The purchasing management and practice of sci-tech books in university library based on Back-propaqation artificial neural network

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Abstract: The statistics of books lending in a university has been classified, indicating the positive correlation between the practicability and the price of the book. For the situation of popular science and technology books demand exceeding the supply, this paper has made a prediction of books purchasing by using the model of BP artificial neural network, realizing the purchasing analysis and reasonable purchasing fund allocation. The empirical results show that the predicted results of the neural network calculation are very close to the actual situation, which shows that the BP artificial neural network can play a guiding role in the procurement of college libraries.

1. Introduction

The procurement of books in university libraries is an important part of the process of teaching and knowledge dissemination in higher education institutions in China. Reasonable book purchasing decision-making can improve the quality of university libraries, and make their service groups—the needs of teachers and students to meet the knowledge needs to be satisfied. It is of great significance to the potential scope of university libraries to develop their own knowledge information.

2. University library science and technology books procurement problem

In today's highly developed computer and Internet era, readers' interest in books is often reflected in their number of hits through the Internet and search engines in major libraries. The main user groups of university libraries are students and teachers, and their interest in books is also reflected in the click statistics of the library's electronic search engine. Science and technology cutting-edge books have always been borrowed by college and university library teachers and students - special high-priced technology monographs often appear several times the online booking volume of book stocks. Therefore, how to plan the procurement ratio of popular science and technology books in college libraries to meet the needs of the readers as much as possible has become an important topic in the current library procurement management.

3. BP artificial neural network and its learning algorithm

The artificial neural network (ANN) was first proposed by the famous psychologist McCulloch in the 1940s. The mathematicians Pitts and Rumelhart mathematically model the concept of McCulloch. The ANN model is derived from the working mechanism of biological neurons. The network node of ANN is the neuron in the biological neural structure, and the synapse that bears the information transfer function between biological neurons uses the "interconnect weight value" in the ANN model. The operational phase of an artificial neural network has two parts:

(1)The learning phase - the values of all the computing units have been determined, the main purpose is to adjust the weight threshold of the connection according to the learning rules and algorithms between each node.

(2)The practice phase - the network of the learning phase determines the weight threshold between each node layer, at which point the ANN system can be used to predict the data that actually meets the established relationship of the trained network.

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Back Propagation is a multi-layer feedforward network learning method based on the error inverse propagation method. Other learning processes can be summarized as follows: data forward input - error reverse propagation - analysis training - learning convergence four processes. The principle and mathematical expression of the BP neural network work and practice process are given in the literature. Figure 1 shows the working mechanism of a single node in a BP neural network:

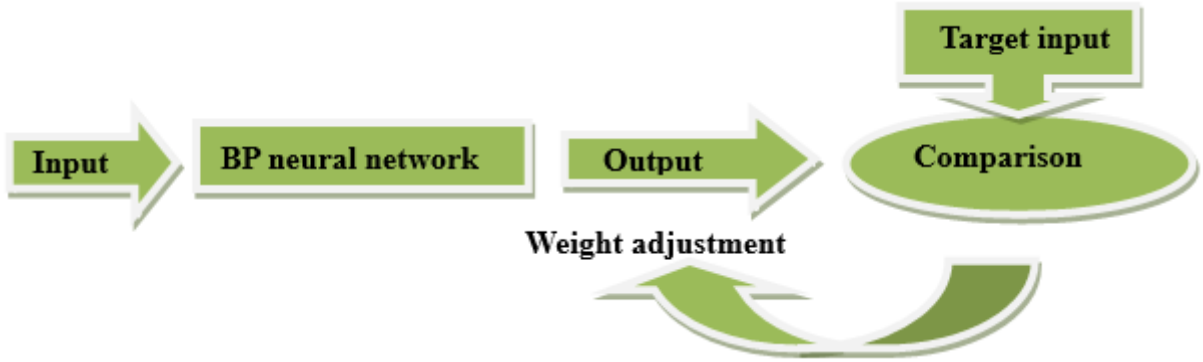

Fig.1 Working mechanism of single node of BP neural network

4. BP artificial neural network data training

According to the readers' borrowing statistics given by the network system of a university library, this paper randomly extracts 20 popular "blockchain" books as BP artificial neural network training samples. Relevant statistical data includes daily search volume of books and books. The price, book stock and book daily average number of reservations, the data is shown in Table 1.

