Application of regression neural network and MIV algorithm in visual communication design

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Abstract. Regression neural network algorithm can continuously learn the characteristics of training samples, and it has good data tolerance, robustness and generalization ability, and has been widely used in all kinds of nonlinear regression problems. In this paper, a multi-input and single output neural network regression model is constructed. Through the weight training of a large number of experimental sample data characteristics, the nonlinear regression mapping relationship of multi-parameter input is established, so as to realize the accurate prediction of the basic situation of cultural and creative enterprises, then to analyze the influence of cultural and creative enterprises on the visual communication design course. The result of the correlation coefficient of the two is 0.79. The average relative errors between the predicted results and the actual results are 9.167% and 9.63%, respectively, both of which are less than 12%. It shows that the regression neural network model constructed in this paper can accurately analyse and predict the data, and the error between the predicted value and the target output value of the network model meets the actual requirements. So it has good prediction accuracy and generalization performance.

1. Introduction
With the advent of the era of creative economy, the country continues to attach importance to the development of cultural creativity. Only by strengthening the teaching of visual communication design course can it promote the development of cultural creativity. The two are mutually reinforcing. In this paper, the mean impact value (MIV) algorithm [1] is used to quantitatively analyze the influence weight of each input parameter on the target output parameter. Based on the data of China's economic and social big data research platform, the impact of cultural and creative industries on the visual communication design course is tested, so as to improve the quality of visual communication design course by improving the content of cultural and creative industries. In March 2021, Lun Zhimei et al. trained by building a training neural network model and based on a large number of data collected in the engine test process, and predicted the NOx emission, then obtain the corresponding results, and the relative error of the prediction results is basically less than 5% [1]. In January of the same year, Xiong Hao et al. used the autoregressive model to predict the linear term, combined the regression neural network with the long-term and short-term memory network to obtain the short-term local dependence characteristics and the long-term development trend of the data at the same time, and combined the results to obtain the final prediction value. The experimental results show that compared with the traditional network traffic prediction model, the Mean Square Error (MSE), Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) of the model are reduced by 1.5604, 0.1468 and 0.1405 respectively.
Jiang Wenping et al. used regression analysis algorithm to prove that there is no linear relationship between the qualified rate of precious metals and individual parameters, and then used grey neural network to find out the maximum influencing parameters in the wire winding production process, and the relative error is 0.12 [3]. In February 2015, Li Wenting and others proposed the specific impact of cultural and creative industries on visual creative design, the reform of curriculum mode, infrastructure and teaching staff, explore the new direction of visual communication design teaching, and continuously improve the quality and standard of teaching [4]. But so far, there is no article using regression neural network and MIV algorithm to analyze the impact of cultural and creative industries on visual communication design course. Therefore, based on the data of cultural and creative enterprises in Taiwan Province, this paper uses regression neural network to predict the turnover and number of visual communication enterprises related to cultural and creative enterprises, and analyzes the number of graduates, students in school, enrollment and graduating class of forestry undergraduate students in ordinary forestry colleges and other colleges in previous years. As a result, the impact of cultural and creative industries on the course of visual communication design can be analyzed.

2. Principle

2.1. Model construction and training

The basic structure of the regression neural network is shown in Figure 1.

![Figure 1. Neural network structure diagram.](image)

In addition to the input and output layers, the model structure also contains two hidden layers. Among them, the number of neurons in the input layer is equal to the number of input parameters of the model; the number of neurons in the output layer is 1, and the output result is related to the predicted value of the turnover and number of visual communication enterprises of cultural and creative enterprises. The model uses S-shaped Log-sigmoid activation function, which aims to introduce nonlinearity into multilayer neural network to better fit the nonlinear mapping relationship. The expression formula of activation function is as follows:

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

(1)

Where x is the input parameter of the network model.
In the process of network model training, gradient descent method is used as the learning algorithm, and the algorithm flow is shown in Figure 2. The training process is described as follows:

1) Initialize the network structure and network parameter weights.

2) The normalized data is used as the training sample set of the training network model, and the data set can be described as (X, Y), where X is the input data vector set of the model and Y is the target output vector of the model.

