

Natural Environment Protection Strategy Based on Cyclic Neural Network

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Abstract: After years of efforts in ecological environment protection (EP), China has made great progress in environmental protection, but there are still some problems in our ecological EP. In this paper, the strategy of natural environment (NE) protection is studied and analyzed based on recurrent neural network. The principles of NE protection and the basic structure of recurrent neural network are briefly summarized; The design of the cyclic neural network(CNN) model is discussed, and the application of the CNN in air quality prediction(AQP) is analyzed; Taking Shanghai AQP as the research object, combined with information entropy and gray correlation analysis methods, relevant input variables were screened out to build the network model, which helped us to have a general understanding of the future pollution factor concentration from the overall situation, and then put forward NE protection strategies to achieve good and effective protection of the NE.

1. Introduction

Biodiversity is decreasing due to serious pollution, and the invasion of alien species has caused a very serious economic burden; The ecological function of some key ecological functional areas has been weakening, and the ecological destruction problem still plagues people's life and production for a long time; Although some cities and regions have made some achievements in environmental protection, which has improved the environmental quality of the region, the overall environmental quality deterioration trend in China has not shown a significant downward trend, and the various institutional and mechanism issues that restrict the improvement of environmental quality at a deeper level have not made substantive progress, and the integration of environmental protection and economic efficiency is still insufficient. Therefore, how to eliminate the problems in China's ecological EP, and how to go further and further on the road of ecological EP, we need to constantly think about and come up with effective and feasible plans.

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More than 1/5 of China's cities have air quality lower than the national standard, and the land area harmed by acid rain 4 accounts for about 1/3 of the total territory of the country; Rivers and lakes around the city are generally polluted by industrial and domestic garbage. About 26% of the national controlled surface water quality is lower than the Class V standard of water environment, losing the drinking function [1]. Protecting the NE is of great strategic significance for maintaining the ecological barrier in the northern part of the motherland and realizing the sustainable development of a region. Through better protection of forestry resources, rational development and utilization of land resources and orderly development of mineral resources, scientific and rational development, explore how to protect the ecological barrier of the motherland and make positive contributions to the construction of human EC [2].

This paper mainly uses different variable screening schemes to build a prediction model for each monitoring factor at the monitoring point for verification. Whether grey correlation analysis or principal component analysis is selected, the prediction effect of the neural network model after screening the input variables is very good. On the whole, the fitting degree between the predicted pollutant concentration change trend of the model and the measured value change trend is very high, It proves that the modeling ideas and methods in this paper are effective and feasible. It can help us to have a general understanding of the future pollution factor concentration from the overall situation, which will be more conducive to the relevant departments and residents to take effective preventive measures in advance, and is of great significance for the effective protection of the NE [3, 4].

2. Research on NE Protection

2.1. Principles of NE Protection

2.1.1. Adhere to the Principle of Ecological City

In the process of ecological city building strategy, the following ways can greatly promote the pace of ecological city building. First, protect and improve the ecological environment; Second, we should develop low carbon ecological industries and lay a solid economic foundation for establishing an ecological city; Third, we should create an environment suitable for people to live in, making the living environment the best place for people to live, live and develop; Fourth, we should change the way of production and life, make people consciously save resources, protect the NE, and learn to live in harmony with nature; Fifth, we should build an EC, establish the awareness of EC, cultivate ecological ethics, and take EC as the banner to guide the overall development of economy and society [5, 6].

2.1.2. Adhere to the Win-Win Principle of Ecological Protection and Development

To take the win-win road of environmental protection and development, first of all, we must firmly establish the awareness of "asking for economy from ecology", and fully realize that ecological protection is to create conditions for the economic development of Yakeshi City; At the same time, in the face of environmental protection and economic development, we should adhere to the principle of doing something and not doing anything, avoid blind and impulsive development, actively explore a win-win development path for economic and environmental benefits, and avoid waste of resources and environmental damage [7]. In all aspects, we should adhere to the environmental access system, measure the health of development quality with the level of environmental protection benefits, resolutely put an end to the decision-making model that places environmental factors outside decision-making, and vigorously implement a series of mechanisms and systems for comprehensive decision-making on environment and development [8]. Adhere to the principle of protection in development and development in protection, promote environmental protection and economic development at the same time, make sure that both are promoted and correct, and avoid favoring one over the other and giving up food because of choking. Therefore, we adhere to the win-win principle of ecological protection and development, and strive to explore a new road of forming the economic development and environmental protection of Yakeshi [9, 10].

