Research on the Development Strategy of TC/CP Based on MSE-CM-BP Neural Network

Zihan Yang

1Confucius International School Qingdao, Qingdao, China

Corresponding author and e-mail: Zihan Yang, 15121402058@stumail.sdut.edu.cn

Abstract. As a science dedicated to simulating human learning by computer, machine learning has the ability to improve itself through empirical learning in dealing with interdisciplinary data statistics and approximation. Among them, BP neural network has stable and good nonlinear optimization processing ability, and it can deal with complex big data from a statistical perspective in strategy development. Therefore, this paper collects the data of income and rural development and its related influencing factors from 2010 to 2019, establishes a BP neural network with mean square error as the convergence measure of the results, and evaluates the application effect of BP neural network with the development strategy and creative products. The relative error of the results is less than 12%, and the correlation coefficient between influencing factors and results is not less than 0.8547.

1. Introduction

In the context of rapid economic development, people are not only satisfied with material consumption, but also inclined to spiritual consumption. The development of transportation and economy makes travel the first choice for most people to have ample free time. As a derivative product of this industry, tourism cultural and creative products carry the humanistic characteristics of the soil and water of one side. Its core competitiveness comes from the cultural connotation and regional characteristics of the tourist destination. Cultural and creative products can arouse the memories and resonance of tourists. Whether as a commemoration of travel or as a gift, the sales of tourism cultural and creative products have become one of the main components of the economic benefits of the tourism industry. So for the development strategy of tourism cultural and creative products, many scholars have also made relevant research on it: In 2020, Yuan Siyu and others analyzed the status of the Jiuhuashan cultural and creative products combined with the market, brand and product design features. Divide Jiuhuashan cultural and creative products into four categories, select Jiuhuashan regional cultural representatives, and propose combining cultural and creative products with regional cultural elements to achieve a strategy of promoting the development of Jiuhuashan’s tourism industry [1]. In 2020, Yang Liling analyzed the development status of cultural and creative tourism products in Longshan District, proposed to make the products film and television artistic, develop peripheral products, and reflect the advantages of high-quality cultural resources in tourism cultural and creative products [2]. In 2020, Ren Ting established an AHP model to analyze the optimization of Xinjiang tourism cultural and creative product development types, which will affect the six factors of product sales: price, size, local characteristics and cultural heritage, collection value, commemorative significance, practical use, and four types of cultural and creative products: tourism, cultural and creative art, tourism, creative, household goods, tourism and cultural and creative experience products, establish a hierarchical
structure model, and use the largest characteristic root method to obtain the final weight vector (0.4812, 0.0404, 0.3740, 0.1043), it is concluded that tourism, cultural and creative artworks and tourism, cultural and creative life products are more attractive to consumers, and suggestions are made for the development of tourism, cultural and creative products in the region [3]. In 2019, Li Wen and others conducted a research on the consumer preferences of museum cultural and creative products based on the KANO model, divided the product cultural attributes into five categories, calculated the proportion of subjects who made different quality judgments, and determined the quality classification of cultural attributes. The judgment ratios of the five types of cultural attributes with the attribute "story-associative" are: 55.6%, 15.4%, 60.0%, 26.5%, and 1.5%. The first judgment has the highest proportion, and this attribute can be judged as attractive quality. The final classification results show that cultural and creative products with intermediate and internal cultural attributes are more popular with consumers [4].

However, the current research on the development strategy of tourism products lacks the consideration of combining urban and rural cultural tourism. Most of them are qualitative theoretical analysis, and quantitative analysis is rare. In recent years, the State Council has issued the "Opinions on Establishing and Improving the Urban-Rural Integration Development System, Mechanism and Policy System", which aims to promote the integrated development of urban and rural areas. Dou Qun proposed to build a rural culture that has rural characteristics and can be integrated with urban culture. Measures such as rural services and leisure systems are conducive to increasing farmers' sustained and stable income, which shows that promoting the effective connection and common development of urban and rural cultural tourism is an important task [5]. This paper will study the development strategy of tourism cultural and creative products based on the comprehensive perspective of urban and rural cultural tourism with BP neural network algorithm.

