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Higher education evaluation system based on BP neural network

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Abstract: The main purpose of this paper is to establish a model which can be applied to evaluate the health status of any country's higher education system, First of all, by collecting data, this paper selects 12 basic indexes for modeling. Then we use principal component analysis to reduce the dimension of these 12 indicators, and extracts three as evaluation indicators, which are named as the past achievements of national higher education. Finally we make evaluation rules, and then use BP neural network model to construct higher education health model. We evaluated six countries with three evaluation indicators as raw data to obtain their higher education health grades.

1. Introduction

The development level of higher education is an important symbol of a country's comprehensive national strength and development potential. But with the progress of the popularization of higher education, "Quality" is an unavoidable problem, so how to measure and assess the health status and improve the higher education system in each country? First of all, we select the data indicators and then make principal component analysis on them. Finally we establish the evaluation system based on BP neural network.

2. Modeling readiness

2.1 Indicator screening

In order to evaluate the health status of the higher education system in any country reasonably and comprehensively, our team chose the following indicators:

(1) The past achievements of national higher education.
(2) The current strength of national higher education.
(3) The development potential of national higher education.

2.2 Implementation

2.2.1 Dimensionless

Suppose that there are m index variables for principal component analysis, which are x1,x2,…,xm,There are n evaluation objects, and the value of the j-th index of the i-th evaluation object is aij.The index value aij is transformed into standard index value.

$$\widetilde{aij} = \frac{aij - \mu_j}{s_j}, i = 1,2,\ldots,n; \ j = 1,2,\ldots m \tag{1}$$

2.2.2 Normalization

A linear transformation of the raw data is carried out to map it between the [0,1], and the specific formula is:

$$M' = \frac{M - min}{max - min} \tag{2}$$

Where M represents the original value of the data, M' represents the normalized data self, max represents the maximum value of the sample, min represents the minimum value of the sample [1].

2.3 Principal component analysis

(1) The eigenvalues and eigenvectors are calculated

The eigenvalues of correlation coefficient matrix R are calculated λ1≥λ2≥…λm≥0, and the corresponding eigenvectors μ1, μ2, …, μm, Where is:

$$\mu_j = [\mu_{1j}, \mu_{2j}, \ldots, \mu_{mj}] \tag{3}$$

m new index vectors are composed of eigenvectors;

$$y_1 = \mu_{11}\widetilde{X_1} + \mu_{21}\widetilde{X_2} + \cdots + \mu_{m1}\widetilde{X_m} \tag{4}$$

$$y_2 = \mu_{12}\widetilde{X_1} + \mu_{22}\widetilde{X_2} + \ldots + \mu_{m2}\widetilde{X_m} \tag{5}$$

$$y_m = \mu_{1m}\widetilde{X_1} + \mu_{2m}\widetilde{X_2} + \ldots + \mu_{mm}\widetilde{X_m} \tag{6}$$

Inside, y_1 is the first principal component, y_2 is the second principal component, y_m is the m-th principal component.

(2) p(p<=m) principal components were selected to calculate the comprehensive evaluation value.

The information contribution rate and cumulative contribution rate of eigenvalue λj(j=1,2, ..., m) are calculated.The information contribution rate of the main component y_j called:

$$b_j = \frac{\lambda_j}{\sum_{k=1}^{m} \lambda_k}, j = 1,2,\ldots,m \tag{7}$$

At the same time,

$$\alpha_p = \frac{\sum_{k=1}^{p} \lambda_k}{\sum_{k=1}^{m} \lambda_k} \tag{8}$$

Is the cumulative contribution rate of the main component y_1, y_2, …, y_p.

By choosing the first “p” index variables y_1, y_2, …, y_p. as the “p” principal components instead of the original “m” index variables, the “p” principal components can be comprehensively analyzed.

(2) Calculate the comprehensive score:

$$Z = \sum_{j=1}^{p} b_j y_j \tag{9}$$

Among them, b_j is the information contribution rate of the j-th principal component, which can be evaluated according to the comprehensive score.

2.4 Application of Model

The comprehensive score of principal component is obtained by multiplying the score of each component with the contribution rate of principal component after rotation. By applying the principal components to these 12 indexes, the specific expressions are as follows:

Past achievements in national higher education = 0.953y1+ 0.643y2+0.952y3;

The current strength of national higher education
=0.985y4+0.940y5-0.063y6+ 0.974y7+ 0.974y8;

The development potential of national higher education
= 0.784y9-0.843y10+0.847y11-0.491y12;

From the above, through principal component analysis, each index of national higher education is divided into three categories, and the weight of each index in each component is different. It is necessary to establish the expression of calculating each level index according to the above relationship.

