International Journal of Frontiers in Engineering Technology
ISSN 2706-655X Vol.5, Issue 12: 71-79, DOI: 10.25236/IJFET.2023.051212

Evaluation Model of Study Style Based on Neural Network and TOPSIS

Jianguo Deng*, Yuan Wang

College of Artificial Intelligence, Tianjin University of Science and Technology, Tianjin, 300222, China
**Corresponding author: dengjianguo426@163.com*

Abstract: *Through the establishment of neural network model and weighted TOPSIS comprehensive evaluation model, this paper analyzes the course learning quality of university process assessment. First of all, a descriptive analysis is carried out, the main influencing factors of students' learning attitude are found, and a neural network model reflecting students' attitude is established and verified. Then the study style and class style of colleges and classes are evaluated reasonably by using TOPSIS comprehensive evaluation model, and the weights are calculated and optimized for the second time, and the optimized weights and corresponding scores are obtained. It is found that the three colleges with the best style of study are [308833, 308861, 308882], and the five classes with the best style of study are [16111009, 16111047, 16110895, 16110975, 16110938,16110894].*

Keywords: *Neural network, Gaussian distribution, Entropy method, Coefficient of variation method, TOPSIS comprehensive evaluation analysis*

1. Introduction

The problems to be solved in this study are as follows:

(1) Make a descriptive statistical analysis of the students' curriculum and examination data, then find the representative factors that can reflect the students' learning attitude, and analyze the students' learning attitude through the found factors. And use the given data for verification and analysis.

(2) Based on the extracted factors and known data, an appropriate mathematical model is constructed to evaluate and analyze the study style and class style of the college, and the five classes and three colleges with the best style of study are selected from the data. And explain why the judgment is like this [1-4].

2. Research methods

(1) To make a descriptive analysis of the existing data, its characteristics can be analyzed by calculating the average, standard error, median, multiplicity, standard deviation, maximum and minimum, range, variance, kurtosis, skewness and coefficient of variation of the given data; find several factors that reflect students' learning attitude, and construct a linear regression equation with error disturbance to evaluate students' learning attitude.

Then in the process of determining the weight of each factor, the Gaussian distribution in a certain interval is used to simulate the random change of the weight, and finally the output scatter diagram is fitted to compare the distribution trend to verify the analysis [5-7].

(2) Based on the evaluation and analysis of the study style and class style of the college, a Topsis model with weights can be constructed by using the above selected indicators. The weights of each index can be calculated by entropy method, coefficient of variation method and CRITIC weight method, and the weights obtained can be selected and secondary optimized. The Topsis model is used to calculate the score of each student.

Finally, all the students in each college and class are averaged by arithmetic to get the score of the college and class, so as to select the five classes and three colleges with the best style of study.

ISSN 2706-655X Vol.5, Issue 12: 71-79, DOI: 10.25236/IJFET.2023.051212

3. Results and analysis

3.1 Establishment and solution of students' attitude Model.

3.1.1 Data preprocessing.

(1) If a student has two or more normalized scores, then the average score of the student's normalized score is obtained by dividing the sum of all the student's normalized scores by the number of normalized scores that the student has.

(2) For college code, professional code, class code, course code, class code, class code, class.

The impact of this prominent value on the final result is adverse, so we choose to delete it.

Finally, the number of deleted data items is less than 1000, accounting for less than 0.1% of the total data, so it is reasonable to maintain the authenticity of the data.

3.1.2 Establishment of students' attitude Model.

3.1.2.1 Descriptive analysis model

For descriptive analysis, construct a descriptive analysis model to solve the mean, variance, standard deviation, standard error, range, skewness, kurtosis and coefficient of variation, and make a descriptive analysis of the data according to these indicators.