2.1.3. Adhere to the Principle of Paying Equal Attention to Protection and Prevention

By adhering to the principle of attaching equal importance to protection and prevention, the city will be built into a resource-saving and environment-friendly city. Only in this way can we achieve the goal of economic prosperity, good ecology and people's happiness [11].

2.2. Basic Structure of Recurrent Neural Network

Like traditional neural networks, recurrent neural networks contain three parts: input layer, hidden layer and output layer. The input layer inputs characteristic data into the network for automatic learning at the next layer, which generally exists in the form of matrix data; Figure 1 shows the simplified structure of the recurrent neural network [12, 13]. Xt represents the input of step t; St represents the implicit state at time t, that is, the memory information retained by the whole network at time t. It is calculated according to the implicit state St-1 of the previous layer and the input Xt of the current layer; Ot is the output of each step; U is the weight matrix from the input layer; W is the weight matrix from the previous hidden layer to the current hidden layer.



Figure 1. Simplified structure of recurrent neural networks

The following formula can be used to express the calculation method of recurrent neural network:

$$o_t = g(Vs_t) \tag{1}$$

$$s_t = f(Ux_t + Ws_{t-1}) \tag{2}$$

Where, f is the activation function. Substitute Formula (1) into Formula (2) to get:

$$p_{t} = Vf \left(Ux_{t} + Wf \left(Ux_{t-1} + Wf \left(Ux_{t-2} + Wf \left(Ux_{t-3} + \dots \right) \right) \right) \right)$$
(3)

It can be seen from Formula (3) that the output value of the recurrent neural network is affected by the previous input value.

2.3. Design of CNN Model

2.3.1. Determine the Network Structure of the Model

The number of nodes in the input (and output) layer of the recurrent neural network will also be determined with the training data set, and then we will further determine the number of nodes in the hidden layer.

When applying the CNN model, when the input mode and output mode are different or the similarity is low, generally we will choose to build a hidden layer between the input and output layers, so as to achieve the purpose of nonlinear conversion of the signals in the input layer of the neural network; On the contrary, if the input and output modes of the neural network are very similar, a two-layer network topology can be considered [14, 15]. In general, to determine the number of nodes in the hidden layer of the neural network according to empirical formulas, step by step testing and other methods, the first thing to do is to set the initial threshold in advance, then accumulate one by one on the basis of the preset initial value, and then compare the predicted performance of the network model that determines the number of nodes in the hidden layer each time. The number of nodes corresponding to the model with the best performance is the best number of nodes in the hidden layer:

$$S = \sqrt{m + n} + \alpha \tag{4}$$

Among them, the number of nodes in the model input layer is m, the number of nodes in the model hidden layer is s, and the number of nodes in the output layer is n, α Is a constant between 1-10 [16]. In order to finally determine the optimal number of nodes contained in the hidden layer of the six common different pollutant concentration prediction models, CO, PM10, O3, PM2.5, SO2, and NO, it must be tested continuously in the subsequent network model training [17].

2.3.2. Determining the Learning Rate

Empirical selection of learning rate: Generally, in order to ensure the stability of model performance, we tend to choose a smaller learning rate. If the learning rate is too small, the model needs to be trained many times to find the minimum error value [18]. Therefore, in general, the selection range of learning rate is 0.01~0.8, and the learning rate to be selected in this paper is 0.01.

3. Application of CNN in AQP

3.1. Filtering Model Input Variables based on Grey Correlation Analysis

This paper takes the establishment of the PM2.5 concentration prediction model of Xuhui Shanghai Normal University environmental monitoring national control point as an example, and combines the information entropy and gray correlation analysis methods to screen out the relevant input variables for the construction of the network model. Based on the eight month hourly mean PM2.5 concentration data provided by Xuhui Shanghai Normal University site as the sample data, the correlation ranking of each influencing factor and PM2.5 pollutant concentration is obtained after analysis based on information entropy and gray correlation theory, as shown in Table 1 below:

Ranking	Influencing factors	Relevancy
1	SO2	0.603
2	03	0.624
3	NO2	0.672
4	CO	0.568
5	PM10	0.784
6	PM2.5	0.769
7	PM2.5_11	0.708
8	PM2.5_12	0.771

 Table 1. Correlation degree between various pollutant influencing factors and PM2.5 pollutant concentration

