Research on BP Neural Network-Based Technical Skills Training Model Under the Background of College-Enterprise Integration

Xin Chen[1][a], Wei Wang[2][b*] and Yindong Zhu[1][c]
[1]*Cyberspace Security Institute, Changchun University, Changchun 130022, China*
[2]*Computer Science and Technology Institute, Changchun University, Changchun 130022, China*

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Abstract: College-enterprise integration is a new model of technical and skilled personnel training produced with the development of education in the new era, and it is also an important way to improve the quality of higher vocational education personnel training. In this paper, we construct a talent cultivation model based on BP neural network, and improve each link of the talent ecological cultivation circle by constantly correcting the weights to arrive at the values of the vocational ability indexes possessed by the graduates satisfied by employers. The MATLAB simulation tests confirmed the scientific and reasonable nature of the talent cultivation model. The MATLAB simulation tests confirmed the scientific and reasonable nature of the talent cultivation model.

1 INTRODUCTION

It is generally believed that technically skilled personnel are composite talents who can use the basic theoretical knowledge of technology learned to create wealth for society, but also work in front-line positions such as production or service, and can perform practical operations skillfully (Cui 2021). Data show that 70% of new front-line practitioners come from vocational colleges every year, which shows that vocational colleges are the main source of technical skill talents. The "college-enterprise integration" means that the school adopts the form of purchasing services to seek cooperation with enterprises and make joint efforts to carry out practical teaching for students, i.e., the school provides design plans and is responsible for personnel management, the enterprise provides equipment, technology and teachers, and the school and the enterprise closely integrate to organize practical training, create a real environment of practical training positions and professional atmosphere in the school, so that Students can get out of the classroom, experience the workflow, and master the operation skills, and then cultivate high-quality technical skill talents who have the knowledge, ability, and quality required by the occupation and can be competent to perform the job duties(Xinhua net 2021). Therefore, this paper proposes to build a model of technical skills training in the context of school-enterprise integration.

2 PROBLEMS

Insufficient substantial output of school-enterprise cooperative education model. Most higher vocational colleges and local application-oriented undergraduate colleges have carried out school-enterprise cooperative education model. However, in the actual implementation process, the model is too single, and the education effect and substantial output are insufficient. The so-called school-enterprise curriculum replacement refers to the fact that enterprises do not fully understand the teaching management mode and assessment requirements of institutions, and participate in the on-campus practical course guidance method for too short a time and too much content, with little process for students to understand, practice and improve. The institution has too little intervention in the enterprise replacement course, the

[a] https://orcid.org/0000-0003-3615-9833
[b] https://orcid.org/0000-0001-6571-6972
[c] https://orcid.org/ 0000-0003-4298-0003

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process supervision is not timely, and the final enterprise replacement course grade is higher and lacks distinction. Literature (Yang 2021) suggests that the modern apprenticeship system can solve the problems of inadequate standards of vocational education system, lack of "application-oriented curriculum" and lack of corporate responsibility, but it does not clarify the specific reform plan and lacks practical effects.

Mismatch between faculty technical skills upgrading and rapid business development. For the training of technical skill talents, the construction of teachers is an important link and the key to ensure the quality of talent training. At present, the construction and continuous training of "dual-teacher" teachers still face many problems. Teachers in colleges and universities are less involved in actual projects in enterprises and less involved in front-line production lines, and teachers who have obtained "dual-teacher" qualifications lack follow-up continuous learning and exercise process, which makes technical skills fail over time**.** In the literature(Jiang 2021, Yi 2021, Zhao 2021)the "1+X" certificate system is used to train technical skill talents in a complex way, and the reform ideas are mainly proposed in three aspects: faculty, curriculum system and quality evaluation, but they only emphasize the reform measures without indicating specific criteria, such as talent training quality evaluation criteria.

3 BP NEURAL NETWORK

3.1 Theory

BP neural network, a multi-layer feed-forward neural network consists of information forward transmission and error back propagation, and the topology is divided into 3 layers, i.e., input layer, implicit layer and output layer. In the process of forward propagation of information, the signal will then be processed from the input layer through the implicit layer by layer and finally reach the output layer and output the information processing results, completing a learning process of forward propagation. When the output layer does not get the expected target output value, it enters the backward propagation phase of the error, adjusts the network weights and thresholds according to the error value, and trains repeatedly to make the BP and repeated training to make the predicted output of the BP neural network The network weights and thresholds are adjusted according to the error value, and the training is repeated so that the predicted output of the BP neural network is continuously approximated to finally achieve the expected output and complete the overall modeling The modeling effect is completed.