2. Principle and algorithm

BP neural network is also called error back propagation neural network. The algorithm contains multi-layer neural networks, which are connected by neurons, but the neurons do not affect each other laterally (see figure 1).

![figure 1](image)

**Figure 1.** Structure diagram of BP neural network.

The training process is divided into a forward propagation stage and a backward propagation stage: the first stage (forward propagation) inputs samples, selects the ideal output value, and calculates the corresponding actual output. Then enter the second stage (backward propagation), get the difference between the actual output and the ideal output, and then modify the connection weight layer by layer in a way of minimizing the error, adjust the weight matrix in the network, return to the input layer, and calculate the sample set. The error measurement is to determine whether it is less than the minimum
error and whether it exceeds the maximum number of iterations. If one of the conditions is met, the result can be output. Otherwise, it returns to the initialization step and loops again. As the number of loops increases, the accuracy continues to improve. The parameters involved include: the input vector, the dimension of the output vector, the number of hidden layers of the network, and the number of neurons in each hidden layer.

The general number of nodes in the hidden layer of BP neural network algorithm is as follows:

\[ \sqrt{I + O + a} \]  

Where, I is the number of nodes in the input layer, O is the number of nodes in the output layer, and a is the adjustment constant in the range of 1-10. If the weight matrix of input layer and hidden layer is marked as \( W_{ik} \), then the calculation method of output value of node \( K \) is as follows:

\[ y_k = \sum_{i=0}^{I} W_{ik} \cdot X_i + B_K \]  

Excitation function selection:

\[ f(x) = \frac{1}{1+e^{-x}} \]

This paper uses the BP algorithm to establish a model to predict the annual operating income of institutions affiliated to the cultural and tourism sector and the growth of rural economic benefits, and figure 2 shows the program flow chart of the BP neural network algorithm.
3. Experimental results and discussion

3.1. Experimental design
In view of the fact that the sales of tourism cultural and creative products has become one of the main income of the tourism industry, and the cultural tourism combining urban and rural areas will drive the changes of rural economic benefit growth, this paper will take the total tourism income and the growth of rural economic benefits as the output neuron vector to evaluate the research results of the development strategy of tourism cultural and creative products combined with urban and rural culture and tourism. Among them, the per capita consumption level of residents will affect the travel intention.
of tourists. The consumer price index of cultural and recreational goods and services price index directly reflects the tourists’ preference for cultural and creative products. The total amount of cultural consumption can show residents’ consumption tendency for cultural and creative products, and the income of rural service personnel reflects the development level of rural tourism service industry. The four factors that may affect the sales of cultural and creative products, including the per capita consumption level of residents, the consumer price index of tourism in the price index of cultural and entertainment products and services, the added value of cultural industry and the per capita income of rural service personnel, are used as input layer neuron vectors to analyze the influence of four factors on the development strategy of cultural and creative products.

Table 1. Tourism income and rural economic growth and its influencing factors from 2010 to 2019.

| Year | China’s total tourism income (trillion yuan) | Rural economic income growth (%) | Per capita consumption of residents (yuan) | Resident tourism consumer price index (previous year=100) | Added value of cultural industry (100 million yuan) | Per capita income of rural service personnel (yuan) |
|------|---------------------------------------------|---------------------------------|------------------------------------------|-------------------------------------------------|-------------------------------------------------|-----------------------------------------------|
| 2019 | 6.5                                         | 9.6                             | 21559                                    | 103                                             | 41935.0                                         | 3506                                           |
| 2018 | 5.97                                        | 8.8                             | 19853                                    | 103.3                                           | 38737.0                                         | 3496                                           |
| 2017 | 5.4                                         | 8.6                             | 18322                                    | 103.6                                           | 34722.0                                         | 3076                                           |
| 2016 | 4.69                                        | 8.2                             | 17111                                    | 102                                             | 30783.0                                         | 3465                                           |
| 2015 | 4.13                                        | 8.9                             | 15712                                    | 99.5                                            | 27235.0                                         | 3291                                           |
| 2014 | 3.73                                        | 11.2                            | 14491                                    | 105                                             | 23940.0                                         | 3014                                           |
| 2013 | 2.95                                        | 19.1                            | 13220                                    | 104                                             | 21351.0                                         | 2809                                           |
| 2012 | 2.59                                        | 13.5                            | 11291                                    | 101.7                                           | 18071.0                                         | 2360                                           |
| 2011 | 2.25                                        | 18.2                            | 10191                                    | 103.8                                           | 13497.0                                         | 2102                                           |
| 2010 | 1.57                                        | 12.6                            | 8926.5                                   | 104.9                                           | 11052.0                                         | 1863                                           |

