A Performance Prediction Method for Talent Team Building Based on Integrated ISA-BP Neural Networks

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Abstract

INTRODCTION: Objective, accurate and fair development of research and effective performance prediction methodology for the construction of the talent team is the current needs of the new era of innovation and reform and development of university management, as well as the need to improve the quality of scientific research and teaching level of the talent team.OBJCTIVES: To address the problems of irrational principle of indicator selection, incomplete system and imprecise methodology in the current research on performance prediction of talent team building.METHODS:This paper proposes a talent team construction performance prediction method based on intelligent optimization algorithm improving neural network with integrated learning as the framework. First of all, through the analysis of the current talent team construction performance prediction influencing factors selection principles, analyze the talent team construction performance management process, select the talent team construction performance prediction influencing factors, and construct the talent team construction performance analysis system; then, with the integrated learning as a framework, improve the neural network through the internal search optimization algorithm to construct the talent team construction performance prediction model; finally, through the simulation experiments to analyze and verify the effectiveness and superiority of the proposed method. The effective type and superiority of the proposed method are verified.RESULTS: The results show that the proposed method satisfies the real-time requirements while improving the prediction accuracy.CONCLUSION: This paper addresses the lack of precision in forecasting the performance of the talent pipeline and the lack of a sound analytical system.

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1. Introduction

The construction of China's world-class universities and first-class disciplines is closely related to the management structure of colleges and universities and the reform of the university talent system, which ultimately depends on the construction of high-quality and high-level talents in colleges and universities [1]. Talent team construction performance as a key part of talent construction, is conducive to the integration of resources in colleges and universities, is conducive to talent selection and job adjustment, is conducive to optimizing the status quo of talent team governance, is conducive to talent incentives [3]. Therefore, how to objectively, accurately and fairly formulate research effective talent team construction performance prediction method is the current new era of

university management innovation reform and development needs, but also the talent team research quality and teaching level improvement needs, has very important practical significance [4].

Talent team building performance prediction method, as a key technology of talent team building in higher education institutions, is not only related to the selection of talent team building performance prediction impact indicators, but also related to the talent team building performance prediction model algorithm [5]. In order to improve the accuracy of talent team construction performance prediction, the specific quantification, rationality, completeness and objectivity of prediction feature indicators and the research of prediction model accuracy and real-time are becoming more and more important, and have been researched and paid attention to by various experts and scholars [6]. Talent team construction performance prediction refers to the talent team construction goals and needs, through the talent team performance prediction impact characterization analysis, combined with the talent team performance data analysis algorithm, to build an efficient talent team construction performance prediction model, the use of realistic statistical data, the talent team construction performance prediction and analysis, and talent team construction performance prediction results to be applied to the main body of the talent team, to improve the talent team quality [7]. Currently, talent team construction performance prediction methods include fuzzy comprehensive evaluation method [9], machine learning method [10], neural network [11], integrated learning technology [12], deep learning method [13] and so on. Literature [14] deals with the performance evaluation weights of public security intelligence personnel through fuzzy theory, and proposes diversified incentive means and methods so as to improve the efficiency of human resources; Literature [15] utilizes hierarchical analysis method to solve the index weights based on the all-round index system of university professors' scientific research work; Literature [16] uses more than two machine learning methods based on the performance data of the construction of the talent team through hierarchical analysis method weight optimization fusion to construct talent team construction performance prediction model, training test results show that the prediction method of multivariate isomorphism is conducive to the improvement of prediction accuracy; Literature [17] optimizes and improves the support vector machine through the use of swarm intelligent algorithm to construct university performance prediction method, so as to improve prediction accuracy and real-time; Literature [18] analyzes the results of the performance evaluation of the feedback is not timely, the performance evaluation of individual teachers and Teacher team performance assessment is inconsistent, teacher performance is not coordinated, performance and personal development can not be integrated, and other existing problems, the neural network as a prediction model, proposed a neural network-based talent team performance prediction method; Literature [19] combines the integrated learning and weak machine learning algorithms, proposed a talent team building performance prediction method based on integrated-support vector machine; Literature [20] through the construction of the talent construction performance system, establish a prediction model based on intelligent optimization algorithm to improve the deep learning method, which provides new ideas for the human resource prediction model. In response to the above literature analysis, the existing human team building performance prediction methods have the following defects [21]:

(1) The principle of constructing the performance system of talent team building is unreasonable;

(2) Influence characteristics and indicators affecting the prediction of the performance of the talent pipeline are not comprehensive enough;

(3) Talent building performance prediction methods are not sufficiently accurate and have poor real-time performance.

Ensemble Learning [22] constructs and combines multiple learners to accomplish a learning task. The general structure is to generate a set of "individual learners" and then combine them with a certain strategy. The main combining strategies are averaging, voting and learning. Therefore, integrated learning is sometimes called multiclassifier system, committee-based learning. A heuristic algorithm [23] is an algorithm based on an intuitive or empirical construction that gives a feasible solution to each instance of the combinatorial optimization problem to be solved at an acceptable cost (in terms of computational time and space), and due to a certain amount of stochasticity of the algorithm, the feasible solution obtained each time tends to be different. Artificial Neural Network (ANN) [24] is a complex network system that consists of a large number of neurons interconnected to simulate the way the human brain nerves process information, and performs parallel processing and nonlinear transformation of information. Integrated learning and heuristic optimization algorithms improve the neural network method to increase the prediction accuracy, and its application to the problem of analyzing and predicting the performance of talent team building has become a research hotspot for experts and scholars in the field.

Aiming at the problems existing in the current talent team construction performance prediction method, this paper proposes a talent team construction performance prediction method based on the integrated heuristic optimization algorithm to improve the neural network. The main contributions of this paper are: (1) according to the principle of influencing factors selection, analyze the talent team construction performance evaluation process, and construct the prediction system; (2) combine the integrated learning technology and the internal search optimization neural network method, and put forward the talent team construction performance prediction model; (3) verified the method of this paper through simulation, which has higher evaluation accuracy and real-time performance.

