Analyzing Influencing Factors of Network Marketing Based on BP Model

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Abstract

How to mine key influencing factors and calculate their action intensity of network marketing plays an important role for enterprises to improve their operating performance in Internet age. This paper takes food for example and presents a new influencing factor system and modified BP neural network for analyzing the influencing factors of network marketing. First, a new influencing factor system of food network marketing is designed based on the specific characteristics and requirements of the food network marketing and with references to the present literatures; Second considering that BP neural network algorithm has high classification accuracy but low convergence, the paper adopts fourier basis functions to improve traditional BPNN algorithm to speed up model convergence and to simplify model structure. Finally, the experimental results show the effectiveness and validity of the presented influencing factors and improved BP model.

Keywords

Network marketing, influencing factors analyzing, BP neural network algorithm, fourier basis functions

1. Introduction

With the development of Internet, network marketing becomes a new marketing model for many industries, and food enterprises cannot be avoided from the trend also. So more and more food enterprises have begun to try to use network marketing to expand its sell scale and build its product brand. Network marketing has brought both opportunities and challenges to food enterprises which is closely linked with people's life enterprise. For the food enterprises, how to effectively mine the key influencing factors and calculate their action intensity to the food network marketing is becoming a key means to build brand reputation and earn much more economic benefit in network age. Although researching on key influencing factors is a research hotspot in the field of food network marketing, it is still in the initial stage of exploration and there is still no systematic research system, because lots of practical characteristics of food such as freshness, safety, taste and nourishment of different foods are involved in it. Therefore the research on mining key influencing factors and calculating their action intensity of food network marketing are of important theoretical and practical significance [1].

At present various methods are used to analyze the influencing factors of network marketing, but all of them have its own disadvantages. Second considering that BP neural network algorithm has high classification accuracy but low convergence, the paper adopts fourier basis functions to improve traditional BPNN algorithm to speed up model convergence and to simplify model structure for calculating the action intensity of influencing factors of food network marketing is presented.

2. Mining Influencing Factors of Network Marketing

Here takes food for example to mine influencing factors of network marketing. It is found from the research on mining influencing factors of food network marketing in the world at present that the perspective of research differs greatly. The influencing factors of food network marketing

constructed by foreign researchers is mainly for e-commerce selling websites, and what it calculates is the marketing website itself. However, researchers in China conducts researches on mining influencing factors of food network marketing in a more deep and abstract way, and influencing factor system is perfecting[2,3]. The paper, combining literatures at abroad and home[4,5,6], considering the specific characteristics of food network marketing, constructs an scientific and extensive influencing factor system of food network marketing based on the factor properties and the system 35 influencing factors and they belong to 4 first-class properties and 7 second-class properties respectively. The system includes there first-class properties, that are food properties (including one second-class properties: food properties), webpage properties (including four second-class properties : webpage design properties, webpage performance properties, online advertising properties and management properties), customer service properties(including two second-class properties : customer service properties and food transportation Properties) respectively. The specific influencing factors are omitted here.

3. Analysis Model Design

3.1 Continuous-time Fourier Series of Periodic Signal

As we all know, for signal $f(t)$ that the period is T, it can be showed by continuous-time Fourier series, i.e. Formula 1[7].

$$f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega_0 t) + \sum_{n=1}^{\infty} b_n \sin(n\omega_0 t) \tag{1}$$

Of Formula 2, $\omega_0 = \frac{2\pi}{T}$ is fundamental angular frequency, a_0 is DC component, and a_n、b_n are Fourier series, i.e. Formula 2.

$$a_0 = \frac{1}{T}\int_0^T f(t)dt \quad a_n = \frac{2}{T}\int_0^T f(t)\cos(n\omega_0 t)dt \quad b_n = \frac{2}{T}\int_0^T f(t)\sin(n\omega_0 t)dt \tag{2}$$

For time-limited nonperiodic signal $f(t)$, $0 \le t \le T$, the periodic signal that $f(t)$ is via continuation of period T is $f_p(t)$, i.e. Formula 3.

$$f_p(t) = \sum_{\mathrm{m}=-\infty}^{\infty} f(t - mT) \tag{3}$$

Of Formula 2, m is a positive number. $f_p(t) = f(t)$ occurs obviously when time t is $0 \le t \le T$. Therefore, the continuous-time series of periodic signal $f_p(t)$ can be also showed by Formula 1 within the principal value period $0 \le t \le T$.