In general, when the relationship between the comparison sequence (subsequence, according to Table 1 above, CO, NO2, PM10, PM2.5, PM2.5_l1, PM2.5_l2, etc. are factor sequences) and the reference sequence (parent sequence, in this paper, the PM2.5 concentration in the sample time) is less than 0.6, they are usually not considered as key factors (or defined as weak correlation factors); The correlation between the comparison sequence and the reference sequence with the correlation degree between 0.6 and 0.75 can be considered as general, but it can also be selectively defined as the key impact factor according to specific background requirements; The key factors refer to those influencing factors whose correlation degree is greater than 0.75, which often have a high correlation with the target feature sequence; Finally, when the parent sequence is closely related to the child sequence, the correlation degree is usually greater than 0.9.

In view of the above, NO2, PM10, PM2.5 and PM2.5 with correlation degree greater than 0.65 will be selected in this paper_11, PM2.5_L2 is the key factor to predict PM2.5 concentration, while SO2, O3 and CO with correlation degree lower than 0.65 will be eliminated. Similarly, we can also calculate the highly correlated factors of other five pollutants at Xuhua Shanghai Normal University.

3.2. Model Debugging of Variable Screening based on Grey Correlation Analysis

In order to clearly introduce how to determine the number of hidden layer nodes in the process of building the CNN model. Here, it is decided to take the PM2.5 concentration monitoring factor of the air environment national control monitoring station of Shanghai Normal University in Xuhui District as an example. Based on the "trial and error method" selected in this paper, it is easy to understand that the number of nodes in the hidden layer of the network model is bound to exist in a certain range at the beginning. Next, it is mainly to calculate the training error when the neural network model uses the number of nodes in different hidden layers.

The number of hidden layer nodes selected by the PM2.5 monitoring factor of the National Air Environment Monitoring Station of Shanghai Normal University in Xuhui District is 4-14. As shown in Table 2 below, the corresponding training error values of different hidden layer nodes are calculated, where S represents the number of hidden layer nodes and Loss represents the model training error.

S	4	5	6	7	8	9	10	11	12	13	14
Loss	0.0138	0.0090	0.0113	0.0082	0.0087	0.0103	0.0085	0.0079	0.0094	0.0038	0.0064

Table 2. Training error of number of hidden layer nodes of PM2.5 prediction model at XuhuiShanghai Normal University

As shown in Table 2 above, we can find that when the number of nodes in the optimal hidden layer of the PM2.5 concentration prediction model at the air environment national control monitoring station of Shanghai Normal University in Xuhui District is 13, the loss is the minimum value of 0.0038. Similarly, the number of hidden layer nodes of the other five common pollution index prediction models at the Shanghai Normal University site can also be obtained.

3.3. Model Performance Verification

As an indispensable model evaluation in the process of model construction, it can help people build a model structure containing huge data information, and also plays a pivotal role in performance and utility. In order to avoid over fitting of the model, we cannot directly use training sample data to evaluate the prediction performance of the model. Cross validation and validation are the two most commonly used model evaluation methods in data analysis. Therefore, we usually divide the sample data into training set and test set in advance. The above two verification methods use the sample test data set to evaluate the prediction performance of the model.

At this time, the R2 calculated by the PM2.5 prediction model is 0.898, the MAE is 4.84, and the MSE is 45.97, indicating that the model has good prediction effect and small training error. As shown in Table 3 and Figure 2 below, the prediction models trained by two different variable screening schemes draw different conclusions based on different evaluation indicators.

project	R2	MAE	MSE	
GRA filter variable	0.894	4.99	47.54	
PCA Filter Variables	0.898	4.84	45.97	

Table 3. Evaluation index of prediction model trained by different variable screening schemes



Figure 2. Comparison of different prediction models for PM2.5 monitoring factors

By comprehensive comparison, the PM2.5 prediction model trained by the variable screening scheme based on principal component analysis (PCA) is better than the variable screening scheme based on grey relational analysis (GRA). The prediction effect of the neural network model after screening the input variables is very good. On the whole, the predicted trend of pollutant concentration changes by the model is highly consistent with the trend of measured values, and as mentioned above, the sum of squares of most models is above 0.8.

The validation results of the model show that the prediction model established in this paper can effectively predict the pollutant concentration, which further proves the effective feasibility of the modeling ideas and modeling methods in this paper. More importantly, the visual interface of dynamic prediction obtained by making a web link can help us have a general understanding of the future pollution factor concentration from the overall situation, which will be more conducive to the relevant departments and residents to take effective preventive measures in advance.