The above data are from CNKI and the statistical yearbook of Chinese culture and tourism published by the National Bureau of statistics.

The model training uses the total consumption level of residents from 2010 to 2015 in Table 1, the residents’ tourism consumption price index in the price index of cultural and recreational goods and services, the total cultural consumption, the per capita income of rural service personnel, and the growth of rural economic income as the training set. Using the eigenvectors of the national cultural and tourism departments from 2010 to 2015 in Table 1 as the predicted label value; using the data from 2016 to 2019 in Table 1 as the test set to predict from 2016 to 2019, the operating income and rural economic income of institutions affiliated to the national cultural and tourism sector will increase.

Before training the BP neural network algorithm, normalize the influencing factors. The normalization formula is as follows:

$$X_{\text{norm}} = \frac{X - X_{\text{min}}}{X_{\text{max}} - X_{\text{min}}}$$  \hspace{1cm} (4)

Where, $X_{\text{norm}}$ is the normalized data, $X$ is the original data, and $X_{\text{max}}$ and $X_{\text{min}}$ are the maximum and minimum values of the data.
Table 2. Data obtained after normalization of Table 1.

| Year | China's total tourism income (trillion yuan) | Rural economic income growth (%) | Resident consumption (yuan) | Resident tourism consumer price index (previous year=100) | Added value of cultural industry (100 million yuan) | Per capita income of rural service personnel (yuan) |
|------|--------------------------------------------|----------------------------------|-----------------------------|----------------------------------------------------------|---------------------------------------------------|-----------------------------------------------|
| 2019 | 1                                          | 0.128                            | 1                           | 0.636                                                    | 1                                                 | 1                                             |
| 2018 | 0.892                                      | 0.055                            | 0.868                       | 0.691                                                    | 0.896                                             | 0.994                                         |
| 2017 | 0.777                                      | 0.037                            | 0.744                       | 0.745                                                    | 0.766                                             | 0.738                                         |
| 2016 | 0.633                                      | 0                                | 0.648                       | 0.455                                                    | 0.639                                             | 0.975                                         |
| 2015 | 0.519                                      | 0.064                            | 0.537                       | 0                                                        | 0.524                                             | 0.869                                         |
| 2014 | 0.438                                      | 0.275                            | 0.440                       | 1                                                        | 0.417                                             | 0.701                                         |
| 2013 | 0.280                                      | 1                                | 0.340                       | 0.818                                                    | 0.333                                             | 0.576                                         |
| 2012 | 0.207                                      | 0.486                            | 0.187                       | 0.400                                                    | 0.227                                             | 0.302                                         |
| 2011 | 0.138                                      | 0.917                            | 0.100                       | 0.782                                                    | 0.097                                             | 0.145                                         |
| 2010 | 0                                          | 0.404                            | 0                           | 0.931                                                    | 0                                                 | 0                                             |

3.2. Results and discussion

The mathematical model established through the BP neural network predicts the growth of operating income and rural economic income of institutions affiliated to the national cultural and tourism sector from 2016 to 2019. The results are shown in Table 3:

Table 3. Forecast the growth of rural economic income and the operating income of institutions affiliated to national cultural and tourism departments from 2016 to 2019.