2. Analysis of the problem of predicting the performance of the talent pipeline

According to the criteria for selecting the influencing factors of the talent team construction performance prediction system, analyze the talent team construction performance assessment process, select the influencing factors, and construct the talent team construction performance prediction system [25].

2.1 Principles for selecting performance influences

Systemic principles

Talent team building performance prediction factors need to be selected to predict the object of multi-directional and multi-level analysis, the collection of college input and output, as well as profit and loss, etc., to consider whether there is a global and holistic, to ensure the integrity of the prediction system.

Quantitative principle

In order to improve the accuracy of the training, the talent team building performance should choose quantifiable influencing factors, use data to show the status and degree of the influencing factors, and comprehensively and objectively show the degree of completion of the prediction object.

Scientific principles

In the process of selecting influencing factors, systematic and reliable methods are utilized to screen predictive factors through rational and scientific logical thinking methods.
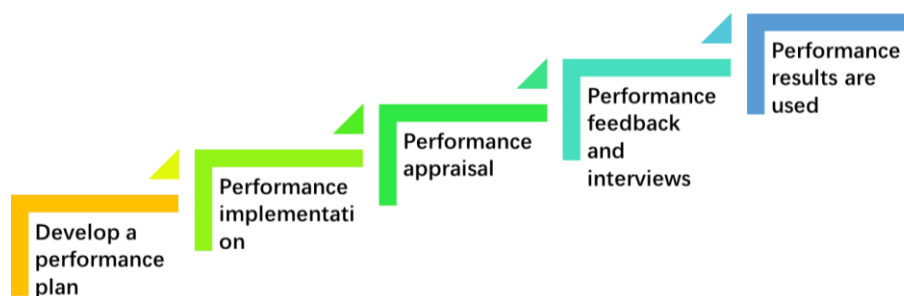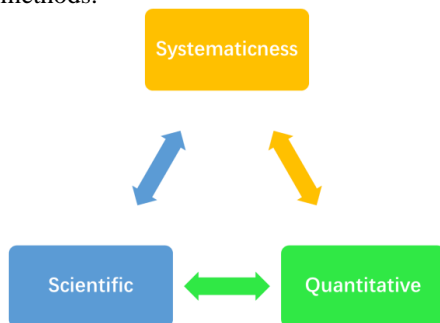
Figure 1. principles of selecting performance influencing factors

2.2. Workforce development performance management process

In order to manage the performance of talent development in universities, this section carries out an analysis of the five aspects of performance management [26]:

Development of performance plans

As a prerequisite for the performance management process, first analyze the work tasks in the context of the school's development strategy and personal development needs, and develop a performance plan through work objectives and job responsibilities.

Performance Implementation

After the development of the performance plan, in accordance with the objectives of the work tasks, from the supervision and management, feedback and communication, data collection and other ways to carry out the collection and analysis of performance-based information.

Performance appraisal

As a key part of the performance management process, based on the performance plan, the use of scientific appraisal methods, fill out the assessment form, divided into appraisal levels, the actual completion of the performance of the talent team to assess.

Performance feedback and interviews

Feedback on the assessment results to the talent team, through the assessment results, to interviews and other ways to the individual talent team to clarify their own shortcomings, to complete the performance plan.

Application of performance results

After the performance appraisal is completed, the performance results will be applied to the channels of job appointment, position adjustment, assessment, reward and punishment, further training, and merit assessment.

Figure 2. performance management process of talent team building

2.3. Analysis of factors affecting the prediction of the performance of workforce development

According to the principle and process analysis of talent team building performance selection, the influencing factors are analyzed in terms of talent input and talent output through questionnaires, interviews, case studies, summarizing experience and other methods [27].

Input of human resources

From the aspect of talent input, the factors affecting the prediction of the performance of talent team building include two elements: the amount of high-level talents and scientific research input, in which the amount of high-level talents is mainly quantified through the influence factors of master's degree senior title A1, doctoral degree senior title A2, deputy senior title A3, and full senior title A4, and the scientific research input mainly includes the scientific research projects A5, scientific research funds A6, and the average monthly salary package A7 and other influencing factors.

Talent output

From the aspect of talent output, the factors affecting the prediction of the performance of talent team building include scientific research achievements and teaching achievements, of which, the scientific research achievements mainly include national research excellence A8, patent authorization A9, and the number of thesis on university-enterprise cooperation A10, and the teaching achievements include the number of master and doctoral graduates A11.

Talent team building performance analysis system takes key elements such as talent input and talent output [27] as the first-level influencing factors, the amount of high-level talents, scientific research input, scientific research achievements and teaching achievements as the second-level influencing factors, and the master's degree senior title A1, doctoral degree senior title A2, associate senior title A3, full senior title A4, scientific research projects A5, scientific research funds A6, average monthly salary package A7, national research excellence A8, patent authorization A9, the number of university-enterprise cooperation papers A10, the number of Bo graduates A11, etc. as the tertiary influence factors [27], which fully embodies the whole process of talent team building performance prediction, and constructs a scientific, objective and comprehensive talent team building performance analysis system, which is schematically shown in Figure 3.
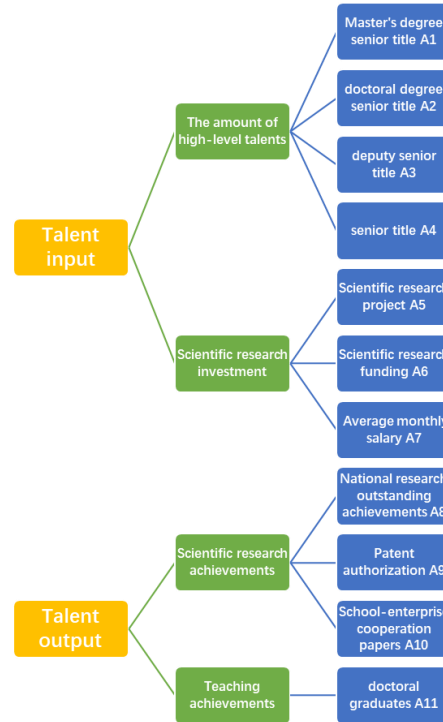

