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A Study on Identification and Quantification Strategies of Realistic Dilemmas of Art Education Development in Colleges and Universities Based on Decision Tree Analysis Methods

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ABSTRACT
In recent years, art education in colleges and universities has been more and more emphasized by the state and education departments, and has been comprehensively promoted and developed. The study builds the evaluation index system of art education development and assesses the development of art education in a university in order to identify its realistic dilemma. On this basis, the dung beetle algorithm is used to optimize the random forest algorithm to construct a decision tree assessment model of art education development. Through comparison experiments, the prediction accuracy and stability of the DBO-RF model are confirmed, and the deviation of its assessment results from the real value is below 4%, and the RMSE (12.247), MAE (9.133), and MSE (178.829) are lower than that of the comparison method, and the EV (0.721) and R^2 (0.719) are higher than that of the comparison method, which is applicable to a certain extent. The long-term and overall development of art education in colleges and universities can be promoted by establishing art education mechanisms, strengthening art practice activities, establishing resource sharing channels and developing scientific systems.

Keywords: decision tree, dung beetle algorithm, random forest, evaluation index system, college art education development

1. Introduction

In the early educational activities of human society, art education occupies an important position. In recent years, art education has been widely promoted in China, especially in colleges and universities, where it has gained the attention of education departments [1-2]. As a kind of aesthetic education activity, art education, after the proposed five education concept of comprehensive development of morality, intelligence, physicality, aesthetics and labor, its status has been continuously upgraded in

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the education of all people, and it is also a kind of lifelong education for all people, and it is an important means for all people to discover beauty, appreciate beauty and create beauty [3-5]. As an important part of the student stage, colleges and universities are an important carrier for the development of art education. Art education in colleges and universities is conducive to students to improve their aesthetic level and life quality, so that students become a well-rounded person. At present, the development of art education in colleges and universities significantly forward at the same time, but also faces a lot of practical challenges, which is the current urgent need to solve the problem of realizing the sustainable development of art education is also the direction of the current efforts to move forward [6-8].

The development of art education in colleges and universities in recent years has gradually been attached importance to its important role and significance has been recognized at the national level, which contains the artistic literacy has been in the evaluation of the comprehensive quality of the students as an important investigation index [9-11]. Art education can improve students' appreciation and aesthetic interest, and it has an indispensable role in promoting students to become well-rounded people while cultivating sentiment and aesthetics. Comprehensive development is the call of the times and society to students, students should develop themselves comprehensively through art education, reject the “unidirectional thinking”, avoid becoming a “one-sided person”, and strive to become a comprehensive development of the people needed by the times [12-14].

Although the enrollment of art education majors in colleges and universities has been expanding in recent years, and the achievements have been very obvious, but it also shows some problems, including the quality of teaching in some colleges and universities art education has declined, and the quality of art education majors varies [15-17]. Public art education in colleges and universities should be located in the basic knowledge theory and appreciation methods in public art to students, so that students can better appreciate and judge various art disciplines, not only the accumulation of art knowledge and art skills training, through comprehensive learning, so that students gradually become a person with artistic cultivation, stimulate innovation, entrepreneurship and creativity of college students, and realize sustainable development [18-20]. Art education, as an organic part of quality education, is also an important and effective way to implement aesthetic education [21].

Art education has the unique function of “supporting morality, educating the mind and promoting physical fitness”. In colleges and universities, public art education for ordinary college students is very conducive to improving their personality, cultivating their feelings, honing their will, improving their overall quality, and helping them in their own professional studies. Yongkang, Z elaborated on the problems faced by college art education such as art and culture inheritance, insufficient students' artistic innovation ability, and considered it necessary to further construct the trinity operation mechanism of government-academy-society, and to further improve the mechanism of art education and civic and political co-parenting [22]. Yuan, P. deeply analyzed the role and positioning played by art education in higher vocational colleges and universities, and at the same time unearthed the problems existing in art education and put forward targeted optimization and improvement suggestions [23]. Xiong, L discusses the teaching dilemmas in teaching design, teaching practice, and art teaching assessment of art majors in colleges and universities in the context of the Internet, and emphasizes the enhancement of art online teaching rituals and students' online teaching cognition, which in turn enhances online art teaching students' participation [24]. Li, J focused on the construction and change of Chinese art history teaching materials for art majors in colleges and universities, arguing that there is a need to focus on the shift from the traditional knowledge-infused teaching mode to the research-under-learning mode in order to enhance students' artistic thinking and artistic ability [25]. Sheng, H., & Fang, X empirically analyzed the construction of the education and training system of student art troupes in several higher vocational and technical colleges based on survey, observation, and interview methods, and pointed out that the management of the art troupes' education and training system is not systematic, the quality level of talents is low, and the teachers are limited [26].

In view of the CIPP model, this paper selects the evaluation indexes of art education development in colleges and universities from the four aspects of teaching background, program, process and results, collects data from teachers and students of a college and university by questionnaire survey, obtains the evaluation results of students and teachers on the development of art education, and explores the realistic dilemmas of its development process. A random forest algorithm is used to develop an assessment model for the development of art education in colleges and universities, and the dung beetle algorithm is used to optimize it. A data set is constructed with questionnaire data as input variables and evaluation results as outcome variables to establish a decision tree model for the evaluation of the quality of art education development in colleges and universities, and the Gini coefficient is used as an indicator to obtain the root node of the model and to determine the important influencing factors for the development of art education in colleges and universities. Subsequently, root mean square error, mean square error, mean absolute value error, explained variance, coefficient of determination and other indicators are used to explore the model performance. Finally, the development strategy of art education in colleges and universities is explored according to the conclusions drawn from the analysis of the article.

2. Identification of the Realistic Dilemmas in the Development of Art Education in Higher Educational Institutions

Based on the CIPP model, this chapter constructs an evaluation index system for the development of art education in colleges and universities, and evaluates the development of art education as a means of identifying the realistic dilemmas of the development of art education in colleges and universities, and providing outcome variables for the subsequent evaluation research based on the decision tree analysis method.

2.1. Design of evaluation indicators

2.1.1. Selection of indicators. The CIPP model was adopted to carry out the evaluation of the development quality of art education in colleges and universities, and the teaching evaluation was divided into four stages, namely, the evaluation of the teaching background, the evaluation of the teaching program, the evaluation of the teaching process, and the evaluation of the teaching results. After finishing and analyzing the questionnaire of experts' opinions and consulting, the initially formulated evaluation system of the development quality of college art education was modified, and the finalized evaluation system of the development quality of college art education is shown in Table 1, which determines 4 first-level indexes, 13 second-level indexes, 37 third-level indexes and evaluation standards.

Table 1. The evaluation system of the development quality of the art education

Primary indicator	Secondary indicator	Tertiary index
Teaching background evaluation A1	Course orientation B1	Curriculum philosophy C1
		Talent training target C2
	Course setting B2	Integrity C3
		Coherence C4
		Systematism C5
	Teacher analysis B3	Faculty level C6
		Faculty size C7
	Study affective analysis B4	Cognitive level C8
		Interest demand C9
Evaluation of teaching scheme A2	Teaching target B5	Clarity C10
		Reasonableness C11
		Comprehensiveness C12
		Hierarchy C13
	Teaching scheme B6	Diversity of teaching diversity C14
		Multimedia resource richness C15
		Teaching activity arrangement C16
	Teaching resources B7	Teaching environment C17
		Textbook construction C18
		Budget C19
Teaching process evaluation A3	Teacher teaching process B8	Teaching content expression C20
		Teaching method C21
		Teacher state C22
	Learning process B9	Classroom participation C23
		Learning focus C24
		Student capacity C25
	Classroom organization B10	Managerial ability C26
		Adjustment ability C27
		Situational creativity C28
Evaluation of teaching effect A4	Student accomplishment B11	Master knowledge C29
		Skill improvement C30
		Shape of values C31
	Learning effect B12	Artistic perception C32
		Aesthetic appreciation C33
		Creative expression C34
	Evaluation of teacher development B13	Teaching reflection C35
		Improved teaching ability C36
		Innovative development C37

2.1.2. Indicator weights. According to the hierarchical analysis method, this hierarchical model is set up with three levels of structure, which are the first target level, the second guideline level for four first-level indicators, and the third program level for 13 second-level indicators. According to the established evaluation index system for the development quality of art education in colleges and universities, a consultation questionnaire is designed, which contains the description of each index and the corresponding weighted scoring options, and the 1-9 scale method is used to allow experts to score the relative importance of each index. The product method is used to calculate the indicator weights for the collected data, and the results of the evaluation indicator weights are shown in Figure

1. The indicator weights of teaching background evaluation A1, teaching program evaluation A2, teaching process evaluation A3, and teaching effect evaluation A4 are 0.235, 0.226, 0.254, and 0.285, respectively.Among the second-level indicators, the weights of student literacy enhancement B11, teaching program B6, and learning process B9 are 0.173, 0.160, and 0.142, which are the most heavily weighted second-level indicators.