3.2 BP Neural Network Mathematical Model

The corresponding data model is constructed according to the principle of BP neural network, and the specific construction process (Cong 2009, Zhang 2013) is as follows.

Let the input layer of the BP network have neurons(m), the output layer has neurons(n), the middle layer(p) has one neuron, and the training samples are N. Then the network is set up as follows: input sample vector $A_k = (x_1, x_2, \dots, x_m)$, expected output vector $Y_k = (y_1, y_2, \dots, y_n)$, actual output vector $\widehat{Y_k} = (\widehat{y_1}, \widehat{y_2}, \dots, \widehat{y_n})$, network weighted input for each layer in the middle of the network $S_k = (s_1, s_2, \dots, s_p)$, network output of the intermediate layers$B_k = (b_1, b_2, \dots, b_p)$, the weighted inputs of the output layer each layer $L_k = (l_1, l_2, \dots, l_p)$, the connection right of the Input layer to intermediate layer $w_{ij,}$ intermediate layer to output layer connection rights $v_{ij,}$ threshold values for each cell in the middle layer θ_j, threshold values for each cell of the output layer $r_{i.}$. Among them in $i = 1,2, \dots, p\,; t = 1,2, \dots, n; k = 1,2, \dots N$.

The whole training process is as follows:

a) Initialize and assign random values to connection rights w_{ij}, v_{ij} and thresholds θ_j, r_i.

b) Input training samples (A_1, Y_1).

c) Using the inputs A_k, connection weights w_{ij} and thresholds θ_j, compute the output of each neuron in the interlayer.

$$b_j = f_{(s_j)}, s_j = \sum_{i=1}^{m} w_{ij} x_i + \theta_j \qquad (1)$$

d) Using b_j the connection weights v_{ij} and thresholds $r_{i.}$, the output of each neuron in the output layer is calculated.

$\widehat{y_t} = f(l_t \quad), \quad l_t = \sum_{j=1}^{p} (v_{ij} b_j + r_t)$ (2)

e) Using Y_k the actual output of the network $\hat{Y}_k$, calculate the correction error of each output layer unit's correction error.

$d_t = \widehat{y_t} \cdot (1 - \widehat{y_t}) \cdot (y_t - \hat{y})$ (3)

f) Using v_{jt}, b_j, $\widehat{y_t}$ to calculate the correction error for each cell in the hidden layer.

$$e_j = b_j \cdot (1 - b_j) \cdot \sum_{t=1}^{n} \hat{y}_t \cdot (1 - \hat{y}_t) \cdot (y_t - \hat{y}_t) \cdot v_{jt} \quad (4)$$

g) Compute the new connection between the hidden layer to the output layer using d_t, b_j, v_{jt}, r_i of the new connection rights.

$$v_{jt}(L+1) = v_{jt}(L) + \alpha d_t b_j$$

$$r_t(L+1) = r_t(L) + \alpha d_t \quad (L \text{ indicates the number of training}) \quad (5)$$

h) Use e_j, x_i w_{ij}, θ_j to compute the input layer to the hidden layer of the new connection rights between.

$$w_{ij}(L+1) = w_{ij}(L) + \beta e_j x_i$$

$$\theta_j(L+1) = \theta_j(L) + \beta e_j \quad (6)$$

i) Select the second set of training samples and repeat steps c to h. until all *N* samples have been trained.

j) Start the second training, starting from the first sample, and Repeat steps c to h until the global error function e is less than the predefined value (network error) or the number of training sessions reaches The whole training process is finished.

4 TALENT CULTIVATION ECOSYSTEM

In the process of talent cultivation in institutions, the concept of "talent cultivation ecosystem" has been proposed in the literature, which means that multiple subjects within the educational ecosystem are interconnected and closely integrated, while energy, material and information are exchanged outside the system to form a larger synthesis with the educational ecosystem (Ling 2005). The details are shown in the figure1.

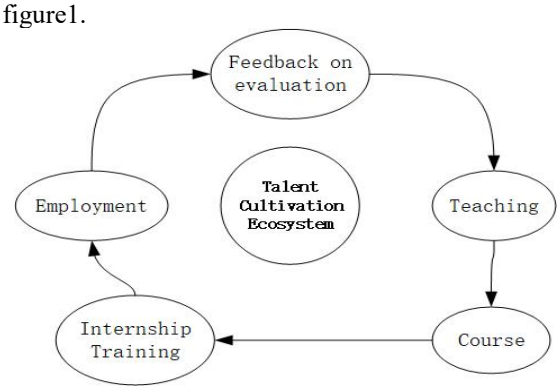

Figure 1: Talent Cultivation Ecosystem

5 BUILDING A BP NEURAL NETWORK MODEL TECHNICAL SKILLS TRAINING

BP neural network has the characteristics of forward transmission of input signal, backward propagation of insufficient information and nonlinearity, which are associated with this talent cultivation model. This paper takes the employment situation of the graduates of Changchun University in 2020 and 2021 as an example, and evaluates the technical skill cultivation level in terms of students' vocational ability, and divides it into two levels of vocational technical skill level evaluation and vocational literacy level for construction.

