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Grey model-based Chinese and American universities competitive sports development research

Yun Liu, Xiaohong Li

Institute of Physical Education, Hunan University of Technology, Zhuzhou 412008, Hunan, (CHINA)

ABSTRACT

Since 2008, China competitive sports have been rapidly developed. However, sports development cannot do without universities competitive physical education. China and America two countries are respectively world sports main country and world sports power, their competitive levels affect world sports competitive levels. The paper utilizes grey model, targeted at China and America two countries university competitive sports development status, it makes prediction. Regard America previous NCAA number of participants and number of participants' changing rate as American universities competitive sports development evidence and take Chinese previous national university students' athletics championships participants athletes and number of participants changing rate as Chinese universities competitive sports development evidence. With respect to this, it establishes four prediction models. The paper takes China previous national participants' amount changing rate as examples, detailed discusses prediction process. Other three models are all using Matlab programming to calculate.

KEYWORDS

Chinese and american universities; Competitive sports; Grey prediction; Development status.

INDUCTION

Nowadays, world presents diversification pattern. Countries competition not only includes economic, military aspects competitions, but also includes sports, culture and others multiple aspects fighting. In view of certain extent, competitive sports development level represents national strength. In competitive spots aspect, China as up-rising star's new emerging power, it appears in the international stage; however, America is historical sports power. Two countries competitive sports development status is a topic of people relative concerns.

In 2003, Liu Hai-Yuan in the article "Chinese university competitive sports development research", adopted multiple research methods, targeted at Chinese University competitive sports development, he made researches. Research results showed that University competitive sports development was beneficial to Chinese competitive sports levels overall improvement. And meanwhile, it could also bring into good economic efficiency to schools. Chinese sports reformation represented in administrative system aspect, sports event management system sports socialization, professionalization aspect, sports industrialization and sports legal construction and others multiple important aspects, these reformation provided basic guarantee for Chinese universities competitive sports. And meanwhile, author targeted at Chinese universities competitive sports management system, it made analysis, the author pointed out, its organizational structure setting was relative simple, and not sound; hierarchical singleness caused weight excessive concentrated, let basic level positivity to be hard to perform; work distribution was not clear, each department work load was excessive big, let organization to be hard to flexible operate. For present universities competitive sports development, the author proposed that regarded "innovation" as University competitive sports development mainline, did a good job in philosophical ideas, management system, operating mechanism three aspects innovation, and meanwhile, focused on referencing overseas success experiences.

In 2008, Wu Lei in the article " Chinese and American universities competitive sports talents cultivation mode comparative research", carried out comparative research on China and America two countries universities competitive sports talents cultivation modes, analyzed from the two management institutions, operation mode and obtained efficiency three aspects. Combined with present Chinese universities competitive sports talents cultivation modes existing problems, and referenced America NCAA success experiences and scientific management ways, it put forward guiding suggestions for developing socialism with Chinese characteristics competitive sports talents cultivation system.

In 2013, Dou Shao-Hua in the article "China and America competitive sports management system comparative research", targeted at China and America two countries competitive sports management system and operation system, he made deepen interpreting and analysis. Author pointed out that in view of competitive sports management system, China was government management-based system, it obviously reflected government indirect participated features, showed macro management-based vivid features; however, America was society-led management system, it obviously reflected government indirect participation features, which showed macro adjustment-based vivid features. In view of competitive sports policies formulation, China was using sports administrative departments to unify formulate competitive sports relative policies; but America was adopting each sport self-government subject on the basis of competition rules and demands to formulate respective sports policies. In view of training system, China carried out professional training or regular intervals centralized training; America however was each club or individual amateur training by market organizations-based with short term collective training as supplement, combined sports with education, competitive sports was centered on schools.

The paper aims to research China and America two countries universities competitive sports development status, carries out comparative analysis from China national university students' athletes and America NCAA championships participants amount two aspects, and estimates on China and America two countries universities future competitive sports development status.

MODEL ESTABLISHMENT

The model takes America NCAA championships participants amount and participants amount changing rate as examples, and China previous national university students athletics championships participants athletes and participants amount changing rate as examples. We predict from participants amount and participants amount changing rate aspects.

