Construction of Nonlinear Prediction Model For the Evolution Trend of Track and Field Training Theory

Xiujun Zeng

Department of Physical Education, Southwest Jiaotong University, Chengdu, 611756, China

Abstract: Track and field is a basic sport based on the coordination of limbs and joints, which reflects the internal relations among various sports and plays a very important role in the progress of competitive sports and the development of various sports. With the continuous development of sports and science and technology, the theory of track and field training is becoming more and more perfect. As for the huge and complex system of track and field training, it is difficult to make statistics and research without establishing a scientific and systematic nonlinear prediction model. In this paper, the evolution trend of track and field training is deeply studied and the model is constructed, which is dominated by gray prediction and mathematical statistics, and assisted by literature materials, in order to help relevant workers understand and apply relevant data and provide reference for track and field training.

Keywords: Nonlinear model constructing; Track and field training; Variation trend

1. Introduction

Track and field sports have strong competitiveness, predictability, enhancement and wide popularity in the comparison of comprehensive sports, and it has not only become a means for people to compete with each other and keep fit, but also a standard to show the national spirit in various competitions. It has become the focus of all nations in the rapid development of sports today. From the perspective of China, the national level of sports is constantly improving, but the progress of track and field level is very little, for example, at the 2008 Olympic Games in Beijing, with the advantage of the host country, China won 151 medals in all competitions, but on the track and field sports the harvest is very little, China only have a breakthrough in the hammer and marathon, winning 2 bronze medals. Compared with other sports powers, if China wants to catch up with them and keep ahead in sports, it is particularly important to make a breakthrough in track and field sports.

However, in the process of daily training and training athletes, there are often many uncertain factors about athlete, such as growth cycle, injury situation, maintenance of state and stability, therefore, it is necessary to have an in-depth understanding of the gray area of these uncertainties, make scientific predictions about training and competition, finally we find the most appropriate and scientific decision information for track and field training [1].

2. The Constructing Theory and Content of Nonlinear Model Prediction based on Grey System Theory

The grey system theory of constructing nonlinear prediction model is to divide information into known, unknown and uncertain parts, select the uncertain part as the next operation target, and form the grey generating to find the rule change, the information, laws and changes that are helpful to the research are selected from these laws. Finally, through the data system and the corresponding mathematical formula, the behavior model is established to accurately describe and classify the unknown data trend and change rules.

The main contents are as follows:

(1) Study the application degree of track and field performance prediction at home and abroad and its development direction.

(2) Stat and analyze the stage characteristics of top three sports score in the track and field competitions for the national games and other large-scale sports events .

(3) Apply the gray system theory to establish GM(3, 2) grey prediction model group, and carry out residual test for these model and modify the model repeat, improve the accuracy of performance prediction, finally the model with a precision of level 1 or close to level 1 (both the average relative error and the origin relative error are less than 1%) is selected as the final prediction model[2].

(4) Study the general characteristics and future development trend of modern track and field.

H K .N C C P

International Journal of Intelligent Information and Management Science
ISSN: 2307-0692, Volume 8, Issue 1, February, 2019

3. Nonlinear Prediction Modeling Mthod for Track and Field Sports

According to GM (2, 3) modeling principle, we refer to the women's 100m record of the 30th to 33rd Asian national games to build data model, and other track and field modeling processes are comparable.

Table 1. Score data sheet of women's 100-metre championship in the 30th to 35th national games

Year	period	score(s)
2004	30	11.84
2008	31	11.87
2012	32	11.85
2016	33	11.69

Step 1: The feasibility of the data is analyzed on the basis of determining the original sequence

According to table 3.1, Assuming the original score time series of the women's 100m is x(0) :

x(0)=(x(0)(1)，x(0)(2)，x(0)(3)，x(0)(4))=(11.84，11.87, 11.85, 11.69).
Seek stepwise ratio(0) (k).

Let S (0) (k) is the stepwise ratio of x (0) at K point :

S (0)(k)=(S (0)(2), S (0)(3), S (0)(4))=(0.9970，1.0020, 1.0165).

