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Forecast of Football League Sales Effect Based on BP Neural Network

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Abstract: Football is one of the sports that is loved by people all over the world. Its sales ability in the league should not be underestimated. Moreover, football has been developed in our country since ancient times and has a huge fan base, and fans are the main target of football league sales. Predicting the sales effect of the football league is helpful for the seller to formulate a suitable sales strategy and avoid the problem of product surplus. This article mainly introduces the prediction research of football league sales effect based on BP neural network, and intends to provide ideas and methods for predicting the sales effect of football league. This paper puts forward the basic method of the sales effect prediction of the football league and the BP neural network football league sales effect prediction method to analyze and predict the sales effect of the football league. In addition, the steps of establishing BP neural network design, building BP neural network football league sales effect prediction model and applying BP neural network football league sales effect prediction model are also proposed. The experimental results of this article show that the difference between the fitting part of the neural network model and the real value of the football league sales effect sample data is in the range of 0.004% ~ 0.042%, the error percentage difference is small, and the prediction results are valid.

Keywords: Back Propagation Neural Network, Football League, Sales Effectiveness, Sales Forecast

1. Introduction

In order to better set categories for sales and ensure that fans can purchase according to their personal needs, the sales effect of the football league should be predicted and a football league sales prediction network should be established. This article analyzes and researches the current situation of football league sales. This can not only improve the sales efficiency of football leagues, but also allow sponsors and advertisers to increase investment in football leagues, and increase the ticket revenue and other aspects of the organizers and related personnel.

Sales forecasts can help sellers make the right investment decisions, thereby making it easier to achieve the goal of maximizing profits. In addition, neural network prediction methods are often used for sales forecasting. BP neural network is currently the most common multi-layer feedforward neural network. BP neural network has any complicated pattern classification function and good multi-dimensional function training function, thus solving the XOR problems that cannot be solved by simple perceptrons. Structurally, the neural network has an input layer, a hidden layer and an output layer. Essentially, the square of the network error is used as the objective function, and the gradient descent method is used to find the minimum value of the objective function. The neural network adds several layers (one or more layers) of neurons between the input layer and the output layer. These neurons are called hidden units. They have no direct connection with the outside world, but their state changes will affect the relationship between input and output, and each layer may have multiple nodes. Using BP neural network to predict the sales effect of the football league can improve the accuracy of the sales effect prediction and better serve the sales of the football league.

Liu Y mentioned in his research that artificial neural networks are effective algorithms for processing recognition, regression and classification tasks. At present, many neural network applications have been developed, such as Hamming network, Grossberg network, Hopfield network, etc. Among these applications, the Back Propagation Neural Network (BPNN) has become the most popular because of its powerful function approximation and generalization capabilities. However, in the current research on the sales effect of football leagues, BPNN is a data-intensive and computationally intensive algorithm, and its efficiency has been greatly affected. Therefore, Liu Y proposed a parallel BPNN algorithm based on data separation in three distributed computing environments such as Hadoop, HaLoop and Spark. In addition, in order to improve the performance of the algorithm in terms of accuracy, Liu Y uses an integrated technology. The algorithm is first evaluated in a small-scale cluster, and then further evaluated in a commercial cloud computing environment. This method has a high cost in practice, which is not conducive to promotion [1]. Chen H Y believes that consumers' psychological perception of products is greatly affected by their marketing plans, so the sales style plays a vital role in determining the commercial success of the product. The evolution of product sales in the marketing process can usually depend on the results and analysis of sales effect predictions. Chen H Y believes that there is a risk that sales methods may not meet consumer expectations or may cause unexpected consumer responses. The development of this research is based on the integrated design method of the digital definition of the product form. A series of evaluation tests were subsequently carried out to establish the correlation between the product form characteristics and the consumer's perception of the product image. The results of the evaluation test are used to construct three different types of mathematical models including multiple regression analysis model, back propagation neural network model, and multiple regression analysis with back propagation neural network model to predict the possible response of consumers to any arbitrary factor method of sales. Chen H Y also demonstrated the feasibility of the integrated design method using a three-dimensional knife mold, and believes that the proposed method is equally applicable to consumer products under any sales method. This research method has not been verified by examples and lacks persuasiveness [2]. The purpose of Margaris AI's research is to propose a neural network for sales effect prediction, which can solve a complete nonlinear algebraic system of unknown equations. The

proposed neural solver uses the classic back propagation algorithm, and its identity function is used as the output function. , And supports the characteristics of the adaptive learning rate of the second hidden layer neuron. Margaris AI introduced the basic theory related to this method and a set of experimental results, which evaluated the performance and accuracy of this method relative to other methods used in practice. The algorithmic process of this research is more complicated and not suitable for promotion in practice [3].

The innovations of this paper are: (1) proposing the BP neural network football league sales effect prediction method; (2) constructing the BP neural network football league sales effect prediction model; (3) applying the BP neural network football league sales effect prediction model.

2.Method of Forecasting Football League Sales Effect Based on BP Neural Network

2.1 Basic Methods of Predicting the Sales Effect of Football League

(1) Frequency statistics

At present, it seems that there is no precise formula to describe the trend of football sales, whether linear or non-linear. However, in the existing football league sales forecasting methods, frequency distribution methods, linear regression methods or systematic sample statistics are often used Data to describe the trend of football sales [4]. Analyze possible sales effects or calculate the total sales volume in each period is greater than or less than a certain number, the frequency of the same value or the probability of sales similar to the inventory chart and sales trend chart, including horizontal and vertical cross comparison, frequency, maximum value , Minimum, average, etc. for analysis [5].

(2) Fundamental analysis

The basic analysis method depends on many basic factors. The difference between intrinsic value and market price will eventually be corrected by the market. When is the best time to sell football leagues is the purpose of market research [6]. It is not difficult to think that if the internal demand is higher than the market demand, sales should not be carried out at this time; and when the market demand is higher than the internal demand, selling at this time will result in considerable profits [7]. In the economic market, economic operators will make full use of the basic principles of the economy, including finance, investment risks, financial management systems, etc., to conduct a unified analysis of financial conditions. Based on our own experience and adjustment of economic policies, we can predict macroeconomic indicators such as economic development, raw material market conditions and industrial market development, and predict sales value and development direction [8]. At the same time, this kind of analysis method that puts forward suggestions on the formulation of sales strategies is the fundamental analysis method, which is also called the fundamental analysis method [9]. In any industry, any commodity will fluctuate on a fixed benchmark of internal demand. Through the floating law, we can predict the trend of future market demand. The acquisition of internal demand can be obtained through professional analysis of the industry [10]. Through market analysis, the staff can analyze some potential sales risks, such as the seller's financial status and management capabilities, which are important factors in formulating the prediction of the sales effect of football games, that is, the results

of market analysis capabilities can be used to predict future trends [11].

(3) Time series analysis

In time series analysis, the extrapolation algorithm based on the development and change of phenomena is described as one of the most important basic characteristics of time series analysis, and it is also a characteristic of time series algorithm [12]. At this stage, the analysis process of time series is generally divided into three forms: the average form of time series, the relative number form of time series and the absolute number form of time series. In the above three forms, the base period is defined as the original sequence [13]. The original sequence is processed and calculated to obtain the average, relative and absolute form of the time sequence. Generally speaking, the general level reached in different periods can be determined by reflecting the time of the average form of the sequence [14]. The average form of time series refers to the order of time evolution. Sort the average series of the same type in order, and calculate the average time series by comparing the time series with absolute numbers [15]. The average form of the time series can be derived by comparing time series indicators or by time series or derived from time series. The interrelationships and internal proportions of different periods can be reflected by the time series of relative numbers reflecting the development process of the phenomenon [16]. The relative number form of the time series can reflect the internal relationship, and its internal law is determined by unrelated sample data in different periods. According to the development sequence of time, a series of related data indicators are arranged in sequence, and the time series formed is in the form of relative numbers [17]. If the data used is absolute numbers, the resulting series is the absolute number form of the time series. In different periods, the absolute number sequence can reflect the change process of the same phenomenon in different development periods, thereby directly reflecting the development process of the phenomenon [18]. The absolute number form of the time series is to arrange the absolute number indicators in chronological order to form a time series data sequence. In the field of time series research, there are many forecasting methods and the processing is more complicated [19]. The most frequently used methods are exponential smoothing, moving average and trend extrapolation. The exponential smoothing method is based on the moving average method and evolves by correcting the normal number [20]. The moving average method changes the original time series through the moving average of n elements in order to obtain a new time series, from which we can see the trend of change [21]. The trend extrapolation method includes four steps, namely, the selection of the trend model, the solution of the model parameters, the identification of the model, and the calculation of the standard error in the final estimate [22].