| Year | Rural economic income growth (%) | Forecast of rural economic income growth (%) | China's total tourism income (trillion yuan) | Forecast China's total tourism income (trillion yuan) |
|------|----------------------------------|---------------------------------------------|-------------------------------------------|-----------------------------------------------|
| 2019 | 9.6                              | 8.46                                        | 6.5                                       | 6.3                                           |
| 2018 | 8.8                              | 7.39                                        | 5.97                                      | 5.06                                          |
| 2017 | 8.6                              | 9.02                                        | 5.4                                       | 5.7                                           |
| 2016 | 8.2                              | 8.09                                        | 4.69                                      | 4.72                                          |

The calculated relative error of the predicted value for 2014 and 2015 is as follows:

\[
\Delta = \frac{|\text{true value} - \text{predicted value}|}{\text{true value}}
\]  

And calculate the correlation, the formula is as follows:

\[
r(x, y) = \frac{\text{Cov}(x, y)}{\text{Var}[x] \text{Var}[y]}
\]  

Among them, Cov(x, y) is the covariance of x and y, Var[x] is the variance of x, and Var[y] is the variance of y.
The relative error and correlation of the obtained predicted value are shown in Table 4.

Table 4. Relative error and correlation coefficient of predicted value of rural economic income growth (%) of operating income of institutions affiliated to national cultural and tourism sector (billion yuan).

| Year | Rural economic income growth (%) | China’s total tourism income (trillion yuan) | Relative error (%) | Correlation coefficient | Relative error (%) | Correlation coefficient |
|------|---------------------------------|-------------------------------------------|--------------------|------------------------|--------------------|------------------------|
| 2019 | 11.5                            | 7.18                                      | 0.8547             | 0.9346                 |
| 2018 | 11.4                            | 5.53                                      |                    |                        |
| 2017 | 7.7                             | 4.93                                      |                    |                        |
| 2016 | 8.8                             | 4.00                                      |                    |                        |

It can be seen from Table 4 that the relative error does not exceed 11.5, and the minimum correlation coefficient is 0.8547, which proves that the data obtained by the model prediction established by the BP neural network algorithm fits well with the true value. Then use the established BP neural network algorithm model to predict the growth (%) of operating income and rural economic income of institutions affiliated to the national cultural and tourism sector from 2016 to 2019.

![Figure 3. Forecast value and real value comparison chart of rural economic income growth (%) from 2016 to 2019.](image-url)
Figure 4. Comparison chart of the predicted value and real value of China’s total tourism income (million yuan) from 2016 to 2019.

Use the data in Table 2 to analyze the correlation between each influencing element and the output value separately, and show the relationship and direction between the two. The correlation diagram is shown below.

Figure 5. Correlation between the influencing factors and China’s total tourism income (trillion yuan). (a) the correlation between residents' consumption; (b) residents' tourism consumption price index; (c) total cultural consumption, per capita income of rural service personnel; (d) operating income of national cultural and tourism departments.
Figure 6. Correlation between the influencing factors and rural economic income growth. (a) the correlation between residents' consumption; (b) residents' tourism consumption price index; (c) total cultural consumption, per capita income of rural service personnel; (d) rural economic income growth.

Since the correlation is not strong, scatter plot is used to show the general trend between the influencing factors and output variables. It can be seen intuitively from Figures 3 and 4 that the difference between the predicted value and the true value is small. Figures 5 and 6 reflect that a single factor and the output value are basically positively correlated, indicating that the four independent variables can more accurately summarize the factors that affect the effects of urban and rural cultural tourism and the development of tourism cultural and creative products, and the output is positively correlated with the independent variables. The relationship indicates that relevant measures can be used to increase independent variables to achieve the goal of improving the development status of tourism, cultural and creative products and increasing rural income levels. Quantitative analysis provides directions for the development strategies of both.

The correlation coefficients between the cultural and tourism sector's institutional operating income and the growth of rural economic income and the total consumption level of residents are 0.895 and 0.906, indicating that tourists’ willingness to travel has increased year by year and they are willing to purchase agricultural products. In this context, rural tourism and tourism cultural and creative products should be paid attention to. The development and perfection of the urban and rural cultural tourism have more tourism value meaning.

