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Application of the broken line type nondimensionalization method in mathematical statistics

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ABSTRACT

This paper introduces three nondimensionalization methods, applies these three methods according to college grade comprehensive sort, describes the three methods in detail and finally makes a comparison of these three nondimensionalization methods. By exploring the application of nondimensionalization method in comprehensive evaluation of student achievement and comparing the advantage and disadvantage of traditional sort method and nondimensionalization sort method, this paper makes the briefly comment at the end and points out its development direction.

KEYWORDS

Nondimensionalization; Student achievement; Comprehensive evaluation.



INTRODUCTION

In physics, the export amount was indicated by the product of the power with a certain basic amount, then it can be said the dimension of this physical quantity, or there is a dimension for this physical quantity. It is a formula expressed by the basic physical unit after selecting units. The dimension can be taken the nondimensionalization treatment; the so-called nondimensionalization treatment is simply to exclude units of physical quantity, but only concerned with the relative size of the physical quantities. For example, the number axes had been nondimensionalization treatment, the figures above are concerned with respect 1. The dimension of nondimensionalization is 1, and its value is independent of the choice of units with represented by a pure digital.

In recent years, the nondimensionalization method is also widely used for calculating scores in colleges. The result rating of students is the overall quality assessment, which not only includes academic performance, but also from five aspects that moral, intellectual, physical, aesthetic and labor. The final assessment results were divided into four grades that excellent, good, fair and poor. In order to effectively carry out a comprehensive assessment, to stimulate the students' interest in learning, to create a good school spirit, improve their moral qualities, to provide qualified personnel for socialism, we need an effective persuasive comprehensive evaluation method. In the process, the moral, intellectual, physical, aesthetic and labor achievements are all have dimensions and scalar with unit. In the comprehensive assessment process, the impact of the unit should be excluded, set a reasonable weight value and turning point, take nondimensionalization treatment for data and thus take more intuitive assessment of the overall quality of students.

From a mathematical point of view, nondimensionalization is a functional relationship that determines the evaluation value of index depends on the actual value of index. From the geometric point of view, nondimensionalization method is divided into three categories: linear nondimensionalization method, line type method and curved nondimensionalization method. In this paper, the XX University is the example, which was taken the nondimensionalization treatment of the comprehensive evaluation data in a class in the first half 2011-2012. This paper calculated, compared and made corresponding improvements by these three methods to find a more scientific and rational calculation method.

METHODS INTRODUCTION

The nondimensionalization method can be divided into three categories from a geometric point of view of Yonghong Hu: linear nondimensionalization method, line type method and curved nondimensionalization method. Linear nondimensionalization method includes threshold value method, standardized method and the proportion method; line type nondimensionalization method includes the broken line convex type, the broken line concave type and triple linear method. This article will introduce three methods, which are the standardized approach of linear nondimensionalization method, the three line method of fold broken line type of the nondimensionalization, and make the introduction for the simple normal distribution of curved nondimensionalization method.

Linear type undimensionalization

Linear undimensionalization method is an actually assumption. It assumed that there has a linear correspondence between the actual evaluation value and the evaluation value after the nondimensionalization. The change in the actual evaluation value will cause the linearly proportional change of the evaluation value after nondimensionalization. This method, particularly the standard deviation normalization method in the linear nondimensionalization method will be used often in the comprehensive assessment of the actual work. This standard deviation can compare multiple sets of data with different dimensions and convert these data to the nondimensionalization data according to the assumption of linear relationship to achieve the elimination of the impact of the dimensionless and do evaluation for different sets of nondimensionalization data. Wherein the standardized standard deviation formula is:

$$y_i = \frac{x_i - x/4}{s} (i = 1, \dots, n)$$

Where: $x/4 = \frac{1}{n} \sum_{i=1}^n x_i$

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - x/4)^2}$$

When using the standard deviation standardized methods, we need to pay attention to: the transformed nondimensionalization evaluation value by using of standard deviation standardized method always distributed on both sides of zero. If the actual assessed value is larger than the average of the actual value assessed, the evaluation of nondimensionalization value is positive, if less than, then the evaluation of nondimensionalization value is negative. If the actual value assessment was farther away from the average value, then the evaluation of nondimensionalization value is farther, so result of the evaluation of the nondimensionalization value appears beyond [0,1] interval case, there will be a positive and negative. In this article, in order to better observe the transformed result, the results value will be converted to the form of the percentage, the specific formulas are as follows:

$$y_i = 60 + \frac{x_i - x/4}{10s} * 100$$

$$\Rightarrow y_i = 60 + x_i - x/4 * 10$$

As can be seen from the above equation, the evaluation value will be 60 or more if the actual evaluation value exceeds the mean value of actual evaluation, whereas 60 or less. In addition, there may also be some extreme value which will exceed [0,100] interval. Taking three experimental grades on the 2011-2012 school year semester of A, B two students of XX classes in XX school as the example, as described above, TABLE 1 is to evaluate the quality of professional basis of A, B two students.

