h-1)$ and $\partial_i(h-1)$ the size of the relationship. [5]

① when $\partial_0(h-1) \geq \partial_i(h-1)$, with $\partial_0(h) \geq \partial_i(h)$, (6) can be simplified

$$\partial_0(h) = \partial_i(h) + \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)} \qquad (7)$$

According to the definition, there

$$\partial_0(h) = \frac{1}{E_0}|\Delta_0(h)|, \partial_i(h) = \frac{1}{E_i}|\Delta_i(h)|$$

Substitute (7) there

$$\frac{1}{E_0}|\Delta_0(h)| = \frac{1}{E_i}|\Delta_i(h)| + \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}$$
$$\Rightarrow |\Delta_0(h)| = E_0\left[\frac{1}{E_i}|\Delta_i(h)| + \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}\right]$$

In the formula E_0 is the average value of the absolute value of the data increment $\Delta_0(k)$ of the sequence Y_0. Under the condition that Y_0 is known, E_0 is a constant

E_i is the average value of the absolute value of the data increment $\Delta_i(k)$ of the sequence X_i, and E_i is a constant under the condition that X_i is known;

$|\Delta_i(h)|$ is the data increment of the sequence X_i at $(h-1) \to (h)$. Since X_i is a factor sequence, when predicting the feature sequence of the number of people in a native language $|\Delta_i(h)|$ is known data;

$\gamma_{0i}(h)$ is the gray correlation coefficient of the sequence Y_0 and X_i from $(h-1) \to (h)$, $\gamma_{0i}(h)$ is calculated by the formula (5) make

$$E_0\left[\frac{1}{E_i}|\Delta_i(h)| + \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}\right] = c_1$$

Because $\Delta_0(h) = x_0(h) - x_0(h-1)$, then:

$$|x_0(h) - x_0(h-1)| = c_1$$

② when$\partial_0(h-1) \leq \partial_i(h-1)$, (6) Transform to

$$\partial_0(h) - \partial_i(h) = -\frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}$$
$$\Rightarrow \partial_0(h) = \partial_i(h) - \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}$$

Similarly, there is:

$$|\Delta_0(h)| = E_0\left[\frac{1}{E_i}|\Delta_i(h)| - \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}\right]$$

Make

$$E_0\left[\frac{1}{E_i}|\Delta_i(h)| - \frac{1-\gamma_{0i}(h)}{\gamma_{0i}(h)}\right] = c_2$$

There：

$$|\hat{x}_0(h) - x_0(h-1)| = c_2 \qquad (8)$$

By the same token, the predictive value formula of the feature sequence of the total number of users of a certain language can be deduced.

To sum up, the prediction formulas of the feature sequence predicted by the number of native speakers of a certain language and the total number of users of a certain language are respectively shown in Table I and Table II below.

Table I. Y_0 Predicted value calculation formula classification table

	Monotonically increasing sequence of Y_0	Monotonically increasing sequence of Y_0	Y_0 is the oscillation sequence
$\hat{x}_0(h) - x_0(h-1) > 0$	$\hat{x}_0(h) = c_1 + x_0(h-1)$	$\hat{x}_0(h) = c_1 + x_0(h-1)$	Not applicable
$\hat{x}_0(h) - x_0(h-1) < 0$	$\hat{x}_0(h) = c_2 + x_0(h-1)$	$\hat{x}_0(h) = c_2 + x_0(h-1)$	
$c_1 = E_0\left[\frac{1}{E_i}\lvert\Delta_i(h)\rvert\right] + \frac{1-\gamma_{oi}(h)}{\gamma_{oi}(h)}$ $c_2 = E_0\left[\frac{1}{E_i}\lvert\Delta_i(h)\rvert\right] - \frac{1-\gamma_{oi}(h)}{\gamma_{oi}(h)}$			

