INTRODUCTION
After the second industrial revolution, the application of a large number of machines promotes the development of human civilization, which is similar to the human medical diagnostic. The most commonly-used diagnosis in industry is the fault diagnosis, and the diagnostic object is the system fault.

There are three stages for the fault model predictions and development course of repair: The first stage is the original stage, just with a simple processing; the second stage is the development stage of testing technology and sensor technology, mainly dealing with signals; the third stage is the stage of intelligent diagnostic techniques for big data processing and forecasting, so that the fault diagnosis achieves considerable development [1]. In recent decades, people explore the industrial potential in the bionic algorithm, showing broad application prospects in many research fields.

Currently, the scientific research fields of the bionic algorithm discussed herein include the following aspects:
1. Expert system of BP neural network.
2. Expert system of connectionism mechanism. It focuses on the connection with the database and sharing platform, which is suitable for diagnosis in the industrial field.

In the industrial field, the object-oriented programming language and database are widely used for real-time tracking and regulation. For teaching and scientific research, mastering its complex language is not conducive to the students to cultivate their interest. This paper constructs a fault diagnosis expert system based on MATLAB. For college students and teachers, it does not require complex and advanced programming, but simply requires calling the function and simple programming. This paper establishes a transformer fault diagnosis expert system based on the practical and efficient principle.

MODELING
Common transformer fault types are: insulation fault, overheating fault and mechanical failure. Corresponding to the fault, there are specific types. For example, the insulation fault is caused by its aging and moisture; for the discharge fault, there is a need to analyze the kind of discharge fault. The next step is to process according to the fault information detection results so as to predict the development trend and severity, and eliminate the fault when the measures of controlling the fault is proposed [2].

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2 MODELING
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2.1 BP neural network theory
BP neural network refers to a kind of multilayer feed-forward bionic algorithm. This algorithm has two main features: The first feature is the forward pass of information; the second feature is the reverse transmission of error. There is no interaction between neurons. The change of values has an inherited effect, which is repeatedly recycled until reaching the desired
error, and training a matrix that is line with the expected rate of specific gravity \[ ^{[3]}\].

![Diagram of feedforward neural network](image)

In Figure 1, \(X_i, X_i \cdots X_m\) are input values of forward transmission; \(Y_i, Y_i \cdots Y_m\) are predicted values of reverse transmission; \(O_{ij}\) are specific gravity of the reverse transmission.

As shown in Figure 1, the reverse-transmission neural network is essentially a nonlinear function; the independent variable is an input value of the network; the dependent variable is an output value of the network, thereby building a function relation from the dimension \(n\) to the dimension \(m\).

The training network can make data become standard and network more intelligent. The training steps are as follows:

First step: initialize the network. Determine the number of nodes at the typing layer \((n)\), the number of nodes at the hidden layer \((l)\), and the number of nodes at the printing layer \((m)\) according to the prediction error \((e)\).

Second step: output at the hidden layer. Determine the number of nodes at the hidden layer \((n)\) and the range \((a)\) according to the matrix \((X, Y)\), so as to calculate the output at the hidden layer \((H)\).

Third step: output at the printing layer. The predicted output \((O)\) of bionic algorithm can be calculated by the output at the hidden layer \((H)\), the specific gravity of connection \((O_{jk})\), and range \((b)\).

Fourth step: error calculation. The prediction error \((e)\) can be calculated by the predicted printing \(O\) and expected printing \(Y\).

Fifth step: update of specific gravity. The specific gravity of connection \((W_{ij}, W_{jk})\) can be updated according to the prediction error \((e)\).

 Sixth step: update of range. The range \((a, b)\) can be updated to the prediction error \((e)\) in the algorithm.

Seventh step: determine whether it is finished. If it is not up to standard, return to the second step \[^4\] .

2.2 Probabilistic neural network theory

The probabilistic neural network was first proposed by Dr. D.F. Specht in 1989. Such neural network is a kind of parallel algorithm based on the probability theory. This algorithm has many advantages, one of which is the outstanding classification capacity and multidimensional processing capability, and the high prediction accuracy.

PNN network is a kind of feedforward bionic algorithm. Its theoretical basis is the minimum risk criteria of Bayes. This algorithm is developed from the radial basis function, which is very suitable for pattern recognition \[^3\].

