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Optimization and Evaluation of Food System Based On BP Neural Network Model

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Abstract: This article studies various factors that affect the supply of the world's food system,establishes a mathematical model,and gives the optimized analysis results of the food system.First of all,this paper collects five types of data to study the sustainability of the world food system,using interpolation and gray forecasting models to process and predict the data.Use the BP neural network model to normalize the relationship between changes in the food system and the fairness of the food system,and predict the impact of the optimization plan on the fairness of the world food system.

Keywords: BP neural network; Grey Model; Food System

1. Introduction

Recent events have shown us that our global food system is unstable even in the parts of the world that it generally serves well. These instabilities are partly a result of our current global system of massive national and international food producers and distributers. Our team to re-imagine and reprioritize our food systems through development of a model.What happens if a food system is optimized for equity and sustainability?How would that system differ from the current one?How long would such a system take to implement?

2. Problem Analysis

We first analyze the phenomenon of inequity and unsustainability,and based on this,select influencing factors,and establish models for optimization and comparison.

2.1 The inequity of the current system

(1)Excessive dependence on imports:Many developing countries have lost their"food autonomy"and gradually rely on foreign imports.

(2)Huge monopoly:The existing food monopoly makes the original agricultural enterprises and farmers unable to make returns,and they have to withdraw from the agricultural industry.

(3)Imbalance in diet:The ratio of protein and fat intake in developed and developing countries is imbalanced.The dietary structure of residents is significantly different.

(4)The government does not support or subsidize agriculture:In underdeveloped areas,farmers can only rely on high value-added cash crops to make a living,which leads to an imbalanced dietary structure of the people in a certain area.[3]

2.2 Unsustainable aspects of the current system

(1)Most countries do not pay much attention to agricultural science and technology,and the development of agricultural science and technology is not high.

(2)Not paying attention to protecting animals and plants and rare animals are preyed on.These have severely damaged biodiversity and caused many problems.

(3)The unsustainability of food production:some countries are relatively backward in agricultural production and management models,leading to many defects.

(4)Agricultural emissions:Greenhouse gas emissions during agricultural production will affect the environment and climate.

After analyzing the conditions affecting the world's food system,we selected a total of 10 indicators to measure equity and sustainability.[2]

3. Model Establishment and Solution

3.1 BP neural network model

The feedforward artificial neural network is composed of non-linearly changing units,referred to as B-P neural network.First,let's analyze and introduce the two-layer neural network.There are n inputs,m outputs,and two intermediate layers in the network.We use subscripts i,h,and j to denote input nodes,intermediate nodes,and output nodes;Use W_{ih} to represent the weight of the h node from the input layer to the middle layer;Use W_{hj} to represent the weight from the middle layer node h to the output layer node j.

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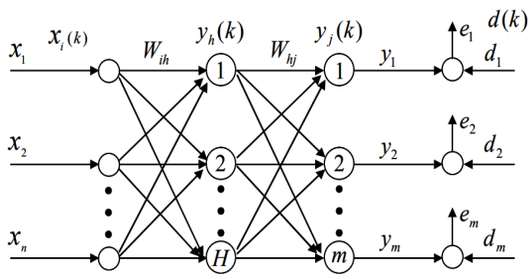

Figure 1 The structure of a 2-layer neural network

When processing the input data,we assume that its target output is d_m and the actual output is y_m .We train the grid by forming training pairs,and mark the serial number above it to represent each training pair.

When the k-th value is input,the input weighted sum of node h in the middle layer is:

$$S_h(k) = \sum_i x_i(k) W_{ih}$$

The output value of node h in the middle layer is:

$$y_n(k) = f[S_h(k)] = f[\sum_i k_i(k) W_{ih}]$$

The output weighted sum of node j corresponding to the output layer is

$$S_j(k) = \sum_h y_h(k) W_{hj} = \sum_h W_{hj} f[\sum_i k_i(k) W_{ih}]$$

The output value of output layer node j is:

$$y_j(k) = f\{\sum_h W_{hj} f[\sum_i k_i(k) W_{ih}]\}$$

The error of output layer node j is:

$$e_j(k) = d_j(k) - y_j(k)$$

Use the sum of the squares of the errors of all output nodes j in the input layer as the calculation index

$$J(W) = \frac{1}{2} \sum_k \sum_j [e_j(k)]^2 \qquad (1)$$

3.2 The impact of the establishment of the new system on the sustainability of the world food system

3.2.1 Data selection

We selected 5 types of data on a global scale to reflect the sustainability of the food system.They are agricultural carbon dioxide emissions.The amount of fertilizer used,the area of arable land,the area of forest land,and the total grain output.We collected data from 2000 to 2019 to fit the existing system.[3]

3.2.2 Data preprocessing

All our data comes from the International Food and Agriculture Organization(FAO).Due to the high data requirements of the neural network,we adopted the Laida criterion to eliminate the huge fluctuations caused by special events in some years,and then used interpolation to fill in the deleted data with the missing data in some years.The data is relatively accurate.The gray prediction model is used to predict the trend changes of various parameters under the existing grain system,and to predict the figures of each data five years later,expand the original data volume,and provide a comparison for the use of neural network prediction values in the following.