A quantity that uses averages to represent trends in a set of data, reflecting the average level of a set of samples:

$$Ave = \frac{1}{n}\sum_{i=1}^{n} sam_i \tag{1}$$

Variance and standard deviation are used to reflect the degree of concentration and dispersion, fluctuation and stability of a group of data. The smaller the general standard deviation and variance is, the more concentrated and stable the data is, and vice versa.

$$Var = \frac{1}{n}\sum_{i=1}^{n}(sam_i - Ave)^2 \tag{2}$$

$$SD = \sqrt{Var} \tag{3}$$

The standard error is used to reflect the degree of variation of the sample average to the total average, so as to reflect the size of the sampling error, which is an index to measure the precision of the results.

$$SE = \frac{SD}{\sqrt{n}} \tag{4}$$

Use the range to reflect the degree of discretization of a set of sample data:

$$EP = Max_{sam} - Min_{sam} \tag{5}$$

Where $Max_{sam} = \max(sam_1, sam_2, \dots, sam_n)$， $Min_{sam} = \min(sam_1, sam_2, \dots, sam_n)$

Using skewness to reflect the direction and degree of skewness of statistical data distribution is a numerical feature of the degree of asymmetry of statistical data distribution.

$$Ske = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{sam_i - Ave}{SD}\right)^3 \tag{6}$$

Kurtosis is used to reflect the steepness of the probability distribution of measured random variables:

$$Kur = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{sam_i - Ave}{SD}\right)^4 \tag{7}$$

The coefficient of variation is used to reflect the degree of variation and discretization of the observations in the data.

$$CV = \frac{SD}{Ave} \tag{8}$$

3.1.2.2 Neural network analysis model based on the weight generated by the Gaussian distribution in a certain interval and the disturbance term with error

The neural network model in this paper is shown in figure 1.

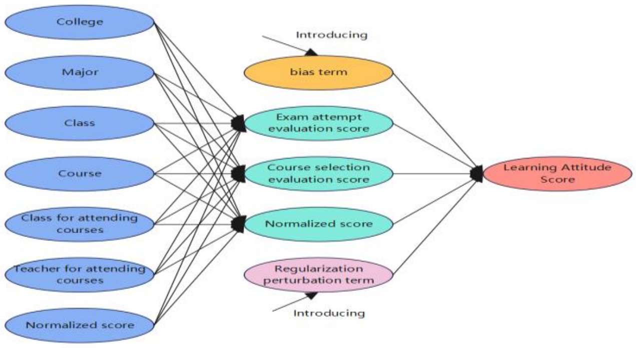

Figure 1: Neural network analysis model

$$LAS = ka^T + e_{LAS} \tag{9}$$

$$k = [k_0, k_1, k_2, k_3], a = [1, a_1, a_2, a_3] \tag{10}$$

$$e_{LAS} = \frac{\lambda}{6}\sum_{i=0}^{3} k_i^2 \tag{11}$$

Where k_0 represents constant coefficient; e_{LAS} represents regularized disturbance term, e_{LAS} disturbs LAS to make it more generalized and representative; the element value (i.e. weight) in vector an is randomly generated in a certain interval by Gaussian distribution (here several groups of experiments are carried out). According to the analysis of students' learning attitude, the characteristics of the given data are analyzed. The normalized score, the evaluation score of the number of selected courses and the evaluation score of examination times are taken as the three main factors, respectively. The corresponding weights are k_1, k_2, k_3, respectively. By introducing the biased term, that is, $k_0 * 1$, introducing the regularized disturbance term and $\frac{\lambda}{6}\sum_{i=0}^{3} k_i^2$, the comprehensive evaluation score of students' learning attitude is calculated. Score 80 to 100 as excellent learning attitude, 60 to 80 as good learning attitude, and below 60 as learning attitude to be improved (Table 1).

Table 1: Analysis of students' learning attitude

Comprehensive evaluation score	Students' learning attitude
80-100	Excellent
60-80	Good
<60	Need to be improved

By using the Gaussian distribution to simulate the change of the weight karma, the expressions of several groups of LAS are obtained, and then 1000 groups of data samples (courses and exams of a thousand students) are randomly selected to calculate their LAS scores under the LAS expression with different weights, draw a scatter chart, and get the same distribution trend, and then verify that the model is reasonable.

3.1.2.3 Solution of students' attitude Model

The descriptive analysis results generated by python programming are as follows (Table 2).