The algorithm model in this paper consists of four layers, namely the typing layer, the model layer, the weighted layer and the printing layer. The basic structure is shown in Figure 2:

![Diagram of probabilistic neural network](image)
Where: $W_i$ is the specific gravity from the typing layer to the model layer. $\delta$ is a smoothness index.

The weighted layer is to calculate statistical values according to the Formula (6) and obtain PDF. The weighted layer is distributed by category and weighted by category without linking with other units. The greater the probability estimate is, the more output at the weighted output will be. The printing layer carries out further normalization processing.

PNN troubleshooting prediction algorithm is described as follows: assuming that there are two known models, $A_h$ and $B_h$. For the fault feature sample $X = (x_1, x_2, \ldots, x_n)$ that is to be judged:

1. If $h_A f_A > h_B f_B$, then $X \in \theta_A$.
2. If $h_A f_A > h_B f_B$, then $X \in \theta_A$.

Where: $h_A$ and $h_B$ are the prior probability of $A$ and $B$ in the fault mode ($h_A = \frac{N_A}{N}$, $h_B = \frac{N_B}{N}$); $N_A$ and $N_B$ are the number of training sample in the accident mode; $N$ is a total number of training samples; $I_A$ is a penalty factor of $\theta_A$; $I_B$ is a penalty factor of $\theta_B$. The so-called penalty factor is to mistakenly divide the sample $X$ that belongs to $B$ into $A$; $f_A$ and $f_B$ are the probability density function (PDF) in the fault mode ($\theta_A$ and $\theta_B$).

Parzen proposed an estimation method in 1962. This method can be used to obtain the probability approximation function. The estimation formula is as follows:

$$f_x(x) = \frac{1}{(3\pi)^{\frac{d}{2}}} \frac{1}{\delta_m} \sum \exp \left[ \frac{(X - X_{ai})^T (X - X_{ai})}{2\delta^2} \right]$$

Where: $X_{ai}$ is the training vector $(i)$ in the fault mode ($\theta_A$); $m$ is the number of training samples in the fault mode ($\theta_A$); $\delta$ is the smoothness factor.

3 MODEL SOLUTION

There is a need to pay attention to some problems in the neural network modeling. The selection of eigenvector is a proper reflection of the features of the problem. The diagnosis result often depends on it. Whether the feature contains sufficient information to be recognized is very important. The latent fault of the transformer shall be predicted and corrected in troubleshooting timely. The analysis method of gas dissolved in oil can be used to be competent in this work. The input eigenvector in the bionic algorithm is the three contrast value of gas dissolved in oil. The fault type is the output matrix.
MATEC Web of Conferences

Figure 5. Training residual plot

Figure 6. Training result

Table 2. Forecast results of fault diagnosis of probabilistic neural network

| Number of forecast samples | Forecast classification results | Actual classification results |
|---------------------------|-------------------------------|------------------------------|
| 1                         | 5                             | 5                            |
| 2                         | 1                             | 1                            |
| 3                         | 4                             | 3                            |
| 4                         | 5                             | 5                            |
| 5                         | 3                             | 3                            |
| 6                         | 3                             | 3                            |
| 7                         | 4                             | 3                            |
| 8                         | 3                             | 3                            |
| 9                         | 3                             | 3                            |
| 10                        | 1                             | 1                            |

In the bionic algorithm of this paper, two factors restrict the accuracy. One is the number of training data, and the second is the selection of S values. The research shows that the more sample values and the wider types are, the more accurate the forecast results are. However, the lower the spread value is, the more accurate the forecast result is. The simulation in this paper and research in the previous literature shows that for the BP neural network, its convergence rate, solution stability and fault-tolerant capability of sample complementing are to be improved. The algorithm used in this paper has robustness on the above issue. The forecast results are shown in Table 2.

4 CONCLUSION

Through the matrix laboratory simulation, the bionic algorithm in this paper has the following advantages:

(1) The process model is simple and the convergence is good.

(2) The network convergence effect with a good stability is better than the optimal solution of Bayes. It has clear theoretical support, which is convincing and explained reasonably.

(3) The fault-tolerant capability of samples is strong, and the specific gravity is mutually independent. The increase and decrease of the samples are very simple and convenient, and the accuracy of forecast results is high with excellent judgment accuracy.

In conclusion, the diagnostic system of artificial intelligence machine based on the probabilistic neural network has superior performance in terms of speed and fault tolerance.

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