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The research and application of posterior error test prediction model on sports competition results based on gray theory

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ABSTRACT

To correctly predict the scores of athletes is to make a best forecast on the future development of athletes; in general, based on the historical performance of an athlete, the results can be predicted. Especially in large athletic competition, it is particularly important to choose the correct athletes. In this paper, it uses the gray model to predict sports results, takes the javelin athlete's performance as an example to predict the athletes' performance of this class, draws trend charts for the athletes, and conducts error analysis. And it uses the performance of hammer throw and men's 100 m to promote the gray prediction system, the obtained data has good predictability, and the error is low, which is applied to the performance predictions of most sports.

KEYWORDS

Gray prediction;
Sports events;
Posterior error test;
Performance forecast.

INTRODUCTION

Being able to effectively predict the future information is an effective way to transform human society. However, due to the incompleteness of the data, it generates a lot of uncertainties. Fuzzy mathematics and rough theory studies the incomplete information from different aspects. In 1979, Chinese Professor Deng Julong first proposed the "gray model", which also marked the establishment of the gray system. With the establishment of the "gray system", it has aroused strong repercussions at home and abroad, and is quickly applied to agriculture, biology, water, social and weather.

The Olympic Game is the world's major sporting event, also a high level sport of high comprehensiveness; in the Olympic Games and other major competitions, whether the achievements of the team is good or bad is the only measuring standard. In this paper, it establishes a mathematical model taking javelin sport as an example, conducts prediction and analysis of results, and gives the overall trend of its past, present, and future. The sport score forecasting based on gray prediction system plays a vital role in the management of sports.

MODELING

Gray system is to study the uncertain of the small information or the information; by the consideration of some information, it creates a system model and correctly describes the location information.

Model assumption

(1) Assuming that every time the measured performance of athletes is the real investigation of the athlete's ability;

(2) Assuming that the data has effective digits;
(3) Assuming the sport event that the model uses has good associativity with the model.

Gray system modeling

Grey System GM (1, 1) model is the dynamic process that fits the time sequence of this data by differential equations to approximate the above time series based on the integrated information of many factors given in the system, and then extrapolates to reach the prediction purposes. This obtained fitting model is a first-order differential equation of time series. Gray system is to establish a differential equation of the discrete sequence:

$$\frac{dx}{dt} + ax = \mu$$

From the definition of the derivative:

$$\frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{x(t+\Delta t) - x(t)}{\Delta t}$$

When the Δt is very small and take the approximate unit 1, then we have:

$$x(t+1) - x(t) = \frac{\Delta x}{\Delta t}$$

Its discrete version is:

$$\frac{\Delta x}{\Delta t} = x(k+1) - x(k) = \Delta^{(1)}(x(k+1))$$

Let the non-negative sequences $X^{(0)} = \left(x^{(0)}(1), x^{(0)}(2) \cdots x^{(0)}(3)\right)$ do one accumulation on $X^{(0)}$, get the generated sequence as:

$$X^{(1)} = \left(x^{(1)}(1), x^{(1)}(2) \cdots x^{(1)}(3)\right)$$

Where:

$$x^{(1)}(k) = \sum_{i=0}^{k} X(i), \quad x^{(0)}(k) + az^{(1)}(k) = b$$

It is simplified as:

$$x^{(0)}(k) = \beta - \alpha x^{(1)}(k-1)$$

Where:

$$\beta = \frac{b}{1+0.5a}, \alpha = \frac{a}{1+0.5a}$$

$$\begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix} = \begin{bmatrix} -\frac{1}{2}(x^{(1)}(1) + x^{(1)}(2)) & 1 \\ -\frac{1}{2}(x^{(1)}(2) + x^{(1)}(3)) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(x^{(1)}(n-1) + x^{(1)}(n)) & 1 \end{bmatrix}$$

$$Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}, B = \begin{bmatrix} -\frac{1}{2}(x^{(1)}(1) + x^{(1)}(2)) & 1 \\ -\frac{1}{2}(x^{(1)}(2) + x^{(1)}(3)) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(x^{(1)}(n-1) + x^{(1)}(n)) & 1 \end{bmatrix}$$

Test of the gray prediction model

According to the posterior error test, test the gray prediction method, as shown in TABLE 1.