TABLE 1 : Evaluate the quality of professional basis of A, B two students

Subjects	Actual scores		All students		Nondimensionalization results	
	A	B	average	Standard deviation	A	B
Ichthyology	86	88	86.42	3.20	58.69	64.94
Biochemistry	80	76	81.0	2.94	56.60	42.99
Aquatic organisms	96	98	87.38	6.44	73.39	76.49
Totals	262	262	/	/	188.67	184.42

As to the actual work, you can use the standard deviation formula in excel software to make the standardization calculation of data. As can be seen from the above table, the ichthyology score of A and biochemical experimental scores of A and B are below the average scores, the standardized scores of three scores are lower than 60. Other scores of A and B are above the average scores, and then the values were above 60 after standardization. In the above table, the total actual scores of A and B are same, but the score of A is higher than B after standardization. Thus different processing methods on the actual fraction, the evaluation result will not be same.

In reality, different papers have different degree of difficulty. When marking schemes, the marking scales of teachers are not same necessarily. Therefore, the gold content of scores will be

inconsistent. When directly sum the results will inevitably lead to a not accurate comprehensive evaluation. In addition, the nondimensionalization method by using standard deviation of standardized methods will be feasible only with sufficient number of sample data and normal distribution. If some subjects showed a normal distribution, while other subjects not, then the same standard linear will result in different percentages levels, the results will not be accurate. So nondimensionalization treatment is not enough with just linear type nondimensionalization, which also need line type or curve type methods to complement each other, so that the different distributions of scores can be compared summed.

Broken line type nondimensionalization

Relative to the simple and intuitive of linear type nondimensionalization methods, the broken line type nondimensionalization often faced with more complex situations. The linear type undimensionalization is actually assumes a linear relationship between the actual evaluation and nondimensionalization assessment, which exhibits a linear change. The actual evaluation value of broken line type nondimensionalization will be different when faced different conditions, such as the actual evaluation value will be subject to different levels and different regions. Another example, make the nondimensionalizationwith standard deviation standardized method of a student's score, then the data are summed with the other, which is same to express from 50 to 60 and from 80 to 90, since both are the same increase. But in fact, from 80 points to 90 points is much more difficult than 50 points to 60 points. Therefore, in this case, it is necessary to adopt broken line type undimensionalization to take segment processing.

The characteristics of broken line type nondimensionalization method is to determine the actual assessment of the value of the different stages of transition and the value of the nondimensionalization post according to a turning point in the development. The broken line type undimensionalization is not the same with linear type, the difference is that you must find out the actual value of the turning point and determine its nondimensionalization value of broken line type. The more commonly used methods of broken line type undimensionalization are three types: convex broken line type, concave broken line type, three fold line and so on.

In order to make a more intuitive understanding of broken line type nondimensionalization approach, we exemplify. As to the comprehensive assessment approach in XX School, grades are the averages of compulsory and optional scores; the weight of academic in the comprehensive assessment is 60. Below are all the results of average scores and nondimensionalization points after assessment of X and Y two students, all grades converted according to the following rules:

$$y_i = m_1 + (m_2 - m_1) * \frac{x_i - x_i^{\min}}{x_i^{\max} - x_i^{\min}}$$

In the above formula: m_1 is the interval x_i corresponding nondimensionalization value y_i of lower limit value;

m_2 is the interval x_i corresponding nondimensionalization value y_i of upper limit value

x_i^{\min} is the lower limit value of the actual assessment value range of the interval x_i

x_i^{\max} is the upper limit value of the actual assessment value range of the interval x_i

When x_i in(85, 100), then y_i in(52.5, 60); when x_i in(75, 85) , then y_i in(40.5, 52.5) ; when x_i in(60, 70) , then y_i in(28.5, 40.5); when x_i in(0, 60), then y_i in(0, 28.5).

When x_i belongs to a different range of interval, then the corresponding y_i will belongs to a different range of interval. In different ranges of interval, actual assessed values will be different with the increasing amount of value after the nondimensionalization. When x_i less than 60, the ratio of y_i and x_i is 0.475 ; when x_i stays from 60 to 75, the ratio of y_i and x_i is 0.8 ; when x_i stays from 75 to 85, the ratio of y_i and x_i is 1.2; when the x_i stays from 85 to 100, the ratio of y_i and x_i is 0.5.

The above method is also called regional linear transformation; such rules explained that different levels of academic performance need different effort in the learning process. For example, the effort from 50 to 60 is different with that from 80 to 90, so the dimensionless values are not the same.

Through the above examples, it can be found that mansard nondimensionalization is more in line with the development of things than the linear nondimensionalization method. However, the mansard nondimensionalization is more complex than the linear nondimensionalization method, which requires the deep understanding of property that need evaluation of evaluation object for the evaluation designer, and can reasonably determine a turning point in the evaluation values process.