For bandlimited signal $f(t)(0 \le \omega \le N\omega)$, Formula 1 can be changed as Formula 4[8].

$$f(t) = a_0 + \sum_{n=1}^{N} a_n \cos(n\omega_0 t) + \sum_{n=1}^{N} b_n \sin(n\omega_0 t) \tag{4}$$

For the numerical computation, Formula 4 is separated into Formula 5

$$f(k) = a_0 + \sum_{n=1}^{N} a_n \cos(n\omega_0 k T_s) + \sum_{n=1}^{N} b_n \sin(n\omega_0 t k T_s) \tag{5}$$

Of Formula 6, T_s is a sampling period, and $T_s \le \frac{\pi}{N\omega_0} = \frac{T}{2N}$. When $T_s = \frac{T}{2N}$, Formula 5 can be changed as Formula 6.

$$f(k) = a_0 + \sum_{n=1}^{N} a_n \cos(\frac{\pi}{N} nk) + \sum_{n=1}^{N} b_n \sin(\frac{\pi}{N} nk) \tag{6}$$

$k = 0,1,2...2N-1$ in Formula 6.

3.2 Neural Network Model Based on Fourier Basis Function

In Formula 6, neural network model based on Fourier basis function is produced if $f(k)$ is a neural network output, $f_d(t)$ is a neural network training sample, a_n、b_n are neural network training weights, and $\cos(\frac{\pi}{N}nk)$ and $\sin(\frac{\pi}{N}nk)$ are neural network excitation functions. See Fig. 1[9].

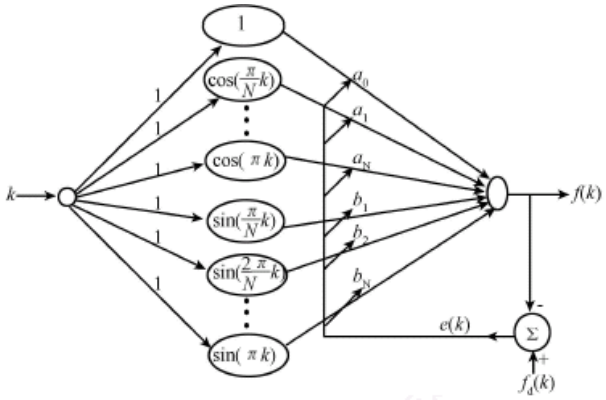

Fig. 1 BP neural network model based on Fourier basis function

The algorithm of neural network model based on Fourier is as follows:

1, See Formula 6 for neural network output.

2, See Formula 7 for error function of network model.

$$e(k) - f_d(k) - f(k) \tag{7}$$

3, See Formula 9 for network model performance index.

4, Weight adjustment by gradient descent algorithm, See Formula 8 and 9 for weight adjustment quantity.

$$\Delta a_n^k = -\eta \frac{\partial J}{\partial a_n^k} = \eta e(k)\cos(\frac{\pi}{N}nk), \quad n = 0,1,2...N \tag{8}$$

$$\Delta b_n^k = -\eta \frac{\partial J}{\partial b_n^k} = \eta e(k)\sin(\frac{\pi}{N}nk), \quad n = 0,1,2...N \tag{9}$$

5, See Formula 10 and 11 for weight adjustment, in which, η is a learning rate, and $0 \prec \eta \prec 1$.

$$a_n^{k+1} = a_n^k + \eta e(k)\cos(\frac{\pi}{N}nk), \quad n = 0,1,2...N \tag{10}$$

$$b_n^{k+1} = b_n^k + \eta e(k)\sin(\frac{\pi}{N}nk), \quad n = 0,1,2...N \tag{11}$$

3.3 Convergence Discussion of the Model

As we all know, the size of learning rate η affects neural network convergence significantly. If too small, the convergence speed of neural network is slow and the computation amount and time are increased; if too large, neural network shocks not to reach the convergence. For absolute convergence of neural network, a theorem of neural network convergence is given as below.

