Olympic Medals: Does The Past Predict The Future?

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Abstract. With the United States retain its position as the top medal-winning nation at last year's Olympic Games in Rio, the most greatly desirable event came to the end. Is the result the same as your expectation? Is it possible to predict how many medals each nation will win? And what is it about a nation that allows it to produce Olympic medal-winning athletes? Even though the performances of individual athletes can vary unpredictably, we reasoned, there might be an overall relationship between a country's fundamental characteristics (its size and amount of wealth, for instance) and the number of medals it would likely take home. First, considering the past Olympic success, we developed a factor model with its weight in achievement of Games calculated by Grey Prediction Model. Based on this model, we chose china for further analysis and found that there is a link between them but not obvious.

1. Introduction

Olympics, hold once every four years, are currently the world's most influential sports event. In the Olympic Games, countries exchange cultures and swap experience and skills. The aim is to encourage people to keep on sport. [1] During the Olympic Games, medal table attracts world attention. The Rio Olympics have come to the end, and of one thing we can be confident - the US and China showed their powerful actual strength once more. But why are they always so successful? And can we predict which other countries will do well the next Olympics? [2]

If we look at the medal counts for the two most recent Olympic Games (see Table 1), we see that the top two nations are the U.S. and China, who happen to be the 3rd and 1st most populous nations in the world. So population seems to be important. But where is India, the world's second most populous nation? Maybe wealth is the key factor. That seems to fit. A lot of the nations at the top of the list are the wealthier nations of the world. But how did Cuba and Belarus rank so high? As we think more and more about it, it quickly becomes clear that the why's behind the medal counts at the Olympics are complex.

Table 1 Olympic medals

Rank	Nation	Olympic Medals 2004	Olympic Medals 2008
1	United States	103	110
2	China	63	100
3	Russia	92	72
4	United Kingdom	30	47
5	Australia	49	46
6	Germany	49	41
7	France	33	40
8	Korea, South	30	31
9	Italy	32	28
10	Ukraine	23	27
11	Japan	37	25
12	Cuba	27	24
13	Belarus	15	19
14	Canada	12	18
15	Spain	19	18
...	....		

In order to make the prediction more accurate, we first discuss laterally the historical results influence of Olympic Games. Then take Chinese as an example to analyze the influence

1.1 Symbol Description

Symbol	Description
$x^{(0)}$	The original sequence of the amount predicted by the model.
$\hat{x}^{(0)}$	The prediction of the amount of simulated sequence
x(0,0)	Observation series
a	Development of gray scale
u	Endogenous gray level
Δ	Average relative error
$\varepsilon(0)$	Residual series
$\varepsilon(k)$	relative error
C	Posterior difference ratio
Y	Olympic medals
y	Winning rate
P	probability of small error
R^2	determinant coefficient

2. Model

In this section, we construct a model capable of analyzing the factors that influence Olympic medal.

2.1 Historical Achievements Model

First, we approached the problem by building a factor model with its weight calculated by grey Relational Analysis.

2.1.1 Model Introduction

Gray Prediction Theory, based on the Gray System Theory, established by Chinese Scholar Professor Deng Julong in 1982, is a new method to solve the problems that are lack of data and information. It is widely used in random and orderly gray forecasting process, thus to find its potential patterns. [3] In this paper, based on the available data and uncertain information, the gray prediction method established a GM(1,1) model from the past extended to the future, in order to determine the trend of system development and provide the basis for projecting and policy-making. The randomness is weakened and the uncertainty is enhanced in the grey prediction model, as predicting the number on the size of time series. Meanwhile, at a deeper level, solve the function, Based on which, the prediction sequence is established and the prediction model is first-order differential equations.

