Construction of legal incentive evaluation model based on BP neural network with multiple hidden layers

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Abstract. BP neural network, the basic algorithm of deep learning, is a multilayer feedforward algorithm trained according to the error back propagation algorithm. BP neural network has the function of realizing any complex nonlinear mapping, which makes it especially suitable for solving problems with complex internal mechanism and has strong fitting ability. In this paper, the number, type, propagation rate and usage rate of the objects from 2013 to 2019 are collected as input and output neurons to establish a 6-layer BP neural network model. After experimental verification, the average relative error between the statistical value and the predicted value is 0.23%, which proves that the model has high prediction accuracy and can be applied in the evaluation of professional development.

1. Introduction

According to the "summary report on statistical analysis of Chinese medicine in 2018" issued by the State Administration of traditional Chinese medicine in 2018, China's traditional Chinese medicine has maintained the momentum of rapid and good development, not only maintaining the advantage of low price, but also significantly improving the service ability, service level and service efficiency. Among them, by the end of 2018, TCM institutions accounted for 4.14% of China's national health institutions, and the total number of TCM departments in various health institutions nationwide increased by 18.17% year-on-year [1]. Therefore, China's traditional Chinese medicine industry is still maintaining a high-speed development trend.

According to the questionnaire survey results of Ma Tianmei and others, in the question of "factors affecting the career development of Chinese medicine practitioners", it is generally believed that the national policy orientation plays the most important role, with a selection ratio of 83.66%, followed by doctors' salary and treatment. The "personal career development space" is the one with the least proportion of options [2]. Occupation can be regarded as the specific social labor attribute that a person engages in for survival. A person's work experience as a member of a particular organization in the course of his career is commonly referred to as career development, and career development is often accompanied by the individual’s job rank, status, labor remuneration, and personal professional achievement in the organization The change. Migrating from one department to another in the organization can be seen as a typical horizontal development; the increase in seniority in the same department of the organization can be seen as a centripetal development; and the occupational level in the same department of the organization. The progressive development is a common vertical development. This shows that career development is multi-dimensional, including the increase and
decrease of the hierarchical dimension, the change of job function dimension, and the centripetalization along the seniority axis [3].

As an important function of the law, the incentive function usually appears as a hidden function in the law, and the actual value of the incentive function has not been fully realized. And according to Zhang Ruijing and others, the institutional value of law can be realized by setting up legal norms [4]. To improve China's legal incentive mechanism, it is necessary to update and clarify the concept of legal incentive mechanism construction, to solve the system problems exposed in the process of social practice, so as to enhance the legal restraint ability and the stimulating effect of the law on various industries.

In recent years, the traditional Chinese medicine industry has become more advanced in society and has spread to all parts of the world. Tu Youyou team has extracted artemisinin based on the research of traditional Chinese medicine, and has made great contributions to the medical industry. The role played by the Chinese medicine industry is increasing year by year. Therefore, a reasonable legal incentive evaluation model should be constructed to evaluate the impact of the corresponding laws and regulations on the professional development of the entire Chinese medicine industry, and adjust and plan accordingly. Through the investigation and collection of corresponding data parameters, this paper uses the BP neural network model to train the data samples to obtain the "Traditional Chinese Medicine Legal Incentive Evaluation Model" and analyze the results.

2. Investigation on personal career development of traditional Chinese medicine teachers

Table 1. The proportion of selected answers to the influencing factors of TCM professional development.

| Questionnaire options | Number of respondents | Percentage (%) |
|-----------------------|-----------------------|----------------|
| National policy orientation | 942 | 83.66 |
| Doctors' salaries and benefits | 898 | 79.75 |
| The social status of doctors | 821 | 72.91 |
| Working environment (including hardware environment, doctor-patient relationship) | 730 | 64.92 |
| Performance appraisal and fairness of salary reward | 675 | 59.95 |
| Personal career development space | 535 | 47.51 |

For the influencing factors of personal career development of TCM practitioners, TCM practitioners should have the most say in their profession and have a deeper understanding of the industry. The influencing factors that play an important role in the personal career development of TCM practitioners can be obtained through the data in Table 1 [6]. In Table 1, TCM practitioners' views on the importance of each influencing factor on personal career development can be obtained, and the importance degree of the factors can be characterized by percentage normalization:

$$R_i = \frac{W_i}{\sum_{n=1}^{6} W_n}$$

(1)
Figure 1. The proportion of factors affecting the professional development of Chinese medicine practitioners.

It can be seen that the policy orientation of the state and the salary of TCM practitioners are the most important factors affecting the career development of TCM practitioners.