2.2 Bp Neural Network Football League Sales Effect Prediction Method

Artificial neural networks can recognize and process information by simulating certain characteristics of the human brain, thereby showing some of the characteristics of the human brain functionally. Its basic functions are: associative memory, nonlinear mapping, classification recognition, optimization and knowledge processing. Two of the most important functions are associative memory and non-linear mapping [23]. Among artificial neural networks, BP neural network is the most widely used, it is a feedforward neural network with error back propagation. In the propagation process, the network is adjusted by adjusting the weight and threshold to the expected output, which is a multilayer

structure network [24-25]. The BP neural network model is shown in Figure 1.

Suppose the number of input neural units in the BP neural network is n , the number of hidden layer neural units is q , the number of output layer neural units is m , the n th neural unit of the input layer is A_n , and the q th neural unit of the hidden layer is C_q , The m th neural unit of the output layer is B_m , $A = A_1, \dots, A_1, \dots, A_n$ is the output vector, $C = C_1, \dots, C_1, \dots, C_n$ is the output vector of the hidden layer, $B = B_1, \dots, B_1, \dots, B_n$ is the output vector of the output layer, R is the weight matrix from the input layer to the hidden layer, and S is the hidden layer to the output The weight matrix of the layer.

The hidden layer formula is:

$$C_k = f(\text{net}_k), k = 1, 2, \dots, q \quad (1)$$

$$\text{net}_k = \sum_{i=1}^q R_{ki} A_i, k = 1, 2, \dots, q \quad (2)$$

The output layer formula is:

$$B_j = f(\text{net}_j), j = 1, 2, \dots, m \quad (3)$$

$$\text{net}_j = \sum_{k=1}^q S_{kj} C_k, j = 1, 2, \dots, m \quad (4)$$

The actual output of the network is:

$$B(n) = [S_m^1, S_m^2, \dots, S_m^m] \quad (5)$$

The expected output of the network is:

$$d(n) = [d_1, d_2, \dots, d_m] \quad (6)$$

The error of repeating the process for the n th time is:

$$e_m(n) = d_m(n) - B_m(n) \quad (7)$$

Define the error energy as:

$$e(n) = \frac{1}{2} \sum_{m=1}^m e_m^2(n) \quad (8)$$

Theoretically speaking, the nonlinear system can be solved by the equation method under certain conditions. The premise is to guide the dynamic equation and some initial conditions. The nonlinear system analysis analyzes the sales effect of the football league as a sequential and random nonlinear system. System, so that you can effectively predict the sales effect [26]. For football league sales effect prediction, it is difficult to fit it to a dynamic equation. In order to solve this problem, a nonlinear analysis tool can be introduced to explain. By adjusting the weight of each layer of neurons, the sales effect can be accurately reflected the nonlinear mapping relationship reflected in [27]. In the BP neural network, the object of the research on the prediction of the sales effect of the football league is the price of related products. After the construction experiment, the BP neural network model can predict the possible situation of the sales effect of the football league, which can avoid the accumulation of product excess, thereby increasing sales revenue.

3. Experiment on Prediction of Football League Sales Effect Based on BP Neural Network

3.1 establish BP Neural Network Design Steps

BP neural network is divided into teacher learning and non-teacher learning according to the learning method. The difference between the two is: the former requires both samples and expected output. The network adjusts the network according to the error between the output result and the expected output, and corrects the difference between each layer. The weight and threshold of the connection between the two; the latter requires only samples. BP neural network belongs to teacher learning, the learning process experiences sample learning W and back propagation process. In the sample learning process, the network calculates the output results of each node in sequence from the input layer to the hidden layer to the output layer, and finally obtains the actual output of the output network; the essence of the backpropagation process is to calculate the difference between the actual output and the expected output Error, through the gradient descent method and other reverse correction of network weights to reduce the error; the two processes are repeated alternately until convergence or the error meets the demand. According to the training results, the network weights with better effects are set, the test sample needs are input, and the output results that meet the requirements are calculated through the network.

Randomly connect weights ω_{ji} and v_{jt} , threshold θ_i and assignment γ_i to the BP neural network in $[-1,1]$, provide network input, and divide a set of random sample data into input sample $P_k = (a_1^k, a_2^k, \dots, a_n^k)$ and target sample $T_k = (s_1^k, s_2^k, \dots, s_m^k)$, where n is the number of input layer nodes, M is the number of nodes in the output layer. After setting the initial weights, thresholds, training samples, and target samples of the neural network, the training can be carried out. During this process, the BP neural network will calculate the input s_j of each hidden layer unit and calculate the output of each hidden layer unit b_j , the formula is expressed as:

$$s_j = \sum \omega_{ji} a_i - \theta_i, j = 1, 2, \dots, m \quad (9)$$

$$s_j = f(s_i), j = 1, 2, \dots, m \quad (10)$$

The BP neural network calculates the input b_j of each unit of the output layer through the output v_{jt} of the hidden layer, the connection weight γ_i between the hidden layer and the output layer, and the output layer threshold L_t , and then uses the neuron transfer function in the output layer to calculate the output C_t of each unit of the layer, the formula is expressed as:

$$L_t = \sum v_{jt} b_j - \gamma_i, t = 1, 2, \dots, q \quad (11)$$

$$C_t = f(L_t), t = 1, 2, \dots, q \quad (12)$$

Use the network target vector $T_k = (s_1^k, s_2^k, \dots, s_m^k)$ and the output C_t of each unit of the output layer to calculate the error d_t^k of the network output layer, the formula is expressed as:

$$d_t^k = (y_t^k - C_t) * C_t (1 - C_t), t = 1, 2, \dots, q \quad (13)$$

The error of the output layer of the network is d_t^k , calculate the error e_j^k of each unit of the hidden layer, and the formula is expressed as:

$$e_j^k = \left| \sum d_t v_{jt} \right| b_j (1 - b_j) \quad (14)$$

Modify the connection weight v_{jt} and threshold γ_i , the formula is expressed as:

$$v_{jt}(N+1) = v_{jt}(N) + \alpha * d_t^k * b_j \quad (15)$$

$$\gamma_t(N+1) = \gamma_t(N) + \alpha * d_t^k \quad (16)$$

$$j = 1, 2, \dots, m; 0 < \alpha < 1$$

Modify the connection weight ω_{ji} and threshold θ_j , the formula is expressed as:

$$\omega_{ji}(N+1) = \omega_{ji}(N) + \beta * e_j^k * a_i^k \quad (17)$$

$$\theta_j(N+1) = \theta_j(N) + \beta * e_j^k \quad (18)$$

$$i = 1, 2, \dots, n; j = 1, 2, \dots, m; 0 < \beta < 1$$

BP neural network design step process is shown in Figure 2.

3. 2 Constructing BP Neural Network Football League Sales Effect Prediction Model

(1) Design the input layer and output layer

The number of nodes in the input layer and output layer of the BP neural network is determined according to the actual situation. The input layer adds data sources to the network and acts as a buffer memory. The number of nodes depends on the actual input data set. The design of the output layer is designed according to the classification results. When the BP neural network is used for classification, the number of nodes in the output layer should be set to be the same as the number of categories.

