Traffic Flow Forecast Based on Ga-Gm Model

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Abstract: In recent years, with the increasing number of motor vehicles, traffic jams on urban roads have become more and more serious. Therefore, it is necessary to study road jams to accurately predict traffic flow, which is an important part of intelligent transportation. A ga-gm prediction model is proposed to predict and analyze traffic flow. Through collecting traffic flow data of a city intersection, simulation and prediction are carried out in matlab environment. The results show that the model has good prediction accuracy and certain practical value.

1. Introduction

At Present, Traffic Jams in Most Cities in Our Country Are Very Serious, Which Has Seriously Affected the Work and Life of Local People. Alleviating Traffic Jams and Making Vehicles Pass in an Orderly and Efficient Way Has Become a Problem That Must Be Solved. Traffic Flow Prediction is Very Important to Alleviate the Above Problems. Corinne Was the First to Use Neural Networks to Predict Traffic Flow. the Model Has Achieved Certain Results [1]. Later Chaos Theory, Support Vector Machine, Bp and Other Neural Networks Have Enriched the Prediction Methods of Traffic Flow [2-5]; Each of the Above Has Its Own Characteristics, Which Can Achieve the Prediction Effect, But There Are Deficiencies, Which Reduce the Accuracy of the Prediction. the Grey Model is Called Gm Model for Short, Which Has the Advantages of Studying Less Data, Poor Information and Being Able to Deal with Sequence Errors with Strong Volatility [6]; Gennetic Algorithms (Ga) is Abbreviated as Ga Algorithm, Which Has the Characteristics of Self-Organization, Self-Adaptation and Self-Study Habits [7-8]. in This Paper, the Traffic Flow Prediction Based on Ga-Gm Model is Proposed. Firstly, the Optimal Individual Obtained by Genetic Algorithm is Assigned to Gm, and the Neural Network is Used to Predict the Traffic Flow.

2. Grey Neural Network

Grey Model is a Differential Equation Based on Time Series. the Grey Neural Network Model Equation of n Parameters is as Follows: $\frac{dy_1}{dt}+ay_1=b_1y_2+b_2y_3+b_3y_3+\cdots b_{n-1}y_n$; Where y_1 is the System Output Parameter, $y_2,\cdots,y_n$ is the Input Parameter, $a,b_1,b_2,b_3,\cdots b_{n-1}$ is the Coefficient[9-12]. the Corresponding Expression for Time is:

$$z(t)=((y_1(0)-d)\cdot\frac{e^{-at}}{1+\mathrm{e}^{-at}}+d\cdot\frac{1}{1+\mathrm{e}^{-at}})\cdot(1+e^{-at})$$

$$=((y_1(0)-d)\cdot(1-\frac{1}{1+\mathrm{e}^{-at}})+d\cdot\frac{1}{1+\mathrm{e}^{-at}})\cdot(1+e^{-at})$$

$$=((y_1(0)-d)-y_1(0)\cdot\frac{1}{1+\mathrm{e}^{-at}}+2d\cdot\frac{1}{1+\mathrm{e}^{-at}})\cdot(1+e^{-at})$$

Among Them $d=\frac{b_1}{a}y_2(t)+\frac{b_2}{a}y_3(t)+\ldots\frac{b_{n-1}}{a}y_n(t)$.

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The above expression is mapped to a BP neural network to obtain a grey neural network with a 4-layer structure. The structure is shown in Figure 1 below.

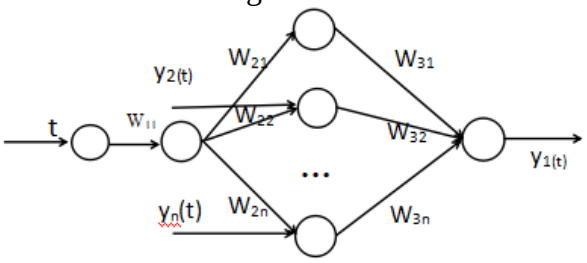

Fig.1 Grey Neural Network Structure

In the picture, $w_{21}, w_{22}, \cdots, w_{2n}, w_{31}, w_{32}, w_{3n}$ is the weight of the neural network. Among them: $u_1 = \frac{2b1}{a}, u_2 = \frac{2b2}{a}, u_{n-1} = \frac{2b_{n-1}}{a}$.

The initial value expression of the weight is as follows: $w_{11} = a, w_{21} = -y(0), w_{22} = u_1, w_{23} = u_2 \cdots, w_{2n} = u_{n-1}\ w_{31} = w_{32} = \cdots w_{3n} = 1 + e^{-at}$. Threshold expression of output node $y_1(t) : \theta = (1 + e^{-at})(d - y_1(0))$.

3. Ga-Gm Neural Network Model

The results of grey neural network prediction are different every time, because the initial weights and thresholds are random. Therefore, the genetic algorithm is first used to optimize the corresponding initial weights and thresholds. The design steps of genetic algorithm are as follows:

(1) Generating a string structure number for each collected data, wherein each structure number consists of' 0' and' 1';

(2) The fitness function is selected to make each individual reach the optimal degree. The function expression is as follows:

$$f(x) = \frac{1}{SE} = \frac{1}{\sum_{i=1}^{n} \left(\hat{t}_i - t_i \right)^2}$$

Among them: $\hat{t}_i$ is the predicted value, t_i is the true value, and n is the number of samples collected.

(3) Operation part: includes selection operation, crossover operation and mutation operation.

The selection operation first calculates the sum $F = \sum_{k-1}^{n_r} f(x_k)$ of fitness. In calculating the next generation probability $p_k = \frac{f(x_k)}{F}$ of individual heredity. Finally, according to roulette operation, the number of individual selections is determined.