From the results, it can be seen that the average level of students' overall academic achievement is close to 90, and the overall learning level is higher. The standard error is about 0.2, and the variation of the overall data is small. The number of 100 reflects that the number of people whose score is a certain value is at most 100, which reflects the rationality of the teaching test. The standard deviation and variance are relatively small, indicating that there is no serious two-level differentiation in the overall learning state of students. The degree of skewness is about-1.33, which reflects that the skew direction of the data distribution is negative along the x-axis, the degree of skew is small, and the degree of asymmetry of the overall data distribution is small. The kurtosis is about 0.31, which reflects the steepness of the probability distribution of students' learning attitude, and also shows that there is no extreme phenomenon in the overall learning state of students. Different weights are generated by Gaussian distribution, which is introduced into the neural network analysis model to calculate the comprehensive evaluation score of students' learning attitude (Table 3), and draw a scatter diagram (figure 2).

ISSN 2706-655X Vol.5, Issue 12: 71-79, DOI: 10.25236/IJFET.2023.051212

Table 2: Descriptive analysis

Descriptive statistics	
Average	87.48835376
Standard error	0.229841647
Multiplicity	100
Standard deviation	20.87640434
Variance	435.824258
Kurtosis	0.313876623
Skewness	-1.334036219
Minimum value	20
Maximum value	100
Extreme difference	80
Coefficient of variation	0.238619238

Table 3: Comprehensive evaluation scores of students' learning attitude

	k1	k2	k3	k0
Weight value	0.7	0.2	0.1	0.01
	0.75	0.15	0.1	0.02
	0.8	0.1	0.1	0.01
	0.8	0.12	0.08	0.03
	0.75	0.2	0.05	0.04
	0.8	0.15	0.05	0.02

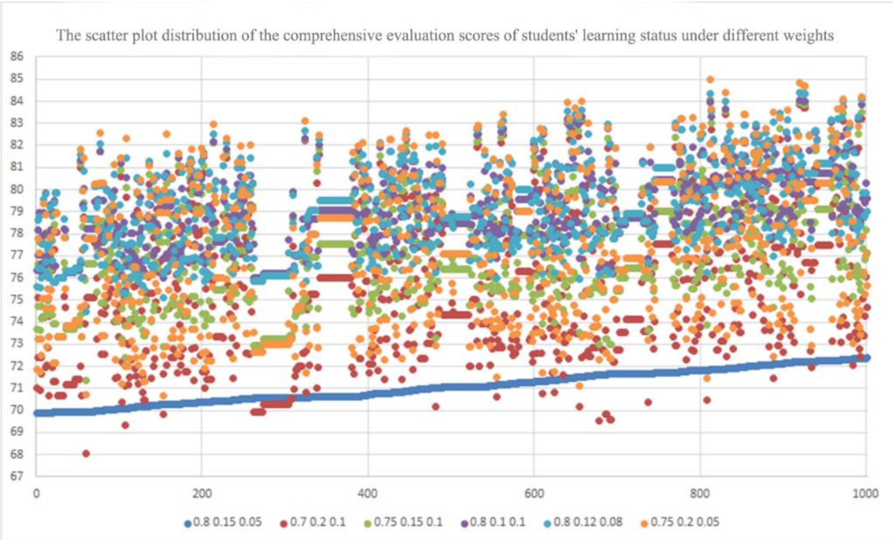

Figure 2: Distribution of scatter plot for comprehensive evaluation of students' learning status under different weights.

From the analysis of Figure 2, we can see that the scatter distribution trend of the output of the model obtained after changing different weights is roughly the same. Therefore, it is verified that the normalized scores of the three factors, the evaluation scores of the number of classes, the evaluation scores of examination times and the established neural network model are reasonable.

3.2 Establishment and solution of the Evaluation Model of College study style and Class style.

3.2.1 Establishment of Topsis model with weights

The extracted factors are the average score of normalized score, the evaluation score of the number of exams and the evaluation score of the number of courses selected. Using the three factors determined in the first question as indicators, a Topsis model with weight is constructed.

3.2.2 Determination of weight

Entropy method, coefficient of variation method and CRITIC weight method are used to get the weight.

(1) Entropy method.

