Research on ideological security of college students based on GA-BP algorithm

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Abstract. In order to evaluate the degree of ideological security of college students scientifically, a prediction model of ideological security of college students based on BP neural network optimized by genetic algorithm is proposed. The entropy method is used to determine the index weight and initial prediction results of the security model prediction. The genetic algorithm is used to optimize the weight and threshold of the BP neural network model, and an ideological and ideological security evaluation model for college students is constructed. The experimental results show that compared with the BP algorithm model, the average error of the improved GA-BP algorithm model is reduced by 12.11%, reaching 0.245%. It shows that the improved GA-BP model can predict the ideological security of college students.

1. Introduction
The security of ideology is a hot issue in China. The evaluation of ideological security of college students is one of the key tasks of higher education. Targeted education is carried out according to the prediction results to ensure the effectiveness of ideological education. Using the global search ability of genetic algorithm to optimize the BP neural network, the application of GA-BP neural network to the ideological and ideological security evaluation model has not been studied by scholars[1]. In this paper, entropy method is used for preliminary evaluation, the results of evaluation are modified by the improved GA-BP neural network model, and the evaluation model of trained ideological security is used for the final evaluation.

2. Algorithm Introduction
The smaller the information entropy in the entropy method, the greater the degree of difference in indicators, the more information provided, the greater the role it plays in comprehensive evaluation, and the greater the weight[2]. In the aspect of ideological security, firstly, entropy method is used to determine the index weight and carry out preliminary evaluation. The evaluation result is taken as the target vector and modified by the improved GA-BP neural network model. In the process of searching, genetic algorithm can automatically acquire and accumulate the knowledge of searching space, and obtain the best solution by controlling the searching process adaptively[3]. It can not only accelerate the convergence of genetic algorithm to the optimal solution, but also maintain the diversity of population and prevent premature convergence[4]. The global search feature of genetic algorithm is used to optimize the weight and threshold of neural network to overcome the disadvantage that neural network based on gradient descent method is easy to fall into local optimum[5].

3. Design of prediction model for Ideological Security
The entropy method, genetic algorithm and neural network are combined to establish the ideological and ideological security evaluation model of college students. The establishment process is shown in Figure 1.

**Figure 1.** Model building process chart.

### 3.1 Model establishment
Through investigation and research, establish the model index system as shown in Figure 2 and takes the input layer of neural network as the evaluation indexes, using A1, A2, A3, …, A11, A12 and A13.

**Figure 2.** Index system.

### 3.2 Data selection
This paper selects 1000 valid data of a college student, uses the first 786 data as training samples, the remaining 214 data as test samples. The original part of the data is shown in Table 1:

| 1. Tutor's evaluation of his ideology | 2. Students' evaluation of their ideology | 3. The evaluation of his ideology by his roommates | 4. Psychological evaluation of students | 5. Voluntary service | 6. Do you actively participate in voluntary service | 7. Student cadre or not | 8. Political affiliation | 9. Personal belief | 10. Achievements in the course of introduction to Mao Zedong Thought and the theoretical system of socialism with Chinese characteristics | 11. Marx's curriculum achievements | 12. Achievements of Ideological and Political Courses | 13. Achievements of Lei Feng's Introduction to spirit |
|----------------------------------------|------------------------------------------|-----------------------------------------------|---------------------------------|------------------|--------------------------------|------------------|-----------------|-----------------|----------------------------------------------------------------|----------------|----------------------|------------------|
| 0.7                                    | 0.7                                      | 0.7                                           | 0.7                            | 0.5              | 0.9                              | 0.5              | 65              | 0.9             | 65                                                             | 75              | 88                   | 64                |
| 0.7                                    | 0.5                                      | 0.6                                           | 0.6                            | 0.4              | 0.9                              | 0.5              | 65              | 0.9             | 65                                                             | 75              | 75                   | 66                |
| 0.5                                    | 0.6                                      | 0.5                                           | 0.7                            | 0.9              | 0.5                              | 0.5              | 65              | 0.9             | 65                                                             | 65              | 68                   | 58                |
| 0.6                                    | 0.7                                      | 0.5                                           | 0.6                            | 0.9              | 0.9                              | 0.9              | 65              | 0.9             | 65                                                             | 75              | 65                   | 62                |
| 0.6                                    | 0.8                                      | 0.7                                           | 0.4                            | 0.9              | 0.9                              | 0.9              | 65              | 0.9             | 65                                                             | 75              | 75                   | 69                |
| 0.5                                    | 0.5                                      | 0.5                                           | 0.8                            | 0.6              | 0.9                              | 0.5              | 65              | 0.9             | 65                                                             | 65              | 65                   | 53                |
| 0.7                                    | 0.6                                      | 0.6                                           | 0.5                            | 0.8              | 0.9                              | 0.5              | 65              | 0.9             | 65                                                             | 75              | 65                   | 59                |
| 0.6                                    | 0.5                                      | 0.7                                           | 0.4                            | 0.3              | 0.9                              | 0.5              | 65              | 0.5             | 65                                                             | 85              | 85                   | 66                |