Table II. Y_1 Predicted value calculation formula classification table

	Monotonically increasing sequence of Y_1	Monotonically increasing sequence of Y_1	Y_1 is the oscillation sequence
$\hat{x}_1(h) - x_1(h-1) > 1$	$\hat{x}_1(h) = c_3 + x_1(h-1)$	$\hat{x}_1(h) = c_3 + x_1(h-1]$	Not applicable
$\hat{x}_1(h) - x_1(h-1) < 1$	$\hat{x}_1(h) = c_4 + x_1(h-1)$	$\hat{x}_1(h) = c_4 + x_1(h-1]$	
$c_3 = E_1\left[\frac{1}{E_i}\lvert\Delta_i(h)\rvert\right] + \frac{1-\gamma_{oi}(h)}{\gamma_{oi}(h)}$ $c_4 = E_1\left[\frac{1}{E_i}\lvert\Delta_i(h)\rvert\right] - \frac{1-\gamma_{oi}(h)}{\gamma_{oi}(h)}$			

E. Construction of Gray Correlation Portfolio Forecasting Model

Gray relational combination forecasting model uses the "regression characteristic" of regression analysis to establish a gray combined forecasting model according to the proportion of the correlation coefficient between the feature sequence of the language distribution and the related factor sequence [10].

For the number of native speakers in a given language, set

$$R = \gamma_{01} + \gamma_{02} + \cdots + \gamma_{0m} = \sum_{i=1}^{m} \gamma_{01}$$

The goal is the number of related factors. Then the gray correlation forecasting model is

$$\hat{x}_0(h) = \frac{\gamma_{01}}{R} \times \hat{x}_{01}(h) + \frac{\gamma_{02}}{R} \times \hat{x}_{02}(h) + \cdots + \frac{\gamma_{0m}}{R} \times \hat{x}_{0m}(h) \quad (9)$$

For the prediction of the total number of users of a language, set

$$R = \gamma_{11} + \gamma_{12} + \cdots + \gamma_{1m} = \sum_{i=1}^{m} \gamma_{11}$$

Then the gray correlation forecasting model is

$$\hat{x}_1(h) = \frac{\gamma_{11}}{R} \times \hat{x}_{11}(h) + \frac{\gamma_{12}}{R} \times \hat{x}_{12}(h) + \cdots + \frac{\gamma_{1m}}{R} \times \hat{x}_{1m}(h)$$

III. Prediction

For ease of calculation, we intend to select five influencing factors for the study, including X_1 (Immigrants and immigrants and countries using other languages), X_2 (Import and assimilation of cultural groups), and X_3 (a language used or promoted by a government), X_4 (economic factor), X_5 (social pressure). Through calculations, from the perspective of Deng's relevance degree, the number of English-speaking speakers Y_0 is highly correlated with the promotion of the government [11]; the total number of English-users Y_1 is highly correlated with economic factors; from the perspective of generalized grey correlation the number of English-speaking populations Y_0 and immigrants are the most significant, and the total number of English-speaking users Y_1 is highly correlated with government promotion [12]. The use of English-speaking population Y_0 and its two highly correlated factors (government promotion and immigration) to construct a grey composite forecasting model, and then using the model to simulate and predict the number of English-speaking speakers Y_0 from 2016 to 2017, At the same time, a combination of Y_1, the total number of English speakers, and two factors (government promotion and economy), which are highly relevant to each other, are used to construct a grey combination forecast model. Then, the total number of Y_1 English users in 2016-2017 is modeled by the model. prediction.

Establish a grey relational prediction model for Y_0 (number of native English speakers), X_1 (immigrants), and X_3 (government promotion) according to equation (9)

$$\hat{x}_0(h) = \frac{\gamma_{01}}{R} \times \hat{x}_{01}(h) + \frac{\gamma_{02}}{R} \times \hat{x}_{02}(h) + \cdots + \frac{\gamma_{0m}}{R} \times \hat{x}_{0m}(h)$$
$$\hat{x}_0(8) = 0.457 \times \hat{x}_{01}(8) + 0.543 \times \hat{x}_{03}(8)$$

Among them

$$\hat{x}_{01}(8) = x_0(7) + \left[\frac{1-\gamma_{01}(7)}{\gamma_{01}(7)} + \partial_1(8)\right] E_0$$
$$\hat{x}_{03}(8) = x_0(7) + \left[\frac{1-\gamma_{01}(7)}{\gamma_{01}(7)} + \partial_3(8)\right] E_0$$