Theorem 1 Only when the learning rate η satisfies $0 \prec \eta \prec \frac{4}{3N+1}$, neural network algorithm is convergent. Here $2N$ is the number of neural network training samples. For the space limitation, see Reference 8 for the detailed proof of Theorem 1[10].

4. Results and Discussion

The proposed influencing factors and intensity calculation model is realized with C language. This paper takes certain 10 food network enterprises for experimental examples and investigates theirs practical operating data in 5 years from 2010-2014 according to the influencing factors designed in

the paper to carry out model application and intensity calculation of each factor. Taking into account the actual accuracy of the demand, the paper takes 2 power cut-off for the fitting curve of every influencing factors, i.e. the expression of the fitting curve is as Formula 12[11].

$$y = a_0 + a_1 x + a_2 x^2 \tag{11}$$

In Formula 11, x means each influencing factor and y operation performance of food network enterprises. So the proposed BP neural network model is used to fit the intensity curve between each influencing factor and operation performance of food network enterprises. Specific calculation results see Table 1 and Table 2. In order to save the paper page, Table 1 only shows calculation results of 14 the influencing factors, and the comprehensive influencing intensities of these 14 factors are the most significant and we defines these 14 factors as key influencing factors of food network marketing.

Table 2 shows the calculation result comparison among least square method [6], original BP neural network [9] and improved algorithm in the paper in the practical application and the experiment is conducted through PC. PC configurations are as follows: P4 2.5G CPU and 512M memories and the population number of genetic algorithm is supposed to be 60, the largest evolutionary generations is 80, crossover probability is 0.9, mutation rate is 0.01, target function takes the minimum total costs sum.

5. Conclusion

Based on the specific characteristics of food products of network marketing and with reference of the presented research results in the world, the paper designs a new influencing factor system. And based on the analysis the advantages and disadvantages of BP neural network model used in calculating the action intensity of the influencing factors, the paper uses fourier basis functions to improves the original BP neural network algorithm and takes corresponding measures to simplify the algorithm structure and improve calculation accuracy and speed up calculation speed. The experimental results show that the algorithm presented in the paper can realize above purposes when used in calculating the action intensity of the influencing factors for food network marketing.

Table 1 The Calculation Results of the 14 Key Influencing Factors

	a_0	a_1	a_2
Food safety	-2.2894	5.4108	-0.6287
Retaining freshness	1.2649	2.1365	1.2782
Comprehensive food information	-1.1458	3.1221	1.6586
Website address design	-1.3554	2.4842	-0.4239
Necessity of information	1.4562	2.0446	-0.2677
Interactivities with costumers	-2.2867	2.3581	-0.4346
Food price	-2.7220	4.5255	-0.7972
Food quality control	-3.2568	2.2314	-0.4554
Traceability of Food information	-1.2545	2.2156	-0.3824
Customer recommendation rate	-1.3048	2.2519	-0.4687
Website reputation	-1.2296	2.5527	-0.3589
Solving efficiency of customer complaint	-0.9669	2.0548	-0.4267
Customer feedback evaluation	7.0258	-2.5669	0.2748
Time for transportation foods	7.3369	-2.5254	0.2567

Table 2 Calculation Performance Comparison of Different Algorithms

	Algorithm in the paper	Least square method	Original BP algorithm
Calculation accuracy	94%	74%	88%
Time consuming (S)	14	13	689

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