Figure 3. Talent team building performance analysis system

In order to analyze the redundancy of the influencing factors, Pearson is used in this paper to calculate the correlation coefficients with the range of $[-1,1]$. The calculation formula is as follows:

$$\rho(x,y) = \frac{\text{cov}(x,y)}{\sigma(x)\Box\sigma(y)} = \frac{E\left[(x-\mu_x)(y-\mu_y)\right]}{\sigma(x)\Box\sigma(y)}$$

(1)

Where $\text{cov}(x,y)$ is the covariance coefficient, $\sigma(x)$ and $\sigma(y)$ are the standard deviation. The correlation analysis of talent team building performance prediction influence factors is shown in Figure 4. From Figure 4, it can be seen that there is no redundancy in the predictive influence factors of talent team building performance analysis.
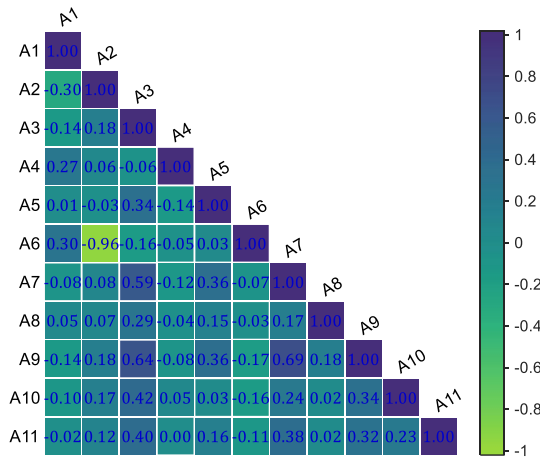
Figure 4. Correlation analysis of factors influencing the prediction of the performance of the workforce building

3. Internal Search Algorithm Improved Neural Network Approach

Neural network iterative optimization algorithm generally uses gradient descent method, which is easy to fall into the local optimum, in order to overcome the above defects, this paper adopts the intelligent optimization algorithm - internal search optimization algorithm to improve the neural network.

3.1. Internal search optimization algorithm

Inspired by renovation, in 2014 Gandomi proposed Internal search algorithm (ISA, Interior search algorithm)[28],which can also be called Aesthetic search algorithm.It is a meta-heuristic algorithm with very fast convergence speed and ability to handle complex problems.

The ISA algorithm is divided into three phases: synthetic design for global search, mirror localization taking into account both global and local search, and local search. The first two phases rely on the unique parameter α in the algorithm to dynamically allocate elements in the space and create the effect of searching from global to local. Elements are assigned to the mirror group when $r_1 < \alpha$ and vice versa to the synthetic design group where the random number of $r_1 \in [0,1]$.

Synthetic design strategy

Decoration is a complex project, at the beginning of the design, we should carefully analyze the space structure, use materials and architectural design aesthetics to create an interior environment that is functional, beautiful, and meets the material and spiritual needs of customers. Interior decoration is a design process from the whole to the local, from the surrounding to the center. The designer first determines the style of the decoration and then works on the synthetic elements and other parts in turn, starting with the walls. Throughout the design process, in order to achieve a coordinated and unified decoration, the composition of the elements in the space will not change at all stages of the interio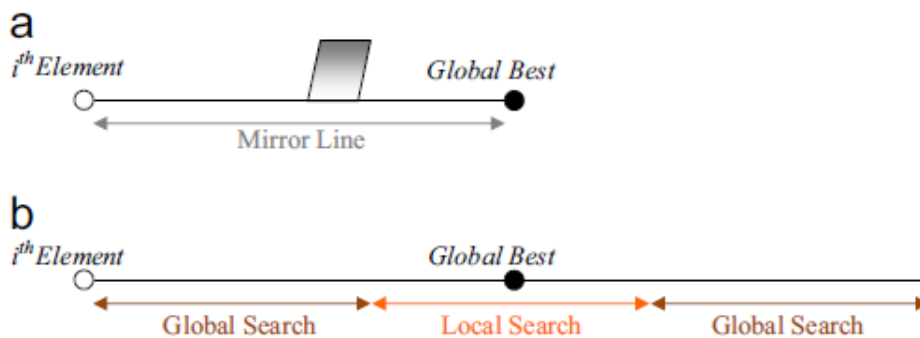r decoration, but you can constantly try to change the position of the elements, and in the process, the position of the elements will change when the customer's satisfaction and the design effect are better.

$$x_i^j = LB^j + (UB^j - LB^j) \times r_2 \quad (2)$$

where x_i^j is the first i element in the j iteration, UB^j and LB^j denote the upper and lower bounds of the synthesized part, respectively, and they represent the maximum and minimum values of all the elements in the $j-1$ iteration, and r_2 is a random number between 0-1.

Mirror Positioning Strategy

Figure 5. mirror search

Mirrors are unique fine art creations used by Persian designers for decorative purposes, highlighting their features by placing them near the most important elements. This idea is incorporated into the optimization algorithm and is the most creative part of this algorithm. Random placement of mirrors on the connecting line between the element and the global optimal point is used to generate the vignette. From Figure. 5(a) it can be seen that the mirror can

be placed on the connecting line between the j th element and the global optimum. Figure. 5(b) By the difference of mirror placement, the generated dummy shadow can be searched globally or locally. Local search is performed

$$x_{m,i}^{j} = r_3 x_i^{j-1} + (1-r_3) x_{gb}^{j} \quad (3)$$

where r_3 is a random number between 0 and 1, x_i^{j-1} is the position of the i element at the $j-1$ iteration, and $x_{m,i}^{j}$ is the position of the i element at the j mirror.