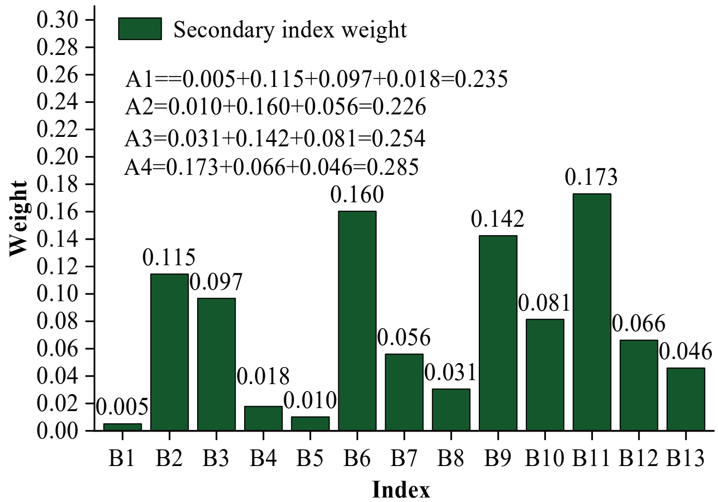


Fig. 1. Evaluation index weight results

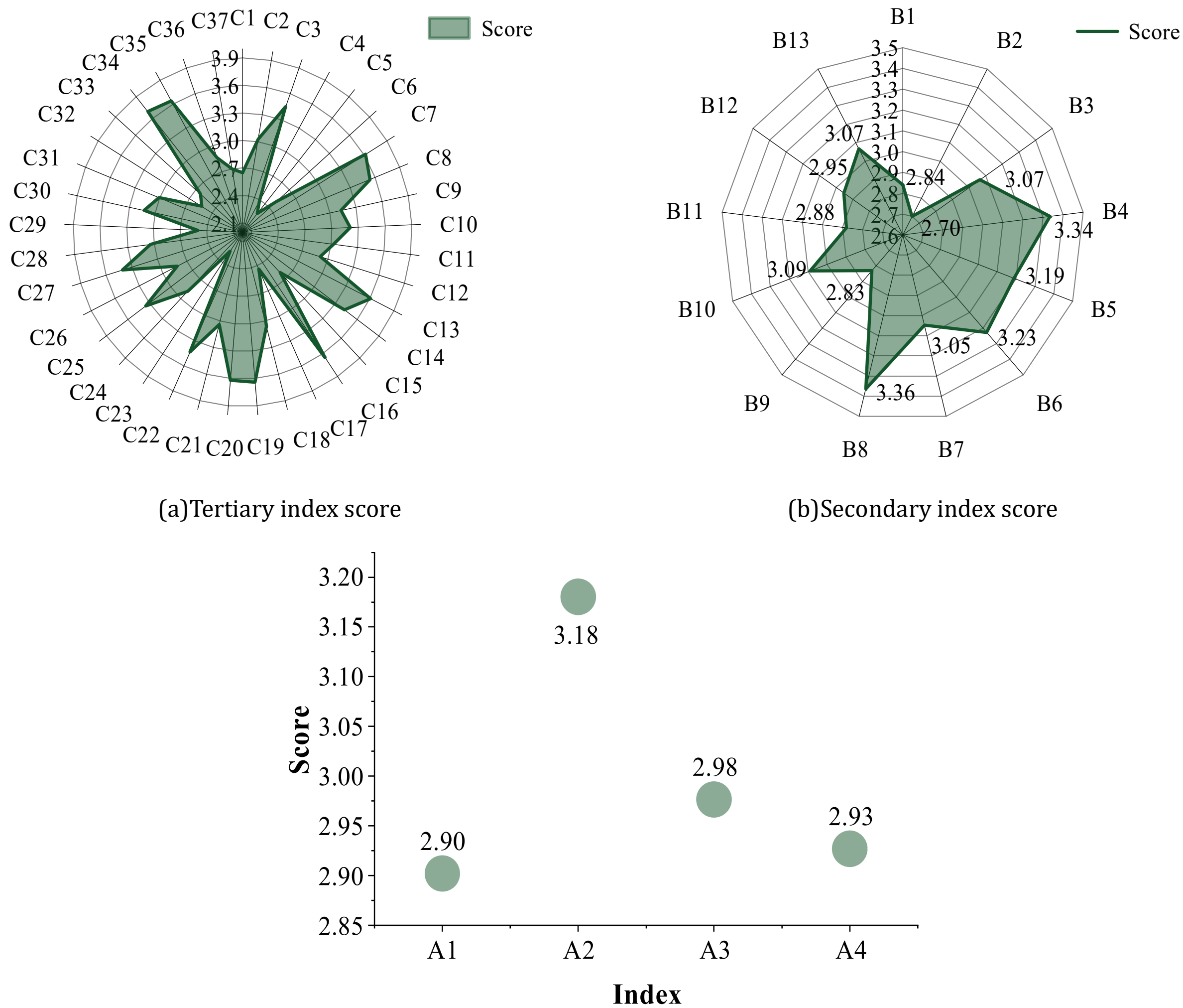
2.2. *Data acquisition*

According to the evaluation system and standards of three-level college art education development constructed above, a questionnaire for evaluating the quality of college art education development was prepared, and the questionnaire was designed using Likert's five-point scale method. The sample objects are students and teachers of four classes of 2023 in a university in a city. A total of 125 student questionnaires and 12 teacher questionnaires were collected. All the scales used Likert's 5-point scale, with the maximum value of 5 and the minimum value of 1. All the scales were such that the higher the score, the higher the corresponding evaluation level.

2.3. *Statistics on evaluation results*

2.3.1. Student evaluation results. The results of the descriptive statistics of the questionnaire were analyzed, and the results of the students' evaluation of the development of art education are shown in Figure 2, with (a)~(c) indicating the scores of the primary, secondary and tertiary indicators. The total score of students' evaluation of the development of art education in the sample colleges and universities is 3.045, of which the lowest score is 2.90 for the evaluation of teaching background, the highest score is 3.18 for the evaluation of teaching program, and the scores of the secondary indicators are 2.70~3.36. It indicates that the overall satisfaction of students with the development of art education in the sample colleges and universities is at a medium level, and that there are still places that need to be improved and optimized in the development of art education.

The evaluation of teaching background has the lowest score, indicating that teachers lack a solid professional foundation, rich educational experience and good teaching resources, and fail to provide students with a good learning environment and conditions. The evaluation of teaching program is the highest, but it is still a big gap from the full score. The possible reasons are that the design of teaching objectives is not reasonable enough, failing to fully consider the actual situation and learning needs of students, or that there are some problems in the implementation of the teaching program that affect the development of art education.