Data collection

America NCAA championship participants' amount and participants' amount changing rate data sources are from the article "American Universities competitive sports management system research", contents are as TABLE 1 shows.

TABLE 1 : America NCAA championships participants' amount

Year	Participants amount	Changing rate (%)
1981-82	231445	
1982-83	254849	10.11
1983-84	268457	5.34
1984-85	286508	6.72
1985-86	288629	0.74
1986-87	277201	-3.96
1987-88	264662	-4.52
1988-89	268700	1.53
1989-90	263745	-1.84
1990-91	275305	4.38
1991-92	278592	1.19
1992-93	282713	1.48
1993-94	294219	4.07
1994-95	294212	0

From TABLE 1, we can see that participants' amount statistics are during year 1981-1995. Due to reference information is limited, so, we take TABLE 1 data as prediction evidence.

China previous national universities students athletics championships participation athletes and participants amount changing rate data sources are from the article " China universities competitive sports development research", contents are as TABLE 2 shows.

TABLE 2 : Previous national university students' athletics championships participation status

Time	Session	Number of participation athletes	Changing rate
1991	1	516	
1993	2	776	50.39%
1994	3	862	9.98%
1995	4	870	0.92%
1997	5	1002	13.17%
1998	6	985	-1.73%
1999	7	1150	14.35%
2001	8	1516	24.14%

From TABLE 2, we can see that number of participants' statistics is during year 1991-2001. Due to reference information is limited, so, we use TABLE 2 data as prediction evidence.

Grey model

Grey system $GM(1,1)$ model is according to known lots of data, ranking these data according to time, fitting according to differential equations to draw near time sequence described dynamic process, by parity of reasoning, arriving at prediction target value. Such fitting method obtained model is time sequence one order differential equation.

Grey model contains two concepts that are respectively, AGO and $IAGO$.

(1) $1-AGO$ represents accumulated generating operation number,it refers to one time accumulated generating operation. Record original sequence as:

$$X^{(0)}=\left\{X^{(0)}(1),X^{(0)}(2),\cdots,X^{(0)}(n)\right\} \quad \textbf{(1)}$$

One time accumulated generating operation sequence is:

$$X^{(1)}=\left\{X^{(1)}(1),X^{(1)}(2),\cdots,X^{(1)}(n)\right\} \quad \textbf{(2)}$$

Among them,

$$x^{(1)}(k)=\sum_{i=0}^{k}x^{(0)}(i)=x^{(1)}(k-1)+x^{(0)}(k) \quad \textbf{(3)}$$

(2) $IAGO$ represents inverse accumulated generating operation number,it is inverse operation of accumulated generating operation. Record original sequence as:

$$X^{(1)}=\left\{X^{(1)}(1),X^{(1)}(2),\cdots,X^{(1)}(n)\right\} \quad \textbf{(4)}$$

One time inverse accumulated generating operation sequence is:

$$X^{(0)}=\left\{X^{(0)}(1),X^{(0)}(2),\cdots,X^{(0)}(n)\right\} \quad \textbf{(5)}$$

Among them, $x^{(1)}(0)=0$

$$x^{(0)}(k)=x^{(1)}(k)-x^{(1)}(k-1) \quad \textbf{(6)}$$

$GM(1,1)$ models

It represents one order, one variable grey system model. Use $X^{(0)}$ to repress sequence that needs modeling, $X^{(1)}$ is $X^{(0)}$ $1-AGO$ sequence,then it has:

$$x^{(1)}(k)=\sum_{i=0}^{k}x^{(0)}(i) \quad \textbf{(7)}$$

Regard $Z^{(1)}$ as $X^{(1)}$ adjoining neighborhood mean value $(MEAN)$ generating sequence:

$$z^{(1)}(k)=\frac{x^{(1)}(k)+x^{(1)}(k-1)}{2} \quad \textbf{(8)}$$

Then it can establish grey differential equation:

$$x^{(0)}(k)+az^{(1)}(k)=b \quad \textbf{(9)}$$

Record $\hat{a}=(a,b)^{T}$,then grey differential equations least square estimated parameter sequence meets following formula:

$$\hat{a}=\left(B^{T}B\right)^{-1}B^{T}Y_{n} \quad \textbf{(10)}$$

Among them,

$$B=\begin{bmatrix}-z^{(1)}(2) & 1\\ -z^{(1)}(3) & 1\\ \vdots & \vdots\\ -z^{(1)}(n) & 1\end{bmatrix} \quad \textbf{(11)}$$

$$Y_n = \begin{bmatrix} x^{(1)}(2) \\ x^{(1)}(3) \\ \vdots \\ x^{(1)}(n) \end{bmatrix} \quad (12)$$