(2) Stepwise ratio smoothing test

The float level of U(0)(k) is ：[1.0234, 0.983], and then it's not hard to figure out μ=0.0259, μ<0.267, In the analog interval, Y(0) is a smooth sequence, satisfying the above test theorem, so it can used as modeling materials.

Step 2: DM(3，2) modeling，calculate the 5th level parameter LII=(A，D，V，F)

The intermediate parameter sequence is x(1)，z(1)
x(2)(L)=x(2)(L-1)+x(1)(L)，L=2，3，4，
L(3)(2)=x(0)(5)
M(1)=AGOL(1) =(5.64, 14.81, 38.50, 49.415)
z(1)(k)=0.5×L(2)(k-3), of which L=2，4，6
The intermediate parameter is G、H、I、J

$$G = \sum_{L=2}^{4} z^{(2)}(L) \quad \text{of which k=3，5，7}$$

G=63.726

$$H = \sum_{L=3}^{4} z^{(0)}(L) \quad \text{of which k=5，9，0}$$

H=30.32

$$I = \sum_{L=3}^{3} z^{(1)}(L) x^{(1)}(L) \quad =13.664 \quad \times 8.76+13.5 \quad \times$$

9.57+23.305 × 8.58
=610.7574

$$J = \sum_{l=1}^{4} z^{(1)}(L)^2$$

=3.664 ×23.664+13.524 ×13.525+13.405 ×34.405
=2008.88788

Step 3: Put the coefficient c into the grey input

c= (D×E-(f-1) ×e)/((u-1) ×e-D×C)
=62.674 ×39-(A-1) ×21.63/((a-1) × 2006.824475-73.785 ×73.785)
=(1980.085-2364.14525)/4920.44425-5344.546225=5.7736/46.282=0.009339
Input constant number b
b= (D×F-C×E)/((n-1) ×F-C×C)
=   (23.31×6579.265975-73.775   ×451.75)/((Q-1) ×1996.103175-73.785 ×96.733
=   (59020.70780975-53241.61428375)/ (6020.473425-5444.226225)
=5779.093526/576.2472=10.028683

Step 4: establish GM (1, 1) grey differential

equation
X (0) (k) + a × z (1) (k) = b
L (1) (t) + 0.1132 ×f (2) (L) = 9.579683
Because a=0.009159，b=10.02868，x(0)(1)=9.84，so b=1094.992778
(L (1) (4)-f/g)= 6.48-1694.679778=-108.56
The whitening response formula of GM(3，2) is:
xˆ (1) (k +1) = (xˆ (0) (1) - b/a) ×e-a k + b / a
The reduction value equation is:
L (1) (f +5) = xˆ (2) (L -3) - xˆ (2) (h)

Step 5: GM(3，2) model residual test

sequence
ε (0) = (ε(1)， (ε(2)， ...(ε(n)) =(x(0)(1)-xˆ(0) (1)，x(0)(2)-xˆ(0) (2)，...，)
The rank of sequence is : (1, -3.199610, 2.559807, -5.478720)
It is not difficult to work out the following values according to the order of the sequence:
Δ(k) = (x(0) (k) - xˆ (0) (k)) / x(0) (k)×100%，k = 0，1，2，
xˆ (0) 1) = 9.84，x(0) (1) = 9.84，Δ(1) = 0%
xˆ (0) (2) = 9.893188，x(0) 1) = 9.87，Δ(2) = -0.2349% xˆ (0)
In the above formula, x (0) (k) is actual value, xˆ (1) (k) get value from XM(4，3) data sequence，Δ(L)，f =3，4，is the absolute relative value.
Because of the average relative error: Δ (avg) = 1/((n -1) × Σ Δ (k))，k = 1，2， With the accuracy G(1) = (3- H(avg)) ×100% formula, it can be concluded that the error value of women's events in the sports meet is 0.0096

H K . N C C P

International Journal of Intelligent Information and Management Science
ISSN: 2307-0692, Volume 8, Issue 1, February, 2019