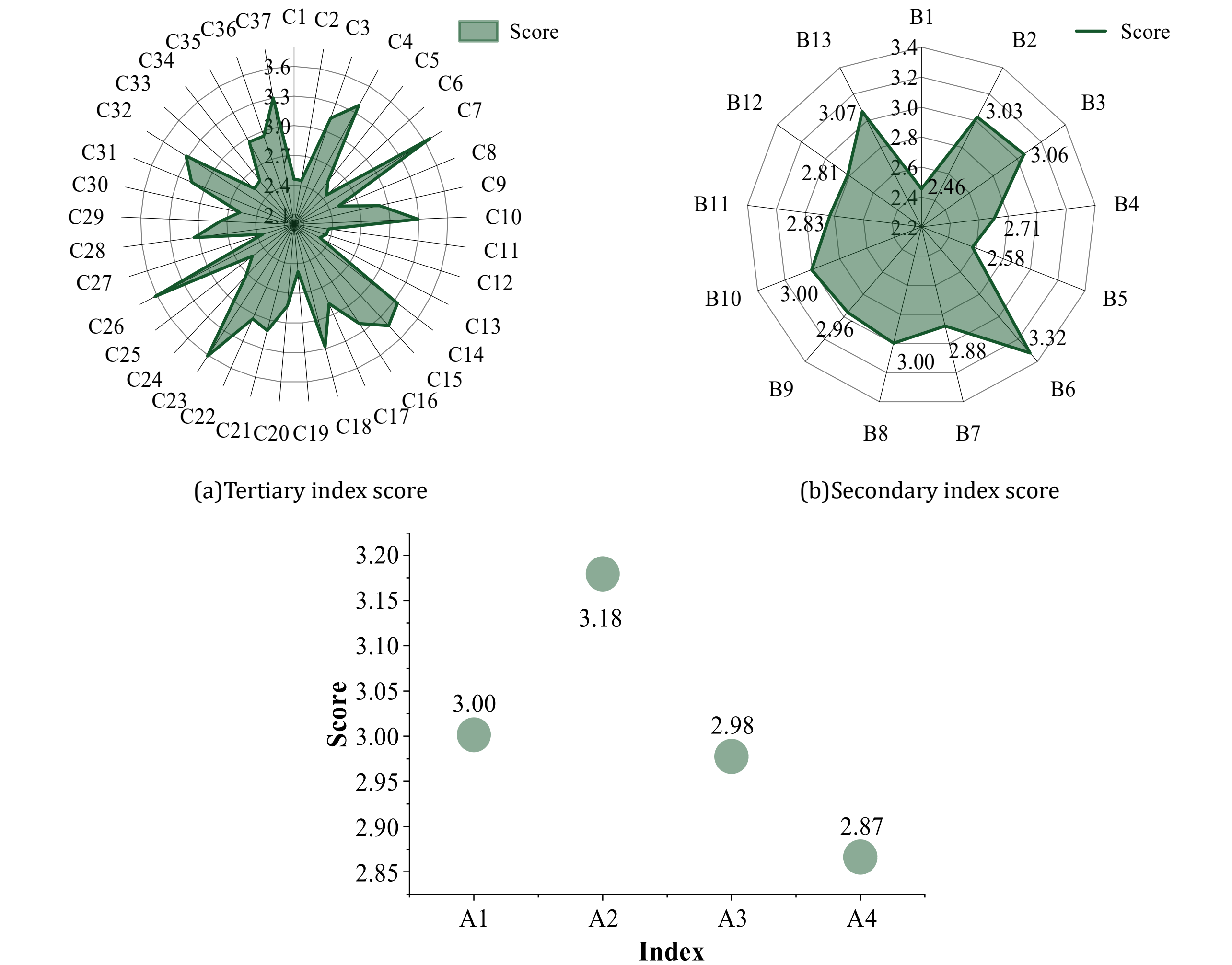
(a)Tertiary index score (b)Secondary index score

(c)Tertiary index score

Fig. 2. Students' evaluation of the development of art education

2.3.2. Teacher evaluation results. The results of teachers' evaluation of the development of art education are shown in Figure 3, with (a) to (c) indicating the scores of primary, secondary and tertiary indicators. The total score of teachers' evaluation of the development of art education in the sample universities is 2.900, showing low quality and satisfaction of art education development. The lowest rating for the evaluation of teaching background was 2.87, and the highest rating for the evaluation of teaching program was 3.18.The total score of this evaluation of the development of art education in colleges and universities was 2.973, indicating that the overall evaluation of the development of art education in colleges and universities was more general.

Teachers' overall evaluation of the teaching context is low, and it is still insufficient in terms of course orientation, curriculum, faculty analysis and learning situation analysis. There is still some room for improvement in the design and implementation of teaching programs. Teaching objectives may fail to fully take into account the actual situation and learning needs of students, resulting in certain difficulties in implementation. The design of teaching programs may lack innovation and relevance, and fail to fully stimulate students' interest and enthusiasm in learning. Teaching resources may not be sufficiently rich or applicable, affecting the effectiveness of teaching. The scores of teaching process evaluation and teaching effect evaluation are both below 3, indicating that there are still deficiencies in the teaching process, learning process and classroom organization of teachers, and that students fail to show sufficient enthusiasm and initiative in the learning process, and that further improvement and enhancement are still needed in the enhancement of students' literacy, the presentation of learning effects and the development of teachers.



(a)Tertiary index score

(b)Secondary index score

(c)Tertiary index score

Fig. 3. Teachers' evaluation of the development of art education

2.4. Realistic Dilemma Identification

Combined with the above evaluation and analysis of the various indicators of the development of art education in a college, the realistic dilemma of the development of art education in colleges and universities is analyzed from the three aspects of the target dilemma, the implementation dilemma and the evaluation dilemma.

2.4.1. The targeting dilemma. The fundamental value of art education in colleges and universities is to awaken the aesthetic consciousness of college students, and to improve their aesthetic quality, humanistic cultivation and spiritual cultivation in the process of perceiving, discovering, appreciating, expressing and creating beauty. However, the usual mode of art education in colleges and universities is that teachers explain the background of creation around art works, lead college students to appreciate classic art work clips, or simply introduce aesthetic theories and the history of art development, and the course content is generally shallow, ignoring the interpretation of the ideological connotation and aesthetic interest of art itself, and lacking effective leadership in the areas of spiritual leadership, value choice and behavioral orientation.

2.4.2. Implementation dilemmas. Most of the art education courses offered by colleges and universities are limited to theoretical courses such as the principles of aesthetics and the history of art, and even if they offer art experience courses such as singing, playing, dancing, calligraphy, painting, etc., they are overly biased towards technical training, which has watered down or even eliminated the value of aesthetic education in art education. In the guarantee of quality educational resources, art education in colleges and universities are also facing difficulties. Confined to the conditions of running schools, teachers' strength, and the art resources reserve of the cities where they are located, it is difficult to provide enough aesthetic education resources for socialized art practice, and it is impossible to meet the development needs of extending from classroom art education to social life experience.

2.4.3. Evaluation dilemma. At present, the assessment and evaluation mechanism of art education in colleges and universities is still lagging behind the requirements of education strategic planning and practical development. A considerable number of colleges and universities have not set up specialized art education teaching and research institutions and management departments, and there is a lack of unified top-level design in curriculum construction, discipline planning and assessment and evaluation. Although some colleges and universities have set up public teaching departments to unify the management of all kinds of public education courses, including art education, they have “marginalized” the art education courses, failing to give them the same importance as that given to moral education, intellectual education and physical education.

3. Assessment models based on decision tree analysis

Aiming at the many uncertainties and complexities existing in the process of college art education development, this chapter selects machine learning algorithms that can deal with complex linear relationships to train and predict the data of college art education development and capture the complex relationships among the data. Random forest algorithm, as a typical of integrated algorithms, is fast in computation and is robust to noise points, missing values and outliers in the dataset, and is not prone to misjudgment. Therefore, Random Forest and Dung Beetle Optimization Algorithm (DBO-RF) are chosen in this study to assess and predict the development of art education in colleges and universities.

