Study on the Relationship Between GGDP and Climate Based on GA-BP Model

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Abstract. In this paper, a neural network with 8 inputs and 2 outputs is constructed by GA-BP model, and the model is trained and error analyzed. Finally, the GGDP data were validated based on the GA-BP model. It is verified that the model has good generality. It is concluded that GGDP, as a major indicator of national economy, can contribute to the impact of climate mitigation.

Keywords: Neural Network, Genetic Algorithm, Green GDP, Climate Impact.

1. Introduction

Gross Domestic Product (GDP) is one of the best-known and most commonly used indicators of a country's economic health, and it counts all output within a country's borders. Convincing countries to agree to this new GGDP may be difficult. However, if this shift starts a movement towards climate change and thus alleviates the climate crisis to some extent, then the fight is worth it. In this paper, eight climate influencing factors are used as inputs and two climate evaluation indicators as outputs. The BP neural network is constructed using genetic algorithm and trained and optimized. The data samples selected for this paper are from five representative countries from 1991 to 2020. China, Germany, South Africa and Australia are used as the training set, while data from the United States are used as the test set.

2. The establishment of GA-BP model

2.1. The establishment of BP neural network prediction model

BP neural network is one of the most widely used neural networks. It is a kind of multi-layer feedforward network which propagates backward by error. BP neural network contains an input layer, an output layer and multiple hidden layers [2], as shown in Figure 1.

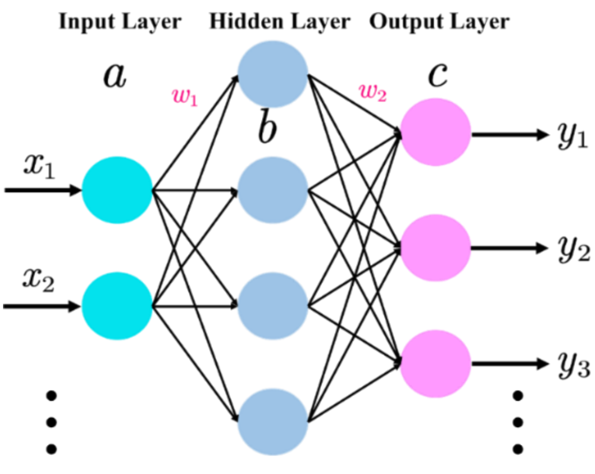

Figure 1. Schematic diagram of BP neural network

2.2. Genetic algorithm to optimize the weight and threshold of BP neural network

2.2.1 Population initialization

The weight and threshold between the input layer, output layer and hidden layer of the BP neural network are carried out real number coding operation, and the real number coding is taken as the individual of the population [3].

2.2.2 Fitness function calculation

Firstly, the initial weight and threshold of the neural network are obtained through individual i, and the predicted value of the grid output is obtained after network training. Calculate the sum value of the absolute error between the predicted value and the expected value, and multiply the sum value by a correlation coefficient k to obtain the fitness value F [4]. The formula is as follows:

$$F=k\left(\sum_{i=1}^{n}\operatorname{abs}(y_i-o_i)\right) \tag{1}$$

2.2.3 Selective operation

The roulette method is a selection strategy based on fitness ratio [5].

2.2.4 Cross operation

$$\left.\begin{aligned}\alpha_{ki}&=\alpha_{kj}(1-b)+\alpha_{1j}b\\ \alpha_{1j}&=\alpha_{1j}(1-b)+\alpha_{kj}b\end{aligned}\right\} \tag{2}$$

In the above equation, b is a random number between [0,1].

2.2.5 Mutation operation

Select the j gene α_{ij} of the i individual and carry out mutation operation on it:

$$\alpha_{ij}=\begin{cases}\alpha_{ij}+(\alpha_{ij}-\alpha_{\max})*f(g) & r>0.5\\ \alpha_{ij}+(\alpha_{\min}-\alpha_{ij})*f(g) & r<0.5\end{cases} \tag{3}$$

In the formula, $f(g)=r_2\left(1-\frac{g}{G_{\max}}\right)$, r_2 is a random number, g is the current iteration times, $G_{\max}$ is the maximum evolution times, and r is the random number between [0,1].