Solving the time residuals S_1 and the original data S_2 within a time interval, according to the ratio formula of the posterior error:

$$c = \frac{S_1}{S_2}$$

Solving the error probability P, according to the

TABLE 1 : Rank test of the accuracy test

Forecast accuracy class	P	C
Good	> 0.9	< 0.35
Qualified	≥ 0.8	< 0.45
Reluctant	≥ 0.7	< 0.5
unqualified	< 0.7	≥ 0.65

TABLE 2 : The javelin results of this athlete in 2004-2007

Year / results	Achievement(m)	The average score (m)
2004	86.5, 84.12	85.31
2005	85.18, 86.13, 85.29, 85.44, 84.13, 84.44	85.26
2006	89.50, 89.78, 90.13, 84.98, 85.18, 87.43, 86.97, 90.34, 90.59	88.37
2007	89.51, 88.36, 86.14, 86.28, 87.79, 80.71, 89.49, 86.39	86.83

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formula:

$$P = P\left\{\left|\varepsilon_{(1)}^{(0)} - \bar{\varepsilon}\right| < 0.6745S_2\right\}$$

Parameter $\bar{\varepsilon}$ is the mean value of the residual error. Depending on the value C and the value P, test the rank test table corresponding to the accuracy test.

The sports results prediction under grey prediction model

In this paper, it uses gray prediction method to predict the javelin results over years, obtain the javelin results of Norwegian javelin thrower Andreas Tuoxierde, as shown in TABLE 2.

According to the javelin result of this athlete in 2004-2007 in TABLE 2, predict the javelin result in 2008-2009, obtain the TABLE 3.

Based on the above model, predict the data to obtain the TABLE 4.

According to the results in TABLE 4, obtain the Figure 1 and Figure 2 by Excel.

Figure 1 is the fold line of the actual values and predicted values for this athlete in 2004-2009, by the intensity of the two lines, the actual values and predicted values can combine well and fit well; figure 2 is the error rate line chart of the predicted value and the actual value; as can be seen in Figure 2 the error rate gradually decreases over time, indicating that the prediction is effective.

TABLE 3 : The javelin results of this athlete in 2008-2009

Year / results	Achievement (m)	The average score (m)
2008	87.73, .85.19, 87.59, 90.57	87.778
2009	89.50	89.50

TABLE 4 : Comparison of the predicted results and the actual results

Year / results	Forecast results (m)	Actual results (m)	Error rate
2004	85.3100	85.31	0
2005	86.0426	85.26	0.918%
2006	86.8171	88.37	1.757%
2007	87.5986	86.83	0.885%
2008	88.3872	87.78	0.692%
2009	89.1828	89.50	0.354%

MODEL PROMOTION

In this paper, it predicts the results of javelin based on gray forecasting system, promotes the model to other sports; under normal circumstances, the results for several years will be obtained, then the future performance can be predicted. TABLE 5 is the competition results of Hammer thrower Bi Zhong over the years based on the above model, as shown in TABLE 5.

Based on the above model, this paper predicts the men's 100 m performance in 1976 Olympic Games, and gets the relative error, as shown in TABLE 6.

The prediction error value for the score of hammer thrower and men's 100 m is very small by the table 6. The established grey prediction model in this paper has good predictability, and it uses the performance predictions of a variety of sports.