3.2.3 The fitting result of the neural network

We found the global food production,farmland area,CO2 emissions,forest land area,and fertilizer usage from 2000 to 2019.A total of 20 sets of data are used for neural network learning and training.From the figure below,we can see that the predicted discount and actual discount have a higher degree of coincidence,and the predicted results are better.

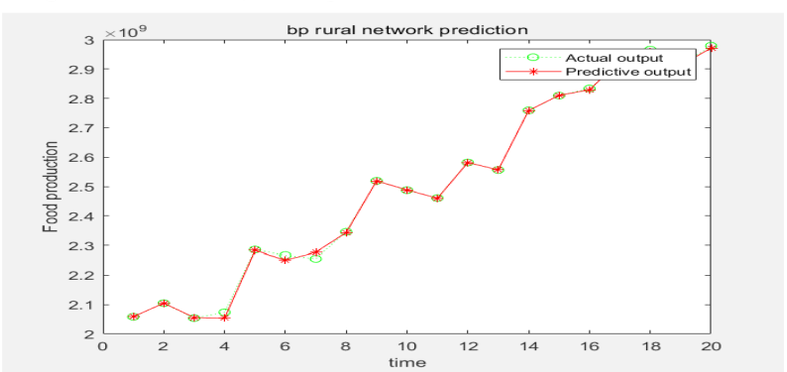

Figure 2 The results of neural network fitting

3.2.4 The trend of various influencing factors

From the known data and the grey prediction model,we simulated the data trend of the five factors from 2000 to 2024,which represents how the sustainability of the food system will change under the existing food system.

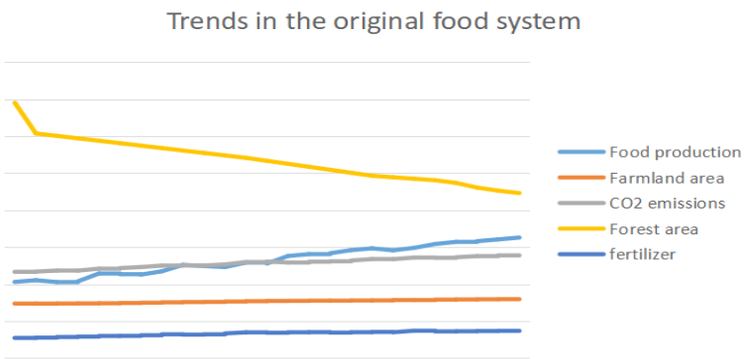

Figure 3 Trend forecast

From the above figure,we can conclude that under the existing system,forest land will be greatly reduced,agricultural carbon dioxide emissions will further rise,and fertilizer use and farmland area will increase in a steady manner.

3.3 Conclusion

When we optimized the equity and sustainability of the food system,we found that if only the recent results are evaluated,the development of the environment can provide more people with rations,and more frequent and effective food trade practices and more Food production can improve the nutritional level of the world's people.The implementation of this system is affected by many aspects,and it is difficult to give an exact time.

4. Model Evaluation

4.1 Error analysis of BP neural network model

(1) When dealing with data about grain in some areas,we believe that its grain output and trade are stable,and there is no change in population growth.But in reality,due to factors such as trade,epidemics,disasters,etc.,statistics on current data will cause deviations in future predictions.

(2) In the established BP neural network,the core associated data has different influence on the research object in different spaces and different times,sometimes it is very small.

(3) Due to the small amount of data,there is no check set to check the error of the model.

(4) Data measurement indicators are not comprehensive enough to fully express the economic situation with existing indicators. Part of the data is incomplete and interpolation is used,which may cause errors in the results.[1]

4.2 Analysis of advantages

(1) Boldly selected a certain highly relevant data to quantify the equity and sustainability of the food system,proposed the rate of return,and quantified the benefits.Three interest evaluation indicators have been established separately,so that the benefits of grain system optimization can be traced.

(2) The data is accurate and reliable.All data are from the official website of the FAO.The audit of the data in this article is to get the number of related documents by looking up the literature keywords.By comparing the number of relevant documents to comprehensively select,you can get the core related data and establish a close influence with the results.

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