5.1 Build Model

The structure of the BP neural network is determined according to the input and output data characteristics of the system. The evaluation index system is established by influencing certain key factors of talent training, and the weight of each index is determined by the neural network after training through adaptive learning. As shown in Table 1-2.

Table 1: Students' professional competence evaluation index system—Tier 1

Professional competence evaluation index system	Tier 1 Indicator--Vocational technical skill level
	Usual grades; Hands-on assignments; Scientific Research Competition; Stage Assessment; Professional qualification level certificate; Academic Certificates; Internship Certification; Industry Certification

Table 2: Students' professional competence evaluation index system—sec

Professional competence evaluation index system	Secondary indicator-- Professional quality level
	Thoughtful Literacy; Psychological Literacy; Behavioral Literacy; Social Literacy

In this paper, the set of occupational competence levels is divided into four levels: = {excellent, good, pass, fail}. According to Table 1, the input layer is assumed to be 12 nodes, i.e., the 12 indicators mainly included in the influence of occupational competence as the input layer. The evaluation result is the output of the network, and its indicators are taken as the employer satisfaction to establish the original model; the

evaluation result is the output of the network, so the number of output layers is assumed to be n=1. In the neural network of BP algorithm, the selection of the number of nodes in each layer has a great impact on the performance of the network, and if there are too many nodes in the implicit layer, then it will have a negative impact on the generalized reasoning ability of the network, i.e., it will affect the network for new input adaptability. A small number of nodes in the hidden layer also affects the accuracy of network learning and increases the number of local minima, so the number of nodes in the hidden layer needs to be chosen appropriately. Currently, the number of nodes in the implicit layer is mainly based on experience, and according to the empirical formula, the number of implicit layers is 5; the S-type function is generally used as the neuron conversion function of BP neural network, and the specific function form is:

$$f(x)=1/(1+e^{(-x)}) \quad (7)$$

The insufficient information is passed backwards through training, and then analyzed and adjusted the structure and data to further optimize the talent training model. The algorithm model of talent training based on BP neural network includes BP neural network construction, BP neural network training and BP neural network fitting walk. The specific algorithm flow is shown in Fig2.

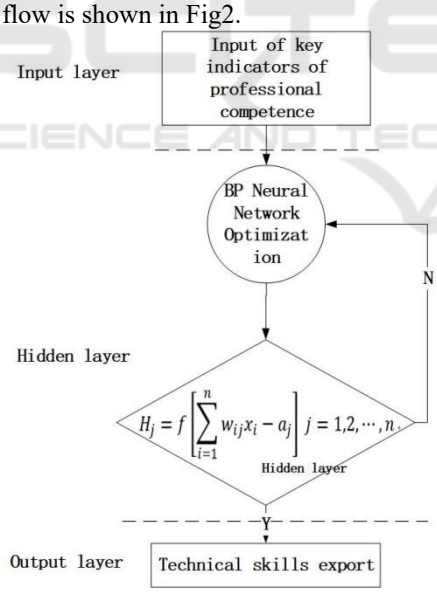

Figure 2: Schematic diagram of BP neural network algorithm

5.2 Implementation

In the implementation process of the model, according to the criteria and numbers of each level of vocational ability level division, as well as according to the employment quality report of Changchun University, the satisfaction of employers to graduates (very satisfied, relatively satisfied, average, unsatisfied) against the level of students' vocational ability, as shown in Table 3.

Table 3: Occupational competence level details

occupational competence levels	Score Criteria	Number（2020）	Employer satisfaction（2020）
Excellent	90-100	2751	68.14%
Good	75-89	1009	25%
Pass	60-74	139	3.43%
Fail	59-	139	3.43%

5.3 Results and Analysis

A three-layer BP neural network model is constructed and then implemented in simulation using MATLAB. This software is widely used in the field of data analysis and can analyze the most valuable information in the shortest possible time. Since the concept of talent training ecosystem was proposed, it has been of great significance in the process of vocational education reform and practice, and has successfully cultivated a batch of high-quality technical skill talents. This cultivation model can be described as a spiral structure model. In order to prove the correct guiding role of the spiral theoretical structure model in practical education, BP neural network is used to test and prove it. Therefore, more than 8,000 sample data from the last 2 years were taken as training test data. Normalizing the sample data, the formula is

$$x_i = (x_i - \min(x))/(\max(x) - \min(x))(x_i \; is \; a \; certain \; sample \; of \; data \; , i = 1,2,\ldots,n) \quad (8)$$