TABLE 5 : The competition results of Hammer thrower Bi Zhong over the years

Years	The actual data	Grey Model		Neural Network Model	
		Predicted data	Relative error	Predicted data	Relative error
89	77.04				
90	75.75	74.99	0.34%		
91	74.76	74.60	0.08%		
92	74.27	74.20	0.28%		
93	73.18	73.81	0.86%		
94	73.34	73.52	0.026%		
95	71.86	73.03	1.63%		
96	73.88	72.64	1.68%		
97	73.88	72.26	0.39%	73.65	2.32%

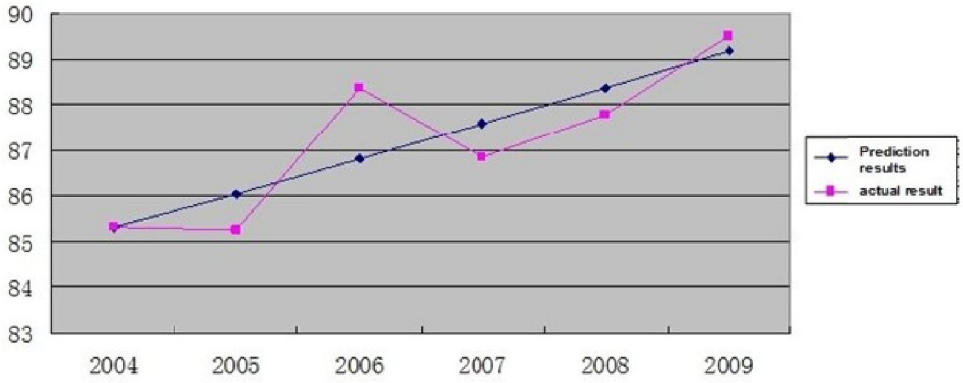

Figure 1 : The trend of forecasting results and actual results

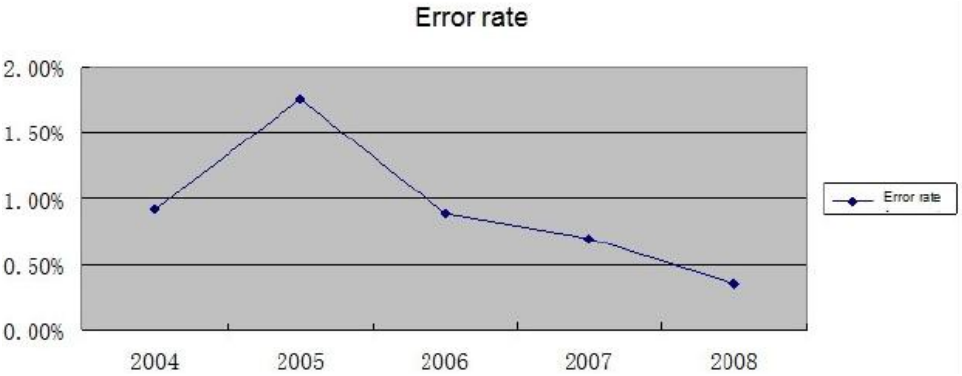

Figure 2 : Error analysis figure

TABLE 6 : The performance prediction of men's 100 m in 1976 Olympic Games

Years	The actual value /s	Absolute value /s	Absolute error /%	Relative error/%
1952	10.04	10.04	0	0
1956	10.05	10.011	0.04	0.4
1960	10.02	10.025	0.001	0.1
1964	10.00	10.032	0.032	0.32
1968	9.95	10.045	0.093	0.93
1972	10.14	10.051	0.094	0.85
1976	10.06	10.068	0.005	0.5

CONCLUSIONS

Gray prediction system is an important part of gray system. Gray system has made a significant achievement in many fields and many aspects, solves many important issues, and gains wide application in agriculture, biology, water conservancy, society and meteorology; The research and improvements of many well-known scholars improve the prediction accuracy and reduce errors to apply it to all aspects of society.

This paper establishes the gray prediction system for javelin athletic performance, and after posterior error test, the obtained model has high precision and good predictability. By predicting the performance of hammer throw and men's 100 m, it obtains that the model applies to most of the sports achievements prediction. It has a significant effect on the scores of individuals. However, for the gray prediction system, it should be noted that the newspaper should have long enough valid digits to better reduce the error.

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