Table 1 Statistics on the “blockchain” science and technology books of a university library

Daily average search	buying price	Stock	Annual average booking amount
32.8	49.6	18	5.4
33.3	50	16	5.6
...	...	...	...
81	95.2	6	10.7
96	100	7	11.8

In fact, the relationship between the average daily search volume and the purchase price of the library can be reflected by a certain functional relationship. Based on the quadratic interpolation calculation in numerical analysis, the relationship between the two sets of data obeys the function is:

$$y = 0.0055x^2 + 0.3072x + 3.9574 \quad (1)$$

Where y represents the daily average number of searches for a certain data of the library, and x represents the purchase price. The data obtained by normalizing the data in Table 1 is shown in Table 2. The normalized expression is:

$$x_N = \frac{x - x_{min}}{x_{max} - x_{min}} \quad (2)$$

Here X represents the data to be normalized.

Table 2 Normalization of statistical data related to the "blockchain" science and technology books of a university library

Daily average search	buying price	Stock	Annual average booking amount
0	0	0.923076923	0.04109589
0.007911392	0.007220217	0.769230769	0.068493151
...	...	...	...
0.762658228	0.823104693	0	0.767123288
1	0.909747292	0.076923077	0.917808219

The data training of Table 2 by BP neural network is realized by MATLAB software. This example uses the BP algorithm network to design a three-layer feedforward network model:

(1)The input layer input vector is: $X = \{x_1, x_2, ..., x_n\}^T$;

Join $x_0 = -1$(The threshold of the hidden layer neurons)

(2)The hidden layer input vector is: $H_i = \{hi_1, hi_2, ..., hi_n\}$;

The hidden layer output vector is: $H_o = \{ho_1, ho_2, ..., ho_n\}^T$;

Join $b_h = -1$(The threshold for outputting neurons)

For the hidden layer output function: $Y_i = f(net_j)$;

The weight adjustment of the hidden layer: $net_k = \sum_{j=0}^{m} v_{ij} x_i, k = 1,2,3...$;

(3)The output layer vector is: $O = \{o_1, o_2, ..., o_n\}^T$;

For the output layer: $O_k = f(net_j)$;

Weight adjustment of the output layer: $net_j = \sum_{j=0}^{m} w_{jk} y_j, k = 1,2,3...$;

The output layer results can be compared to the expected vector: $d = \{d_1, d_2, ..., d_n\}^T$;

(4)The transfer function f(x) can be taken as a unipolar Sigmoid function: $f(x) = \frac{1}{1+e^{-x}}$;

Such functions have the characteristics of continuous and derivable, so that the data can be stopped during the network work to avoid training due to insufficient gradient.

In this example, the implicit layer uses the transfer function of matlab, in which the hidden layer selects the tansig hyperbolic tangent transfer function; the output layer selects the linear purelin output function; finally the error backpropagation selects the traingdm function to compare the prediction accuracy of the network.

The artificial neural network structure of this study is divided into three layers: input, implicit and output layers. The determination of the number of hidden layers and the number of neurons in the hidden layer is the key to construct BP artificial neural network. When the middle hidden layer increases, the error of the neural network may be reduced, the accuracy is improved, but the network is also complicated, so that the training time falls into the local minimum error, so that the weight number is difficult to be adjusted to the minimum error. Affect the effect of network training. In this example, a BP artificial neural network with a single hidden layer is selected, and the number of neurons in the hidden layer is determined by heuristics.

According to the empirical formula: $h = (mn)^{1/2} + a$

Where h - the number of hidden layers; m - input layer unit; n - output layer unit; a - take 2-10

The hidden layer h=4-14 is determined, followed by error comparison. In this paper, according to the characteristics of the decimal digits of the normalized data in Table 2, the iteration stop error should be $1e^{-6}$; to improve the training efficiency, the upper limit of the training iteration step = 10000. The specific determination of the hidden layer value is determined according to the

minimum error reached within the upper limit of the iteration. The minimum error calculation result is shown in Fig 2. In the case where the hidden layer number h=11, the training error value reaches the minimum value of 1.136e-5, so For example, the number of hidden layers with h=13 should be selected as the hidden layer number of BP network training.

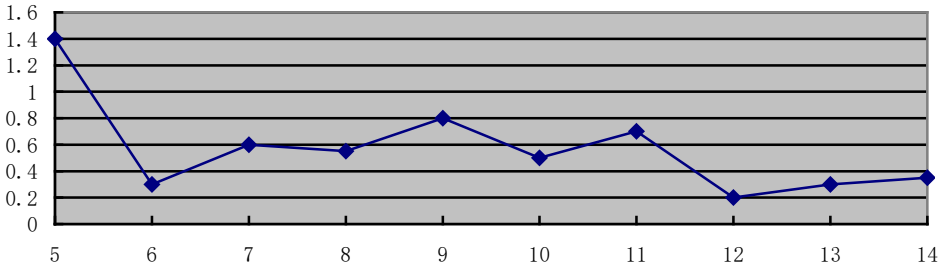

Fig.2 Minimum training error of different hidden layers in BP network

5. Using BP artificial neural network for procurement management practice

In order to continue to meet the knowledge needs of teachers and students, the library intends to order two types of popular books on “blockchain” in a book purchasing task in 2018, and its budget cannot exceed 3000 yuan. Among them, the purchase prices of the two types of books are 68.4 and 95.5 yuan respectively. According to the relationship between the price reflected by the fitted formula (1) and the number of books in the library, the average daily search volume of the two popular books can be estimated. The calculation result is shown in Fig3.