(2) Design hidden layer

For any complex system, if the output layer uses a linear transformation function, and the hidden layer uses a transformation function, the number of nodes in the hidden layer, the complexity of the object to be checked, the number of noise data and the observations in the training data set. If the number of hidden layer neurons is too small, the network may receive too little information to solve the problem, and the nonlinear relationship in the network cannot be fully expressed, resulting in poor training effects. However, if there are too many neurons, the nonlinearity of the network will become too complicated, which not only increases the training time, but also causes a lot of cycles, which may lead to the so-called over-matching problem, that is, test errors. The common method to determine the optimal number of hidden layer nodes is trial and error. First, train the network with fewer hidden layer nodes, then gradually increase the number of nodes, and observe changes in errors. When the error increases significantly, stop increasing the number of hidden layer nodes, and the number of hidden layer nodes is the optimal number, usually the number of hidden layer nodes is between 5 and 100.

(3) Design network parameters

The learning rate will affect the stability of the neural network system in the learning process, and the stability determines the weight change in each cycle of training. If the learning rate is too high, it may cause the network weight correction of each neuron to be too much, so that the weight correction of each neuron exceeds the minimum value of the error and causes non-convergence. Too low a learning rate will cause the learning time of each neuron of the neural network to be too long, but a too low learning rate will ensure that the network result converges to a certain minimum. Rumelhart

concluded in his research that a lower learning rate can often achieve better network learning results, and when the learning rate is greater than 0.006, the network operation results cannot converge.

(4) Initial weight

Since the BP neural network is not linear, the initial selection of the network weights plays an important role. It determines the starting point of the neural network training on the error surface. If the initial weights are selected correctly, the network will converge quickly. If the initial weights are not selected correctly, the network will be located in a saturated area, which is not easy to converge, and due to the local minimum constraint, the network may also fail to form. If the initial weight is too large or too small, the learning speed of each neuron will be affected, usually a random number between the initial weight.

(5) Convergence error and maximum training times

If the convergence error of the neural network is small, it is obvious that higher learning accuracy can be achieved, but this will lead to sample over-fitting and poor generalization of the network. Usually, when the network convergence error is set to 0.05, the network is in a certain training Will run indefinitely, because the network has fallen into a local minimum, but has not yet reached the minimum convergence error of the system. At this point, it is necessary to set the maximum training time of the network to solve the problem. When constructing the model, one of the criteria for the convergence of the network operation result is that the number of iterations should not exceed 3000.

(6) Transfer Function

The transfer function is usually Sigmoid type in each hidden layer, and the linear transfer function is usually used in the output layer neurons. Therefore, in this model, the transfer function from the input layer to the hidden layer is a hyperbolic tangent function, and the transfer function from the hidden layer to the output layer is a linear transfer function.

3.3 Application of BP Neural Network Football League Sales Effect Prediction Model

The BP neural network model is divided into three parts, the first part is "data acquisition and data processing". In this part, first connect to the database of football league sales data management, take out the relevant data of product sales management, and then clean these data, remove all garbage data, use normalization, and other methods to organize the data into relevant sales forecasts The preparatory data is used as a training sample, waiting for training. The second part is "Sequence of impact factor selection by analytic hierarchy model". In this part, we first collect multiple impact factors recognized in the industry that have an influence on football league sales, and then use analytic hierarchy process to establish a hierarchical matrix. The method of scoring by experts is to score different degrees among different impact factors, and finally pass the consistency test to get the ranking of the weight of each impact factor on the sales volume. The third part is "Prediction of Football League Sales Effect Based on BP Neural Network", where the units of the input layer are training samples and sales volume impact factors. The training samples are derived from the output in the first part of "Data Acquisition and Data Processing" Data, the data that needs to be included in the training is obtained through

manual selection. The sales volume impression factor comes from the top three impact factors output in the second part of the "AHP Model Selection Impact Factor Ranking", which makes the BP neural network Forecast accuracy will be further improved.

As for the BP neural network football league sales effect prediction model, it includes a data management module, a data processing module, a sales forecast analysis module, a forecast result generation module, and a setting module; in the data management module, it contains the processed product data and sales data ; In the data processing module, the data extracted from the database will be cleaned and other operations to make it more suitable for being quoted by the later model; in the sales forecast analysis module, the first part is the level analysis to determine the influence molecule, in this part Through a combination of qualitative and quantitative methods, the weights of the sales impact factors are calculated and ranked. The second part is the BP neural network to predict sales, the training data obtained after the data processing module and the top three impact factors obtained after the level analysis The input layer is composed together, and the sales volume is budgeted through the BP neural network; in the prediction result generation module, the value of the forecast sales volume and the actual sales volume are displayed, which is convenient for the decision-making layer to make intuitive choices; in the setting module, it includes data source settings and users Basic system functions such as management, system settings and logout.

4. Football League Sales Effect Prediction Based on BP Neural Network

4.1 BP Neural Network Football League Sales Effect Forecast Model Data Analysis

(1) Sample survey analysis

For football league sales, inventory control management is relatively complex. The daily sales demands of various sales outlets or sales websites show different states in different time periods, and the sales volume of various commodities will also vary according to customers The purchasing tendency and the efficiency of the distribution center have changed greatly. The research on the prediction of the sales effect of the football league usually includes factors such as out-of-stock cost, the credit level of the organizer, the undertaking price, the scale of the game, the level of inventory management, advertising and marketing promotion, among which the order quantity, delivery efficiency and information level are also in the football league Sales have a decisive role in inventory control-related strategies. In order to have a more in-depth understanding of the factors affecting the sales effect of the football league, interviews and surveys were conducted with the relevant staff of the football league. The personnel composition and basic information of the interviewees are shown in Table 1 and Figure 3.

Table 1. Basic information of the interviewee

Basic information	Gender	Number of people	Percentage
Organizer staff	Man	2	15.69%

	Women	6	
Operations director	Man	3	11.76%
	Women	3	
General manager of operations	Man	5	17.65%
	Women	3	
Sales manager	Man	6	21.57%
	Women	5	
Market commissioner	Man	7	33.33%
	Women	10	

It can be seen from the interview results that there were 51 interviewees, and the proportions of men and women were almost the same. The functions of each department were clearly defined, and the division of job responsibilities was clear. Among them, the number of market investigators was the largest, which is conducive to more professional collection and closer to the grassroots market. Related data. After understanding the basic information of the interviewee, this article also sorted out and analyzed the content of the follow-up interview questions, and extracted the keywords of the questions answered by 51 interviewees about the factors affecting the prediction of the football league sales effect. Influencing factors in two aspects are obtained: one is that the manager of the football league host city needs to pay attention to the inventory management in the daily report, including the net gross profit margin, high inventory ratio, weather, sales amount and other indicators; the second is from the staff (Market investigators and information managers) Factors mentioned many times in the interview, such as supplier delivery methods, on-time delivery rate, customer unit price, etc. The main factors affecting the prediction of the sales effect of the football league are drawn into a chart for clear and intuitive analysis, as shown in Table 2 and Figure 4.

Table 2. Main factors affecting the prediction of the sales effect of the football league

Major factor	Proportion	Number of mentions
Net gross profit margin	9.67%	48
High inventory proportion	17.59%	51
Weather	24.21%	51
Sales amount	6.54%	37
Delivery method	18.36%	44

Punctuality	16.25%	51
Unit price	7.38%	36

From the chart data, we can see that weather accounts for the largest proportion of the factors affecting the sales effect of football leagues. Football is an outdoor sport. Choosing the right weather to host football leagues can increase sales; focusing on the weather can be more effective. Improve the accuracy rate of football league sales effect prediction.