3.1. Random Forests

Random Forest (RF) is an integration algorithm, the basic idea is to integrate multiple trees, its basic unit is the decision tree, and its essence belongs to a large branch of machine learning □ integrated learning methods.

3.1.1. Decision trees. Decision tree is a non-participatory supervised machine learning algorithm. The algorithm model is an inverted tree structure (binary tree or non-binary tree), mainly composed of root nodes, internal nodes and leaf nodes. The decision tree realizes the classification or prediction of data by splitting the nodes layer by layer, and the nodes select the optimal attributes to split to produce left and right subtrees, and different comparison rules produce different decision tree generation algorithms.

Considering the complexity and robustness of the model, the features selected and decisions made at the root node or intermediate nodes should optimize the classification effect. The criteria for judging “purity” include entropy, Gini coefficient, information gain, squared error minimization, and so on. Information gain indicates the degree of information uncertainty reduction before and after using a certain feature to classify a dataset, which is prone to overfitting in the face of high-dimensional data or noisy data. Therefore, the Gini coefficient is chosen as an indicator in this paper.

Suppose the training set is X , $|X|$ its number of samples which have W classes G_w , $w = 1, 2, \ldots, W$, $|G_w|$ representing the number of samples belonging to G_w . For different values $\{a_1, a_2, \ldots, a_m\}$ of a feature A , the number of samples is divided X into n sub-datasets based on their different values, which are $X_1, X_2, \ldots, X_n$ and $|X_i|$ are X_i respectively.

The Gini coefficient for data set X can be expressed as:

$$Gini(X) = 1 - \sum_{w=1}^{w} \left(\frac{|G_w|}{|X|} \right) \tag{1}$$

The Gini coefficient takes a value in the range [0,1] and the uncertainty in the set of samples increases as the Gini coefficient increases. If all the samples in the set belong to the same class, the Gini coefficient takes the smallest value of 0, and the maximum valid information can be obtained. Therefore, the feature with the smallest Gini coefficient is selected to generate the decision tree.

3.1.2. Bagging. Bagging SamplingBagging is a sampling technique with put-back based on Bootstrap sampling, which can improve the correct recognition rate of unstable classifiers by combining several models to reduce the generalization error.

Bootstrap is a sampling method with put-back. In the n sample set, n samples are sampled with putback to form a new dataset. Since sampling is regressive, a training sample may be repeated in the new dataset or may not appear at all. Thus, the probability that each sample is not drawn when sampled N times in a row is $(1-1/n)^N$. When the number of samples is large enough and the value of N is large enough, then:

$$\lim_{N \to \infty} \left(1 - \frac{1}{N} \right)^N = e^{-1} \approx 0.368 \tag{2}$$

The Bagging algorithm reduces model overfitting by reducing the variance, which can suppress the overfitting tendency of complex models. The parallel operation of each learner in the process not only reduces the correlation between decision trees, but also ensures that individual models have good performance.

3.1.3. RF construction. Based on the foundation of Bagging strategy, the steps to construct a random forest are as follows:

1) Denote the number of training samples by N and the number of features by M .

2) Input a much smaller number of features m than M for determining the decision outcomes of the nodes in the decision tree.

3) Sample N times from the N training samples by playback sampling to form a training set, which is predicted with unselected examples and evaluated for error.

4) For each node, m features were randomly selected and the decision of each node in the decision tree was based on these features. Based on these m features, the optimal split was calculated.

5) Each tree will be fully grown without pruning, which may be employed after a normal tree classifier is built.

3.2. Dung Beetle Algorithm

Dung Beetle Algorithm (DBO) is an innovative swarm intelligence optimization algorithm inspired by dung beetles. Dung beetles are common insects in nature that feed on animal feces.The DBO algorithm is largely inspired by the dung beetle's behavior of rolling balls, dancing, foraging, stealing, and reproducing.

In nature, dung beetles press their dung into a ball and use the sun for navigation to ensure that the ball rolls in a straight line. To simulate the behavior of rolling a ball and using the sun for navigation, the DBO algorithm enables the dung beetle to roll in a predetermined direction throughout the search space. As it rolls, the dung beetle updates its position according to the following equation:

$$x_i(t+1) = x_i(t) + \alpha \times k \times x_i(t-1) + b \times \Delta x \tag{3}$$

$$\Delta x = |x_i(t)| - x^{\omega} \tag{4}$$

where t is the number of the current iteration, $x_i(t)$ is the position information of the i rd dung beetle at the t th iteration, $k \in (0, 0.2]$ denotes the deflection coefficient, $b \in (0,1)$ is a natural coefficient, Δx simulates the change of light intensity, and x^{ω} is the worst position of the current population class.

When the dung beetle encounters an obstacle and cannot move forward, it needs to orient itself by dancing to get a new route. To simulate the dancing behavior, the $\tan x$ function is utilized to obtain a new rolling direction, and once the dung beetle successfully determines the new direction, it continues to roll the dung ball. The position of the dung beetle while rolling the dung ball is updated as shown in the following equation:

$$x_i(t+1) = x_i(t) + \tan(\theta)|x_i(t) - x_i(t-1)| \tag{5}$$

where $\theta \in [0, \pi]$ is the angle of deflection and the dung beetle does not change position when $\theta = 0$ or $\pi / 2$ or π.

When a dung ball is rolled home by a dung beetle, it is crucial for the dung beetle to choose a suitable spawning site in order to provide a safe environment for its offspring. Thus, a boundary selection strategy was proposed to model the area where female dung beetles lay their eggs with the following equation:

$$Lb^* = \max\left(X^* \times (1-R), Lb\right) \tag{6}$$

$$Ub^* = \min\left(X^* \times (1-R), Ub\right) \tag{7}$$

$$R = 1 - t / T\max \tag{8}$$

where Lb^*, Ub^* are the lower and upper limits of the spawning area, Lb, Ub are the lower and upper limits of the search space, X^* is the optimal position within the current population, R is the inertia weight, and Tmax is the maximum number of iterations of the algorithm.

During the iterative process, the position of the hatching egg fecal pellet changes dynamically with the following equation:

$$B_i(t+1) = X^* + b_1 \times \left(B_i(t) - Lb^* + b_2 \times \left(B_i(t) - Ub^*\right)\right) \tag{9}$$

where $B_i(t)$ is the position of the i nd hatching dung ball at the t rd iteration, b_1 and b_2 denote two independent random vectors of size $1 \times D$, and D is the dimension of the optimization problem.

When the small dung beetles successfully hatch, they come out to forage in groups, then the optimal foraging area needs to be established to guide the small dung beetles to forage with the following equation:

$$Lb^b = \max\left(X^b \times (1-R), Lb\right) \tag{10}$$

$$Ub^b = \min\left(X^b \times (1-R), Ub\right) \tag{11}$$

where X^b is the global optimal position, Lb^b and Ub^{b} are the lower and upper limits of the optimal foraging area.

After determining the optimal foraging area, the way of updating the position of the small dung beetle can be determined with the following formula:

$$x_i(t+1) = x_i(t) + C_1 \times \left(x_i(t) - Lb^b + C_2 \times \left(x_i(t) - Ub^b\right)\right. \tag{12}$$

where $x_i(t)$ is the position information of the i nd small dung beetle at the t rd iteration, C_1 denotes a random number that follows a normal distribution, and $C_2 \in (0,1)$ a random vector.

In the dung beetle society, some dung beetles are known to steal, and assuming that the theft occurs at the global optimal position, the way in which the thief's position is updated can be determined during the iteration process by the following formula:

$$x_i(t+1) = X^b + S \times g \times \left(\left|x_i(t) - X^*\right| + \left|x_i(t) - X^b\right|\right) \tag{13}$$

where $x_i(t)$ is the position information of the i nd thief at the t rd iteration, S is a constant, and g is two independent random vectors of size $1 \times D$ obeying a normal distribution.