Call $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$ as grey differential equation $x^{(0)}(k) + az^{(1)}(k) = b$ whitening equation, is also called silhouette equation.

Based on above analysis, it has following relationships:

(1) Solution of whitening equation $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$ is also called time response equation :

$$\hat{x}^{(1)}(t) = \left(x^{(1)}(0) - \frac{b}{a} \right) e^{-at} + \frac{b}{a} \quad (13)$$

(2) $GM(1,1)$ Grey differential equation $x^{(0)}(k) + az^{(1)}(k) = b$ time response sequence is:

$$\hat{x}^{(1)}(k+1) = \left[x^{(1)}(0) - \frac{b}{a} \right] e^{-ak} + \frac{b}{a}, k = 1,2,\cdots,n \quad (14)$$

(3) Select $x^{(1)}(0) = x^{(0)}(1)$,then:

$$\hat{x}^{(1)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a} \right] e^{-ak} + \frac{b}{a}, k = 1,2,\cdots,n \quad (15)$$

(4) Restore the value and can get:

$$\hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k) \quad (16)$$

Formula (16)is prediction equation.

Ultimate ratio test

Establish participants' amount changing rate time sequence is as following:

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(1), \cdots, x^{(0)}(1))$$

$$= (50.39,9.98,0.92,13.17,1.73,14.35,24.14)$$

Solve ultimate ratio $\lambda(k)$

$$\lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)} \quad (17)$$

$$\lambda = (\lambda(2), \lambda(3), \cdots, \lambda(7))$$

$$= (5.05,10.85,0.07,7.61,0.12,0.59) \quad (18)$$

By (18),it is clear that all ultimate ratios cannot meet dropping in admissible coverage $(e^{-\frac{2}{7+1}}, e^{\frac{2}{7+2}})$,do conversion handling with sequence $x^{(0)}$,the purpose is to let it to drop in admissible coverage. Take constant $c = 200$, make translation conversion

$$y^{(0)}(k) = x^{(0)}(k) + 200, k = 1,2,\cdots,n \quad \textbf{(19)}$$

Then ultimate ratio is:

$$\lambda = (1.19,1.05,0.94,1.08,0.92,0.96) \quad \textbf{(20)}$$

(2) Ultimate ratio judgment

By (20), we can know $\lambda \in (0.78,1.24)$,therefore it can use $y^{(0)}(k)$ to make $GM(1,1)$ model prediction.

$GM(1,1)$ modeling

(1) For original data $y^{(0)}$,make one time accumulation, that :

$$y^{(1)} = (50.39,460.37,661.29,874.46,1072.73,1287.08,1511.22)$$

(2) Construct data matrix B and data vector Y :

$$B = \begin{bmatrix} -\frac{1}{2}(y^{(1)}(1) + y^{(1)}(2)) & 1 \\ -\frac{1}{2}(y^{(1)}(2) + y^{(1)}(3)) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(y^{(1)}(6) + y^{(1)}(7)) & 1 \end{bmatrix}, Y = \begin{bmatrix} y^{(0)}(2) \\ y^{(0)}(3) \\ \vdots \\ y^{(0)}(7) \end{bmatrix} \quad \textbf{(21)}$$

(3) Calculate $\hat{u}$

$$\hat{u} = (a,b)^T = (B^T B)^{-1} B^T Y = \begin{pmatrix} -0.0133 \\ 198.4947 \end{pmatrix} \quad \textbf{(22)}$$

Then, it has $a = -0.0133$, $b = 198.4947$ 。

(4) Establish models

$$\frac{dy^{(1)}}{dt} - 0.0133y^{(1)} = 198.4947 \quad \textbf{(23)}$$

It solves:

$$y^{(1)}(k+1) = (y^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a} = -14924.4 + 15174.79e^{-0.133k} \quad \textbf{(24)}$$