The position of the mirror determines the position of the vignette, and the vignette position is calculated as follows:

$$x_i^j = 2x_{m,i}^j - x_i^{j-1} \quad (4)$$

Localized Search Strategy

The local search method is realized by tiny random wandering around the global optimum point, this method enhances the convergence of the algorithm, increases the diversity of exploration, and further improves the efficiency of the algorithm search, the calculation formula is as follows:

$$x_{gb}^j = x_{gb}^{j-1} + r_n \times \lambda \quad (5)$$

where r_n is a random number conforming to a normal distribution, which has the same dimensions as x ; λ is a scaling factor that determines the dimensions of the search space, where λ is set to $(UB-LB) \times 0.1$.

when the dummy shadow is near the global optimum and vice versa for global search, this flexibility enhances the diversity of the algorithm population. The formula for mirror placement is given below:

According to the principle and mechanism analysis of ISA algorithm, the specific steps of ISA algorithm are as follows:

Step 1: Initialize the number of ISA populations with the number of iterations;

Step 2: Initialize the ISA population. Initialize the ISA population using the random uniform distribution strategy, calculate the fitness value, or obtain the current optimal value and optimal solution;

Step 3: Divide the population. Based on the magnitude between the value of a and the random value r, the population is divided into a synthetic design sub-population and a mirror localization sub-population;

Step 4: For the synthetic design subpopulation, Equation (2) is used to update the population position; for the mirror localization subpopulation, Equation (4) is used to update the population position;

Step 5: Perturb the global optimal point using a local search strategy;

Step 6: Calculate the fitness value and select and retain the better solution using an elite selection strategy;

Step 7: Determine whether the number of iterations reaches the maximum number of iterations. If it reaches, output the optimal solution and optimal value; otherwise, return to step 3.
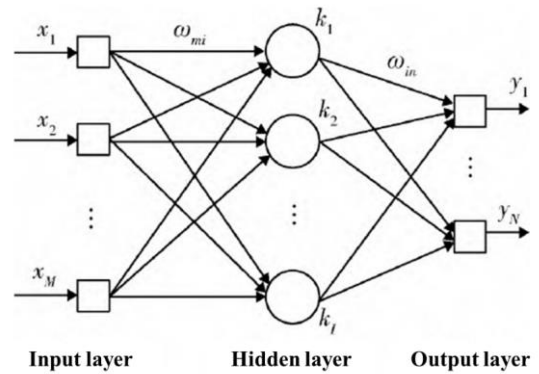
3.2. BP Neural Network

BP neural networks are widely and successfully used for classification, prediction and problem solving. It consists of three layers: input layer (I layer), hidden layer (H layer) and output layer (O layer), and the input and target samples are automatically divided into training, validation and test sets.The neurons in the I layer, H layer and O layer can be denoted as $x_m (m=1,2,\ldots,M)$, $k_i (i=1,2,\ldots,I)$, $y_p (p=1,2,\ldots,N)$, and W_{mi}, W_{in} denote the connection weights from x_m to k_i and from k_i to y_n , respectively, and the structure of BP neural network is shown in Figure. 6.

Figure 6. BP neural network model

Let the number of network iterations be s , u , v denote the inputs and outputs of each layer respectively, then the actual output of the network can be defined as

$$Y(s) = (v_N^1, v_N^2, \ldots, v_N^N) \quad (6)$$

Its desired output is

$$d(s) = (d_1, d_2, \ldots, d_N) \quad (7)$$

Input signal forward propagation

Let the input signal be x_s, then the output of the m th neuron in layer I can be expressed as

$$v_M^m(s) = x(s) \tag{8}$$

The inputs u_I^i and outputs v_I^i of the i th neuron of layer H are respectively defined as

$$u_I^i(s) = \sum_{m=1}^M w_{mi}(s) v_M^m(s) \tag{9}$$

$$v_I^i(s) = f\left(u_I^i(s)\right) \tag{10}$$

where $f(\square)$ denotes the H-layer transfer function.

Then the input u_N^n and output v_N^n of the n th neuron of layer O can be expressed as

$$u_N^n(s) = \sum_{n=1}^N w_{in}(s) v_I^i(s) \tag{11}$$

$$v_N^n(s) = g\left(u_N^n(s)\right) \tag{12}$$

where $g(\square)$ denotes the output layer transfer function.

Then the overall error of this network can be expressed as

$$e(s) = \frac{1}{2}\sum_{n=1}^N e_n^2(s), e_n(s) = d_n(s) - v_N^n(s) \tag{13}$$

Error signal back propagation

When the overall system error is greater than a threshold value, the weights need to be adjusted so that the error gradually decreases.

The weighting between the H and O layers is changed to

$$w_{in}(s+1) = w_{in}(s) + \Delta w_{in}(s) \tag{14}$$

The weighting between layers I and H is changed to

$$w_{mi}(s+1) = w_{mi}(s) + \Delta w_{mi}(s) \tag{15}$$

Where, $\Delta w_{in}(s)$ denotes the weight adjusted value of H layer and O layer, and $\Delta w_{mi}(s)$ denotes the weight adjusted value of I and H layers.

After continuous learning and training until the error is reduced to within the threshold, the trained neural network can be utilized for regression prediction of performance.

3.3. ISA-based parameter optimization method for BP neural networks

Coding method

In this paper, the real number coding method is used to encode the hidden layer parameters, and the coding region is mainly divided into the hidden layer weight values and the hidden layer bias, l The coding dimension of the m dimensional inputs for hidden layer units is $m \times l + l$, and the coding dimension of the two hidden layers is $(m_1 \times l_1 + l_1) + (m_2 \times l_2 + l_2)$.

Adaptation function

In order to accurately reflect the strengths and weaknesses of the trained BP network, this paper adopts MAE as the fitness function

ISA-BP method

According to the coding method and fitness function, the steps of BP neural network prediction method based on ISA algorithm are as follows:

Step 1: The ISA algorithm encodes the initial parameters of the BP, and also initializes the algorithm parameters such as the population parameters, the number of iterations, and so on; calculates the value of the fitness function;

Step 2: Update the location information of ISA population using synthetic design strategy, mirror localization strategy, and local search strategy;

Step 3: Calculate the fitness function value and update the global optimal solution;

Step 4: Judge whether the termination condition is satisfied. If it is satisfied, exit the iteration, output the optimal network parameters and execute step 6, otherwise continue to execute step 3;

Step 5: Decode the ISA-based optimization network parameters to obtain the hidden layer unit weights and biases of the BP network;

Step 6: Construct ISA-BP network and train the network to get the prediction model using the sample set.