For entropy method, standardize each value to get St_{xi}, St_{yi}, St_{zi} and calculate the weight of the first student of each index:

$$P_{xi} = \frac{St_{xi}}{\sum_j^n St_{xj}} \tag{12}$$

$$P_{yi} = \frac{St_{yi}}{\sum_j^n St_{yj}} \tag{13}$$

$$P_{zi} = \frac{St_{zi}}{\sum_j^n St_{zj}} \tag{14}$$

Then use the entropy value of the index to calculate the formula:

$$H(p) = \sum_{i=1}^n P_i log \frac{1}{P_i} = -\sum_{i=1}^n P_i log P_i \tag{15}$$

In order to facilitate the calculation of the coefficient of variation, the entropy value is often multiplied by a constant K on the basis of this formula.

$$H(p) = -K \sum_{i=1}^n P_i log P_i \tag{16}$$

$$K = \frac{1}{\ln(n)} \tag{17}$$

The entropy values of the three indexes are obtained: Hallelx (p), Hemery (p) and Hemoz (p). Then calculate the coefficient of difference of each student in each indicator:

$$d = 1 - H(p) \tag{18}$$

We get d_x, d_y, d_z.

Finally, the specific weight is calculated:

$$w = \frac{d}{\sum_{j=1}^n d_j} \tag{19}$$

The weights of the three indicators are obtained, and the final results are as follows Table 4.

Table 4: Weights of three indicators

Entropy weight method			
Item	Information entropy value e	Information utility value d	Weight (%)
Average score of normalized score	0.998	0.002	2.166
Evaluation score for the number of exams (%)	0.99	0.01	8.834
Evaluation score on the number of elective courses (%)	0.901	0.099	89

Note: $w_x = 2.116\%, w_y = 8.834\%, w_z = 89\%$.

(2) Coefficient of variation method.

First of all, the actual values of each variable are standardized, and then the weighted average method is used to determine the comprehensive score. The formula for calculating the coefficient of variation of each index is as follows:

$$V_{xi} = \frac{\sigma_i}{x_i} \tag{20}$$

$$V_{yi} = \frac{\sigma_i}{y_i} \tag{21}$$

$$V_{zi} = \frac{\sigma_i}{z_i} \tag{22}$$

In the formula, V_{xi} is the coefficient of variation of the I index, σ _ I is the standard deviation of the I index, and X _ I is the arithmetic mean value of the I index.

Finally, the weight of each index is calculated:

$$w = \frac{V_i}{\sum_{i=1}^n V_i} \tag{23}$$

The following results are obtained in Table 5:

ISSN 2706-655X Vol.5, Issue 12: 71-79, DOI: 10.25236/IJFET.2023.051212

Table 5: Weight of each indicator

Item	Average value	Mean	CV	Weight (%)
Average score of normalized score	0.805	0.159	0.198	10.881
Evaluation score for the number of exams (%)	0.428	0.176	0.412	22.605
Evaluation score on the number of elective courses (%)	0.207	0.25	1.211	66.513

Note: $w_x = 10.881\%, w_y = 22.605\%, w_z = 66.513\%$.

(3) CRITIC weight method.

1) The normalization process is carried out first:

$$x'_i = \frac{x_i - \min(x_i)}{\max(x_i) - \min(x_i)} = \frac{x_i - \min(x_i)}{(\max(x_i) - x_i) + (x_i - \min(x_i))} \tag{24}$$

2) Calculate the variability of indicators (expressed in the form of standard deviation):

$$S' = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} \tag{25}$$

3) Conflict of calculation indicators (expressed in the form of correlation coefficient):

$$R_j = \sum_{i=1}^{n} 1 - r_{ij} \tag{26}$$

R_{ij} is the correlation coefficient between indicators.

4) Calculate the amount of information:

$$C_j = S'R_j \tag{27}$$

5) Calculate the weight:

$$w = \frac{C_j}{\sum_{j=1}^{n} C_j} \tag{28}$$

The results are shown in Table 6 below:

Table 6: CRITIC weights

Item	Index variability	Index conflict	information content	Weight (%))
Average score of normalized score	0.159	2.137	0.341	27.975
Evaluation score for the number of exams (%)	0.176	1.948	0.344	28.222
Evaluation score on the number of elective courses (%)	0.25	2.13	0.533	43.803

Note: $w_x = 27.975\%, w_y = 28.222\%, w_z = 43.803\%$.

(4) The secondary treatment of weights.

Comparing the weights obtained by the above three methods, we can see that the CRITIC weight method is more in line with the actual situation, because in the actual situation, the average score can better show the students' learning attitude.