The average of L(0) is : $\overline{f} = \dfrac{1}{n}\sum_{k=2}^{n} x^0(L) = \dfrac{1}{4}\sum_{k=2}^{4} x^0(L)$

$$=8.569$$

The variance of x(0)is : $s_1^2 = \dfrac{1}{n}\sum_{k=1}^{n}\left(x^0(k) - \overline{x}\right)^2$

$$=0.006825$$

The variance of residual error : $s_2^2 = \dfrac{1}{n}\sum_{k=1}^{n}\left(e(k) - \overline{e}\right)^2$

$$=0.000826312$$

The mean variance ratio is : $C = \overline{S}_2 = 0.347953$

Table 2. Reference table for accuracy test level

Rank	Average	P	C
First level	< 0.01	> 0.99	< 0.35

Second level	< 0.05	> 0.95	< 0.50
Third level	< 0.10	> 0.90	<0.65
Fourth level	> 0.20	> 0.80	> 0.80

Step 6: Build a reference similar to FM (3.6) based on the model of other dimensions

We put the women's track and field achievements of five sets of data (11.96, 11.84, 11.87, 11.85, 11.69), as the benchmark data of chart coordinate reference, set up the data platform of women's shot put in National Games. Taking (11.92, 11.96, 11.84, 11.87, 11.85, 11.69) as an object, 6D, 7D and 4D model are established. When dimensional data are obtained, the accuracy chart of coordinate system FM (3.6) is calculated according to the above formula, see figure 3.3 as below.
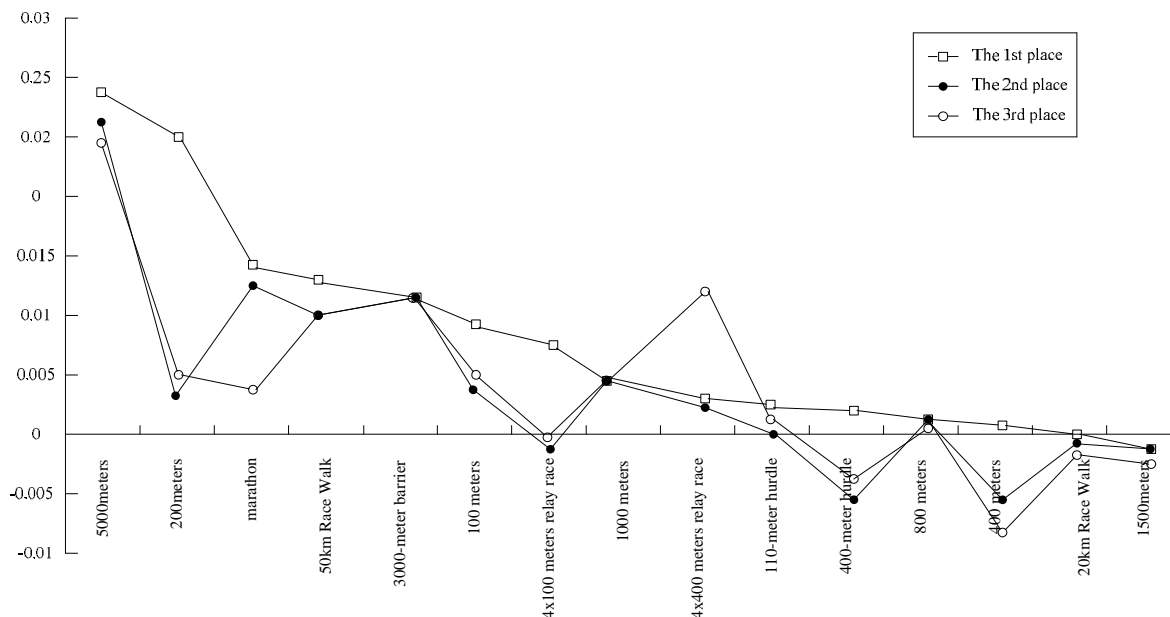
Table 3.The accuiacy chart of women shot put FM(3.6) in national dames