3) The actual output value o of the neural network is obtained by forward calculation layer by layer. For the output layer, the calculation formula of the actual output value is

\[
o = f\left(\sum_{j=0}^{m} w_j y_j\right)
\]

(2)

\[
o = f\left[\sum_{j=0}^{m} w_j \cdot f\left(\sum_{i=0}^{16} v_{ij} \cdot f\left(\sum_{k=0}^{12} \lambda_{ki} x_k\right)\right)\right]
\]

(3)

Where: j is the number of input layer (H2 layer) neurons in the output layer; Wj is the weight between the j-th neuron node in H2 and the output layer node. In the same way, the expression relationship between input layer xk and output value o can be obtained by continuously transforming output layer yj, where i is the serial number of H1 layer neurons; vij is the connection weight between the i-th neuron in H1 layer and the j-th neuron in H2 layer; \(\lambda_{ki}\) is the connection weight between the k-th input parameter node in input layer and the i-th neuron in H1 layer.

4) To calculate the error between the target output value y and the actual output value o, this paper is a single output model, and the calculation formula of the reverse error is defined as

\[
E(W) = \frac{1}{2} (y - o)^2
\]

(4)

2.2. MIV (Mean Impact Value) influence factor algorithm

As an important index to determine the influence of input neuron on output neuron, the absolute value of MIV (Mean Impact Value) quantificationally represents the relative weight of the influence [5]. Therefore, this paper considers that on the basis of neural network model, the MIV algorithm is used to evaluate the correlation of input variables and measure the relative influence weight of input variables on output variables. The flow of MIV algorithm is shown in Figure 2, and the implementation steps are as follows:

1) Set the adjustment rate Ki of MIV, which is the change ratio of each input variable, where I is the serial number of the adjustment rate.

2) Each independent variable of the model training sample is added and reduced the proportion of the current adjustment rate on the basis of its original value Po, and a new training sample data set Pi_max,Pi_min is obtained.
3) For each independent variable, the adjusted new training sample data $P_{i_{\text{max}}}$, $P_{i_{\text{min}}}$ is used as the test sample data of the independent variable, and the trained neural network model $M_{\text{Net}}$ is used to simulate test and two sets of prediction results $R_{i_{\text{max}}}$, $R_{i_{\text{min}}}$ are obtained.

4) The difference between the two predicted values of each independent variable is IVi value. Its physical significance is that: adjusting the independent variable size in a certain proportion can change the influence of the output results of the model.

5) The mean value of IVi is calculated, which is MIVi value of the independent variable for the output target variable of the network model. The absolute value $|\text{MIVi}|$ can measure the relative importance and influence weight of the corresponding input variable to the output variable, or eliminate the input variable with smaller weight based on the relative influence weight value, so as to reconstruct and optimize the training model, realize the dimension reduction of the input parameters of the network and further reduce the complexity of the network model.

3. Experimental design

3.1. The influence of cultural and creative enterprises on Visual Communication Design Course

Cultural and creative industry enterprises indirectly affect the quality of visual communication design courses, and the higher the turnover of cultural and creative enterprises, the more the number of enterprises, the better the quality of students majoring in visual communication design. Therefore, this paper establishes the corresponding neural network model based on the turnover and number of enterprises of cultural and creative industries in Taiwan Province from 2008 to 2017, as well as the recruitment number of visual communication specialty. The results are shown in Table 1 and figure 3 (Note: the turnover unit is NT $1$ million).
Table 1. Situation of visual communication cultural and creative enterprises in Taiwan Province from 2008 to 2017.

| Year | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|------|------|------|------|
| Turnover | 2229 | 2750 | 3639 | 2735 | 1671 | 1739 | 2006 | 2454 | 2864 | 3297 |
| Enterprise number | 208 | 217 | 243 | 289 | 315 | 671 | 836 | 1057 | 1220 | 1331 |

Based on the above data, the established regression neural network model can predict the number and turnover of cultural and creative industries in 2018 and 2019.

3.2. Analysis on the relationship between the number of students majoring in visual communication design and cultural and creative enterprises in forestry colleges

In order to better investigate the impact of cultural and creative industries on visual communication design major, this paper makes statistics on the number of graduated students, students on campus, enrollment and graduating class of forestry undergraduate students in ordinary forestry colleges and other colleges and universities from 2012 to 2017, as shown in Table 2. Thus, it can analyze the number of students majoring in visual communication design with the growth of years.