The error accuracy is set to"1e-8"(Error sum of squares), Training function is "trainlm", Learning Rate is "lr=0.4","err-goal=1e-5", "max_epoch=100".

```
net=newff(minmax(p),[s1,s2],{'tansig',
'purelin'},'trainlm');
net.trainParam.lr=0.4;
net.trainParam.show=5;
net.trainParam.epochs=100;
net.trainParam.goal=1e-5;
net.trainParam.min_grad=1e-8;
```

The sample data are trained iteratively at third time (Figure 3), and the actual output fits very well with the target output. It is easy to see that the errors

obtained from training the sample data for the last two years are very small, basically hovering around, so this network model is considered to be very successful, and it also confirms the scientific validity and reasonableness of this model in the talent training ecosystem. the training generations of the BP model are shown in Figure 4.

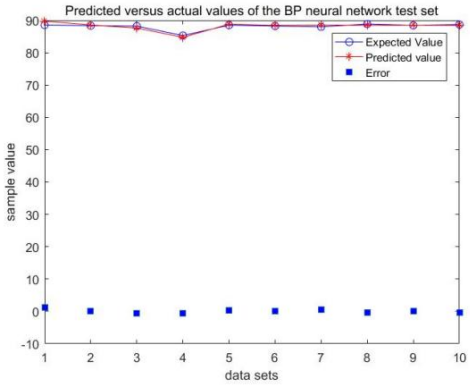

Figure 3: The effect of training and fitting

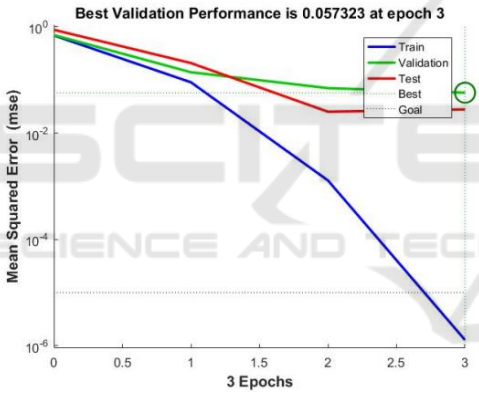

Figure 4: Network training algebra

The test data of this model are the specific data of vocational ability and level of graduates in 2021, which are conducted according to Tables 1 to 3. The absolute and relative errors obtained from the training tests are shown in Table 4.

Table 4: Absolute and Relative Errors

occupational competence levels	Actual number	Predicted number	AE	RE/%
Excellent	3209	3200	9	0.2
Good	629	625	4	0.6
Pass	130	129	1	0.7
Fail	130	128	2	1.5

6 PRACTICE EFFECTIVENESS

According to the results of the tracking survey and external evaluation of the training quality of graduates, all network engineering students of Changchun University participate in innovation and entrepreneurship practice, and are awarded more than 10 innovation and entrepreneurship projects at provincial level and above every year; in the past three years, they have won in the skills competition, network security competition, robotics competition, programming competition and other events In the past three years, they have won more than 80 awards at the provincial level or above in skills competitions, network security competitions, robotics competitions and programming competitions.

The exploration and practice of "excellent engineer" training in computer science under the deep integration mode of industry-university was awarded the second prize of teaching achievement in Jilin Province; 2 golden courses were built in the institute; the first 32km-long quantum-secure communication demonstration network based on commercial optical fiber was built in the northeast provinces for textbook research practice. The first 32km long quantum confidentiality communication demonstration network based on commercial optical fiber has been built; the faculty team has been reasonably constructed, and nearly all of them are equipped with "double teachers". The faculty team is reasonably constructed, with nearly all of them possessing "double teacher" qualification.

7 CONCLUSIONS

The cultivation of technical skills is a long-term process, and students need to accumulate and improve their technical skills under the framework of lifelong learning if they are to be equipped with more technical skills that can be applied in practice. By using BP algorithm to build talent training data model, combined with the annual school dynamic data analysis and subject research results, quantitative analysis and optimization, tracking to find the lack of indicators and the number of deficiencies affecting talent training, and constantly revised. However, the program has not been promoted, and we will cooperate with other institutions and enterprises in the future to further optimize the talent training model, adjust the network weights and thresholds, so that the predicted output of the BP neural network can be approximated

to reach the desired output, and provide a more scientific basis for vocational education talent training.

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