3. Prediction based on GA-BP and BP neural network prediction model

3.1. Data preprocessing

Step1 Normalization

$$x_i{}'=2*\frac{(x_i-x_{i\ \min})}{(x_{i\ \max}-x_{i\ \min})}+(-1) \tag{4}$$

Step2 Antinormalization

$$y_i{}'=(y_{i\ \max}-y_{i\ \min})*\frac{y_i-(-1)}{1-(-1)}+y_{i\ \min} \tag{5}$$

3.2. Parameter design of the model

Genetic algorithm parameters are shown in the following Table 1:

Table.1. Genetic algorithm parameters

parameter	genetic algebra	Population size	crossing-over rate	aberration rate
price	200	100	0.3	0.1

BP algorithm parameters are shown in the following Table 2:

Table.2. The BP algorithm parameters

parameter	Maximum iteration times	Minimum error improvement rate	Error target value	learning rate	cycle index
price	200	0.00001	0.001	0.01	50

The comparison between the true value and expected value of the test set and the error are shown in Figure 2.

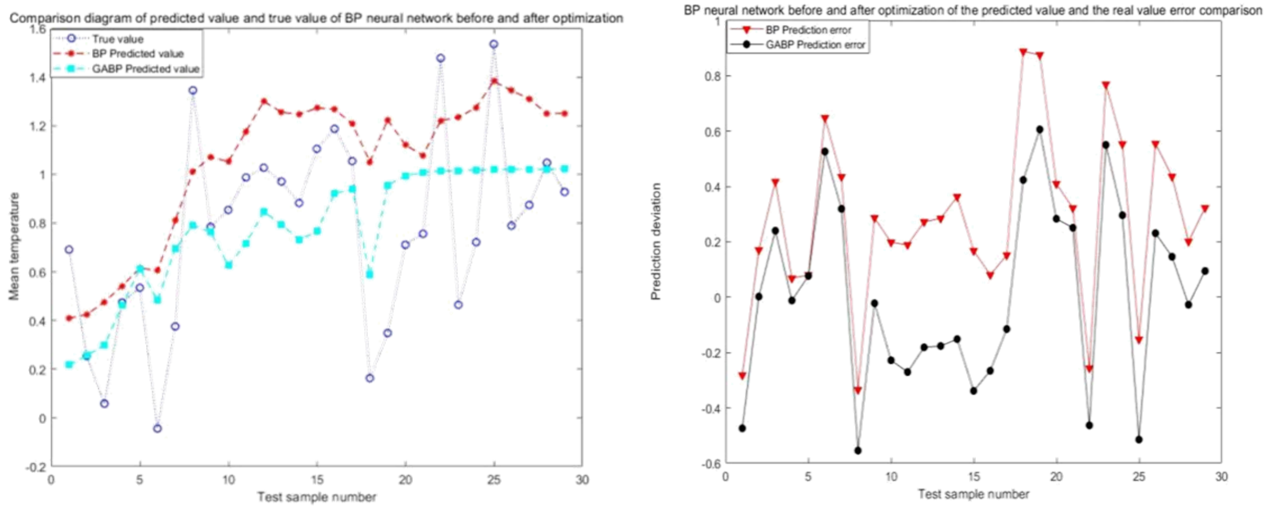

Figure 2. Comparison of true values vs expected values and error comparison of the test set

It can be seen from Figure 2 that GA-BP is significantly better than BP, indicating the accuracy and stability of this model [6]. Therefore, after replacing GDP with GGDP, we continued to forecast carbon dioxide and average temperature, as shown in Figure 3:

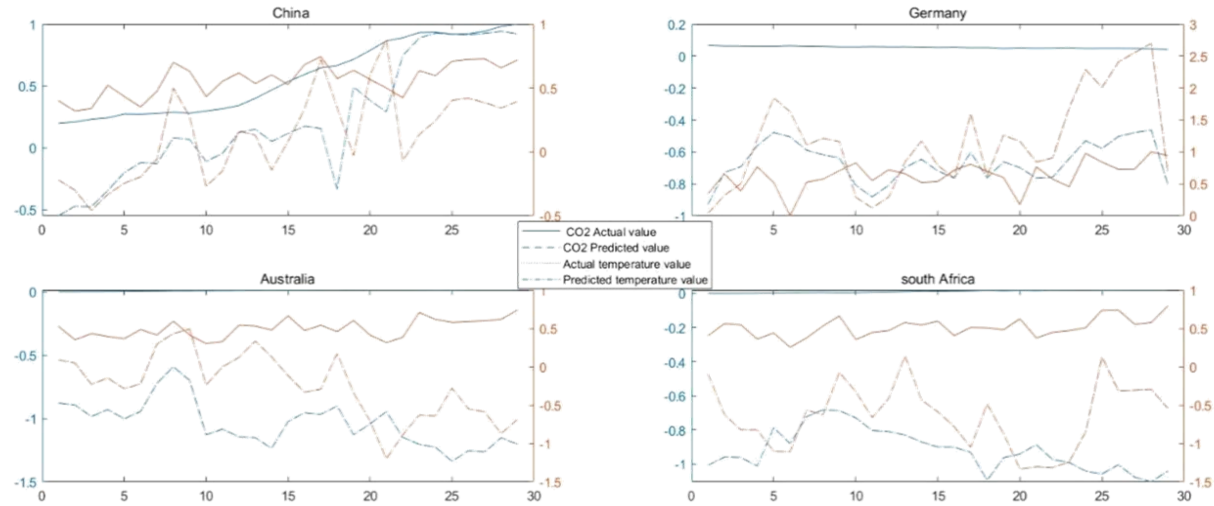

Figure 3. Impacts of GGDP on climate and environment

It can be seen from Figure 3 that after replacing GDP with GGDP, the change trend of climate and environmental assessment index is relatively gentle. After integrating the four representative countries, the same conclusion can be reached [7]. Therefore, it can be considered that replacing GDP with GGDP contributes to the mitigation of climate impact globally [8].

3.3. Validation of model

Just like the impact on GDP, our team takes the data of the United States as the verification of GGDP's impact on climate, and then analyzes whether the data of the Americas has a certain impact on climate mitigation [9]. By observing the change trend of the predicted data of five countries, as shown in Figure 4.

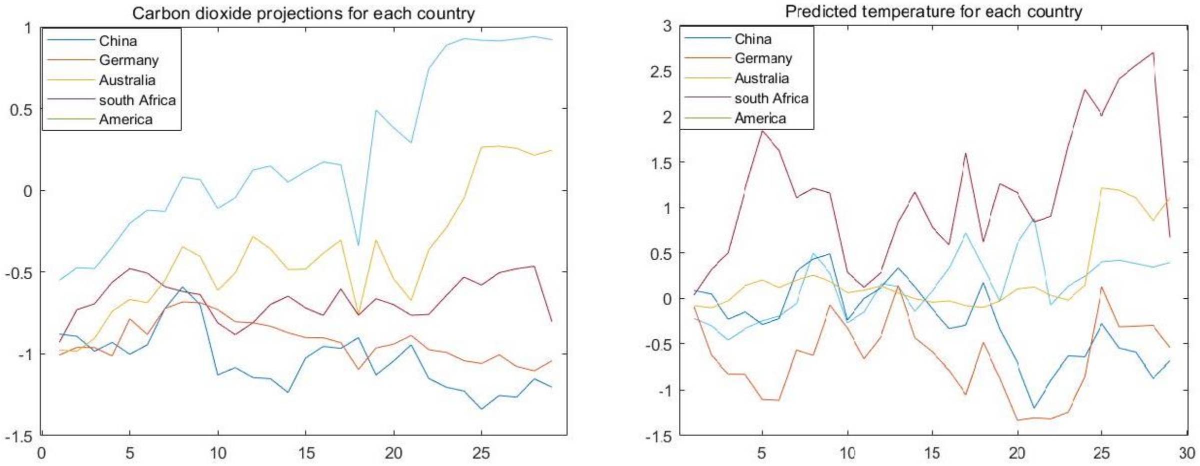

Figure 4. Prediction result of GGDP on climate evaluation index

Since the trend of change in the five countries is consistent, it can be concluded that GGDP, as the main indicator to measure national economy, has a driving effect on climate mitigation [10].

4. Conclusions

This paper validates the GGDP data based on the GA-BP model and obtains that the model has good generalizability, eight climate influencing factors are used as inputs and two climate evaluation indicators as outputs. Finally, it is concluded that GGDP, as a major indicator of national economy, can contribute to the impact of climate mitigation.

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