In Table 2, the employment rate of fresh graduates from 2013 to 2019, the average salary of Chinese medicine practitioners, and the proportion of Chinese medicine practitioners changing professions were collected to characterize the status of career development of Chinese medicine practitioners.

Table 2. Career development of TCM practitioners (2013-2019).

| particular year | Employment rate of fresh graduates (%) | Average salary of doctors (yuan) | Proportion of bank transfer (%) |
|-----------------|---------------------------------------|---------------------------------|-------------------------------|
| 2013            | 90.90                                  | 7930                            | 32.3                          |
| 2014            | 91.80                                  | 8280                            | 31.4                          |
| 2015            | 92.18                                  | 8400                            | 30.5                          |
| 2016            | 93.40                                  | 9101                            | 24.2                          |
| 2017            | 93.82                                  | 9120                            | 20.1                          |
| 2018            | 94.89                                  | 9209                            | 12.3                          |
| 2019            | 98.8                                   | 9810                            | 10.3                          |

It can be clearly seen in the table that the employment rate of fresh graduates and the average salary of doctors are rising steadily and rapidly, while the proportion of job transfer is declining. This is not only related to the national economic development, but also inseparable from the national policy support for the TCM profession and the stimulating effect of the laws and regulations introduced every year on the career development of the whole industry.
3. The current situation of the development of TCM laws and regulations

The development of traditional Chinese medicine is a hot issue in today's Chinese society. Since ancient times, the development of Chinese medicine has been accompanied by the protection of corresponding laws and policies of traditional Chinese medicine. The development of Chinese medicine is closely related to the improvement of relevant policies and regulations [5].

Chinese medicine is the crystallization of Chinese philosophy wisdom, unique health concept and practice. It is the benign product of the combination of Chinese traditional culture and health undertakings, and also the characteristics and advantages of Chinese medical undertakings. In order to fully implement the important instructions of general secretary Xi Jinping on the development of Chinese medicine and the spirit of the national health and health conference, in 2016, China promulgated the outline of the strategic plan for the development of Chinese medicine 2016~2030, which provided legal protection for the construction of Chinese medicine in China’s health.

In 2017, China promulgated the first Chinese medicine law, the Chinese medicine law of the people's Republic of China, and soon after the promulgation, there were corresponding detailed documents issued, such as the Interim Measures for the record management of TCM clinics and the Interim Measures for the administration of qualification assessment and registration of doctors with expertise in traditional Chinese medicine (TCM), which respectively planned different aspects of the TCM profession and promoted the career development of TCM practitioners It has a huge impact.

Therefore, this paper investigates the amount of relevant laws and regulations issued each year in recent years and the categories specified in various documents, and lists Table 3. The calculation methods of popularization rate and utilization rate refer to formula (2) and formula (3):

$$S_1 = \frac{\text{read}}{\text{scan}}$$

$$S_2 = \frac{\text{transmit}}{\text{read}}$$

$S_1$ is the spread rate of laws; $S_2$ is the usage rate of laws; read is the total average daily reading volume of the category of laws; scan is the daily browsing volume of the website; transmit is the forwarding volume of the category of laws.

Table 3. Law and communication effect of TCM law from 2013 to 2019.

| Particle year | Number of laws and regulations | Types of laws and regulations | Transmission rate (%) | Utilization rate (%) |
|---------------|--------------------------------|--------------------------------|-----------------------|----------------------|
| 2013          | 3                              | Scope of practice; Industry management | 3.2; 2.9             | 0.5; 0.3             |
| 2014          | 2                              | Illegal restraint; Policy orientation | 2.5; 4.5             | 0.3; 0.9             |
| 2015          | 3                              | Policy orientation; Salary guarantee | 4.8; 5.6             | 1.0; 2.3             |
| 2016          | 10                             | Policy orientation; Salary and welfare protection; Social status; Examination supervision; Work environment guarantee | 7.5; 6.8; 5.5; 6.3; 5.6 | 2.4; 2.2; 1.5; 1.9; 1.3 |
Table 3, cont

| Year | Industry | Management; Continuing Education | Examination | supervision; Continuing Education | Policy orientation; Salary and welfare protection; Industry management |
|------|----------|----------------------------------|-------------|-----------------------------------|--------------------------------------|
| 2017 | 8        | 3.2; 6.4                         | 5.9; 6.9    | 16.5; 13.5; 12.9                  |
| 2018 | 13       |                                  |             |                                   |
| 2019 | 5        |                                  |             |                                   |

It can be seen from table 3 that the laws and regulations related to TCM practitioners are constantly improving, while the spread rate and utilization rate of the regulations are increasing steadily year by year. However, in 2019, the transmission rate and utilization rate increased sharply, which is due to the impact of the epidemic situation, which greatly promoted the development of China's pharmaceutical industry. As an important part of Chinese medicine, the field of traditional Chinese medicine has also been greatly assisted.

