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ORIGINAL

Regional Economic Growth Forecast Based on Artificial Intelligence and Computer Vision Model

Previsión del crecimiento económico regional basada en un modelo de inteligencia artificial y visión por ordenador

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ABSTRACT

Introduction: regional economic growth can be predicted to make more effective countermeasures and promote the development of local regions. However, the existing regional economic growth forecasting models have the problems that the forecasting speed is too slow and the forecasting results are inaccurate, which greatly hinders people's understanding of economic growth.
Methods: based on artificial intelligence and computer vision model, this paper designed a regional economic growth forecast model and predicted the economic growth of different regions. Through testing different areas, it was found that: The prediction risk index of the economic growth prediction model based on artificial intelligence and computer vision model was lower.
Results: Among them, the accuracy rate was increased by 6,9 %, and the prediction speed was improved, as well as the user satisfaction rate was increased by 9,16 %.
Conclusion: Therefore, artificial intelligence and computer vision technology could optimize the regional economic growth forecast model.

Keywords: Economic Growth Forecast; Artificial Intelligence; Computer Vision; Artificial Neuron Model.

RESUMEN

Introducción: el crecimiento económico regional puede predecirse para tomar contramedidas más eficaces y promover el desarrollo de las regiones locales. Sin embargo, los modelos existentes de previsión del crecimiento económico regional tienen el problema de que la velocidad de previsión es demasiado lenta y los resultados de las previsiones son inexactos, lo que dificulta enormemente la comprensión del crecimiento económico por parte de la población.
Métodos: basándose en la inteligencia artificial y en un modelo de visión por ordenador, este artículo diseña un modelo de previsión del crecimiento económico regional y predice el crecimiento económico de diferentes regiones. A través de pruebas en diferentes áreas, se descubrió que: El índice de riesgo de predicción del modelo de predicción del crecimiento económico basado en la inteligencia artificial y el modelo de visión por ordenador era menor.
Resultados: entre ellos, el índice de precisión se incrementó en un 6,9 %, y la velocidad de predicción se mejoró, así como el índice de satisfacción del usuario se incrementó en un 9,16 %.
Conclusiones: por lo tanto, la inteligencia artificial y la tecnología de visión por ordenador podrían optimizar el modelo de previsión del crecimiento económico regional.

Palabras clave: Previsión del Crecimiento Económico; Inteligencia Artificial; Visión por Ordenador; Modelo de Neuronas Artificiales.

INTRODUCTION

Economic forecast is related to the development of the entire region, and many researchers have studied the regional economic growth forecast. Pindado J introduced the grey system theory into the study of regional economic growth, and formed and tested the grey dynamic sequence forecasting model, as well as applied it to the forecasting analysis of economic growth. The results showed that the economy would maintain stable and rapid development.(1) Guckes carried out theoretical analysis and practical application verification on the application of the model in economic forecasting, indicating that the method could obtain relatively accurate forecasting results.(2) Liu Z extended the analysis to spending data to assess the relative economic impact of tourism on the region. He provided practical management results through a new approach to forecasting tourism spending as an indicator of economic growth.(3) Iregui A constructed a combined model of regional logistics forecasting based on BP neural network.(4) Zhao S analyzed the causal connection and mutual feedback characteristics of system dynamics. On the basis of defining the impact index area of technological innovation, the feedback causal relationship between variables in the system was analyzed, and a system dynamics model of technological innovation and regional economic growth was established.(5,6)

Glauner P proposed a new method for the appearance quality inspection of Chinese prickly ash based on computer vision technology, which could not only meet the requirements of rapidity, automation and high precision, but also avoid the problems of poor repeatability, low efficiency and high randomness of traditional manual methods.(7) In the field of real-time appearance quality inspection of fruits based on computer vision, Thrall J analyzed the main problems existing in the detection of fruit surface defects and proposed further research directions.(8,9,10)

This paper used artificial intelligence and computer vision to improve the regional economic growth forecast model, so that the model could process economic data faster and better, which could improve the speed and the accuracy of forecasting. Users could better understand the economic growth of the local area, which could promote the economic development of the area.