(2) Data Analysis of BP Neural Network Forecast Model

1) For the choice of estimation parameter estimation methods, this study selected three algorithms: nonlinear least squares, simulated annealing and genetic algorithms for comparison. Combining the three algorithms, the algorithm with the best degree of fit and its estimated parameter values will finally be selected. This paper uses nonlinear least squares method, simulated annealing algorithm and genetic algorithm to estimate the three parameters of BP neural network model. After that, the predicted cumulative sales and actual cumulative sales obtained by the three parameter estimation methods are drawn into a table, as shown in Table 3; and the predicted cumulative sales curve obtained by the three parameter estimation methods is compared with the actual cumulative sales curve, as shown in Figure 5.

Table 3. Comparison of sales forecast and actual sales of football league sales by BP neural network model

Quarterly	Nonlinear least squares	Simulated annealing algorithm	Genetic algorithm	Actual sales
1	18630	18546	17998	19991
2	17496	15468	16483	18527
3	19850	18634	19431	19983
4	19768	19874	18462	18975

By observing the four fitted curves, we can know that the sales forecast model using nonlinear least squares and genetic algorithm is closer to the actual sales curve than the sales forecast model using simulated annealing algorithm. It can be seen from the figure that the nonlinear least square method almost coincides with the curve of genetic algorithm.

According to the definition of the BP neural network model, for the value range of the three parameters, the value of the market potential is greater than 4631, and the range of the innovation coefficient b and the imitation coefficient c should be between 0 and 1. Through the 1stopt software,

three parameter estimation algorithms are used to estimate the model parameter results and some statistical error parameters, as shown in Table 4 and Figure 6.

Table 4. Fitting parameters of three parameter estimation algorithms

	Market potential (a)	Innovation coefficient (b)	Imitation coefficient (c)
Nonlinear least squares	4900.00321	0.65043	0.60421
Simulated annealing algorithm	4900.01567	0.64527	0.61371
Genetic algorithm	4900.30461	0.57841	0.75634

It can be seen from the model fitted value and the predicted value that the model fits well, and there is a large error in the second quarter. However, according to Figure 5, it can be observed that the sales effect of the football league is basically in line with the characteristics of the demand trend of spiritual and cultural products. The demand reaches a peak during a period of the holiday. Later, as time goes by, consumer demand gradually decreases, and then gradually rises .

2) The sales of football leagues produce different sales effects according to different price ranges. This article collects and analyzes the relevant data of the sales volume in each sales price range for five years from 2016 to 2020, and draws them into charts, as shown in Table 5 and Figure 7.

Table 5. Sales volume by sales price range in the past five years

Amount range/RMB	2016	2017	2018	2019	2020
300~500	26803	25738	27006	26831	20341
500~1000	18647	19463	17693	18460	11370
1000~1500	17341	17421	16534	16799	10562
1500~2000	14036	15011	15462	14531	8970
2000~3000	15300	14988	15306	15327	9463
Above 3000	7873	8631	7962	7846	5124

From the above chart, we can see that the sales of football leagues with a unit price of between 300 and 500 yuan are the best, while the sales of football leagues with a unit price of more than 3,000 yuan are relatively poor, while the sales of football leagues with a unit price of 500 to 1,000 yuan are relatively poor. Which shows a relatively obvious upward trend. We can conclude that the sales price greatly affects the sales volume.

4.2 BP Neural Network Football League Sales Effect Forecast Analysis

After stratifying all data according to price ranges, forecasts are divided into price ranges. Sample data from different price ranges, the sample data size is 1512 and 829 respectively. Due to the small number of samples, we choose to allocate training set and test set to some representative data for network training. Examples of prediction results for different price ranges are shown in Table 6.

Table 6. Examples of BP neural network training results in different price ranges

Interval test value	First interval prediction	Relative error	Actual test value	Second interval prediction	Relative error
16350	16342	0.049%	13571	13566	0.037%
17351	17346	0.029%	16425	16417	0.049%
16498	16487	0.067%	15784	15774	0.063%
15034	15022	0.080%	14797	14789	0.054%
14673	14622	0.087%	13452	13446	0.045%

After determining the structure and related parameters of the BP neural network, fit and predict the football league sales sample data, as shown in Figure 8.

In the figure, the red dots represent the true value of the sample data, and the red trend line is divided into four stages. The first two stages represent the fitting values of the sample data in the first and second quarters, and the latter two stages represent the sample data in the third and fourth quarters. It can be roughly seen that the neural network model has a small gap between the fitting part and the true value of the football league sales effect sample data. There is a slight deviation from the true value in the prediction part. The difference range is 0.004% ~ 0.042%. The overall forecast data is basically the same. The scope is still small. Overall, the BP neural network model fitting prediction is in line with expectations. Therefore, this article believes that the BP neural network model is extremely effective in fitting, and thus has significant results in predicting the sales effect of football leagues.

5. Conclusions

As the cost of holding football leagues continues to increase, labor costs and venue rents are also rising, greatly reducing the profit margin of the organizer. When the sales price cannot be increased accordingly, the football league organizers often choose to control costs. For the football league organizer, accurately predicting sales and reducing inventory backlog can effectively reduce hosting costs. In addition, a reasonable marketing plan can be made after the product sales forecast, which saves marketing costs and obtains the best marketing effect when marketing expenses are limited.

At the beginning of the research, this paper summarizes the basic methods of the football league sales effect prediction research, including frequency statistics, basic analysis and time series analysis.

According to these three basic prediction methods, a method for using BP neural network to predict the sales effect of football leagues is proposed. ; Establish BP neural network design steps, build BP neural network football league sales effect prediction model, including design input layer and output layer, design hidden layer, design network parameters, design initial weights, design convergence errors and maximum training times and The transfer function is then applied to the BP neural network football league sales effect prediction model, including data management module, data processing module, sales forecast analysis module, forecast result generation module, and setting module.

This paper collects and analyzes the BP neural network football league sales effect prediction model data through experiments, and finds that the net gross profit margin, high inventory ratio, weather, sales amount, supplier distribution methods, on-time delivery rate, customer unit price, etc. affect the football league sales The factors of effect prediction, of which weather accounts for the largest proportion, and sales price to a large extent affect sales; the analysis of the sales effect prediction of BP neural network football league shows that the BP neural network football league sales effect prediction model is There is a slight deviation between the forecast part and its true value, and the difference range is 0.004% ~ 0.042% , which can be better used in real life to provide convenience for football league sales forecast.

LIST OF ABBREVIATIONS

Back Propagation(BP)

Back Propagation Neural Network (BPNN)

COMPETING INTERESTS

These no potential competing interests in our paper. And all authors have seen the manuscript and approved to submit to your journal. We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

DECLARATIONS

Ethical Approval and Consent to participate: Approved.

Consent for publication: Approved.

Availability of supporting data: We can provide the data.

AUTHOR'S CONTRIBUTIONS

All authors take part in the discussion of the work described in this paper.

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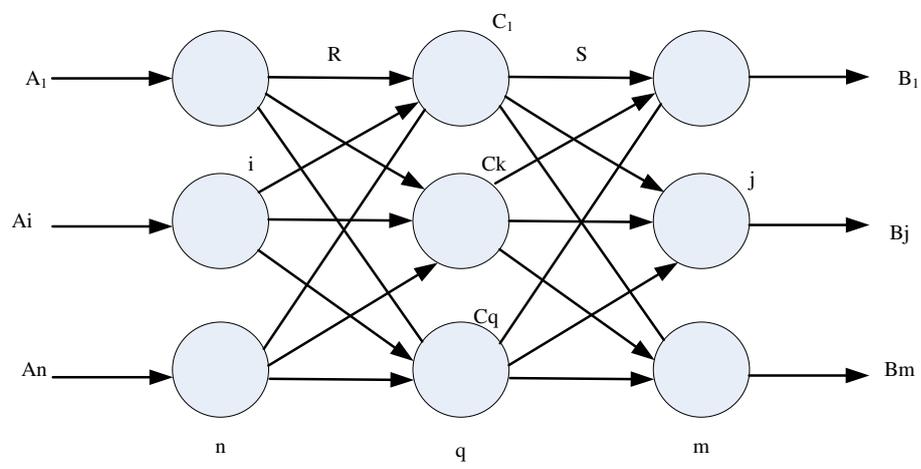