The correlation coefficients between the output and the residents' tourism consumer price index are 0.853 and 0.926, which can reflect that tourists spend more on the journey, and thus can try to develop more high-quality and high-value cultural and creative products.

The correlation coefficients between output and total cultural consumption are 0.963 and 0.926, indicating that tourists are more inclined to cultural tourism and creative products with cultural
connotations, so the rural tourism industry can consider corresponding development that contains local cultural characteristics and humanities. Amorous products stimulate consumers' desire to buy.

The correlation coefficients between output and rural service personnel's per capita income are 0.973 and 0.961, indicating that the rural service level directly affects the effect of urban and rural cultural tourism and the income level of the local economy. The more developed the rural service industry, the higher the educational background and service level of service personnel. The higher the local economic income, the better the sales of tourism cultural and creative products. The development suggestions that can be made are to improve the service level of the rural tourism industry and systematize the rural tourism industry. At the same time, it combines Internet+ and adds intelligent elements to build its own brand to attract young people to choose urban and rural cultural tourism. You can also add trend elements to the design of some tourism cultural and creative products to enter the youth market and increase the audience of tourists and consumers.

However, the large errors in individual years can be explained from the following three aspects.

a. In the established model, the factors that affect the sales of tourism cultural and creative products are not properly selected, and the generalized angle is not comprehensive enough, and the amount of collected data is small, which leads to the error of individual years caused by accidental factors that cannot be ruled out.

b. The preprocessing of the data is not in place. It can be seen from the analysis of the influence of single factors on the output in Figure 4 that in addition to the normalization of the data, the factors that affect the output should also be weighted to avoid unimportant factors. The statistical fluctuations have a greater impact on the output results.

c. Lack of algorithm improvement, the algorithm model should be optimized for specific problems to make the BP algorithm more suitable for the actual situation.

4. Conclusions
The development and research of cultural and creative tourism products has been a hot topic in recent years, and the promotion of rural economic development through urban-rural interaction is also the focus of current national policies. The research in this article shows that the combination of the two can often achieve complementary effects. Cultural tourism can drive the development of rural tourism, which indirectly affects the development and research of its tourism cultural and creative products, and rural economic growth has gained new impetus. By analyzing the correlation coefficient between single factor and output, it is found that rural service personnel's per capita income and total cultural consumption have the largest correlation coefficient with output. From this point, it can be concluded that tourists who choose urban and rural cultural tourism pay more attention to cultural connotation elements. The tourism industry can focus on the development of cultural and creative products rich in regional and cultural types; similarly, it can be proved that tourists are more inclined to use rural areas with higher service levels as cultural tourism locations, and rural tourism projects such as farmhouses, tour groups, etc. can be systematically developed. Summer resorts, etc., attract more tourists, and at the same time promote the development of cultural and creative products, thereby driving the development of the rural economy, which is more conducive to the combination of urban and rural cultural tourism and its cultural and creative products.

References
[1] Yuan Siyu, Tong Dengfeng, Hu Jia. Research on the Development Strategy of Jiuhua Mountain Tourism Cultural and Creative Products [J]. Journal of Anhui Vocational and Technical College, 2020, 19(03): 43-46.
[2] Yang Liling. Suggestions on the development of cultural and creative tourism products in Longshan District [J]. Farm Staff, 2020(06): 215-216.
[3] Ren Ting. Research on the optimization of Xinjiang tourism cultural and creative product development types based on AHP [J]. Northern Economy and Trade, 2020(06):154-157.
[4] Li Wen, Zhang Tao. Research on Consumer Preference of Museum Cultural and Creative
Products Based on KANO Model [J]. Design, 2019, 32(17): 76-79.

[5] Dou Qun. Promoting the integration of urban and rural areas to develop cultural and tourism industry has done a great deal [N]. China Tourism News, 2019-06-17 (003).

[6] Yang Yi, Chen Qiuning, Zhang Lin. Research on the pricing mechanism of cultural and creative products based on signaling model [J]. China Cultural Industry Review, 2019, 27(01): 64-80.