Dimensional model\paramet	Average relative error%	Origin relative error %	Precision P%	Mean variance ratio C	Origin prediction value	Actual origin value
4D	0.32	0.24	99.76	0.347953	9.71	9.69
5D	0.4855	0.54	99.51	0.447276134	9.74	9.69
6D	0.41	0.48	99.52	0.436658411	9.74	9.69
7D	0.48	0.48	99.46	0.476167386	9.74	9.69

4. Over Development Prediction Analysis After Nonlinear Modeling

If we use time as a benchmark, we can calculate the performance accuracy of track and field events very clearly, because most track and field events are measured according to time. Generally speaking, the more outstanding the performance, the more excellent the sports performance, and vice versa, in the GM (3, 2) system built by us, we can set a as the time change trend as a reference, judge the improvement and decline of sports performance by the level of a [3].

Figure 1. The reference value of coordinate constant precision foe men's sports

H K .N C C P

International Journal of Intelligent Information and Management Science
ISSN: 2307-0692, Volume 8, Issue 1, February, 2019

The following conclusions can be drawn from the reference value of constant precision of Olympic men's sports winners in figure 4.1.

(1)Taking the first place in men's race as an example, the progress of long-distance running and relay race is the most prominent. Throwing events such as javelin and shot put have also developed rapidly and made great progress. However, traditional events such as hurdles, medium and long distance arrangement and other events have made slow progress, and walking race has a declining trend.

(2)Taking the second place as an example, the men's long-distance running develops the fastest, especially the 5,000m. Meanwhile, the sprinting and marathon events develop slowly and even have some setbacks. The hurdles and other events are relatively stable with little fluctuation. In general, the performance of the second place is relatively stable and rising steadily.

(3)Taking the third place of men's performance as an example, the data show that the data of the third place is relatively complex, among which, the development of long-distance running and sprinting is prominent, and the development of walking race is also fast. Sprints, such as the 200meters, 100 meters and relay race have a slight decline, while the hurdle performance rebound after the decline. Generally speaking, it was relatively stable, but the short-term fluctuations are large.

Based on the above data, it is not difficult to draw a conclusion that the top three men's competitions are generally stable and progressive, of which the fastest growing events are team competitions, relay race and middle-long

distance running such as marathon and 5,000m. The hurdling, shot put and other events have been declining despite the recovery, showing a trend of continuous decline and need to be improved.

5. Forecast and Analyze the Track and Field Development in China According to the Modeling Data

The constructed theoretical system can be compared with the grey system, make long-term or short-term evaluation and guidance on the statistical data through the construction of the model. However, the prediction based on the system modeling is only a relative value of the real data with limited accuracy, and track and field performance is not only predicted by data, but also related to many factors that cannot be modeled, for example, the players' state problems and weather conditions, as well as the strategic arrangement of the coaching team, the sudden injury of athletes, all of these have great uncertainty and unpredictability [4]. Therefore, it is appropriate to use the relatively stable middle region in the gray construction model as the benchmark for performance prediction, because it is not only accurate, but also more obvious, close to the real situation and data, so as to improve the success rate of modeling prediction. Based on the above comparison, we can select the gray area boundaries of three and six dimensions for statistics and prediction, as shown in figure 5.1 below.
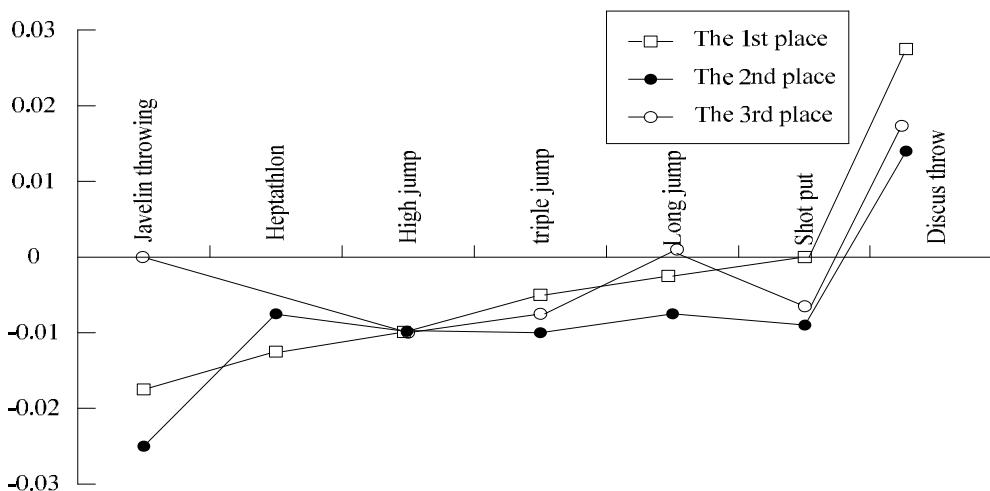