Figure 1.BP neural network model

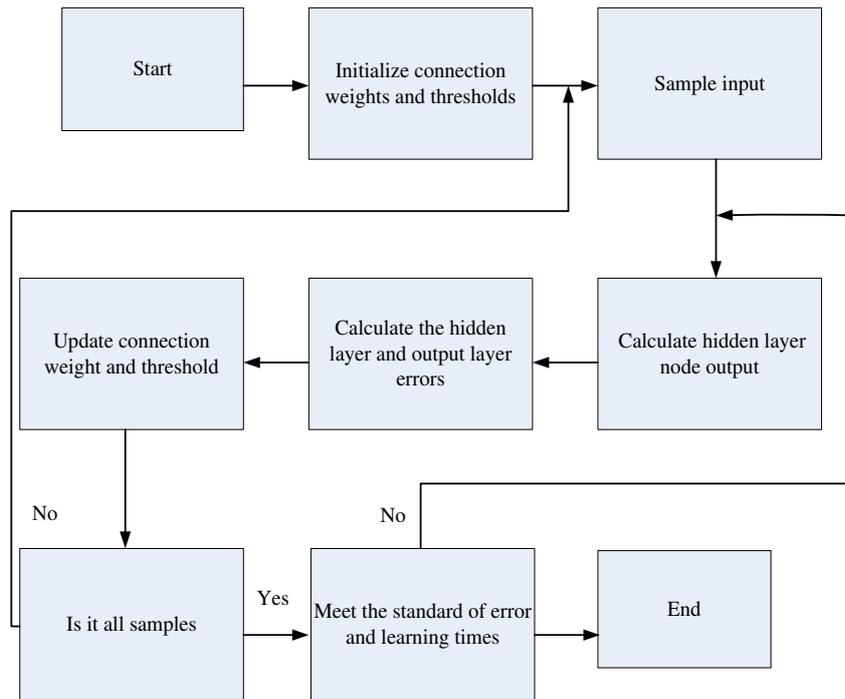


Figure 2. BP neural network design steps

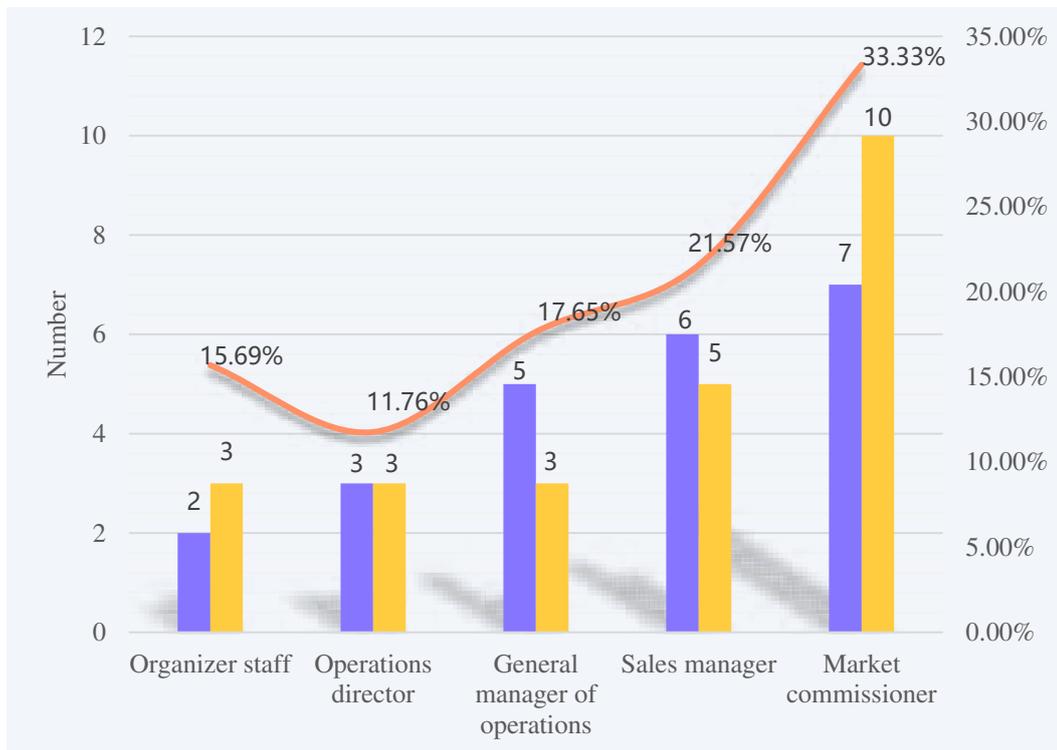


Figure 3. Basic information of the interviewee

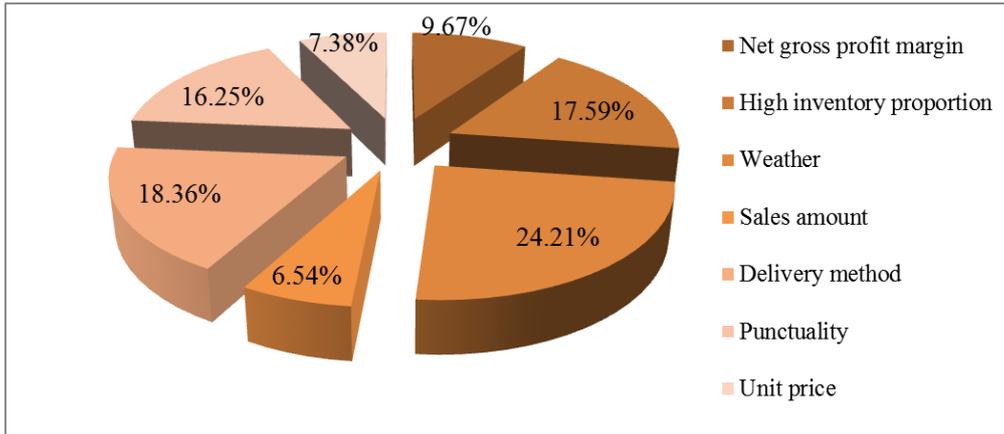


Figure 4. The main factors affecting the prediction of the sales effect of the football league

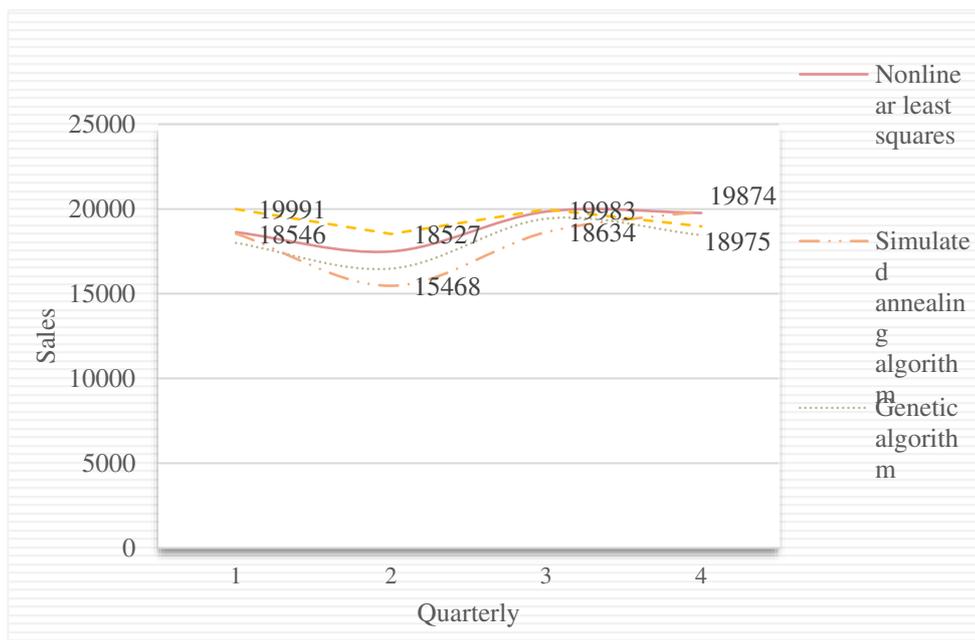


Figure 5. Comparison of sales forecast and actual sales of football league sales by BP neural network model

