SUMMARY : THE CITY TAXI QUANTITY PREDICTION VIA GM-BP MODEL

ZHANG Xuewu
Department of Computer Science
Changshu Institute of Technology
Changshu, China
zhangxuewu4116@163.com

LIU Yongjun
College of Information Science & Engineering
Northeastern University Shenyang, China
Yongjun1981@126.com

Amina Benzerga

OVERVIEW

The variation process of city taxi quantity is **nonlinear**, **grey** and **random**.

Single prediction model reflects part information of variation process, and its prediction accuracy is low.

To improve prediction accuracy, the grey neural network method is put forward based on the analysis of city taxi quantity variation process.

1. GM(1,1) model is used to predict the variation trend of city taxi quantity;
2. The BP neural network is trained through the prediction errors of GM(1,1),
3. Trained model is used to predict the nonlinear and uncertain variation of city taxi quantity
4. Two results are combined to calculate the final predicting result.

WHAT MAKES THIS PAPER DIFFERENT FROM THE OTHERS ?

City taxi quantity variation process is grey dynamic system contains both known and unknown information.

Artificial neural networks :

The artificial neural networks model is a random prediction model. So, it's the prediction result has great randomness and instability.

Pros :

- good learning ability
- nonlinear fitting capabilities

=> used to predict the city taxi quantity

Cons :

- easy to fall into slow convergence speed.

Grey system prediction model :

Pros :

- fits for predict exponential data growth trend.

Cons :

- The prediction accuracy of the model on data set with random fluctuations is low.