In the experiment, the data need to be normalized, and the maximum and minimum method can be used to normalize the data[6]. The entropy method is used to calculate the normalized data and get the initial evaluation results:

a) Standardized raw data:

$$X'_{ij} = (x_{ij} - \bar{x})/s_j$$

Where $x_{ij}$ is the performance value of sample i in index j; $x'_{ij}$ is the value after standardized operation; $\bar{x}$ is the average value of index j; $s_j$ is the standard deviation of index j. The translation amount of the value is:

$$z_{ij} = x'_{ij} + B$$

Where $z_{ij}$ is the value after translation; $B$ is the length of translation.

b) The ideological and ideological security evaluation index is quantified. Under the j index, the proportion of the i sample in the index $p_{ij}$ is calculated as follows:

$$p_{ij} = z_{ij}/\sum_{i=1}^{13} z_{ij}$$

Where $i=1, 2, ...786; j=1, 2, ..., 13$

c) The entropy value of index J is calculated as:

$$E_j = -k \sum_{i=1}^{13} p_{ij} \ln(p_{ij})$$

Where $k = 1/ \ln(n)$, $E_j \geq 0$.

d) Calculate the difference coefficient of index j:

$$G_i = 1 - E_i$$

e) Normalize the difference coefficient, and calculate the weight of index j as follows:

$$w_j = G_i/\sum_{i=1}^{13} G_i$$

f) Calculate the ideological security of the i-th sample
For:

\[ F_i = \sum_{j=1}^{m} w_{ij} p_j \]  

(7)

### 3.3 BP neural network design

Because the three-layer feedforward neural network can approach any continuous nonlinear function with any accuracy[7]. In order to ensure better network generalization ability, we use as few hidden layer nodes as possible[8]. Sigmoid function is a nonlinear function commonly used in BP neural network. The formula is:

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

(8)

The transfer function of BP neural network must be differentiable, so in general, the sigmoid function or linear function is used as the transfer function of BP neural network[9]. Trainlm is used as the training function in this model.

### 3.4 Optimization of BP neural network by genetic algorithm

Individuals in the population can calculate individual fitness value through fitness function, and then find the optimal individual by selecting crossover and mutation operations[10]. The weights and thresholds of the network are assigned by the optimal individuals, and the output layer outputs after the network training[11].

#### 3.4.1 Fitness function

Through the optimized weight and threshold of the improved genetic algorithm, the sum of error squares between the output value of BP neural network and the target value of the prediction sample is minimized, so the model can be transformed into the problem of finding the minimum value [12]. The reciprocal of the square sum of the neural network errors is taken as the fitness function, and the calculation formula is as follows:

\[ f = \frac{1}{SE} \]  

(9)

\[ SE = \sum (y_i - o_i)^2 \]  

(10)

In equation (10), \( y_i \) it is the predicted output of the network, and \( o_i \) it is the actual output. SE represents the sum of squares of errors.

#### 3.4.2 Control parameters of genetic operators

After training samples for many times, the size of the selected group is 50. The roulette selection method was used to determine the survival elimination of individuals. The basic idea of roulette is that the probability of each individual being selected is directly proportional to its fitness.

