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A Strategic System of Evaluation and Promotion for Higher Education

Hengyi Zhang, Guanyu Zhao

School of Automation and Software Engineering, Shanxi University, Taiyuan, Shanxi 030006, China

Abstract: *The higher education system is an important factor for a country to provide citizens with basic education and continuing education after secondary education. But looking around the world, countries have different methods of higher education, each with its own advantages and disadvantages. Our team decide to develop a model to determine and evaluate the health and sustainability of a country's higher education system. Analyze selected countries and formulate a set of feasible policies to improve the current problems in the national higher education system.*

Keywords: *System of Higher Education, Weighted Rank-Sum Ratio, BP Neural Network, Grey Prediction Method*

1. Introduction

The higher education system is of great value as an industry itself and as a source of trained citizens for the country's economy, and its health and sustainability will largely affect the country's future development level. Looking around the world, there are various ways of higher education in various countries, and the financial investment in education, the level of scientific and technological development and the degree of internationalization of education can objectively reflect the national education level. Each country's higher education system has its strengths and weaknesses. All countries must seize the opportunity of this reform, examine their own characteristics, and make useful changes in education.

2. Summary of References

• **References [2]:** This paper constructs a comprehensive evaluation index of the development level of higher education from two dimensions of scale economy and fiscal revenue and expenditure, and analyzes the development of higher education in the United States. In the process of higher education development, we should correctly understand the phenomenon of unbalanced development, not only optimize the regional layout and promote the construction of high-level universities, but also encourage and strengthen the overall planning and investment of the regional government in the development of higher education.

• **References [3]:** The rank-sum ratio method is used to comprehensively evaluate the medical and health level of several provinces. Experiments have shown that the rank-sum ratio method is simple and easy to use, and it is a statistical method that can meet the practice of China's primary health statistics. It provides theoretical support for the establishment of the evaluation model of this article.

• **References [5]:** Based on economic data, the VAR model is used to formally analyze the relationship between brain drain and per capita GDP, industrial growth rate and living standard. He results show that the brain drain has a complex impact on the life of urban people, which has both positive and negative effects, but the negative effects are dominant.

• **References [6]:** This paper provides the idea of a grey prediction model, which is a truly multidisciplinary and general theory that deals with systems characterized by lack of information and/or lack of information. An improved grey GM (1,1) model is proposed by combining residual correction with artificial neural network symbol estimation.

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3. Evaluation Model

3.1 Determine Indicator Weights

The analytic hierarchy process (AHP) method adopted in this paper is the most widely used method in weight evaluation, which belongs to the relatively subjective method to determine weight. This method is used to calculate the weights of six selected important indexes, aiming to reflect the difference of the relative importance of each index to complete the subsequent numerical analysis and calculation. However, the weight determined by objective method can not completely accord with its importance in practice. In the evaluation of the higher education system, we believe that the selected six indicators have an important impact on the evaluation of the education level. Considering the lack of unified objective standards for the evaluation of higher education system, it belongs to a fuzzy subjective judgment. Therefore, we believe that it is more scientific and reasonable to determine the weight through the subjective analytic hierarchy process.

The judgment matrix based on the evaluation indicators is as follows:

$$\begin{matrix} 1 & 3 & 5 & 1 & 3 & 5 \\ \frac{1}{3} & 1 & 5 & \frac{1}{5} & 3 & 3 \\ [\frac{1}{5} & \frac{1}{5} & 1 & \frac{1}{7} & \frac{1}{3} & \frac{1}{3}] \\ \frac{1}{3} & \frac{1}{3} & 3 & \frac{1}{7} & 1 & 1 \\ \frac{1}{5} & \frac{1}{3} & 3 & \frac{1}{7} & 1 & 1 \end{matrix}$$

According to the calculation results, the weight of each indicator is shown in the Figure 1

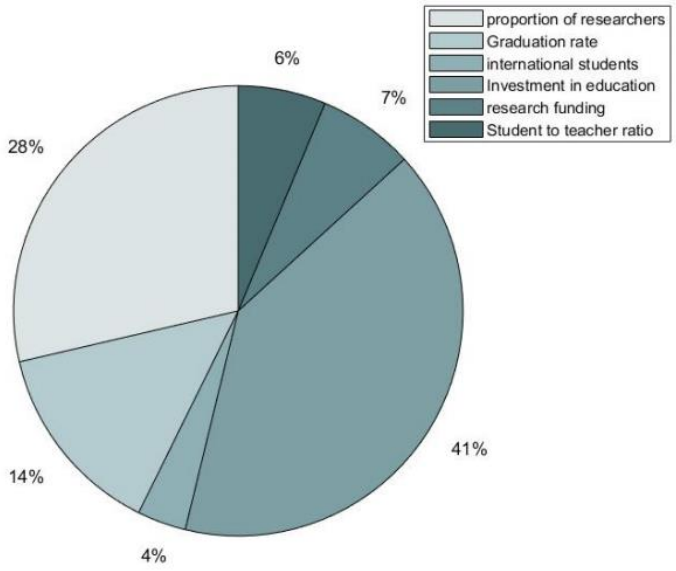

Figure 1: The weight ratio chart of different indicators to the evaluation process

3.2 Calculating Score with WRSR Method

In order to transform existing educational evaluation data into a specific evaluation of higher education system, we combined the weight generated by AHP with the improved RSR method to obtain a higher confidence weighted rank-sum ratio (WRSR).We used the WRSR as the final evaluation score for the country. We use the improved RSR method to evaluate the education situation of each country, and use the weight obtained from the AHP method to solve the deviation problem caused by the diversity of indicator units. The detail can be described by equation (1):

$$WRSR_i = \frac{1}{n}\sum_{j=0}^{m} w_j R_{ij}, i = 1, \dots, n$$

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wj always observe the following equation :

$$\sum_{j=0}^{m} w_j = 1, j = 1, \dots, n$$

The table 1 shows some of our calculations, sorted by their score.We select ten countries with the best higher education levels in the dataset for our presentation.