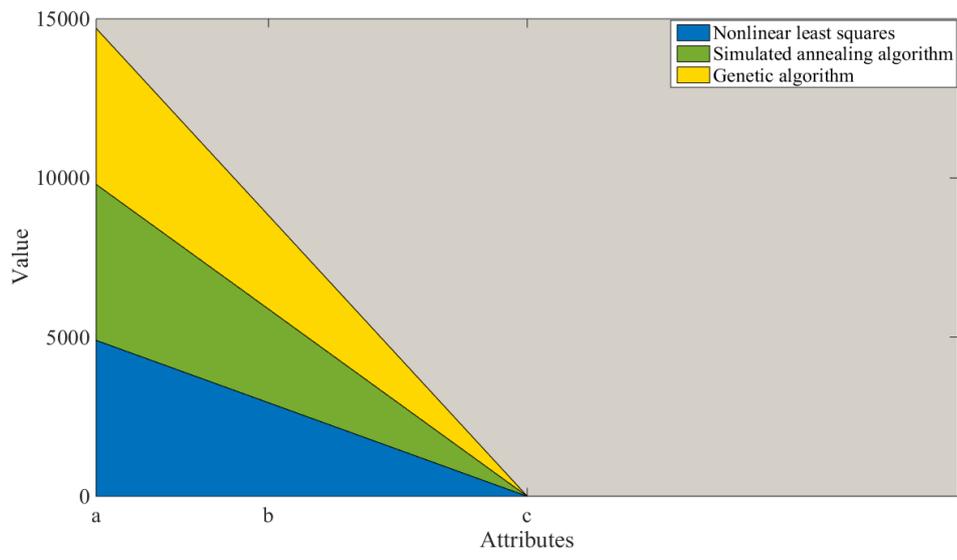


Figure 6. Fitting parameters of three parameter estimation algorithms

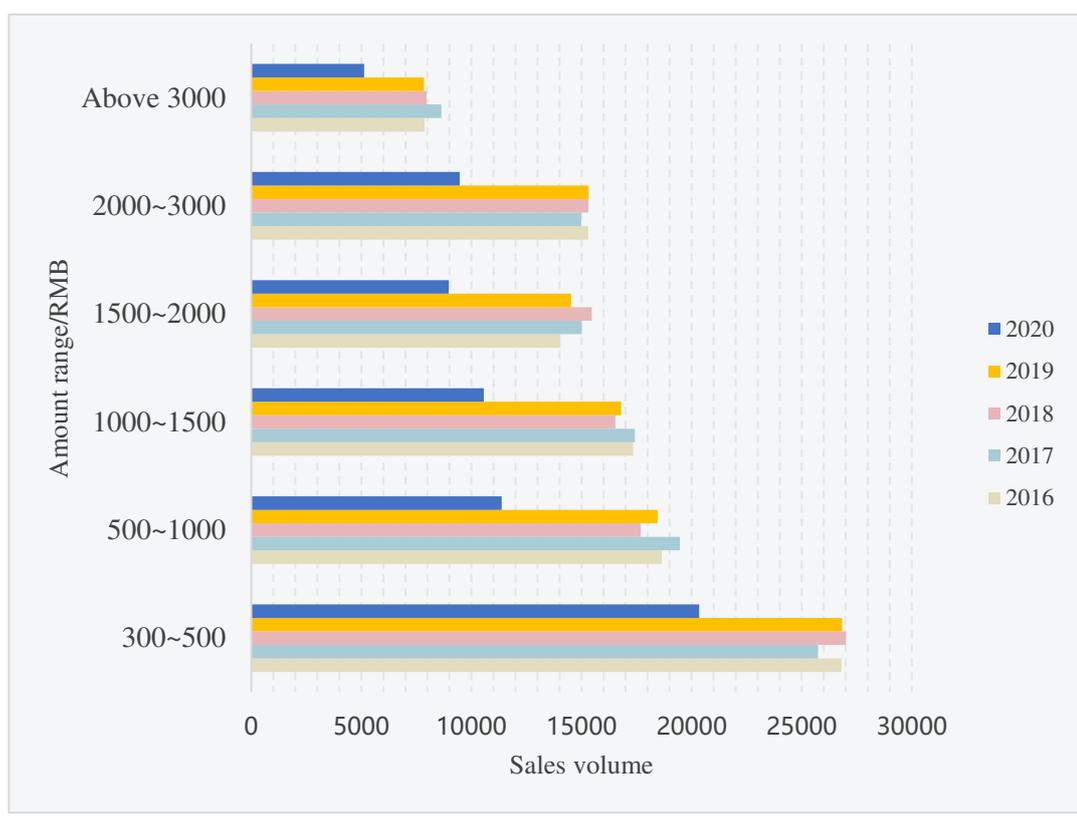


Figure 7. Sales volume by sales price range in the past five years

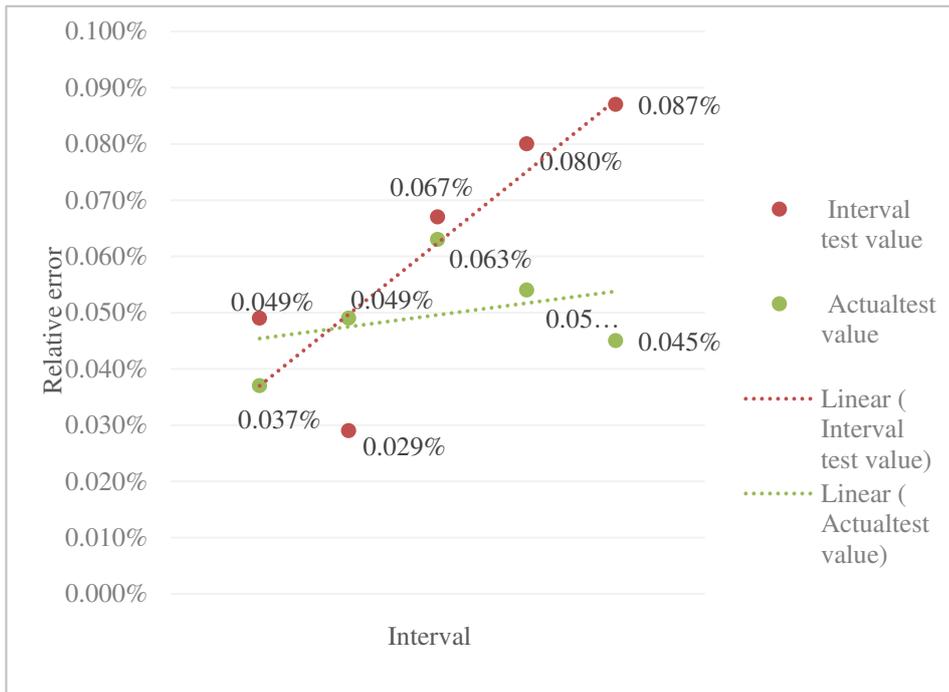


Figure 8. Fitting and forecasting sample data of football league sales

Figures

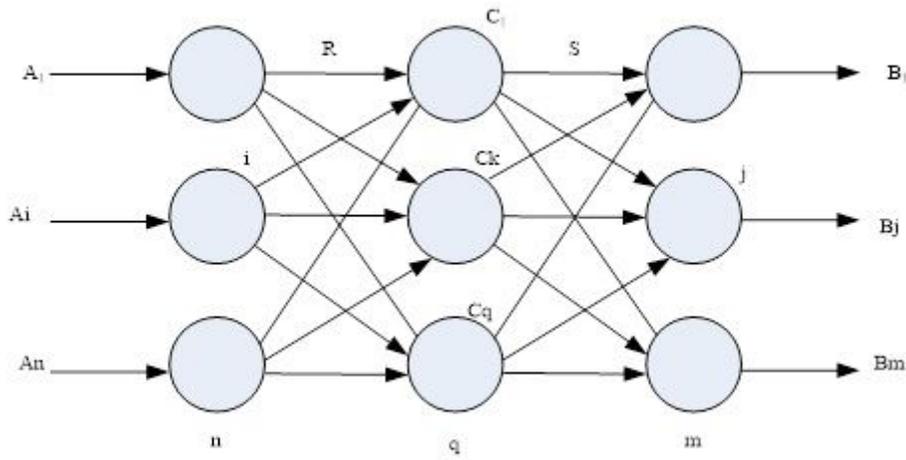