So multiply the subjective weights given in the first question ($w_x{}' = 80\%, w_y{}' = 15\%,\ w_z{}' = 5\%$) with the weights obtained in the previous step ($w_x{}'' = 27.975\%,\ w_y{}'' = 28.222\%,\ w_z{}'' = 43.803\%$) and normalize them:

$$W = w_x{}'w_x{}'' + w_y{}'w_y{}'' + w_z{}'w_z{}'' \tag{29}$$

$$w_x = \frac{w_x{}'w_x{}''}{W} = 77.699\% \tag{30}$$

$$w_y = \frac{w_y{}'w_y{}''}{W} = 14.697\% \tag{31}$$

$$w_z = \frac{w_z{}'w_z{}''}{W} = 7.604\% \tag{32}$$

3.2.3 Establishment of Topsis model

In this model, the three indicators are all very large indicators (benefit index), and the larger the index, the greater the score, so there is no need to make the index positive.

The weight values obtained from the secondary processing by using the CRITIC weight method are

ISSN 2706-655X Vol.5, Issue 12: 71-79, DOI: 10.25236/IJFET.2023.051212

brought into the table to obtain Table 7:

Table 7: Weight values

School number	Average grade point. (after empowerment)	The number of exams to judge the score (weighted)	Evaluation score on the number of elective courses (weighted)
i	$w_x * x_i$	$w_y * y_i$	$w_z * z_i$

(1) Standardization.

In order to eliminate the influence of different index dimensions, the standardized indicators are obtained by standardizing the data in the table.

Grade point average (standardization):

$$X_{1i} = \frac{w_x * x_i}{\sqrt{\sum_{j=1}^{n}(w_x x_j)^2}} \tag{33}$$

Evaluation scores for the number of examinations (standardized):

$$Y_{1i} = \frac{w_y * y_i}{\sqrt{\sum_{j=1}^{n}(w_y y_j)^2}} \tag{34}$$

Evaluation score on the number of elective courses (standardization):

$$Z_{1i} = \frac{w_z * z_i}{\sqrt{\sum_{j=1}^{n}(w_z z_j)^2}} \tag{35}$$

The standardized data are shown in Table 8:

Table 8: Standardized data

School number	Average grade point. (after empowerment)	The number of exams to judge the score (weighted)	Evaluation score on the number of elective courses (weighted)
i	X_{1i}	Y_{1i}	Z_{1i}

(2) Calculate the score.

Find out the average score after standardization, the proportion of examination times, and the maximum and minimum values in the proportion of selected courses: $\max(X_1)$, $\min(X_1)$, $\max(Y_1)$, $\min(Y_1)$, $\max(Z_1)$, $\min(Z_1)$, and normalize them.

Grade point average (normalized):

$$X_{2i} = \frac{X_{1i} - \min(X_1)}{\max(X_1) - \min(X_1)} = \frac{X_{1i} - \min(X_1)}{(\max(X_1) - X_{1i}) + (X_{1i} - \min(X_1))} \tag{36}$$

The number of examinations to judge the score (normalized):

$$Y_{2i} = \frac{Y_{1i} - \min(Y_1)}{\max(Y_1) - \min(Y_1)} = \frac{Y_{1i} - \min(Y_1)}{(\max(Y_1) - Y_{1i}) + (Y_{1i} - \min(Y_1))} \tag{37}$$

Evaluation score on the number of elective courses (normalized):

$$Z_{2i} = \frac{Z_{1i} - \min(Z_1)}{\max(Z_1) - \min(Z_1)} = \frac{Z_{1i} - \min(Z_1)}{(\max(Z_1) - Z_{1i}) + (Z_{1i} - \min(Z_1))} \tag{38}$$

Then find out the maximum and minimum values of each index: $\max(X_2)$, $\min(X_2)$, $\max(Y_2)$, $\min(Y_2)$, $\max(Z_2)$, $\min(Z_2)$, and calculate the Euclidean distance from each student to the maximum point (${D_i}^+$) and the Euclidean distance to the minimum point (${D_i}^-$):

$${D_i}^+ = \sqrt{(\max(X_2) - X_{2i})^2 + (\max(Y_2) - Y_{2i})^2 + (\max(Z_2) - Z_{2i})^2} \tag{39}$$

$${D_i}^- = \sqrt{(X_{2i} - \min(X_2))^2 + (Y_{2i} - \min(Y_2))^2 + (Z_{2i} - \min(Z_2))^2} \tag{40}$$

Finally, the total score is calculated and normalized.