Table 1: The scores and data for the top ten countries.

Country	F1	F2	F3	F4	F5	F6	WRSR	Rank
Denmark	66.05	2.45	11.65	11229.07	3.06	10.71	0.9452	1
Norway	63.62	2.11	8.49	8776.01	2.07	4.23	0.7512	2
Australia	75.31	1.29	112.84	9169.97	1.87	26.50	0.6016	3
Iceland	61.29	1.85	22.45	9485.84	2.03	8.02	0.7312	4
Switzerland	64.20	1.36	8.43	9668.09	3.37	17.70	0.73	5
Finland	68.47	1.66	19.53	9055.74	2.77	8.05	0.6936	6
France	67.28	1.23	8.66	6945.98	2.20	8.77	0.6068	7
China	53.66	1.33	4.73	3068.99	2.19	0.40	0.5448	8
Vietnam	52.61	1.67	12.55	895.69	0.53	0.24	0.5224	9
Poland	65.39	1.08	15.33	4271.79	1.21	3.64	0.4564	10

4. Building the Models

4.1 Overview

In order to build a universal evaluation model, we use BP neural network to complete the evaluation work. We use the collected data and the calculated WRSR values as the input layer and output layer of the training set respectively. The corresponding data of the other 5 countries were selected as the validation set to judge the fitting effect. The final results show that our evaluation model works well.

4.2 Building Neural Networks

We make a specific description for the higher education evaluation model, so we determine the initial input node n = 6 of the input layer; the number of output nodes m = 1. After many adjustments and parameter comparisons, we set the number of hidden layer nodes to 7.

Sigmoid function (formula 3) is selected as the activation function of the neural network, and xi is regarded as the variable of the input node.

$$f(x) = \frac{1}{1 + e^{-x}}$$

Therefore, we can get the calculation formula of hidden layer's output and output layer's input.

$$h_j = f(\sum_{i=1}^{n} w_{ij}x_i - a_j), j = 1,2, \dots, l$$

$$o_k = \sum_{j=1}^{l} h_j w'_{jk} - b_k, k = 1,2, \dots, m$$

In the process of neural network self-learning, we determine the update function of weight, so that it constantly self-update.

$$w_{ij}(t+1) = w_{ij}(t) + \eta[(1-\beta)D(t) + \beta D(t-1)], i = 1,2, \dots, n$$

$$w'_{ij} = w'_{ij}(t) + \eta[(1-\beta)D'(t) + \beta D'(t-1)], k = 1,2, \dots, m$$

$$D_t = -\frac{\partial L}{\partial w_{ij}(t)}, D'_t = -\frac{\partial L}{\partial w_{jk}(t)}E$$

4.3 Validity of Evaluation

In the environment of MATLAB 2020A, six data of five countries, such as the expenditure and the

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proportion of researchers, are used as the validation set input of the model. The results are shown in the figure below, and the fitting degree of the model to the verification set reaches 94%. It shows that the performance of this training is good and the evaluation result of the national higher education level is more reliable.

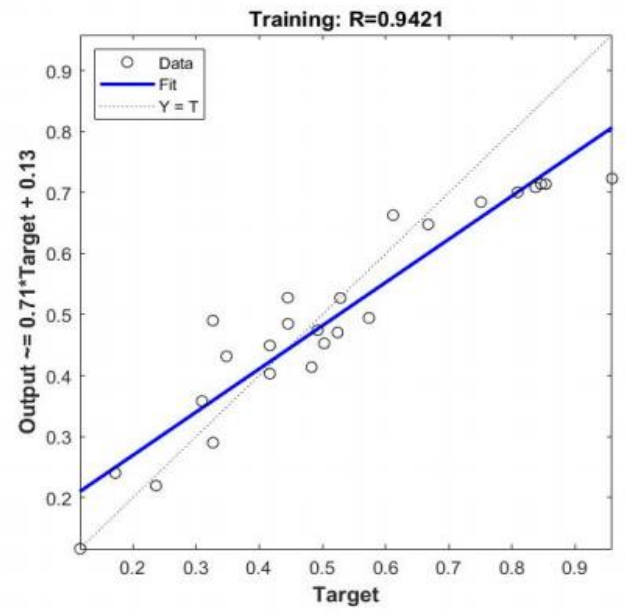

Figure 2: The fitting of the evaluation model

4.4 Assessment

We choose Germany and Thailand, applied our evaluation system, and the final score is as follows: Germany 0.71, Thailand 0.58. It is obvious that higher education in Thailand has more room for development by comparison. Therefore, we choose Thailand as the object of further study.

Table 2: Comparison of evaluation results

Country	F1	F2	F3	F4	F5	F6	WRSR
Germany	40.76	1.25	7.51	8499.99	3.09	9.97	0.7039
Thailand	25.32	2.16	24.64	2003.24	1.00	1.31	0.5946

5. Conclusion

In summary, through a large amount of data search and sorting, we have established a higher education health evaluation model based on data from more than 30 countries. Through a step-by-step optimization model, the implementation of the policy is simulated using gray forecasts, and the simulation results are consistent with the theoretical results. After sensitivity analysis, our model shows strong accuracy and robustness.

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