4. Integrated Learning Technologies

In order to make the training process less prone to overfitting phenomenon and improve the accuracy of the weak predictor, combined with AdaBoost technology, the integrated ISA-BP algorithm is constructed based on the ISA optimization to improve the BP algorithm. Assuming the training sample set $X = \left[x_{ij}\right]_{n \times d}$, where n is the number of samples and d is the dimension of talent team building performance analysis system; the base predictor ISA-BP, denoted as $f_{ISA-BP}(\cdot)$; the number of base evaluators is T. The specific algorithm is described as follows:

Step 1: Initialize the weight distribution of the samples $D_1 = (\omega_{1,1}, \omega_{1,2}, \cdots, \omega_{1,n})$, the weights of each sample are calculated as follows:

$$\omega_{1,i} = \frac{1}{n}, i = 1, 2, \cdots, n \tag{16}$$

Step 2: For the iteration round $t = 1, 2, \cdots, T$, use the training sample base evaluator $h_t = f_{ISA-BP}(X, D_t)$ with the current distribution D_t;

Step 3: Calculate the prediction error of the base evaluator h_t on the set of training samples:

$$\varepsilon_t = \sum_{i=1}^{m_s} \omega_{t,i} e_{t,i} \tag{17}$$

$$e_{t,i} = \begin{cases} 1 & y_i \neq h_t(x_i) \\ 0 & y_i = h_t(x_i) \end{cases} \tag{18}$$

where $e_{t,i}$ is the error of the ith sample on the t base evaluator, $e_{t,i}=1$ indicates that the error is 1 at the supervised signal $y_i \neq h_t(x_i)$, and $e_{t,i}=0$ indicates that the error is 0 at the supervised signal $y_i = h_t(x_i)$.

Step 4: Calculate the weight coefficients for the base evaluator h_t a_t :

$$a_t = 0.5 \lg \frac{\varepsilon_t}{1-\varepsilon_t} \tag{19}$$

Step 5: Update the sample distribution of the training sample set D_{t+1} , until the number of iteration rounds reaches the maximum.

$$\omega_{t+1,i} = \omega_{t,i} e^{-a_t y_i^2} \tag{20}$$

Step 6: Linearly combine the T base evaluators to end up with the strong evaluator, Integrated ISA-BP (ISA-BP with AdaBoost, ISA-BP-Ada):

$$f_{ISA-BP-ada}(X) = round\left(\sum_{t=1}^{T}\left(\ln\frac{1}{a_t}\right)G(X)\right) \tag{21}$$

Where $G(X)$ is the median of all $a_t h_t(X)$ and $round(\cdot)$ indicates rounding.

5. methodological process for predicting the performance of talent team building based on ISA-BP-Ada algorithm

Combining AdaBoost and ISA-BP, this section proposes a prediction modeling method for talent team building based on the integrated ISA-BP-Ada algorithm. The prediction model focuses on the mapping relationship between the influencing factors and the predicted value of performance with the analyzing system influencing factors as input and the predicted value of performance as output. The flow chart of talent team construction prediction based on integrated ISA-BP-Ada algorithm is shown in Figure 7. The specific steps are as follows:

Step 1: Extract the talent team building performance data based on questionnaires, performance appraisals, etc.; pre-process the acquired samples, adopting sparse smoothing data processing method; divide the data set, dividing the data set into training set, validation set and test set;

Step 2: Initialize AdaBoost parameters. Randomly initialize the parameters of ISA-BP; set the number of weak classifiers T' ; initialize the distribution weights of training samples D_1' ;

Step 3: Train the weak predictor ISA-BP.

(1) Use ISA algorithm to encode the initial parameters of the BP neural network, as well as initialize the algorithm parameters such as the population parameters and the number of iterations; initialize the population and calculate the value of the objective function;

(2) Updating location information using synthetic design, mirror localization, and local search strategies;

(3) Compare the value of the objective function of the population with the value of the objective function of the current global optimal solution and update the global optimal solution;

(4) Judge whether the termination condition is satisfied, if so, exit the iteration, output the optimal BP parameters and execute step (2), otherwise continue to execute step (5);

(5) Decode the parameters of ISA-based optimized BP network to obtain the optimal network parameters and construct the weak predictor ISA-BP network;

Step 4: Calculate the weight coefficients a_t' as well as update the sample distribution D_{t+1}' ; train the weak classifier until the end of the iteration rounds and output the strong classifier ISA-BP-Ada;

Step 5: Predict the current test set using the trained strong predictor and output the corresponding predicted values.
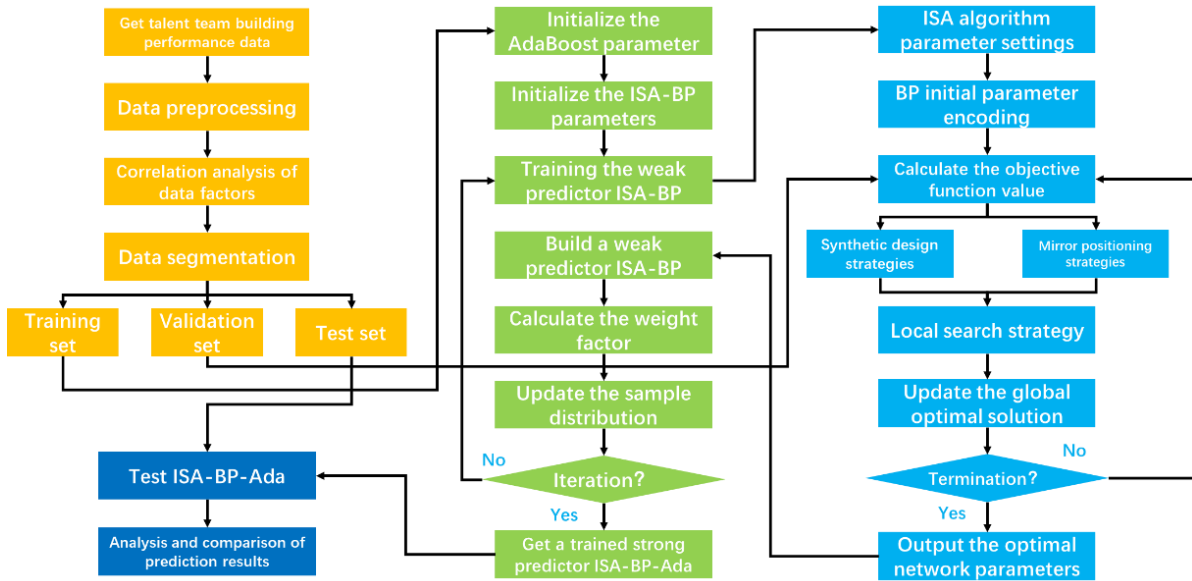
Figure 7. Flow chart of talent team building performance prediction method based on ISA-BP-Ada algorithm