3.3. DBO-RF algorithm

The steps of the DBO-RF algorithm are as follows:

1) Initialization. Set the number of dung beetle populations, the number of iterations, the upper and lower bounds of the iteration range, and related parameters. Randomly initialize the position and direction of each dung beetle individual to determine the probability of information exchange.

2) Adaptation calculation. Using the position of each dung beetle individual as the parameter configuration, train the random forest classifier and calculate the fitness value of each individual.

3) Iterative updating. In each iteration, each dung beetle individual senses the position and orientation of neighboring dung beetle individuals. The position of the dung beetle individual is adjusted according to the specified step size and direction. The parameters of the random forest, such as the number of decision trees and the maximum number of features, are adjusted according to the final positions and directions of the dung beetle individuals.

4) Optimal solution. The fitness value of the new position is calculated and compared with the fitness value of the current optimal solution. If the fitness value of the new position is better than the current optimal solution, it is replaced. During the optimization process, the dung beetle algorithm gradually updates and iterates the optimal solution to find a more perfect model of the random forest algorithm.

5) Iterative optimization process. Repeat steps 2 to 4 above until a predefined upper limit of iterations is reached or the stopping criterion is satisfied. The stopping criterion can be that the maximum number of iterations is reached or the fitness value changes less after several consecutive iterations, indicating that the results have converged to the optimal solution.

3.4. Model Performance Evaluation Criteria

The difference between the predicted value calculated by the model and the real value in the data set often exists, and the error is usually used to judge the model's good or bad performance, the smaller the error value, the more accurate the model's prediction results, the better the model performance, and vice versa, the worse the model performance. Common error functions include mean absolute value error, mean square error, root mean square error, etc., which are used to reflect the difference between the predicted value and the actual value of the model, and to judge whether the prediction model is reliable or not.

The error functions are calculated as follows:

1) Mean Square Error (MSE):

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(y_i - \hat{y}_i\right)^2 \tag{14}$$

2) Root Mean Square Error (RMSE):

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(y_i - \hat{y}_t\right)^2} \tag{15}$$

3) Mean Absolute Error (MAE):

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|y_i - \hat{y}_l\right| \tag{16}$$

In the above equation, y_i is the true value, $\hat{y}_i$ is the predicted outcome value, and n indicates the number of samples.

Error metrics such as MSE, RMSE, and MAE produce values of different magnitudes depending on the type of study and lack readability. Therefore it can also be evaluated using explained variance (EV) and coefficient of determination (R^2).

Explained variance and coefficient of determination take values between 0 and 1. The closer to 1, the better the model, and conversely the closer to 0, the worse the prediction.

4) Explained Variance (EV):

$$EV = 1 - \frac{Var\left(y_i - \hat{y}_i\right)}{Var\left(y_i\right)} \tag{17}$$

5) Coefficient of determination (R^2):

$$R^2 = 1 - \frac{MSE\left(y_i - \hat{y}_i\right)}{\frac{1}{n}\sum_{i=1}^{n}\left(y_i - \overline{y}\right)^2} \tag{18}$$

In the above equation, y_i is the true value, $\hat{y}_t$ is the predicted value, and n indicates the number of samples.

In this study, the model effect is evaluated by root mean square error, mean square error, mean absolute value error, explained variance, and coefficient of determination.

4. Decision tree modeling applications and quantitative strategies

4.1. Decision Tree Modeling Applications

Using the DBO-RF algorithm, after the full-text questionnaire data and evaluation results as a training sample data set, the decision tree model for evaluating the development quality of art education in colleges and universities is built and its classification rules are extracted. The construction of the decision tree model needs to determine the root node, calculate the Gini coefficient and sort, the Gini coefficients of all attributes are shown in Table 2, and the Gini coefficient of the academic analysis B4 is the smallest of 0.21, i.e., the teaching program is taken as the root node.

Direct extraction of classification rules is the biggest advantage of decision trees. In this paper, we mainly get the factors affecting the development quality of college art education from the constructed decision tree model. The Gini coefficient of academic situation analysis, students' literacy improvement, learning process, and with the curriculum is low compared with other indicators, so it is a few key indicators to measure the development of art education in colleges and universities. Therefore, in the actual teaching process, it is necessary to analyze the cognitive level and interest needs of students according to the differences in the students' foundation, design the teaching objectives as well as the curriculum, and improve the students' classroom participation and learning concentration. In addition, the development strategy of art education in colleges and universities can be combined with these aspects.

Table 2. The Gini coefficient of all properties

Attribute	Gini coefficient
Course orientation B1	0.32
Course setting B2	0.29
Teacher analysis B3	0.36
Study affective analysis B4	0.21
Teaching target B5	0.37
Teaching scheme B6	0..32
Teaching resources B7	0.51
Teacher teaching process B8	0.53
Learning process B9	0.25
Classroom organization B10	0.43
Student accomplishment B11	0.23
Learning effect B12	0.45
Evaluation of teacher development B13	0.52

4.2. Analysis of model evaluation

Taking the quantitative data of 13 indicators of the development quality of art education in colleges and universities as the independent variables of the model, and the score value of the comprehensive evaluation of the development quality of art education in colleges and universities as the dependent variable, the data were split into test set and training set. Among them, 75% is used as the training set and 25% as the test set to test the performance status of the DBO-RF model after training, and Bayesian network, elastic network, support vector machine, gradient boosting decision tree (GBDT), and random forest algorithm are selected as the comparison methods.

4.2.1. Model Training Comparison. Comparison of real and predicted values of different models is shown in Fig. 4, (a) to (f), which shows the comparison of real and predicted values of Bayesian Network, Elastic Network, Support Vector Machine, Gradient Boosted Decision Tree (GBDT), Random Forest and DBO-RF models. The evaluation value fitting results of Bayesian network and elasticity network have a large deviation, and the evaluation effect still needs to be improved. The evaluation results of Support Vector Regression are highly biased, and the algorithm's use of kernel tricks leads to its weak performance when dealing with samples containing a large number of features. The evaluation results of Gradient Boosting Decision Tree are improved compared to the previous three methods, and the gap between the true value and the predicted value is smaller. Random forest evaluation results are better, with smaller deviations between true and predicted values and higher prediction accuracy. The prediction results of the random forest algorithm improved by using the dung beetle algorithm are the closest to the real results, and the prediction accuracy for the development of art education in colleges and universities is higher than that of the other five models, and it has a good performance on the experimental dataset.