Figure 1

BP neural network model

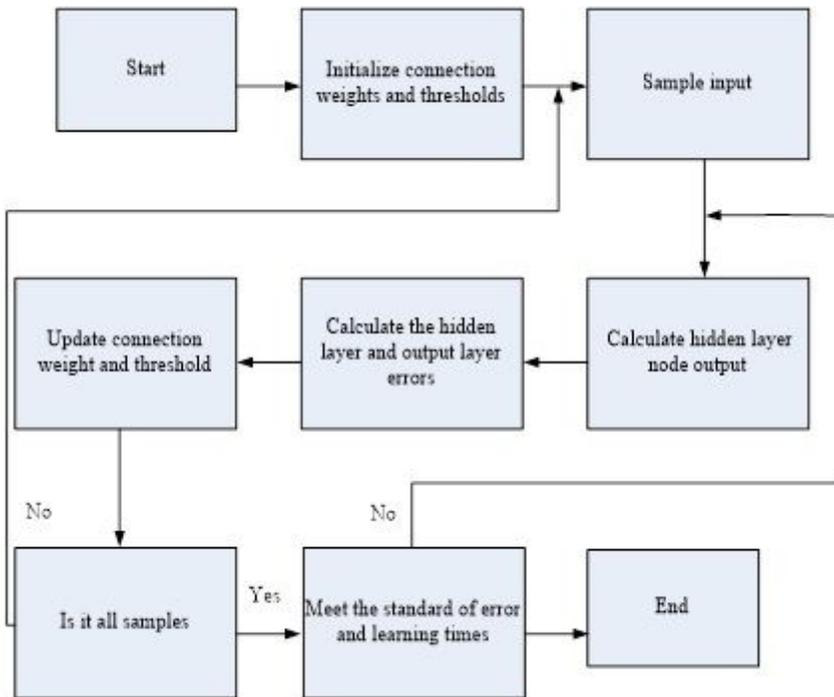


Figure 2

BP neural network design steps

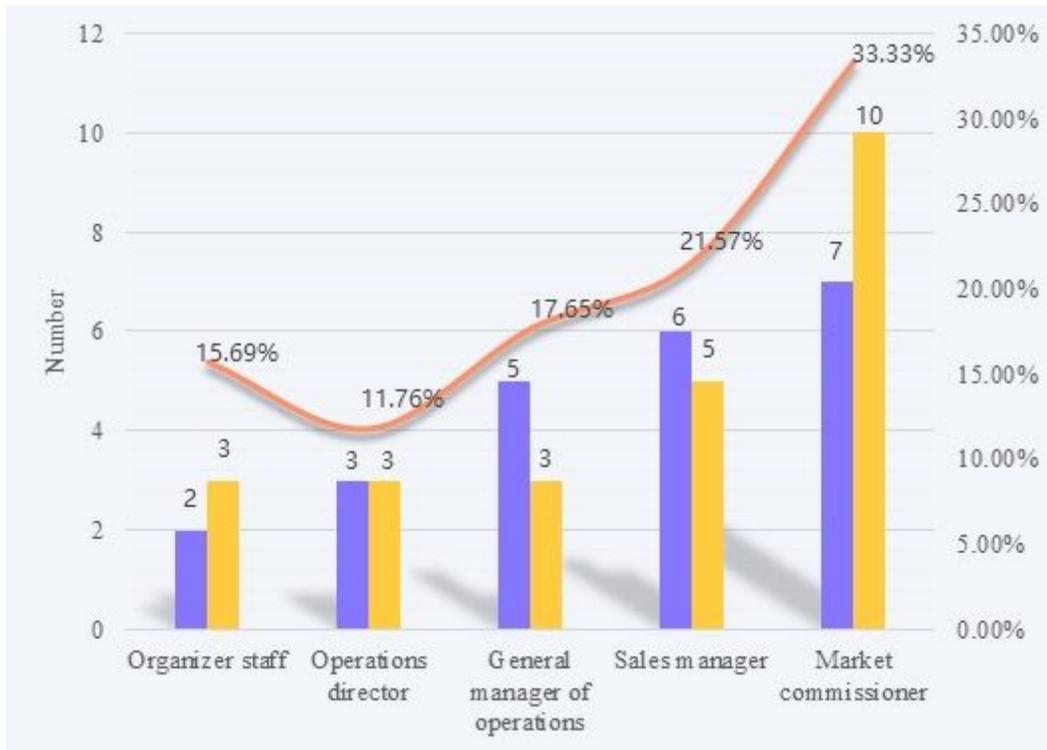


Figure 3

Basic information of the interviewee

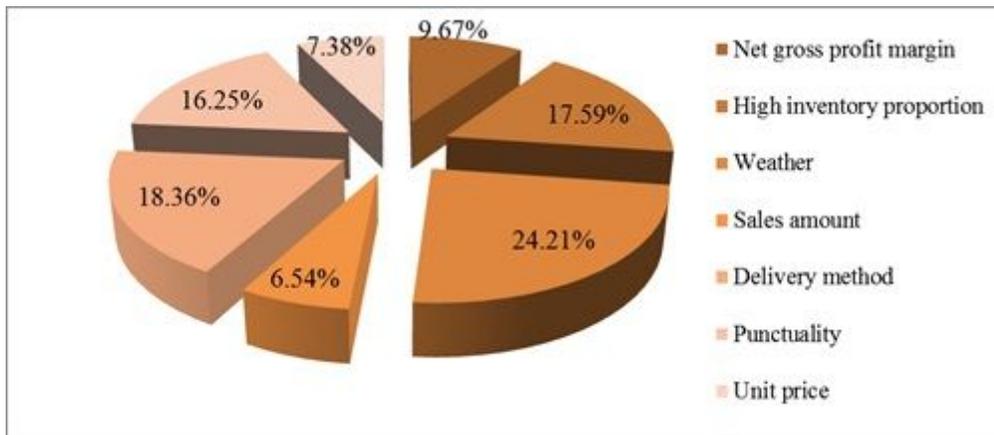


Figure 4

The main factors affecting the prediction of the sales effect of the football league