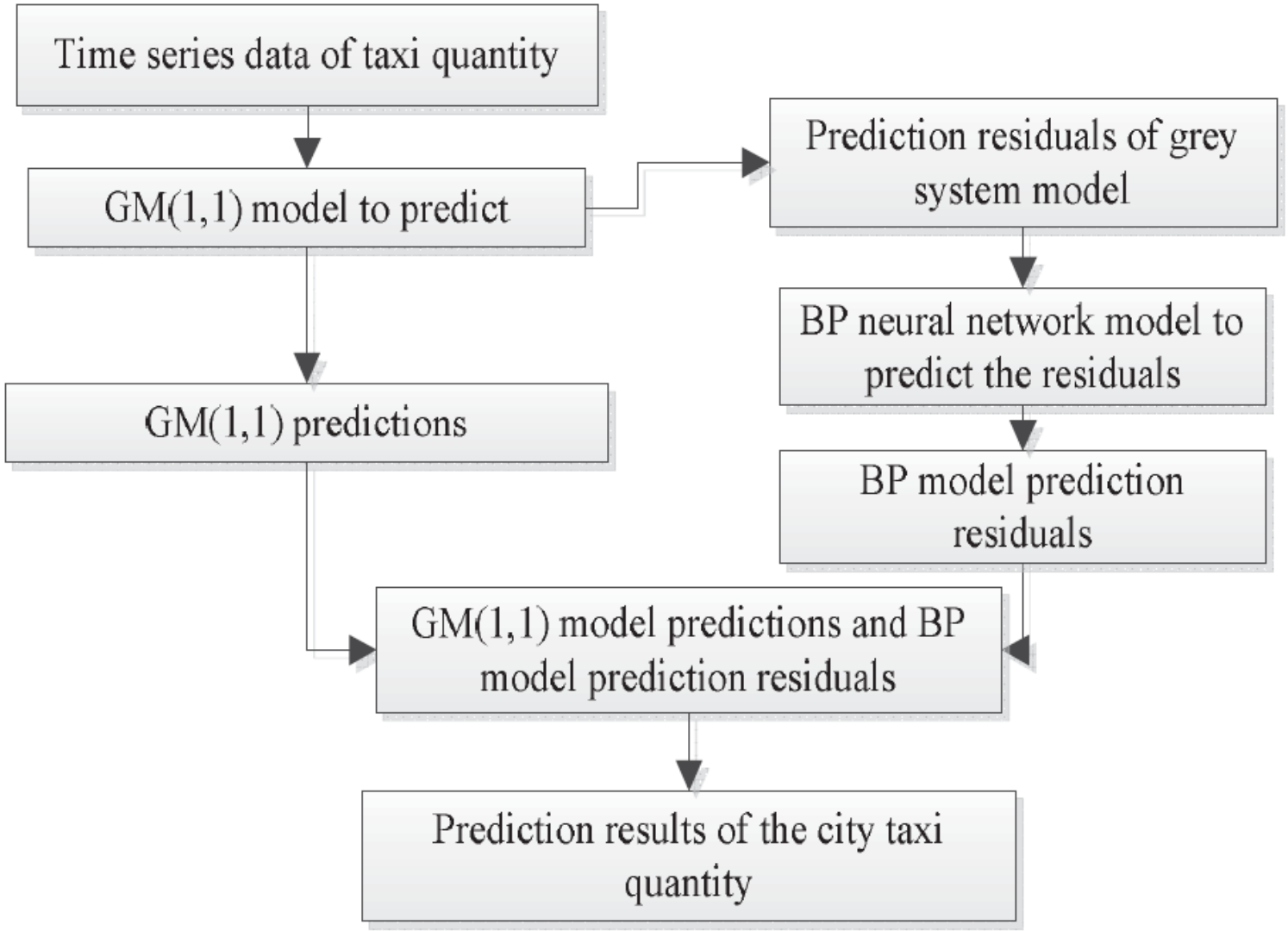
NN + GM

WHY NOT A SIMPLE MODEL?

The **variation** of the city taxi quantity is a **complex dynamic system** with **complex features trends**, **random**, **nonlinear**, and **poor information**.

The traditional linear prediction model and a single nonlinear prediction model can't accurately reflect the complexity of the variation, thereby resulting in lower prediction accuracy.

PREDICTION PROCEDURE FOR CITY TAXI QUANTITY BASED ON GM-BP METHOD



GM-BP PRODICTING CITY TAXI QUANTITY - I

A. Taxi Quantity Data Normalization :

To eliminate the impact on the prediction results from fluctuations of initial data and to speed up the training speed, the initial data needs to be **normalized**.

B. Grey System Model :

The **systems which lack information document**, are referred to as **Grey Systems**.

The research objects of the grey system theory are systems with small sample and uncertainty poor information, to realize the system operating rules description and effective control.

Variation of city taxi quantity is preferred to as a grey system, and the taxi quantity is a single sequence of time-series data, so it can be predicted by the grey GM(1, 1)model.

GM-BP PRODICTING CITY TAXI QUANTITY - 2

C. BP Neural Network :

WHY?

The general variation trends of city taxi quantity can be calculated through the GM (1, 1) model.