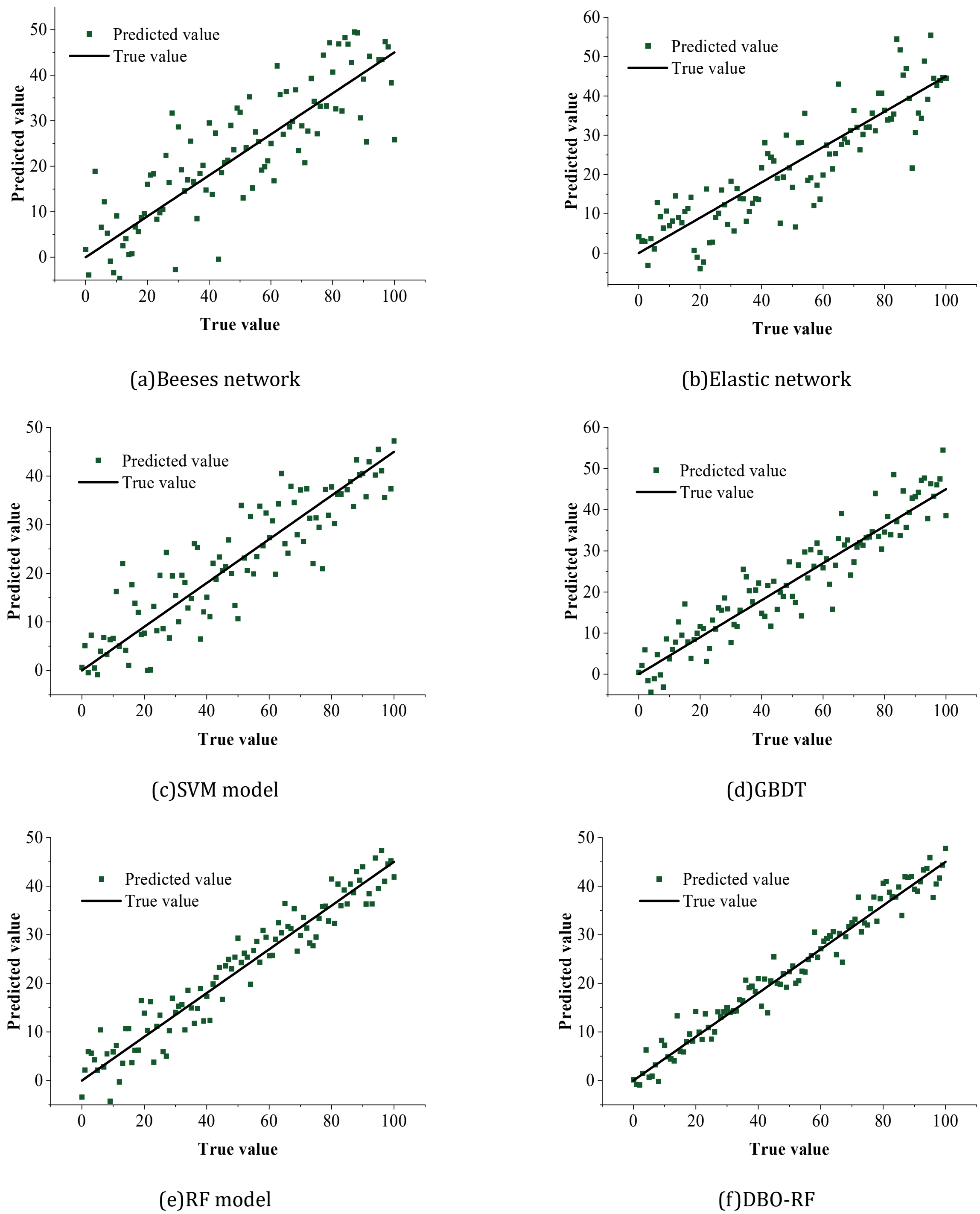
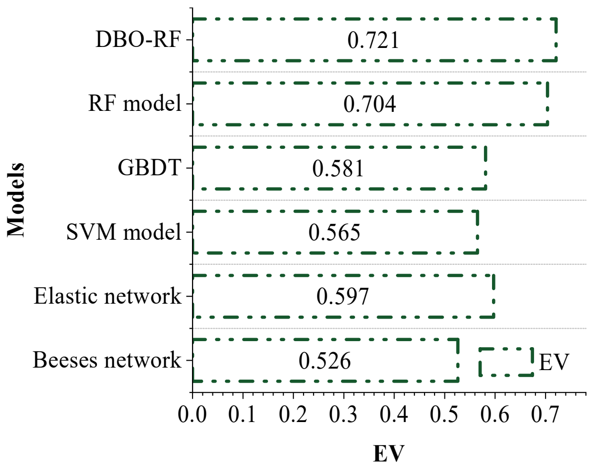
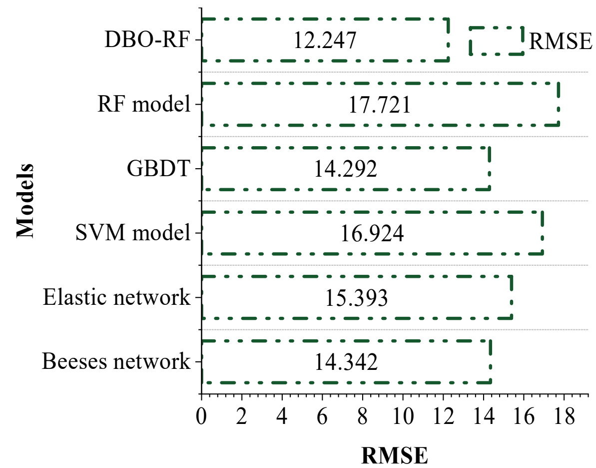


Fig. 4. The comparison between the real value and the predicted values of different models

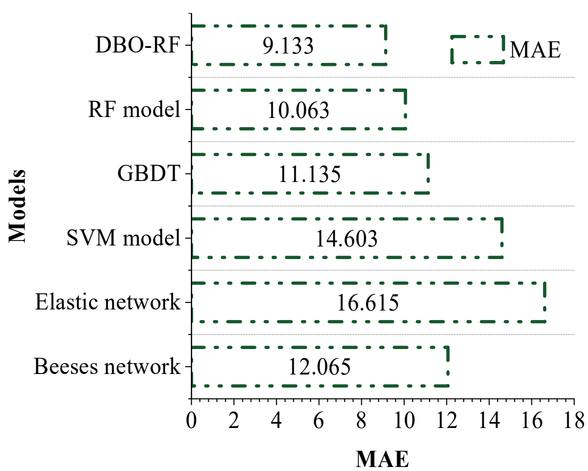
4.2.2. Comparative results of indicators. In this experiment, six methods with different principles are selected from Bayesian network, elastic network, support vector machine, gradient boosting decision tree, random forest and the DBO-RF model in this paper in various classical common machine learning regression algorithms, and the model is constructed and trained on the experimental dataset, and the performance of each model is tested on the test set, and the quantitative pairs of each model index are shown in Figure 5, and (a)~(e) represent the index results of EV, RMSE, MAE, MSE, R^2 respectively. Among the five groups of model evaluation indexes, the DBO-RF model had the lowest RMSE, MAE and MSE, and the highest EV and R^2 were all DBO-RF models, with the index results of 12.247, 9.133, 178.829, 0.721 and 0.719, respectively, indicating that the error between the true value and the predicted value was the smallest, and the interpretation rate was the highest. The Bayesian network and elastic network models performed poorly, while the ensemble models such as gradient boosted regression and random sender regression performed better.