Table 3 Estimates the average daily search volume in the library based on the price of the book to be purchased

Book type	Book price / yuan	Daily average number of searches/times
A	68.4	50.70
B	95.5	83.41

Referring to the number of daily appointments shown in the library statistics of this type of books in 2017, this procurement activity should consider controlling the proportion of purchases of the two books within the scope of reasonable purchases of the two books, so that the number of reservations after the books are put into use is reduced. According to the library's past purchasing experience and library bookcase capacity, the purchase amount of both A and B books should be between 7 and 19 books. According to the purchase funds and the amount of the two types of books, the following is adopted. The program calculates the number of possible purchases for A and B books:

Procedure I:

```
i=1;      (program loop variable)
F=[];    (F matrix is the number of possible purchases of A and B books)
for a=7:19;for b=7:19
if    68.4*a+95.5*b<=3000    (Purchase price and number of books constraints)
        F(i,:)=[a,b];
        i=i+1;
```

Through the above MATLAB program calculation, a total of 166 kinds of book purchase distributions are met.

Therefore, in the BP neural network prediction process, the number of books is used as the prediction input vector, and the reservation amount is used as the neural network output vector, and the predicted input vector data as shown in Table 4 is constructed:

Table 4 Input vector data of two types of procurement books in college libraries A and B

Book type	Book price (yuan)	Average daily search times	Purchase Replica Scope (this)
A	68.4	50.70	10~19
B	95.5	83.41	10~19

The data of Table 4 is normalized with reference to Table 1 and the formula (2). The results are shown in Table 5:

Table 5 Input vector normalized data of two types of procurement books in college libraries A and B

Book type	Book price (yuan)	Average daily search times	Purchase Replica Scope (this)
A	0.2832	0.3394	0~1
B	0.8008	0.8285	0~1

The data in Table 5 is separately input into the trained neural network of MATLAB, and the prediction amount of the A and B book outputs is summed. The code of the specific MATLAB program implementation calculation is as follows:

Program II

```
Ymax=12.4;    (According to the data in Table 1, the maximum amount of reservation is 12.4)
Ymin=5.1;    (According to the data in Table 1, the maximum amount of reservation is 5.1)
TA=zeros(19-10+1,3);TB=TA;
R=zeros(19-10+1);
R1=R;R2=R;    (R, R1, R2 matrix record)
for p=10:28
    for q=10:28
        TA(p-9)=[0.2832;0.3394;(p-10)/(28-10)];
        TB(q-9)=[0.8008;0.8285;(q-10)/(28-10)];
        S1=sim(net_1,TA(p-9);
          R1(p-9,q-9)=S1*(Ymax-Ymin)+Ymin;    ( S1 is denormalized and recorded)
        S2=sim(net_1,TB(p-9);
        R2(p-9,q-9)=S2*(Ymax-Ymin)+Ymin;    ( S2 is denormalized and recorded)
        R(p-9,q-9)=R1(p-9,q-9)+R2(p-9,q-9).
```

The data results are obtained.

According to the calculated data, when the B book purchases 19 books and the B book purchases 1-19 books, the predicted reservation amount reaches the minimum value of 13.5 copies. In combination with the price boundary conditions in which the total purchase amount cannot exceed 3,000 yuan, the following procedures are added to the program I after the operation of the program I to perform the eligible A-book purchase screening:

Procedure III:

```
H=size(F); (characterizes the number of rows and columns of the F matrix)
j0=1;    (program loop variable)
for j=1:H(1)
    if F(j,2)==19
        f(j0)=F(j,1);
        j0=j0+1;
```

The output of program III is f=[7 8 9 10 11 12 13 14 15 16 17], that is, the purchase amount of the book can be determined as 7~17 books and 19 books. In the end, the university library took 17 books for A book purchase.

6. Conclusion

According to the university library, according to the ratio, the two books A and B are purchased and put into use in 2018. According to the statistics of nearly one year, the actual reservations of the two books A and B are 5.32 and 8.05, respectively. The total reservation amount is 13.37, which is very close to the result of neural network calculation 13.5, which indicates that BP artificial neural

network can provide a certain guiding effect on the procurement work of university libraries. With the advent of the era of big data, BP neural network algorithm combined with advanced server parallel computing technology can be used to further explore the interest patterns of library users and improve the level of procurement management.

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