Figure 2. Model index of women's performance in the 30th - 33rd national games

The following conclusions can be drawn from the information of women's track and field performance in the figure:

(1) In the first place of women's performance, except shot put, only throwing events and long jump, triple jump

show obvious fluctuations, other achievements such as long-distance running and sprint have made great progress. Overall development is relatively flat, making progress while maintaining stability.

(2) In the second place of women's performance, javelin performance is outstanding and maintained well, heptathlon performance is relatively stable, high jump and triple jump are obviously backward, and the medium-term amplitude is large, although shot put and discus are relatively stable but the performance has been poor, not optimistic.

(3)In the third place of women's performance, the discus performance is the most prominent and maintains the best condition, and the shot put project is also outstanding, but in addition to the throwing project, the long jump project and the long and middle distance race project have been unstable and always weakness, so there is a lot of development space.

To sum up, the women's middle- distance race turns obvious upward trend in the first place and the third place; the first three women's javelins show a significant downward trend; the upward trend of Women's heptathlon, high jump, triple jump, long jump (the 3rd exception) and shot put (the 1st exception) is relatively moderate [5]. Although the men's and women's track and field achievements have been ups and downs, but still develop steadily toward progress, and in many projects there are very outstanding performance, a growing number of sports have the level of competition for medals at major events such as the national games and the Olympics, and with the development and improvement of the sports system, the differences in track and field sports also gradually decreases for men and women, and the number of medals won by women gradually surpass that of men, occupying a certain advantage.

According to the coordinate system values and big data obtained above, as well as previous achievements, the track and field events in China expected to win medals in the next national games includes women's middle and long distance running, throwing events, hurdle events. Medal hopeful events include traditional strengths projects such as the women's high jump, men's marathon and walking race [6]. Of course, data analysis alone is not enough to draw reasonable predictions and conclusions. The final performance of athletes still depends on the weather conditions at that time and the performance of players in the competition, as well as the performance of opponents and the arrangement of coaches. The predicted results based on the chart have some reference significance, but the final results of the competition still need to see the actual play, but if the athletes in the competition can play their due level, it should be in line with the statistics, obtaining the expected results.

References

[1] Liu Sifeng, Dang Yaoguo, Fang Zhigeng. Naiming Xie. Grey system theory and its application (the fifth edition) . Beijing: Science Press. 2010, 1(15), 226-236.

[2] Deng Julong. Grey theoretical basis. hanWu: Huazhong University of Science and Technology Press. 2002, 1(17), 210-278; 361-367.

[3] Deng Julong. Essential Methods of Grey System (the second edition). Wuhan: Huazhong University of Science and Technology Press. 2005, 1-2.

[4] Lu Minyi. Trends, projections of Olympic champion performance, Olympic review. 1989, 4-5.

[5] Translated by Jianzhong Liang. Track and field performance forecast for the 1992 Olympics. China sports science and technology. 1990, 19-21.

[6] Yuyi Yuan. Track and field swimming and weightlifting forecast for the 1992 Olympics. Sports and Science. 1989, 39 - 40.