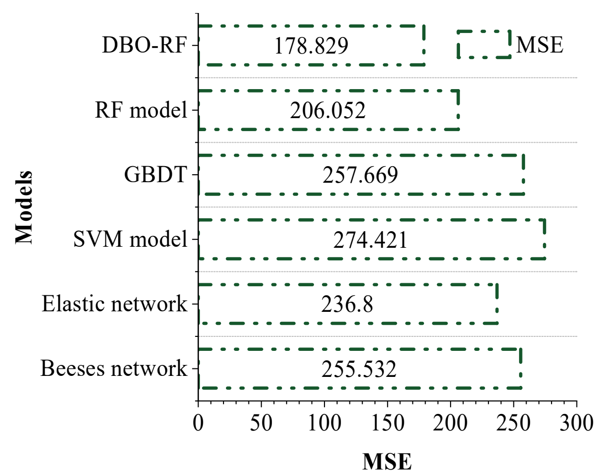
(a)EV



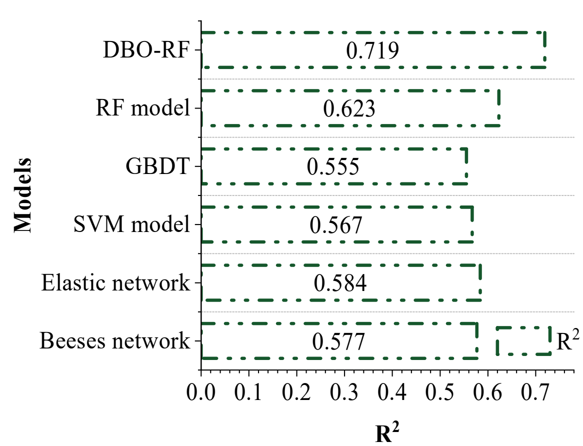
(b)RMSE



(c)MAE



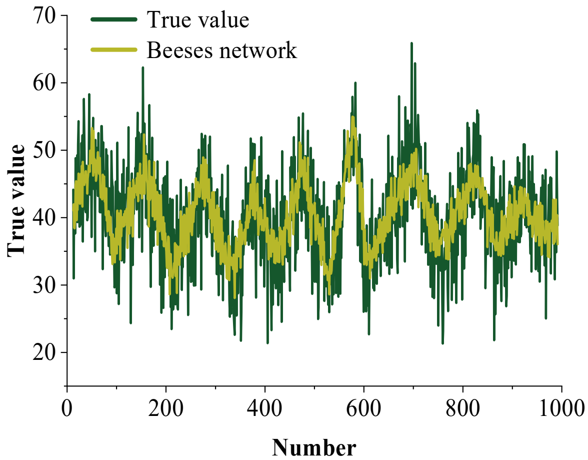
(d)MSE



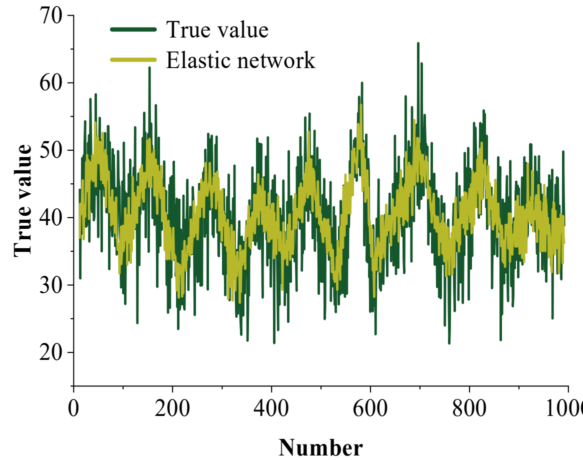
(e)R^2

Fig. 5. Quantitative comparison of each model index

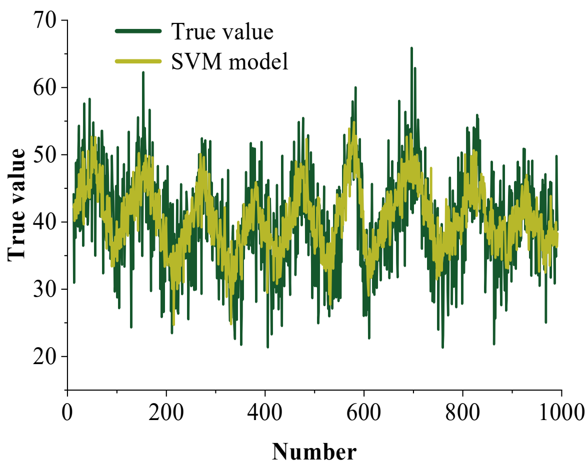
4.2.3. Comparison of fits. Comparison of the fitting situation of each model test set is shown in Figure 6, (a)~(f) are the comparison of the fitting situation of Bayesian network, elastic network, support vector machine, gradient boosting decision tree (GBDT), random forest and DBO-RF model respectively. Among them, the dark part is the real value of the comprehensive score of the evaluation of the development of art education in colleges and universities, the light part is the predicted value, and the dark part that can not be covered by the light color is the difference between the real value and the predicted value, and it can be clearly seen in the figure that the prediction error of the DBO-RF model of this paper is small, and the performance of the evaluation of the development of art education in colleges and universities is good.



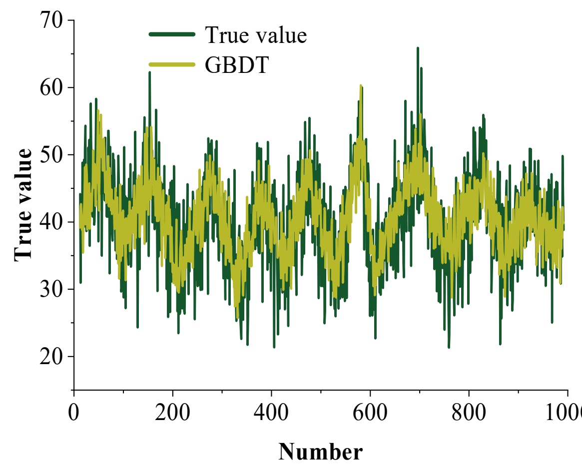
(a)Beeses network



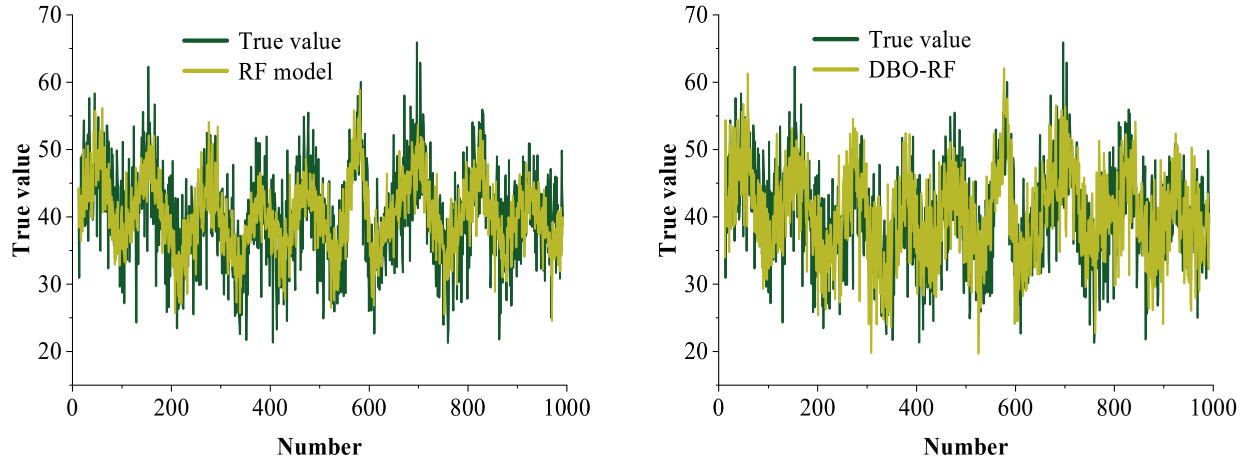
(b)Elastic network



(c)SVM model



(d)GBDT



(e)RF model (f)DBO-RF

Fig. 6. The comparison of the fitting of the model test set

4.2.4. Model generalization performance. The generalization performance of the models is further compared using K-fold cross-validation, where K is taken to be 15 for ten comparisons, and a comparison of the cross-validation results for all models is shown in Figure 7. The performance of Random Forest Regression and Gradient Boosting Regression is more stable, and the performance of Random Forest Regression is slightly better than Gradient Boosting Regression, Elasticity Network and Bayesian Network almost overlap, the decision coefficients of Support Vector Machine are higher than those of Elasticity Network and Bayesian Network, and the decision coefficients of the DBO-RF model are in the range of 0.706~0.834, which are higher than those of other comparative methods, and it is able to obtain a better prediction result on the evaluation of the quality of development of art education in higher education. The DBO-RF model has a coefficient of determination of 0.706~0.834, which is higher than other comparative methods and can achieve better prediction results for the evaluation of the development quality of college art education.