Unnormalized score:

$$s_i = \frac{{D_i}^-}{{D_i}^+ + {D_i}^-} \tag{41}$$

Normalized score:

$$S_i = \frac{s_i}{\sum_{j=1}^{n} s_i} \tag{42}$$

The final score of each student is shown in Table 9:

Table 9: Score of each student

School number	Unnormalized score	Normalized score
i	s_i	S_i

Average the scores of the students of the same college and rank the colleges from large to small, the top three and the three colleges with the best style of study, similarly average the scores of the students in the same class and rank the classes from large to small, the top five and the five classes with the best style of study (Table 10).

Table 10: Scoring results

College code	Unnormalized score	Normalized score
j	s_j	S_j
k	s_k	S_k

3.2.4 Solution of the model

The normalized score of the college is solved by using the model established above, and the results of table 11 below are obtained from large to small.

Table 11: Normalized score of the College

College code	Unnormalized score
308833	0.00016612
308861	0.000129626
308882	0.00012609

It can be concluded that the codes of the top three colleges are 308833, 308861 and 308882, which can be considered as the three colleges with the best style of study.

The above model is used to solve the normalized score of the major, and the following 12 results are obtained from large to small.

Table 12: Normalized scores of majors

Class code	Normalized total score
16111009	0.000186131
16111047	0.000181375
16110895	0.000175206
16110975	0.00017074
16110938	0.000170142
16110894	0.000169806

It can be concluded that the top five class codes are 16111009, 16111047, 16110895, 16110975, 16110938, 16110894, which can be considered as the five classes with the best style of study.

4. Conclusion

This paper studies the evaluation of curriculum learning quality of university process assessment, and evaluates students' learning attitude, college study style and class style by establishing neural network model and weighted TOPSIS comprehensive evaluation model. For the students' learning attitude, a descriptive analysis is carried out and a neural network model reflecting the students' attitude is established, and the verification results of the scatter plot of the model output are obtained through verification analysis. The results show that the three colleges with the best study style are [308833, 308861, 308882], and the five classes with the best class style are [16111009, 16111047, 16110895, 16110975, 16110938, 16110894].

ISSN 2706-655X Vol.5, Issue 12: 71-79, DOI: 10.25236/IJFET.2023.051212

References

[1] Liu Haoran, Tang Shaoliang. Study on the equalization level of basic medical services in Jiangsu Province based on TOPSIS method and rank sum ratio method [J]. Chinese General Medicine, 2016pct 19 (7): 819-823.
[2] Shih H S, Shyur H J, Lee E S. An extension of TOPSIS for group decision making [J]. Mathematical & Computer Modelling, 2007, 45 (7): 801,813.
[3] Jian-Zhong X U , Sun Y .Study on the Environmental Innovation Capability Evaluation Model of Manufacturing Enterprises Based on Entropy Weight TOPSIS-BP Neural Network and Empirical Research[J]. 2018.DOI:10.1109/ICMSE.2018.8745309.
[4] Liu Panpan, Ren Guangyue, Duan continuous, Li Linlin, Zhao Lujie, Ren Xing, Miao Junwei. Evaluation of quality and flavor of white radish with different drying methods based on coefficient of variation method [J/OL]. Food and fermentation Industry: 1-11 [2022-03-31].
[5] Lei Mingfeng, Zhang Yunbo, Qin Guifang, Shi Yuanbo, Gong Chenjie, Zhang Yong, Gao Hongfei. Study on neural network evaluation model of blasting effect of mountain tunnel and optimization decision-making method of blasting parameters [J]. Modern Tunnel Technology, 2023 (02): 54-61.
[6] Jiang Yuansheng. Research on vehicle Sound Insulation quality Evaluation Model based on BP Neural Network [D]. Fujian Institute of Engineering, 2022.
[7] Zhu Yongjun, Wu Qiong, Zhan Zhongyu. Water quality evaluation based on principal component analysis and artificial neural network coupling model [J]. Jiangsu Water Conservancy, 2021 (08): 48-54.