6. Experiments and analysis of results

In order to verify the accuracy and timeliness of the talent team building performance prediction model proposed in this paper, five evaluation algorithms are selected for comparison, and the specific parameter settings of each algorithm are shown in Table 1.The data are mainly from the talent team building performance data, which are divided into training set, validation set, and test set, where the training set is mainly used to train the model, the validation set is mainly used to compute the fitness value in the optimization process, and the test set is mainly used to test the evaluation model. The experimental simulation environment is Windows 10, CPU is 2.80GHz, 8GB memory, programming language Matlab2017a.

Table 1. Parameterization of the performance prediction methodology for the building of the talent force

arithmetic	parameterization
BP PSO-BP	Hidden layer node is 50, activation function is radial basis function
GA-BP GWO-BP ISA-BP	Hidden layer nodes refer to section 5.1, the activation function is radial basis function, the population size setting refer to the analysis in section 5.1, and the maximum number of iterations is 500.
ISA-BP-Ada	Hidden layer nodes refer to section 5.1, the activation function is radial basis function, the population size setting refer to section 5.1, the maximum number of iterations is 500, and the number of weak classifiers is 10.

6.1. Parameter setting analysis

In order to analyze the impact of the ISA algorithm population size and the number of hidden layer nodes of BP neural network on the prediction performance, this paper separately compares and analyzes the performance prediction performance of talent team building under the conditions of different population sizes and different numbers of hidden layer nodes. Figure 8 gives a graph of the impact of different population sizes and different numbers of hidden layer nodes on prediction accuracy, and Figure 9 gives a graph of the impact of different population sizes and different numbers of hidden layer nodes on performance prediction time.

From Fig. 8, it can be seen that as the population size of ISA algorithm increases, the performance prediction value has a tendency to decrease; as the number of hidden layer nodes increases, the performance prediction value also decreases. From Figure 9, it can be seen that as the ISA algorithm population size increases, the prediction time is increasing; as the number of nodes increases, the prediction time is increasing. In summary, the intelligent optimization algorithm population size selected in this paper is 30 and the number of hidden layer nodes is 70.
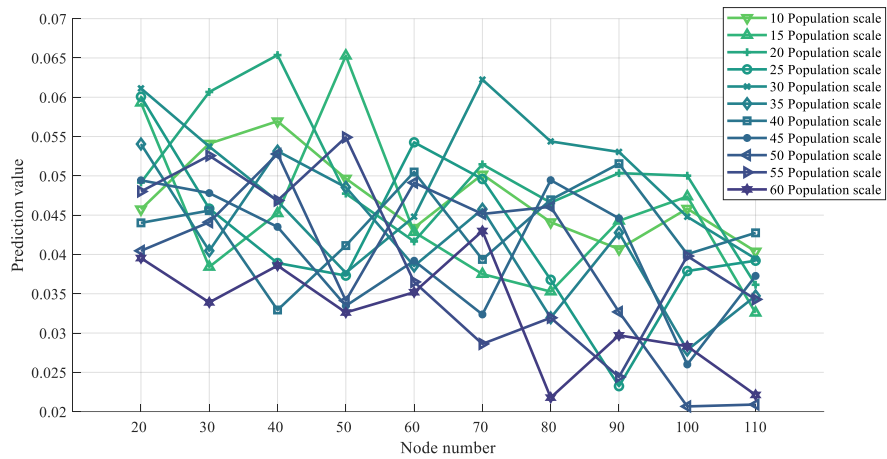
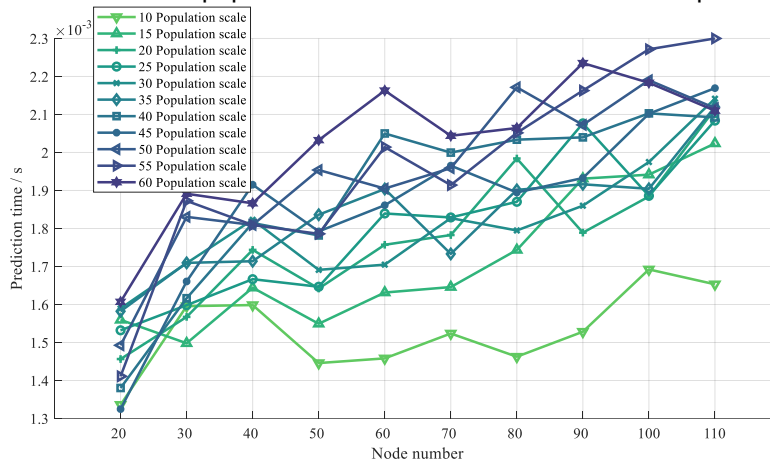**Figure 8.** Effect of different population sizes and number of nodes on prediction accuracy

Figure 9. Effect of different population sizes and number of nodes on prediction time