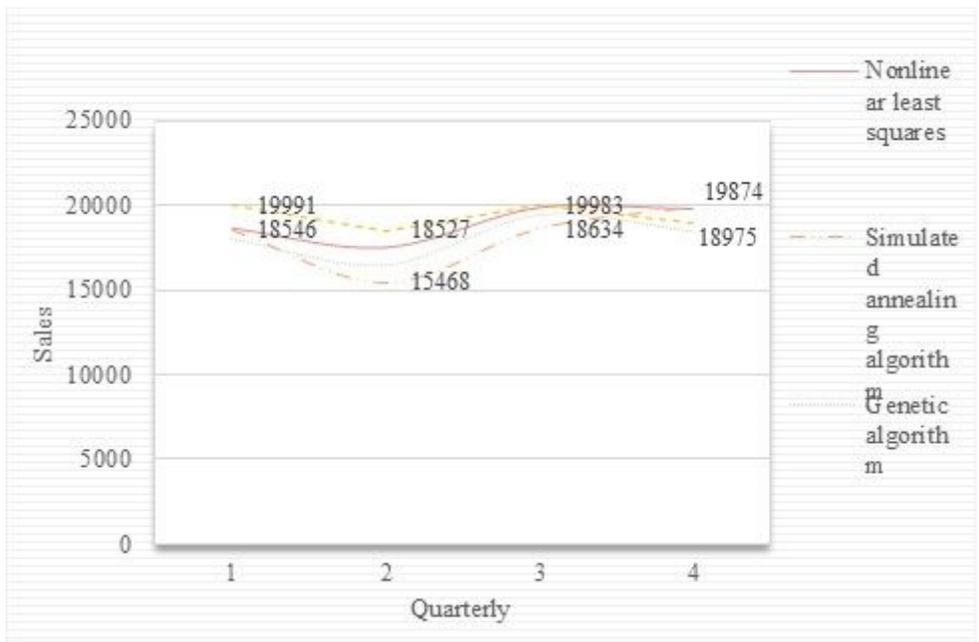


Figure 5

Comparison of sales forecast and actual sales of football league sales by BP neural network model

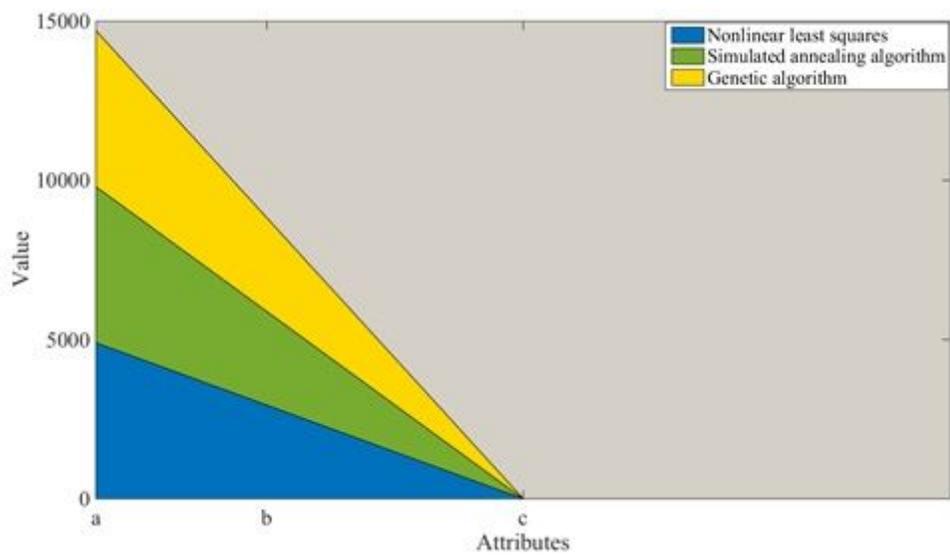


Figure 6

Fitting parameters of three parameter estimation algorithms

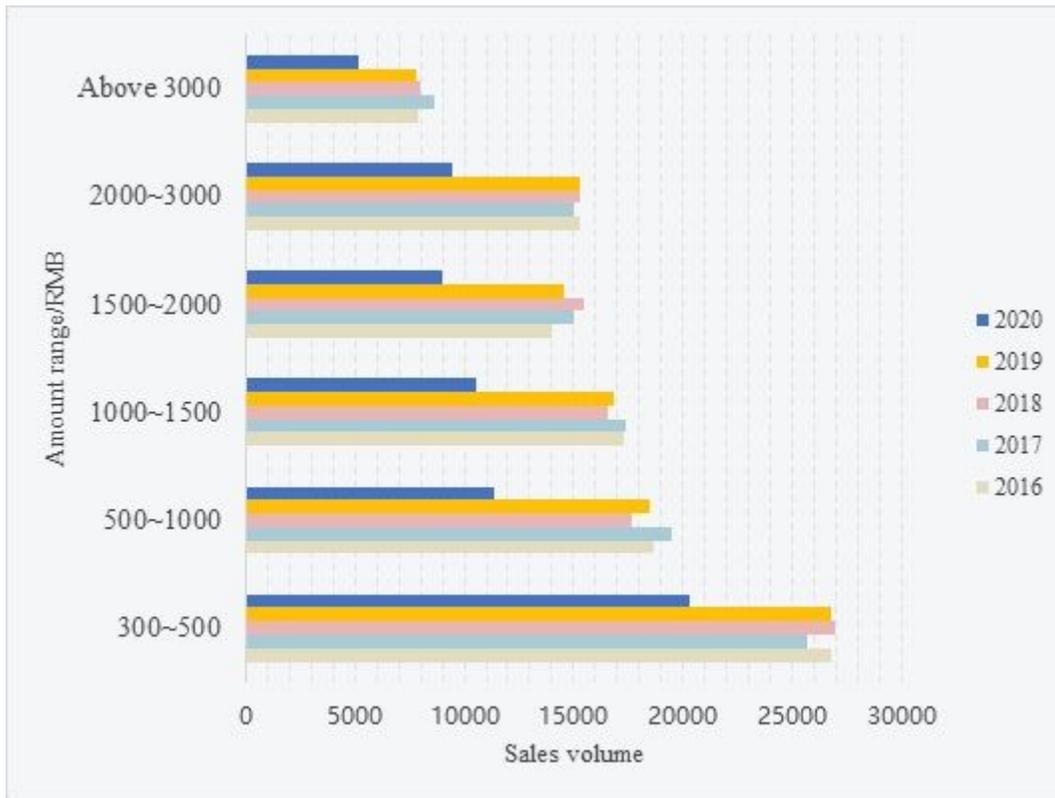


Figure 7

Sales volume by sales price range in the past five years

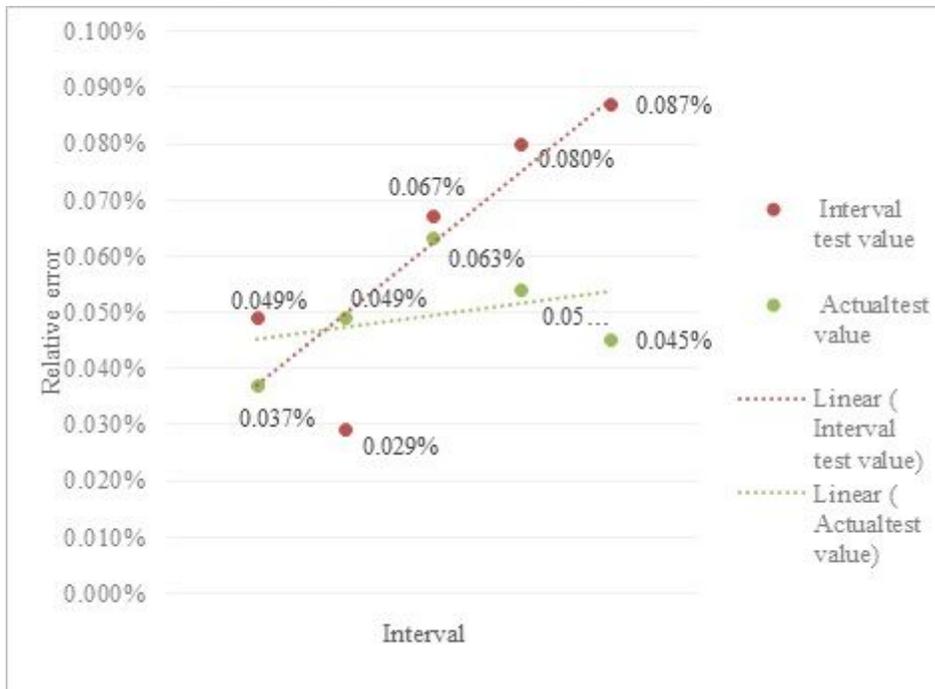


Figure 8

Fitting and forecasting sample data of football league sales