The crossover operation uses arithmetic crossover operators to recombine a pair of individuals to generate offspring according to a given probability.

The mutation operation is to change the “0” of the mutation position to “1” or “1” to “0”.

(4) Output parameter optimization results.

The optimized results are obtained through genetic algorithm, the selected parameters are extracted, and the grey neural network is used for learning and forecasting, thus the results are analyzed.

The grey neural network algorithm is as follows (as can be seen from fig. 1):

(1) Initialization parameter a, b

(2) Calculate w_{21}, w_{22}, w_{31}, w_{32},? w_{nn} according to weight value

(3) Calculating the output of each layer of the neural network according to each input sequence $(t, y(t))$;

(4) Calculate the error and adjust the weight and threshold value according to the initial error.

(5) Judge whether the training is over. Otherwise, continue with step 3.

GA-GM algorithm flow is shown in Figure 2 below.

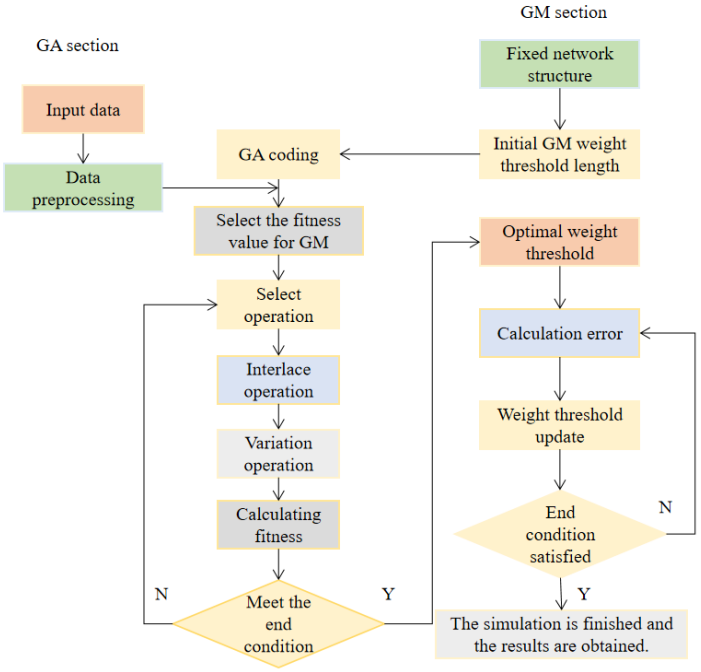

Fig.2 Flow Chart of Ga-Gm Algorithm

4. Model Prediction Results

4.1 Sample Collection

Sample collection is a traffic light intersection in a city center as traffic flow sample data. The collection time is 7: 00-9: 00, 13:30-14:30 and 17: 00-19: 00 every morning, and the time interval is 5min. A total of 5 days were collected, the data of the first 4 days were taken as training samples, and the data of the fifth day were taken as test samples.

4.2 Implementation of the Model

This paper is implemented in Matlab environment, among which the main functions of genetic algorithm are pop, ga (). GM optimizes weights and thresholds, all weights and thresholds included by all individuals in the population, and individual fitness values are calculated by fitness function, and the optimal individuals are found through selection, crossover, mutation and other operations. The optimal initial parameter values are obtained by real number coding, population size 50 and iteration number 200. The best parameters are shown in Table 1 below.

Table 1 Optimum Parameter

Parameter name	a	b	b1
Parameter value	0.8632	0.7534	0.3235

The optimal parameters are input to the grey neural network. According to the fact that the input data has one dimension and the output data has one dimension, the structure of grey neural network is 1-1-2-1. According to the collected training data, the neural network is trained for 2100 times. Finally, the data of the 5th day is used as the prediction ability of the model. The prediction results are shown in Figure 3 below.

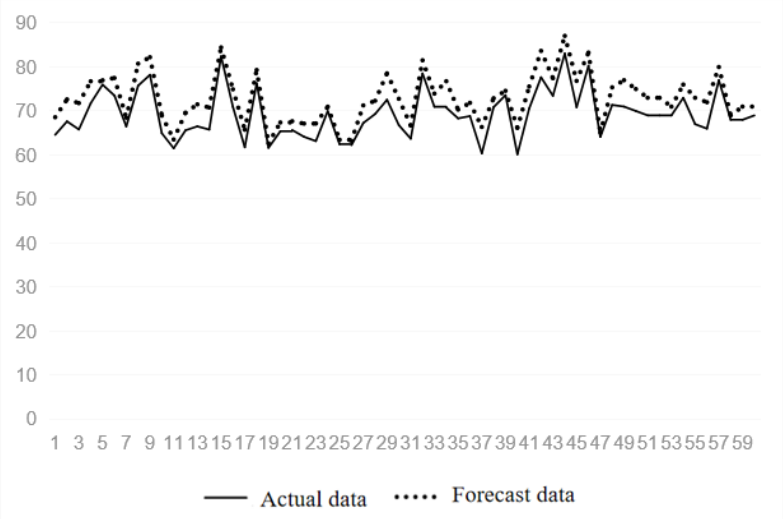

Fig.3 Traffic Flow Forecast Results

According to the prediction data, the average error rate of grey neural network model optimized by genetic algorithm is 3.29%, the average error rate of grey neural network prediction is 8.20%, and the average error rate of BP neural network is 12.73%. This shows that the optimization of grey neural network based on genetic algorithm has achieved better results.

5. Conclusion

The traffic flow prediction is studied based on GA-GM model, and the prediction analysis is carried out according to the existing historical sample data. The research results show that GA-GM model prediction model is better than traditional neural network model and other individual neural network learning algorithms. The prediction results are greatly improved, which shows that the model is feasible and can provide certain theoretical basis and support for traffic flow prediction.

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