6.2. Experimental Predictive Performance Analysis

In order to verify the effectiveness and superiority of the talent team performance prediction method based on the ISA-BP-Ada algorithm, ISA-BP-Ada is compared with five

Figure 10 gives the prediction results of talent team building resources based on each algorithm. As can be seen from Figure 10, comparing ISA-BP-Ada with ISA-BP algorithm, it can be seen that the integration technology can improve the prediction accuracy of ISA-BP algorithm; comparing ISA-BP with BP, PSO-BP, GA-BP, GWO-BP algorithms, it can be seen that ISA algorithm can optimize

other models such as BP, PSO-BP, GA-BP, GWO-BP, ISA-BP, etc., and the evaluation results of each model are shown in Figure 10 and Figure 11. the BP network parameters, which can improve the BP prediction accuracy; comparing ISA-BP-Ada with BP, PSO-BP, GA-BP, GWO-BP, and ISA-BP shows that the prediction accuracy of ISA-BP-Ada network is better than other models. Meanwhile, the predicted value of talent team building performance based on ISA-BP-Ada is closest to the real value.
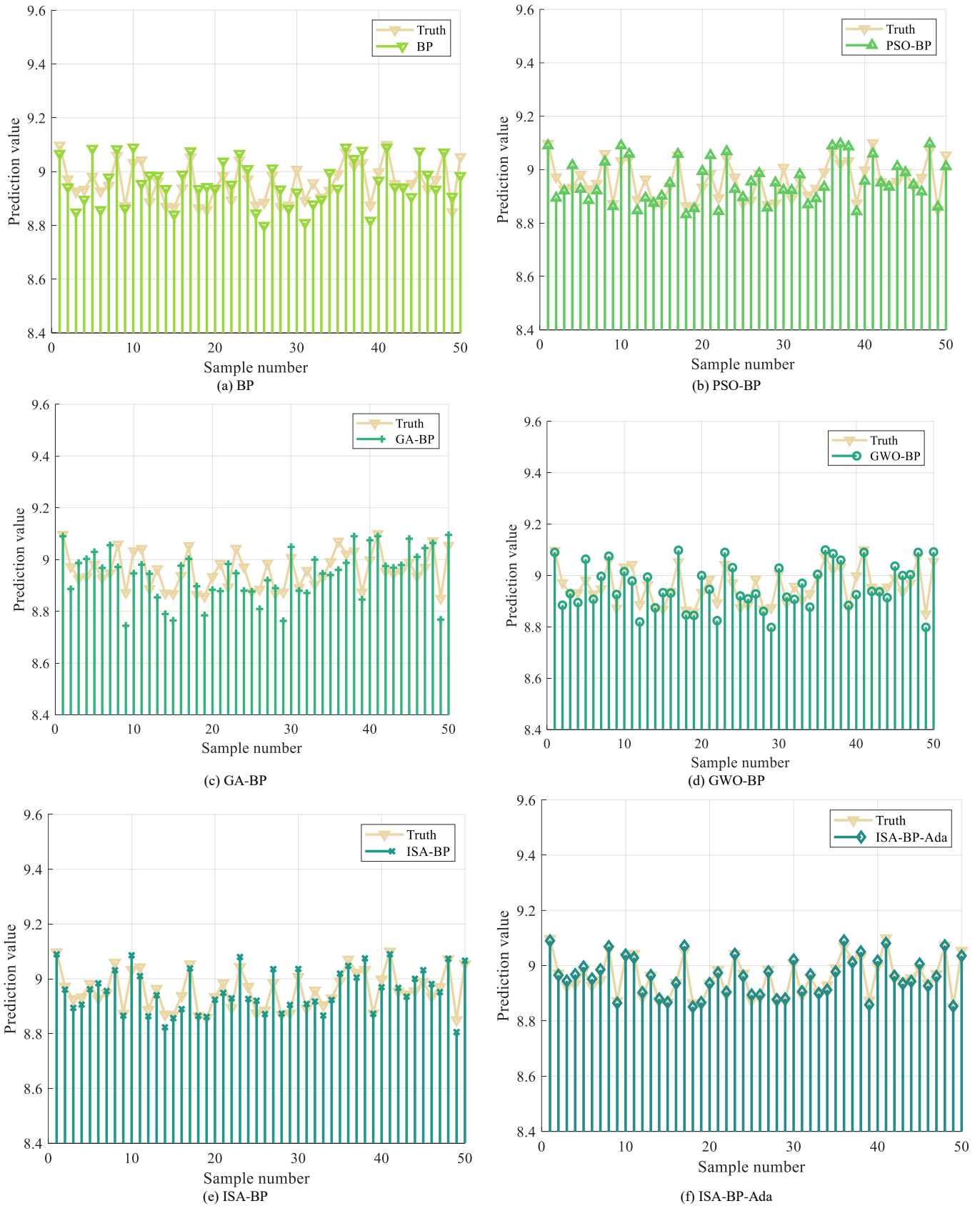
Figure 10. Predicted Performance of Talent Workforce Building Resources Based on Each Algorithm

Figure 11 gives the results of the prediction error of talent team building resource performance based on each algorithm. As can be seen from Figure 11, the prediction error value of talent team building resource performance