It is known that Y0 (English-speaking population) affected by immigrants in 2016 was 56 million, and Y0 affected by government promotion was 331 million. Then $x_0(7) = 335$, $\gamma_{01}(7) = 0.485$, E0 = 6.5

$$\partial_1(8) = \frac{(56-47)}{6.38} = 1.410$$
$$\partial_3(8) = \frac{(331-315)}{9.51} = 1.683$$

Can be calculated

$$\hat{x}_{01}(8) = 351.07 \,,\ \hat{x}_{03}(8) = 352.84$$

Into the formula:

$$\hat{x}_0(8) = 0.457 \times \hat{x}_{01}(8) + 0.543 \times \hat{x}_{03}(8)$$

Then

$$\hat{x}_0(8) = 352.03$$

Similarly, it can be calculated

$$\hat{x}_0(9) = 370.15$$

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Using Eviews to establish a linear regression model for the number of English-speaking population Y_0, the number of people affected by the migration X_1, and the number of people affected by the government X_3, the regression equation is

$$x_0 = 0.027x_1 - 2.587x_3 + 1148.735 \quad (10)$$

In 2016, Y0 (English-speaking population) affected by immigration was 56 million and Y0 affected by government promotion was 331 million substitutions (10). The estimated Y0 in 2016 is:

$$\hat{x}_0(8) = 293.95$$

Similarly, the estimated Y0 for 2017 can be calculated as:

$$\hat{x}_0(9) = 250.27$$

IV. Conclusion

Table III. Analogue and Error Comparison of English-speaking Numbers in 2016-2017

project / model	2016 year			2017 year		
	Actual value	Predictive value	Prediction error	Actual value	Predictive value	Prediction error
Gray combo model	358	352.03	1.67%	371	370.15	0.23%
Regression model	358	293.95	17.89%	371	250.27	32.54%

As can be seen from Table III, the prediction error of the grey combination forecasting model is smaller than that of the regression model, mainly because the sample size is small and does not meet the application range of the regression model. Therefore, the prediction result of the regression model is also invalid. The grey combined forecasting model combines the advantages of the regression model and the grey forecasting model. The prediction accuracy is within 10% and can be used for forecasting.

In summary, due to the influence of various "gray" uncertainties on the distribution of various languages, the use of grey-relational combined forecasting models to predict the distribution of various languages is scientific and reasonable.

References

[1] Lane, J, (2017). The 10 Most Spoken Languages in the World. Babbel Magazine, Retrieved from. https://www.babbel.com/en/magazine/the-10-most-spoken-languages-in-the-world.

[2] Lu Yi.Research and application of gray prediction model [D]. Zhejiang University of Technology: School of Mechanical and Automatic Control, 2014.

[3] He Mingfang. Population Prediction Model Based on Gray System Theory [D]. South China University of Technology: South China University of Technology, 2012.

[4] Zhang Jun. Improvement of Gray Prediction Model and Its Application [D]. Xi'an University of Technology: Xi'an University of Technology Applied Mathematics, 2008.

[5] Jiang Qiyuan. Mathematical model [M]. Higher Education Press: Jiang Qiyuan, Xie Jinxing, Ye Jun compiled, 2004.

[6] Deng Julong. Grey theoretical basis [M]. Wuhan: Huazhong University of Science and Technology Press, 2002.

[7] Luo Dang, Liu Sifeng, Dang Yaoguo. Optimization of grey GM (1, 1) [J].Engineering Science, 2003, (8):50-53.

[8] Zhong zhong Wang, Chunyan Wu. Improved Model of GM (1, 1) and Its Application [J]. Mathematics in Practice and Theory, 2003, (9): 20-24.

[9] ZHAO Hai-qing,et al. Research and application of dimension correction grey correction model [J]. OR Planning and Management, 2007, 16(1): 97-99.

[10] Wang Yihuao, Liu Kaidi, Li Yingchuan. GM (1, 1) Modeling Method for Optimizing Grey Derivative Whitening Value [J]. Systems Engineering-Theory & Practice, 2001, 21(5): 124-128.

[11] Deng Julong. Gray system theory basis tutorial [M]. Wuhan: Huazhong University of Science and Technology Press, 1990.

[12] Chen Huayou, Wu Tao, Xu Yisheng. Improved Calculation of Grey Relational Degree and Grey Relational Degree [J]. Journal of Anhui University (Natural Science), 1999, 23(4): 1-4.

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