Curvilinear undimensionalization

Despite the straight line and polyline undimensionalization, there is a special non-dimensional way, which is curvilinear undimensionalization. In practice, the developments of things are not necessarily linear or mansard, the demarcation points of the various stages of development are not obvious. The actual value and the dimensionless value are not in accordance with the linear scale changes, which may show some kinds of curve changes. In curvilinear dimensionless equations, the more common one is the transformation of positive state. The normalized transform is a nonlinear transformation, its transformation has nothing to do with the actual value of morphological, the transformed data are showing the standard normal distribution, and transformed scores are called normalized standard scores. The position of actual value in the whole can be observed by this kind of standards scores. Its transformation steps are as follows:

Step one: sort the actual value and find the corresponding percentage of the actual value of x :

$$P_x = \frac{\text{Number of candidates with less than } X \text{ points}}{\text{Number of candidates}}$$

Step two: query the standard normal distribution table by using percentage, you can get the normalized standard score z of each score, then

$$p_x = \int_{-\infty}^{z_x} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dx$$

Making the corresponding percentage of each actual value x multiplied by 100 to obtain the percentile rank score of that subject. The so-called percentile rank score, in fact, is a rank of certain actual score in a group, which somewhat similar to the criteria points of the college entrance previous years. Compared with the actual scores, the normalized standard scores follow the normal distribution; it can glance to see the relative position of the actual score.

In the above formula of the step two, the calculated scores z , in order to avoid z appear decimal places, we will carry out a transformation for the z based on the linear transformation and get the derived score of z . The derived score is also called T score, which may also be called non-linear T scores. T scores are specifically normal standard scores with an average of 50 and a standard deviation of the 10, T's formula is as follows:

$$T = 10z + 50$$

According to the above formula, calculated all the scores of each student, if it is assumed that the heavy weights of all courses are the same, and then the result will be calculated for each subject T scores are added, and then sort these scores. Based on the percentage that student of total number of students and calculated the total score T for each student, then you can take the compare.

VERIFICATION OF PRACTICAL APPLICATION

The application of comprehensive evaluation with nondimensionalization method described in this paper will take the calculation of the performances of first half of the 2011-2012 school year of XX class of XX College in XX University to verify the superiority of non-dimensional approach. Making the statistics of the totaling 26 student achievement scores of XX class, the scores were sorted from high to low first, and then calculate the percentage of students with below the original scores duty ratio. It followed by the normal form of the percentage grade, and then converted the score to non-linear T scores. Finally, the integrated results will be obtained by adding the T scores, the comprehensive results are sorted according to size and the last sort is reflected the overall level of students.

For more intuitive description, the comprehensive evaluation data by traditional calculation method and the nondimensionalization method were attached to compare shown as TABLE 2:

Student ID	Nondimensionalized overall score	Order after nondimensionalization	The traditional sense of overall score	The sort of traditional sense
1	54	9	46.76	10
2	68	1	52.82	1
3	40	22	41.79	21
4	49	14	43.81	16
5	60	4	49.4	4
6	45	18	41.73	22
7	43	20	43.31	18
8	36	24	38.77	25
9	51	12	44.82	14
10	56	7	47.58	7
11	46	17	43.64	17
12	52	11	47.36	8
13	50	13	44.84	13
14	47	16	44.43	15
15	62	3	50.44	3
16	32	25	40.94	23
17	38	23	40.49	24
18	57	6	47.84	6
19	10	26	35.53	26
20	41	21	42.13	19
21	48	15	45.61	12
22	55	8	46.93	9
23	44	19	51.87	20
24	53	10	46.07	11
25	59	5	48.30	5
26	64	2	52.12	2

As can be seen from the table, during the two process ways for results, compared to dimensionless and traditional method, there are 10 people whose the sort results did not change, there are 8 students whose grades forward, another 8 students whose sort results back. The reason is the different setting of weight. In the students' comprehensive quality assessment, there are some indicators to be called qualitative indicators, which also known as subjective indicators, such as political attitudes, ethics, collective sense of honor and so on. Under different conditions, different indicators should have different weights. The resulting score rankings by dimensionless treatment as described above can not

only make dimensionless data achieve comprehensive evaluation requirements, but also means the position of each subject score of each student in overall, this approach is more science and rationality.

SUMMARY

When conducting dimensionless, we should as much as possible to select the method suited for the nature of the discuss object to suitable, cannot just choose a method without consider them. Of course, you can choose several methods and then make the analysis of results produced by different undimensionalization methods. In practice, the more complex approach is not better necessary; the key is to determine whether the method can meet practical requirements. Under this context, it should be said that the more simple and more convenient way, the more popular.

The advantage of dimensionless is the process of for multiple targets or multiple data. The method with traditional sense, which takes the simple addition of index number and sort, cannot effectively display the actual position of integrated body. The nondimensionalization method can make the comprehensive assessment more accurate and more convincing by imparting the weight by, setting the turning point, setting curve formula and other methods. Therefore, in many cases, non-dimensional treatment of multiple indicators is a very meaningful thing.

However, many research of non-dimensional aspects are to analyze specific issues, which to explore research for more specific sample data. The theory research and methods have universal significance are less, which is the direction of dimensionless study.

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