based on ISA-BP-Ada algorithm is controlled within 0.04, and the prediction error value of talent team building resource performance of BP, PSO-BP, GA-BP, GWO-BP, and ISA-BP algorithms is controlled within 0.1, 0.07, 0.15, 0.08, and 0.05, respectively. It can be seen that the prediction error of talent team building resource performance based on ISA-BP-Ada algorithm is minimized.
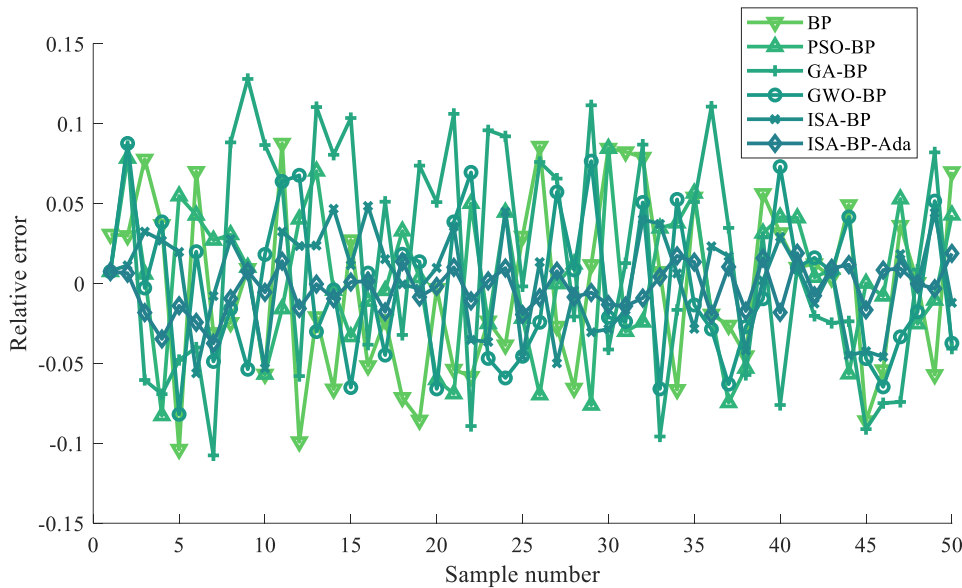

Figure 11. Relative error results for predicting the performance of talent pipeline resources based on each algorithm

6.3. Analysis of model performance metrics

In order to further verify the superiority of the talent team building resource performance prediction method based on ISA-BP-Ada algorithm, the prediction performance results of each algorithm are statistically given in this section, as shown in Figure 12. From Figure 12(a), it can be seen that the MAE value of talent team building resource performance prediction based on ISA-BP-Ada algorithm is smaller than other algorithms, and the prediction effect is better than other algorithms. From Figure 12(b), it can be seen that the R2 value of talent team building resource performance prediction based on ISA-BP-Ada algorithm is larger than other algorithms, and the prediction effect is better than other algorithms. From Figure 12(c), it can be seen that the prediction time of talent team building resource performance based on ISA-BP-Ada algorithm is smaller than BP, PSO-BP, GA-BP, GWO-BP, and ISA-BP algorithms. In conclusion, the talent team building resource performance prediction method based on ISA-BP-Ada algorithm works better than other algorithms and meets the real-time requirements.

(a) MAE

(b) R2
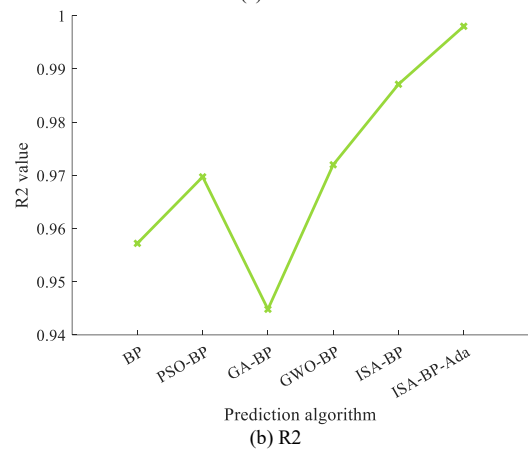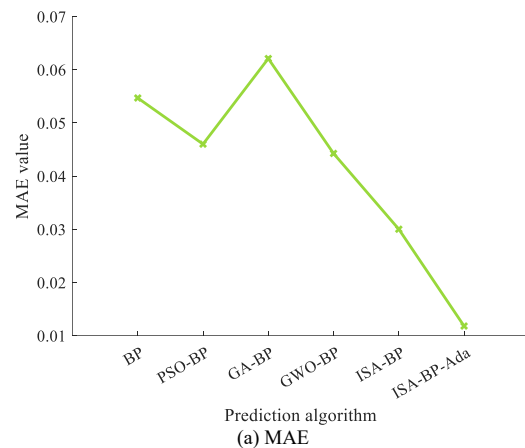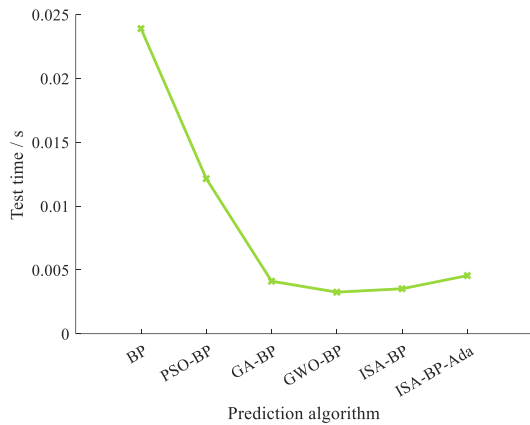
(c) Forecasting time

Figure. 12. Comparison of the performance analysis of predicting the performance of talent team building based on each algorithm

7. Conclusion

Aiming at the defects of incomplete, low accuracy and low real-time performance prediction method of talent team construction, this paper adopts integrated learning technology, internal search optimization algorithm and BP neural network to construct talent team construction performance prediction method. The method constructs the talent team construction performance analysis system by analyzing the talent team construction performance management process according to the principle of selecting performance influencing factors. Combined with integrated learning technology, the ISA algorithm is used to improve the BP neural network and construct the talent team construction performance prediction model. Simulation experiments are carried out using talent team construction performance data, and the following conclusions are drawn:

(1) The ISA algorithm can improve the accuracy of BP neural network by comparing the prediction performance of ISA-BP with BP, PSO-BP, GA-BP and GWO-BP models;

(2) Integrated learning further improves the prediction model accuracy by comparing the prediction performance of ISA-BP-Ada and ISA-BP models;

(3) ISA-BP-Ada prediction time meets real-time requirements.

The BP neural network used in this paper has a shallow hierarchy, making the prediction accuracy somewhat limited. In future work, the introduction of deep learning for optimization will be considered to improve the accuracy of the algorithm.

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