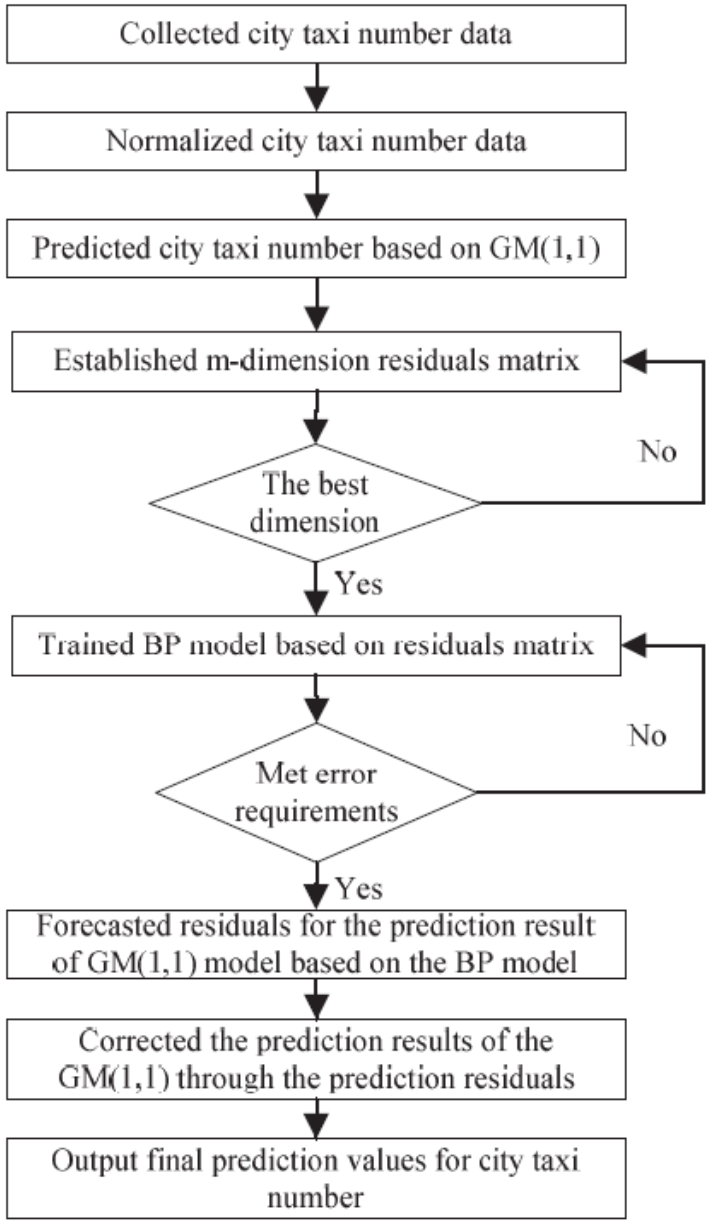
Due to the volatility and nonlinear of city taxi quantity variation, the accuracy of prediction results is lower.

Prediction error based on GM (1, 1) model is non-linear, so BP neural network can be used to correct prediction residuals, to improve prediction accuracy.

BP neural network is a kind of **nonlinear continuous transformation multi-layered feed forward neural network** and connection between the network layers is to be achieved through the transfer function.

It can simulate any nonlinear mapping by studying the samples.

BP neural network consists of an input layer, an output layer and one or more hidden layers. Three-layered BP neural network is the most common one.



EXPERIMENT

1. Raw data was processed;
2. The GM (1, 1) model and the m-dimension residuals matrix were confirmed;
3. The BP model was trained based on the residuals matrix;
4. The final prediction results were output based on the combined model.

accuracy of prediction models :

- mean square error (MSE),
- mean absolute error (MAE)
- mean absolute relative error (MAPE).

DISCUSSION

Prediction result of the GM-BP model includes two parts, prediction values of GM (1, 1) and prediction values of BP neural network model.
Variation trend of the city taxi quantity can be simulated by the GM (1, 1) model accurately. In order to weaken the randomness of the raw data, the raw sequence data was processed by accumulating method. So, processed data shows significant regularity. Meanwhile, GM (1, 1) model updates the input parameters based on the metabolic strategies, meaning using new data to replace the old data progressively according to the order of their appearance.

BP neural network model can fit the complex randomness variation process. So, the trained BP model can be used to forecast prediction residuals of the GM (1, 1). The trend variation prediction results of the GM model can be corrected by the prediction results of the residuals from the BP model, and that may improve prediction accuracy of the combined model.

only the historical city taxi quantity, to predict the future city taxi quantity.

CONCLUSION

The traditional linear model and the single nonlinear model expressing a fragment of the whole variation process, cannot fully and accurately describe the variation process of city taxi quantity.

Grey model suitable for **predicting trends in data series**, can p**redict variation trends** of city taxi quantity accurately; **BP neural network model suitable for non-linear**, **volatile data series prediction**, can predict random values in city taxi quantity variation process accurately.

Grey model and neural network model combined with each other to achieve the complementary advantages, to ensure the **precision** and **stability** of the model.