4. Design and principle of legal incentive evaluation model

4.1. Principle

BP neural network is a multilayer feedforward neural network trained according to the error back propagation algorithm. It is designed to simulate the structure of biological neurons, and is also the most widely used neural network. In this network, each neuron receives input signals from other neurons, and each signal is transmitted through a weighted connection. The neuron adds up these signals to get a total input value. Then, the total input value is compared with the threshold value of the neuron (simulating the threshold potential), and then the final output (modulus) is obtained through an "activation function" processing The output will be transferred layer by layer as the input of the later neurons (as shown in Fig. 2), and finally get the prediction value that you need, and take the neural layer as the output value to end the network.

BP neural network has the ability of arbitrary complex pattern classification and excellent multidimensional function mapping. It solves XOR and other problems that simple perceptron can't solve. In terms of structure, BP network has input layer, hidden layer and output layer; in essence, BP algorithm takes the square of network error as the objective function and uses gradient descent method to calculate the minimum value of the objective function.
Figure 2. Schematic diagram of BP neural network principle.

The relu activation function is used in this experiment:

\[
\text{ReLU}(z) = \begin{cases} 
  z & z > 0 \\
  0 & z \leq 0 
\end{cases}
\]

Figure 3. Relu function image.

4.2. Experimental design

Data preprocessing. This model uses BP neural network as the modeling algorithm, takes the quantity of laws and regulations, types of laws and regulations, dissemination rate and utilization rate in Table 3 as the characteristics of each training sample, and takes the data of each year as a training sample, and takes the employment rate of fresh graduates, average salary of traditional Chinese medicine
practitioners and the proportion of job transfer in Table 2 as the corresponding types of laws and regulations. The measurement of the role of career development.

Before importing the training data, normalize the data in Table 3 to eliminate the dimension:

$$A' = \frac{A - \text{min}}{\text{max} - \text{min}}$$  \hspace{1cm} (5)

A is the data before normalization; A' is the data after normalization; min is the minimum value in the variable; max is the maximum value in the variable.

### Table 4. Map and normalize the types of laws and regulations.

| Mapping values (normalization) | 1   | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
|-------------------------------|-----|---------|---------|---------|---------|---------|---------|---------|---------|
| Types of laws and regulations | Practice area | Industry management | Illegal restraint | Policy orientation | Salary and welfare | social position | Examination supervision | Work environment guarantee | Continuing Education |
| Mapping value (normalization) | 0   | 0.125   | 0.25    | 0.375   | 0.5     | 0.625   | 0.75    | 0.875   | 1       |

### Table 5. Laws and communication effects of TCM law issued from 2013 to 2019 (normalization).

| Particle year | Number of laws and regulations | Types of laws and regulations | Transmission rate (%) | Utilization rate (%) |
|---------------|-------------------------------|--------------------------------|-----------------------|----------------------|
| 2013          | 0.091                         | 0; 0.125                       | 0.0500; 0.0286        | 0.0167; 0.0000       |
| 2014          | 0                             | 0.25; 0.375                    | 0; 0.1429             | 0.0000; 0.0570       |
| 2015          | 0.091                         | 0.375; 0.5                    | 0.1643; 0.2214        | 0.0583; 0.1667       |
| 2016          | 0.727                         | 0.375; 0.5; 0.625; 0.75; 0.875 | 0.3571; 0.3071; 0.2143; 0.2714; 0.2214 | 0.1750; 0.1583; 0.1000; 0.1333; 0.0833 |
| 2017          | 0.545                         | 0.125; 1                      | 0.0500; 0.2786        | 0.0417; 0.2000       |
| 2018          | 1                             | 0.75; 1                        | 0.2429; 0.3143        | 0.1667; 0.2167       |
| 2019          | 0.273                         | 0.375; 0.5; 0.125             | 1.000; 0.7857; 0.7429 | 1.000; 0.8000; 0.4167 |

Table 4 shows the results of numerical mapping of text types of laws and regulations and normalization by formula (5); table 5 shows the results of normalization of influencing factor data of traditional Chinese medicine from 2013 to 2019.
4.2.1. **BP neural network layer construction and training.** The parameters and structure of BP neural network are shown in Figure 4.