Set X (0,0) as the raw data sequence, and

$$x^{(0)} = \left\{x^{(0)}(1), x^{(0)}(2), \ldots x^{(0)}(n)\right\} \tag{1}$$

Using 1-AGO to generate a first order cumulative generation sequence

$$x^{(1)} = \left\{x^{(1)}(1), x^{(1)}(2), \ldots x^{(1)}(n)\right\}, \tag{2}$$

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i) \tag{3}$$

The differential equation is established for the generation sequence $x^{(1)}(k)$

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = u \tag{4}$$

a stand for development of gray scale

u stand for endogenous gray level

We can estimate the parameter a, u by the least square method, construct the data matrix B and vector Y as follow:

$$\hat{x}^{(1)}(k+1)=(x^{(0)}(1)-\frac{u}{a})e^{-ak}+\frac{u}{a} \tag{5}$$

The $\hat{x}^{(1)}$ were down reduction from the original series fitting sequence

$$\hat{x}^{(0)}(k+1)=(x^{(0)}(1)-\frac{u}{a})(1-e^{a})e^{-ak} \tag{6}$$

2.1.2 Assumption

Based on this model, we chose china for further analysis. First we discuss the possible relevance between history records and this time. Hypothesizing that for a long time, the number of Chinese participants in Olympic Games will not make a larger change.

2.1.3 Analysis and results

Take the recent eight (25th, 26th, 27th, 28th, and 29th) Summer Olympic Games medals results as the object. The table below is the data we can compile.

Table 2 Olympic medals and medals in China

China	1988	1992	1996	2000	2004	2008	2012	2016
medals	28	54	50	59	63	100	87	70
ranking	11	4	4	3	2	1	2	3
percentage	0.0387	0.0698	0.0615	0.0653	0.0695	0.1104	0.0960	0.0772

Winning percentage=the number of medals/total medals

We can get the raw data sequence from Table 1 as follow:

$x^{(0)}=\{0.0387 \quad 0.0698 \quad 0.0615 \quad 0.0653 \quad 0.0695 \quad 0.1104 \quad 0.0960 \quad 0.0772\}$

Using grey system prediction model, the obtained fitting sequence equation is

$$x^{(1)}(k+1)=\left(x^{(0)}(1)-\frac{0.0610}{-0.0595}\right)e^{0.0595k}+\frac{0.0610}{-0.0595} \tag{7}$$

$$x^{(0)}(k+1)=x^{(1)}(k+1)x^{(1)}(k) \tag{8}$$

$$x^{(1)}(k+1)=\left(x^{(0)}(1)-\frac{0.0610}{-0.0595}\right)e^{0.0595k}-\left(x^{(0)}(1)-\frac{0.0610}{-0.0595}\right)e^{0.0595(k-1)} \tag{9}$$

Based on Grey Prediction, forecasting sequence is:

$x^{(1)}=\{0.0653 \quad 0.0693 \quad 0.0735 \quad 0.0780 \quad 0.0828 \quad 0.0879 \quad 0.0933 \quad 0.0990\}$

The establishment of the GM(1,1) of the gold-medal results of Olympic Games:

Table 3 the result of forecast

china	1988	1992	1996	2000	2004	2008	2012	2016
percentage	0.0387	0.0698	0.0615	0.0653	0.0695	0.1104	0.0960	0.0772
Forecasting percentage	0.0635	0.0693	0.0735	0.0780	0.0828	0.0879	0.0933	0.0990
relative error $\varepsilon(k)$	-0.0248	0.0005	-0.012	-0.0127	-0.0133	0.0225	0.0027	-0.0281

Besides, posterior difference ratio $C=\frac{S_1}{S_2}=0.6260$, Small probability error P=0.75, Correlation degree is 63.29%.

According to the error level:

Table 4 the level of model

grade	relative error q	variance ratio C	Small probability error P
I	<0.01	<0.35	>0.95
II	<0.05	<0.50	<0.80
III	<0.10	<0.65	<0.70
IV	>0.20	>0.80	<0.60

So the model level is 3(Barely qualified), which illustrates, for percentage of medals, the relationship between the history of Olympic Games and the Olympic Games in China this time without considering any other factors is

$$x^{(1)}(k+1) = \left(x^{(0)}(1) - \frac{0.0610}{-0.0595}\right)e^{0.0595k} - \left(x^{(0)}(1) - \frac{0.0610}{-0.0595}\right)e^{0.0595(k-1)} \quad (10)$$

To predict more accurately, other factors need to be taken into account.

3. Conclusion

Numerous factors, ranging from the physical to the political and socioeconomic, affect whether a country performs well during the Olympic Games. Among these are national power, population, economic status, professional capacity (including education and working conditions), political issues, social issues, and so on.

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