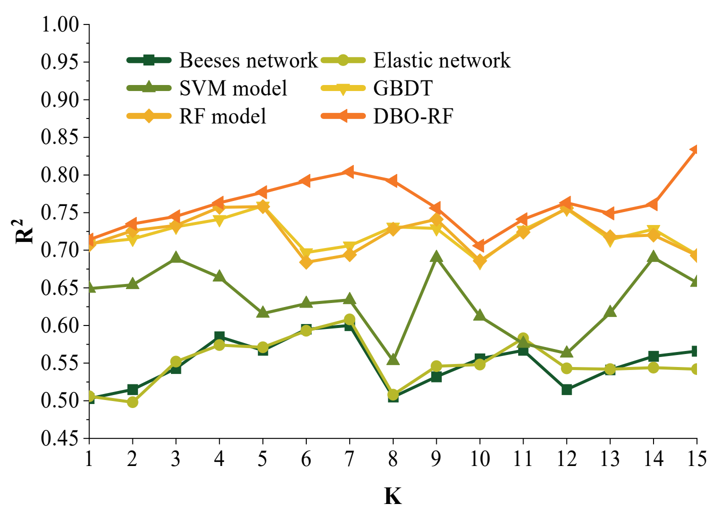


Fig. 7. Comparison of cross-validation results of all models

4.2.5. Results of model evaluation. The DBO-RF model is used to assess the total evaluation score and the scores of each indicator of the development of art education in colleges and universities, and the assessment results of the model are shown in Figure 8. The total score of the model's evaluation of the development of art education in the sample colleges and universities is 3.082, which is 1.22% different from the true value of 3.045, and the difference of the assessment results of indicators A1~A4 ranges from 1.31% to 3.84%, and the difference of the assessment results of indicators B1~B13 ranges from 2.58% to 3.87%, which indicates that the accuracy of the DBO-RF model's assessment of the development of art education in the sample colleges and universities is high.

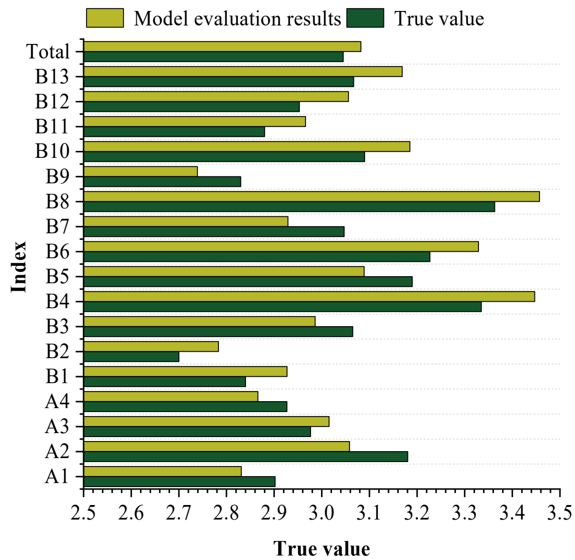


Fig. 8. Model evaluation results

4.3. Art Education Development Strategy

The art education development strategy is shown in Figure 9.This paper proposes the following art education development strategy by reasonably analyzing the art education development quality evaluation data of a university:

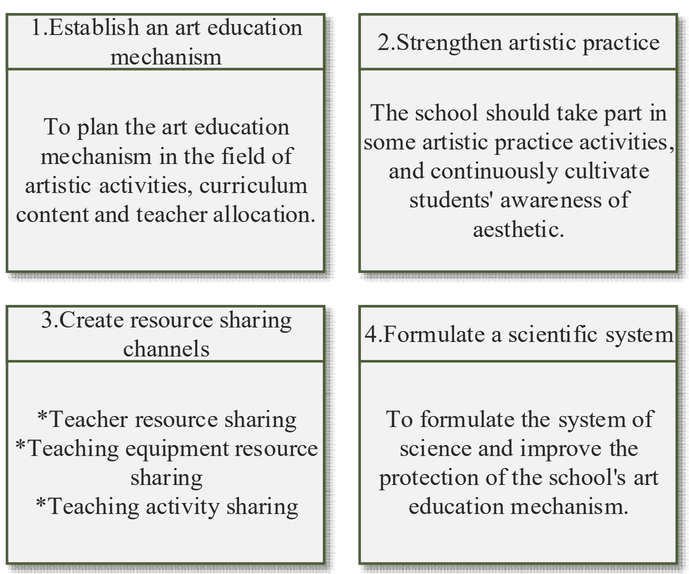


Fig. 9. Art education development strategy

4.3.1. Establishment of mechanisms for arts education. Schools should analyze and study the composition and characteristics of students, and plan a scientific and reasonable art education mechanism from various aspects and angles, such as the arrangement of art activities, curriculum content setting, and teacher allocation plan, etc. Among them, in the curriculum content setting, we should pay attention to the scientific spirit of the students and humanistic qualities that must be combined with the artistic cultivation, in order to improve the theoretical level of the art education mechanism.

At the same time, the introduction of some excellent art teachers with profound theoretical knowledge, but also focus on cultivating the school's potential art teachers, and hiring experts outside the school for lectures and training, so as to strengthen the school's art education faculty, to provide students with better art education. For the teaching method of art, the main channel role of art education can be fully utilized, combining activities inside and outside the classroom, combining theory and practice, so as to make the atmosphere of the art classroom more active and effectively improve the effect of art teaching.

4.3.2. Enhancement of artistic practices. Schools should often organize students to participate in some art practice activities, so that students can have zero-distance contact with art creations and works of art, experience and know art more deeply, constantly cultivate students' awareness in aesthetics, enhance their aesthetic ability, and stimulate more artistic creativity. Schools should carry out scientific and reasonable planning for the construction of student art troupes, and give full play to the exemplary role of student art troupes in the implementation of art education mechanisms.

4.3.3. Establishment of resource-sharing channels. Schools should establish channels and mechanisms for sharing excellent resources within arts teaching and promote resource sharing among different arts education programs. This includes the following: First, teacher resource sharing. Schools should establish a system of work assessment and teaching incentives to encourage teaching cooperation and sharing of teaching materials among art teachers, as well as synergistic sharing of different courses by teachers to solve the problem of weak teachers' strength in art education. The second is the sharing of teaching software and hardware equipment resources. Formulate a resource-sharing program and form a clear system of rules to improve the degree of utilization and circulation of equipment and reduce the duplication of investment in equipment in schools. Third, the sharing of teaching activities. During the development of art education, there will be art rehearsals, art achievement reports, painting exhibitions and music recitals and other kinds of art activities, teachers can let students participate in the activities under different courses, expanding students' participation in activities and promoting the sharing of teaching activities.

4.3.4. Developing scientific systems. Schools should pay attention to the overall, long-term and forward-looking nature of the system, give full consideration to the market demand and development needs of artistic talents, and take the cultivation of high-quality artistic talents as the starting point of the system construction, then refine the system system one by one, and finally form a “people-oriented” art education system. Schools should, in conjunction with the guidance of the national and local government education departments, set up art education management organizations similar to those for physical education, and be responsible for coordinating the development of art education in schools and regulating the management of art education activities.

5. Conclusion

At present, art education in colleges and universities as a whole shows a good development trend, but there are still certain dilemmas. This project constructs an evaluation index system for the development quality of art education in colleges and universities, and identifies the realistic dilemmas in the development of art education by evaluating the development of art education in sample colleges and universities. Design the assessment model based on the dung beetle algorithm to improve the random forest, and apply it to the analysis of art education development to mine the development strategy of art education.

The total scores of students' and teachers' evaluation of the development of art education in the sample colleges were 3.045 and 2.900 respectively, which were in the middle level. Both evaluations of the teaching context were the lowest, indicating the shortcomings of art education in colleges and universities in terms of course orientation, curriculum, faculty analysis, and analysis of the learning situation. From the three dimensions of goals, implementation and evaluation, the development dilemma of college art education is revealed.

Compared with other analysis methods, the constructed DBO-RF model has the smallest error between predicted and real values, high prediction accuracy, and better generalization ability.The RMSE, MAE, and MSE values of the DBO-RF model are 12.247, 9.133, and 178.829, which are lower than those of the comparison methods, and the EV and R^2 are 0.721 and 0.719, which are higher than those of the comparison methods. It reflects its good performance in assessing the development of art education in colleges and universities.

The application of the DBO-RF model identifies the analysis of learning situation as the root node, and finds the important influence of students' literacy improvement, learning process, and curriculum on art education. Based on this, the optimization strategies of establishing art education mechanisms, strengthening art practice activities, establishing resource sharing channels, and developing scientific systems are proposed to promote the quality of art education development in colleges and universities.

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