Table 2. The graduated students, enrollment, graduators, and graduating students of visual communication design course from 2012 to 2017.

| Year | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|------|------|------|------|------|------|------|
| Graduated students | 11 | 13 | 99 | 79 | 138 | 302 |
| Enrollment | 23 | 258 | 170 | 205 | 183 | 180 |
| Graduators | 68 | 759 | 756 | 773 | 1037 | 992 |
| Graduating students | 68 | 163 | 317 | 79 | 138 | 257 |

4. Discussion and analysis

In order to intuitively analyze the impact of cultural and creative industries on the curriculum, the content of Table 1 is obtained as shown in Figure 3.
From this, it can see that the number of cultural and creative enterprises related to visual communication design is gradually increasing, while the turnover is fluctuating, reaching the highest value of NT $2639 million in 2010 and the lowest value of NT $1671 million in 2012. There are many reasons for this. For example, the general election of Taiwan leaders in 2012 has played a restraining role in the consumption of cultural and creative industries of local people. As a result, the consumption of the people is reduced, and the consumption of cultural and creative industries related to visual communication is reduced. However, after 2012, the turnover of cultural and creative industries is gradually increasing. The established neural network model is used to predict the turnover and the number of enterprises in 2018, 2019, and 2020. The results are shown in Table 3 and Figure 4.

Table 3. Forecast of turnover of cultural and creative enterprises related to visual communication from 2018 to 2020.

| Year  | 2018  | 2019  | 2020  |
|-------|-------|-------|-------|
| Turnover forecast | 2978  | 3215  | 3896  |
| Turnover of the Actual value | 3256  | 3564  | 4006  |
| Relative error(%) | 10.25 | 11.9  | 5.35  |

Table 4. Forecast of the number of cultural and creative enterprises related to visual communication in 2018-2020.

| Year  | 2018  | 2019  | 2020  |
|-------|-------|-------|-------|
| Enterprise number forecast | 1420  | 1599  | 1756  |
| Actual value of Enterprise number forecast | 1547  | 1752  | 1652  |
| Relative error(%) | 9.26  | 11.4  | 8.23  |

It can be seen from the above that the relative errors of turnover and the number of enterprises is less than 12%, which indicates that the neural network model can be used to predict the data from 2021 to the following years.

Similarly, the visual communication design of forestry undergraduate students in ordinary forestry colleges and universities and other colleges and universities from 2012 to 2017 is analyzed. The number of graduates, students on campus, enrollment and graduating class is shown in Figure 4.
Figure 4. The graduated students, enrollment, graduators, and graduating students of visual communication design course from 2012 to 2017.

As can be seen from the figure, the number of graduated students, the number of students in school and the number of school enrollment are gradually increasing, only the number of graduating classes decreased in 2015, but generally the total number is increasing, and the turnover of cultural and creative enterprises and the number of students majoring in visual communication design is 0.79, so the development of cultural and creative industries promotes the growth of the number of students majoring in visual communication design. Therefore, the model constructed in this paper can fully prove that the development of cultural and creative enterprises can obviously promote the curriculum quality of visual communication design.

5. Conclusions
Based on the data of cultural and creative enterprises in Taiwan Province and using regression neural network, this paper forecasts the turnover and number of visual communication enterprises of cultural and creative enterprises, and analyzes the number of graduated students, students in school, enrollment and graduating class of forestry undergraduate students in general forestry colleges and other colleges in previous years, and the correlation coefficient is 0.79, which proves that cultural and creative enterprises can affect the quality of visual communication design courses, and the better the development of cultural and creative enterprises is, the higher the enrollment of visual communication major is. After using the regression neural network model, the average relative errors between the predicted results and the actual results are 9.167% and 9.63%, respectively, both of which are less than 12%. It shows that the regression neural network model constructed in this paper can accurately predict the data of analysis, and the error between the predicted value and the target output value of the network model meets the actual demand, and has good prediction accuracy and generalization performance.

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