4. NE Protection Strategy Based on CNN

4.4. Improve People's Awareness of Ecological EP

Strengthen publicity and education on environmental protection. To strengthen environmental protection publicity and education, we need to expand the objects of environmental protection publicity and education. Teenagers are an important part of every family. Their words and deeds will not only affect the people around them, but also affect every member of the family. They have the characteristics of educating one person to influence another. For example, we specially hold lectures, calligraphy, knowledge contests and other activities on environmental protection. Under the premise of their active participation, they will also educate their family members, classmates and children around them. Through its economic behavior, it can achieve more impact on environmental protection.

Create a cultural atmosphere for environmental protection. To create a cultural atmosphere for environmental protection, first of all, we need to strengthen the publicity and coverage of environmental protection work by various media. On the one hand, we can organize journalists to go to the front line of environmental protection and actively cooperate with relevant environmental protection departments to write environmental protection written materials and shoot video materials; On the other hand, we should strengthen the publicity of environmental protection public welfare, increase the publicity of environmental protection public welfare events, actively mobilize the enthusiasm of people to participate in environmental protection, make environmental protection work deeply rooted in the hearts of the people, and effectively improve the environmental awareness of the whole people.

Expand the right of environmental claims: make more people realize that citizens have the right to claim environmental claims, and encourage people to report pollution sources, so that people who are not harmed by pollution also have the right to claim compensation from polluters. For individuals or organizations that cause environmental pollution, they should increase the punishment to prevent pollution again.

4.2. Establish and Improve the System and Mechanism of Industrial Development and Ecological EP

We will improve the market mechanism for protecting the ecological environment. Improving the market mechanism of environmental protection is an effective help to achieve environmental protection. By improving the market mechanism of environmental protection, we can not only reduce the pressure of government departments, but also bring certain economic benefits to enterprises. In many places, when dealing with ecological environmental pollution and improving environmental quality, not only the governance cycle is long, but also the large amount of capital, human and material resources invested in the governance process has caused great pressure on government departments at all levels. In the face of this problem, we can explore the way of contract awarding, and transfer the treatment package of the regional environment to the environmental company according to the market price.

Establish and improve the paid mechanism for ecological EP. Improving the paid mechanism of environmental protection is an important way to protect resources and environment. By improving the compensation mechanism for environmental protection, the beneficiaries of the utilization and development of resources and environment have the responsibility and obligation to make certain economic compensation to the local people and the people who provide a good ecological environment for the occupation or destruction of resources and environment by their economic activities. Adhere to the principle of "who benefits, who compensates", and establish a paid mechanism. For example, in areas with insufficient water resources, enterprises with large water consumption need to raise the price of raw water, which not only restricts enterprises from wasting water, but also provides funds for the government to implement other environmental protection work.

4.3. Improve the Participation Rate of People in Ecological EP

The masses are the main body of the environmental protection work. Only when the masses actively participate in the ecological EP can the environmental protection work be done well and greatly. Improving the people's ability to participate in ecological environmental protection can enable more people to understand environmental protection, generate awareness of environmental protection, and integrate environmental protection into their lives. The more people involved, the more obvious the contribution to environmental protection. Therefore, improving the ability of the masses to participate is the key to establish ecological EP. Publicize environmental protection knowledge to the masses by issuing environmental protection brochures, holding paintings, speeches, literary performances, knowledge lectures, etc. on environmental protection. Through public selection, government recognition and other forms, highlight a number of advanced models emerging in environmental protection work, and actively mobilize the whole people to participate in ecological environmental protection.

5. Conclusion

In this paper, the concentration prediction model of air pollutants is constructed by using the CNN technology, and the variables that have a greater impact on the concentration of pollutants are screened out; In order to test the effectiveness and superiority of the variable screening method in this paper, the principal component analysis method is also used to screen variables for comparison. Finally, the NE protection strategy is proposed. For the protection of the NE, it is necessary to pay more attention to the basic education of ecological EP, and incorporate the laws, regulations and relevant contents of ecological EP into the compulsory content of primary and secondary education; At the same time, we should strengthen the guidance and supervision of public opinion, make full use of traditional and emerging media, resolutely expose organizations and individuals that damage the environment, highlight outstanding examples of environmental protection, and strive to create a public opinion atmosphere in the whole society where everyone is responsible for protecting the environment.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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