**Figure 4.** Structure of BP neural network.

| Layer (type)                  | Output Shape   | Param # |
|-------------------------------|----------------|---------|
| dense_1 (Dense)               | (None, 1, 64)  | 320     |
| batch_normalization_1 (Batch) | (None, 1, 64)  | 256     |
| dense_2 (Dense)               | (None, 1, 32)  | 2080    |
| batch_normalization_2 (Batch) | (None, 1, 32)  | 128     |
| dense_3 (Dense)               | (None, 1, 16)  | 528     |
| batch_normalization_3 (Batch) | (None, 1, 16)  | 64      |
| dense_4 (Dense)               | (None, 1, 8)   | 136     |
| dense_5 (Dense)               | (None, 1, 3)   | 27      |

Total params: 3,539
Trainable params: 3,315
Non-trainable params: 224

In the network model, a batch is connected behind each full connection layer: Normalization layer, which can prevent the full connection layer from falling into over fitting and enhance the generalization ability and robustness of the model.

The model training uses the data from 2013 to 2017 in Table 5 as the feature vector of the training set, uses the employment rate of fresh graduates, average salary of doctors and the proportion of job transfer in Table 2 as the predicted tag value; takes the data of 2018 and 2019 in Table 5 as the test set to predict the employment rate of fresh graduates, average salary of doctors and job transfer ratio in 2018 and 2019 For example. And 1000 rounds of network training.

4.3. **Processing and analysis of experimental results**

The prediction results are shown in Table 6.
Table 6. Forecast result data.

| Particle year | Number of laws and regulations | Transmission rate (%) | Probability of use (%) | Employment rate of new graduates (%) | Average salary of doctors (yuan) | Proportion of bank transfer | Forecast employment rate of fresh graduates | Predicted average salary of doctors (yuan) | Forecast transfer proportion |
|---------------|-------------------------------|-----------------------|------------------------|-------------------------------------|---------------------------------|---------------------------|-------------------------------------------|------------------------------------------|---------------------------|
| 2018          | 1                             | 0.75; 0.3143          | 0.2429; 0.3143         | 94.89                               | 9209                            | 12.3                      | 94.98                                    | 9150                                     | 12.1                      |
| 2019          | 0.273                         | 0.375; 0.7429         | 1.000; 0.8000          | 98.8                                | 9810                            | 10.3                      | 97.63                                    | 9890                                     | 10.2                      |

The correlation between predicted value and real value of each variable was calculated:

\[ r(X, Y) = \frac{\text{Cov}(X, Y)}{\sqrt{\text{Var}(X)\text{Var}(Y)}} \]  

(6)

The results are R1 = 1, R2 = 1, R3 = 1, which means that the predicted results are positively correlated with the real values.

The relative error between the real value and the predicted value was calculated:

\[ \sigma = \frac{\text{real} - \text{predict}}{\text{predict}} \times 100\% \]  

(7)

The results are as follows:

Table 7. Relative error of prediction results.

| Index                      | Employment rate of new graduates (%) | Average salary of doctors (%) | Proportion of bank transfer (%) |
|----------------------------|--------------------------------------|-------------------------------|--------------------------------|
| Relative error(2018s)      | 0.095                                | 0.645                         | 0.16                           |
| Relative error(2019s)      | 0.037                                | 0.34                          | 0.12                           |
| Mean relative error        | 0.23                                 |                               |                                |

Figure 5. Relative error of forecast in 2018 and 2019.
In addition to the lack of training index and the training algorithm, there are three reasons for the existence of the error. However, it can be seen from Figure 5 that the relative error of the prediction of the average salary of doctors is the highest, that of the fresh graduates is the lowest, and that of the turnover rate is medium. However, the relative errors of the three indicators are far less than 1%, indicating that the model has strong stability, and the maximum relative error and minimum relative error are both acceptable. Within the scope. The average relative error obtained in Table 7 is 0.23%, which is in an excellent level, which shows that the overall prediction ability of the model is very accurate and reliable, and it can be used in practice through the only training data and training indicators.

5. Conclusions
As a traditional Chinese industry, Chinese medicine practitioners play an important role in both cultural heritage and medical and health undertakings. Especially in the current epidemic situation, the role of Chinese medicine in the prevention and treatment of diseases has been played incisively and vividly. Based on prevention, traditional Chinese medicine can enhance people's immunity, strengthen the ability to recover after getting sick, and so on. At the same time, Chinese medicine has been gradually recognized in foreign countries, especially in Africa. Therefore, the future career development of Chinese medicine practitioners is significant, for the professional development of Chinese medicine practitioners, the role of legal policies is extremely important. This model can predict the professional development prospect of TCM practitioners in corresponding years with a small relative error of 0.23%. In this way, it can compare and adjust the decrees to be issued in the year and the predicted results, so as to prevent the unexpected results from hitting the TCM profession and make all factors within a controllable range.

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