### 4. Experiment and result analysis

#### 4.1 Ideological model prediction

In the experiment, the maximum number of iterations is 100, the training goal is 0.0001, and the learning rate is 0.1. The input layer of neural network is 13, the output layer is the evaluation result, and the output layer node number is 1. When the hidden layer node number is 19, the convergence accuracy of network structure is the best. The topological structure of the neural network model is 13-19-1.

#### 4.2 Experimental comparison of prediction results

Genetic algorithm is used to optimize BP neural network. The following is a comparative analysis of ideology of some predicted students, as shown in Table 2.

| True value | Predicted value (BP) | Predicted value (GA-BP) | Predicted value (improved GA-BP) | Error rate 1 (BP) (%) | Error rate 2 (GA-BP) (%) | Error rate 3 (improved GA-BP) (%) |
|------------|----------------------|-------------------------|-------------------------------|----------------------|------------------------|----------------------------------|
| 80.0000    | 70.0013              | 82.1137                 | 79.8520                       | 12.50                | 2.64                   | 0.21                             |
In the model of ideological and ideological security assessment of college students, the average error of BP neural network model is 14.56%, the average error of GA-BP neural network model is 5.79%, and the average error of improved GA-BP neural network model is 2.45%. It can be seen from the average error results that the average error of the improved GA-BP neural network model is 12.11% less than that of the only BP neural network model.

R² is a model fitting evaluation coefficient, the closer it is to 1, the better the performance of the model. The figure below shows the fitting between the predicted results of BP neural network optimized by genetic algorithm and the real values. Figure 3 shows the fitting results of BP algorithm. It can be seen from the figure that the fitting effect is not very good. Figure 4 shows the fitting results obtained by GA-BP algorithm. Through the comparison of R² values, it can be concluded that the fitness of GA-BP algorithm is better than that of BP algorithm alone. The experimental results show that R²=0.88307 for GA-BP algorithm and R²=0.73916 for BP neural network. Through numerical comparison, it can be seen that the fitting degree of GA-BP algorithm model is higher than that of BP algorithm model only. The improved genetic algorithm optimizes the BP neural network model as shown in Figure 5. According to R², the fitting degree of the improved algorithm model is 0.95584, which is greatly improved compared with the previous algorithm.

|     | 80.0000 | 80.0000 | 95.0000 | 95.0000 | 35.0000 | 35.0000 |
|-----|---------|---------|---------|---------|---------|---------|
|     | 71.4561 | 76.9728 | 97.7147 | 97.3581 | 37.2328 | 37.2848 |
|     | 10.68   | 21.14   | 6.28    | 8.42    | 18.11   | 16.76   |
|     | 3.78    | 9.14    | 5.95    | 3.91    | 6.14    | 6.89    |
|     | 0.20    | 4.33    | 2.86    | 1.73    | 5.32    | 0.08    |
|     |         |         |         |         |         |         |

|     | 85.0000 | 85.0000 | 35.0000 | 35.0000 | 35.0000 |
|-----|---------|---------|---------|---------|---------|
|     | 86.3125 | 90.8902 | 41.3389 | 32.6591 | 40.8643 |
|     | 95.3251 | 95.3512 | 37.2848 | 36.8609 | 38.2421 |
|     | 9.14    | 14.99   | 18.11   | 16.76   | 16.76   |
|     | 4.33    | 2.93    | 6.69    | 9.26    | 9.26    |
|     | 0.34    | 0.08    | 5.32    | 0.12    | 0.12    |

Figure 3. BP fitting result chart.

Figure 4. GA-BP fitting result chart.
5. Summary
This paper analyzes the research methods of ideological and ideological security of college students, and proposes an improved adaptive mutation genetic algorithm to optimize the BP neural network model. Through in-depth study, the index system of ideology security model is established. The error of BP network optimization is analyzed. Compared with the simple network model using BP algorithm, the error of GA-BP algorithm and improved GA-BP algorithm is significantly reduced, from the original 14.56% to 2.45%, and the average error is reduced by 12.11%. Experiments show that the improved GA-BP neural network model can accurately predict the ideological security of college students. It is helpful to discover the problems of ideological and ideological security of college students in time in the future, and provides an efficient channel for colleges and universities to understand the development of ideological and ideological development of college students.

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Figure 5. The improved GA-BP fitting result chart.
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