3. Establishing evaluation model

According to the three indexes selected before, that is, the historical background of national higher education, the strength of national higher education and the development potential of national higher education, we have established an evaluation system based on BP neural network.

3.1 BP Neural Network Principle

We can find that the BP neural network is a kind of multi-layer neural network with three or more layers. It is characterized by the connection between the adjacent two layers of neurons, the forward signal transmission and the reverse error propagation. A signal is transmitted from the input layer to the hidden layer and the hidden layer to the output layer, but if the desired output is not obtained, the back error propagation will be carried out. The updated network weights and thresholds make the predicted values of the BP neural network output approximate the expected output values [2].

3.2 BP Neural Network Implementation Process

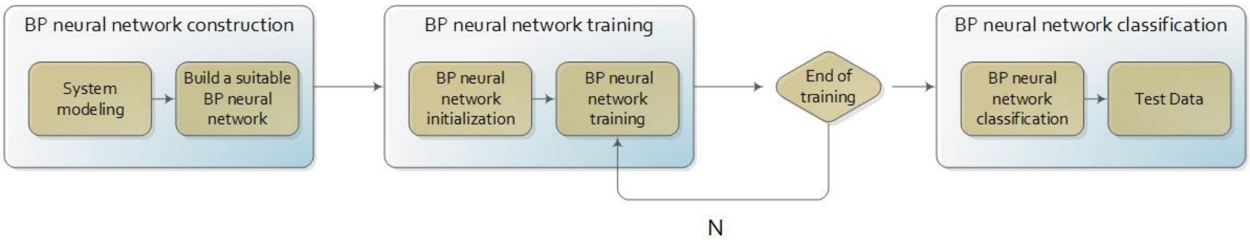

Figure 1: BP neural network implementation process

Except for the 3D input signal, there are five kinds of national higher education health status to be evaluated. Therefore, we have established a BP neural network structure with three nodes in the input layer, five nodes in the hidden layer and one node in the output layer. Based on this, we develop the comprehensive evaluation criteria shown in Table 1:

Table 1: Comprehensive evaluation criteria

Category	Past achievements of national higher education (x)	Current strength of national higher education (y)	The development potential of national higher education (z)
1~2	[-2,-1.29]	[-2.1,-1.39]	[1.4,0.69]
3~4	[-1.28,-0.59]	[-1.38,-0.69]	[0.68,-0.01]
5~6	[-0.58,0.11]	[-0.68,0.01]	[-0.02,-0.71]
7~8	[0.12,0.81]	[0.02,0.71]	[-0.72,-1.41]
9~10	[0.82,1.5]	[0.72,1.4]	[-1.42,-2.1]

3.3 Model result

Table 2: Evaluation results

Country	America	Australia	Germany	Japan	India	South Africa
Grade	9	7	8	6	3	1

By substituting the relevant data of the United States and South Africa into the test, the prediction results are consistent with our expectations. Therefore, the model of national higher education health evaluation is appropriate.

4. Evaluation of the model

4.1 Advantages of model

(1) In establishing the model, the data selected in this paper analyze the health status of global higher education from many angles, countries and levels, so the model is more comprehensive and accurate.

(2) In this paper, the principal component analysis method is used to establish the model, which can eliminate the correlation between the indexes, so the indexes can be selected quickly and conveniently.

4.2 Disadvantages of the model

(1) The world has been affected by the new crown epidemic, so there are many interference factors in the data of higher education in recent years, resulting in inaccurate data.

(2) In principal component analysis, it can be seen that the fitting degree of the model is not very good, so there may be deviations in the selection of our indicators or data sources in the modeling process.

References

[1] Peng Yongjun, Coupling [J]. Between the Evolution of Quality View and the Evaluation of Higher education Jiangsu higher Education 2020(10): 8-15.

[2] Jian Hua Li, Anthony N.Michel, and Wolfgang Porod."Analysis and synthesis of a class neural networks: Linear systems operating on closed hypercube,"IEEE Trans. Circuits Syst. 36(11): 1405-1422, November 1989.