(5) Solve generating sequence value $\hat{y}^{(1)}(k+1)$ and model restoring value $\hat{y}^{(0)}(k+1)$:

Let $k = 1,2,3,4,5,6$,by formula (24), it can calculate and get $\hat{y}^{(1)}$, from which it gets:

$$\hat{y}^{(1)}(1) = \hat{y}^{(0)}(1) = y^{(0)}(1) = 250.39 \quad \textbf{(25)}$$

According to $\hat{y}^{(0)}(k) = \hat{y}^{(1)}(k) - \hat{y}^{(0)}(k-1)$,take $k = 2,3,4,\cdots 7$,it can get:

$$\hat{y}^{(0)} = (\hat{y}^{(0)}(1), \hat{y}^{(0)}(2), \cdots \hat{y}^{(0)}(7)) = (250.3900\ \ 203.1874\ \ 205.9162\ \ 208.6817\ \ 211.4843\ \ 214.3246\ \ 217.2030)$$

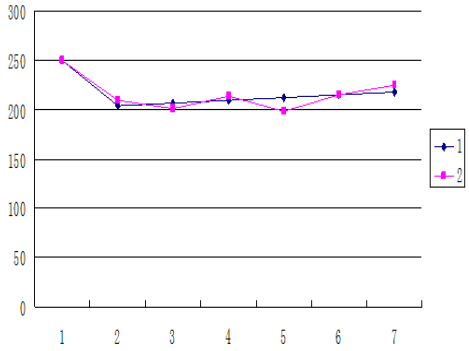

Figure 1 : Comparison chart of predicted and actual values

From Figure 1, we can see that carry out comparison between prediction model obtained result and practical result, we find broken line "1(prediction result) and broken line"2" (actual result) are basically consistent, and then, it also indicates prediction model has rationality.

Grey prediction model establishment can implement by mathematical software Matlab program. Targeted at NCAA championships participants amount and participants amount changing rate, and China previous national universities students' athletics championships athletes amount, it establishes grey prediction model.

(1) Use TABLE 1 China and America NCAA championships participants amount item as $x^{(0)}$

$$x^{(0)} = (254849,268457,286508,288629,277201,264662,268700,263745,275305,278592,282713,294219)$$

By calculating, it can get:

$$x^{(0)}(k) = -1.03598 \times 10^8 + 1.30853 \times 10^8 e^{0.0026k} \quad \textbf{(26)}$$

(2) Use TABLE 1 China and America NCAA championships participants amount changing rate item as $x^{(0)}$:

$$x^{(0)} = (10.11,5.34,6.72,0.74,-3.96,-4.52,1.53,-1.84,4.38,1.19,1.48)$$

By calculating, it can get:

$$x^{(0)}(k) = 21.7471 - 11.6371 e^{-0.278937k} \quad \textbf{(27)}$$

(3) Use TABLE 2 China national universities students' athletics championships participation amount item as $x^{(0)}$:

$$x^{(0)} = (516,776,862,870,1002,985,1150,1516)$$

By calculating, it can get:

$$x^{(0)}(k) = -5792.86 + 6308.86 e^{0.107985k} \quad \textbf{(28)}$$

Formula (26)(27)(28) are respectively America NCAA championships participants' amount and participants amount changing rate, as well as China previous national university students athletics championships participation athletes amount prediction model, above three models all pass testing, and meet prediction rationality.

CONCLUSION

Grey prediction method overcomes single data variable unpredictable difficulties. Due to its owned convenience, quickness, it is widely used in every field. The paper applies grey model into predicting Chinese and American universities competitive sports development status, not only predicts from participants amount, but also predicts from participants changing rate. The model establishment process can also be popularized to sports equipment' quantity prediction, sports fields amount prediction and other problems. However, grey model has certain drawbacks, it requires data to meet within certain ranges, and otherwise it needs to adjust. The paper predicts from two aspects on China and America two countries' universities competitive sports conditions, obtained four prediction models all have rationality. In future relative problems research, the four models can provide certain reference values.

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