Role of artificial intelligence in forecasting regional economic growth

Predictive model logic design

Based on large-scale economic operation data, the system completes and performs statistical information analysis through the process of data collection, selection, transmission, analysis and application, which is used for advanced decision analysis such as data analysis, forecasting, and early warning. The system includes four basic systems: basic analysis system, basic prediction system, early warning system and information generation system, as shown in figure 1.

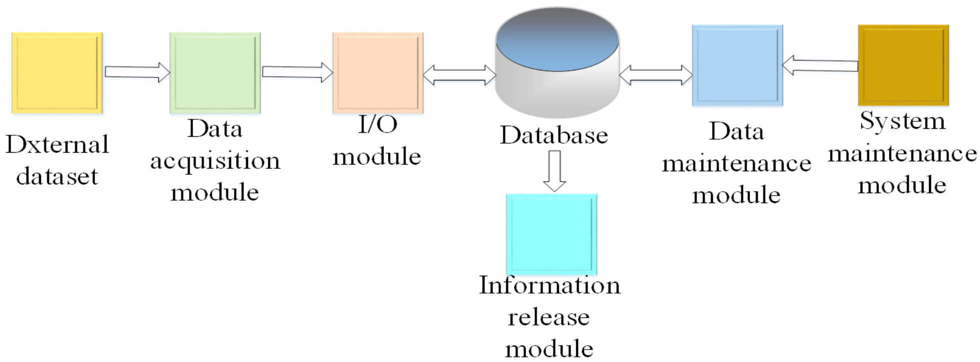

Figure 1. Predictive model logic design

Prediction model structure design

Most of the traditional economic forecasting systems use the Client/Server (C/S) model, which has little flexibility and ease of use. The prediction system based on artificial intelligence and computer vision technology adopts the Browser/Server (B/S) mode(11,12) and the system structure is designed as shown in figure 2, which has the following advantages:

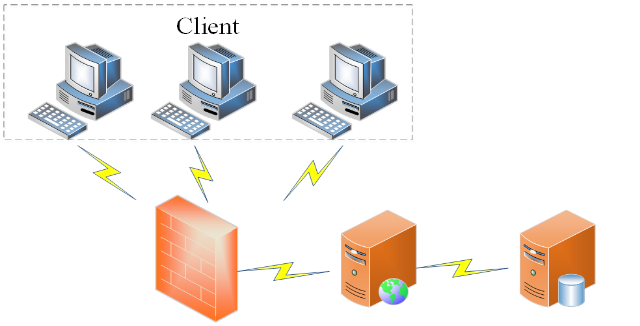

Figure 2. Predictive model structure design

Process of economic forecasting

Error index inspection

The main cause of economic forecast errors is the uncertainty of the economic forecast tools themselves. On the one hand, economic forecasting tools are affected by some basic factors that play a deterministic role and show appropriate accuracy; on the other hand, they are affected by random factors that play a non-deterministic role, which show irregular weaknesses.(13)

The economic forecast test is a test of the degree of correlation between the forecast result and the actual situation, which can usually be expressed by the following error rate:

$$e = i - \hat{i} \qquad (1)$$

e is the $\hat{i}$ error of the predicted value.

Relative error of prediction

The percentage of the prediction error to the actual value is called the relative error and is calculated as:

$$\bar{e} = \frac{e}{i} = \frac{i - \hat{i}}{i} \times 100\% \qquad (2)$$

This metric overcomes the effect of the size of the forecast itself and can be used to compare the accuracy of different forecasting problems.

Average prediction error

The sum of the forecast errors x is called the mean error and is calculated as:

$$MD = \frac{1}{y}\sum_{m=1}^{y}(i_m - \hat{i}_m) \qquad (3)$$

Mean absolute error

The absolute value of the prediction error x is called the absolute error, and the formula is:

$$MAD = \frac{1}{y}\sum_{m=1}^{y}|e_m| = \frac{1}{y}\sum_{m=1}^{y}|i_i - \hat{i}_m| \qquad (4)$$

Mean squared error

In the real prediction, since the true value i of the prediction is not known, the accurate prediction error cannot be obtained yet. Even if it were acceptable, in terms of statistics and forecasting methods, it would not end up with a single predictable outcome due to the possibility of random interference. Therefore, in order to estimate the degree of forecast error in the mean sense, the concept of mean error can be introduced. It is assumed that the actual value of an economic variable is i and the predicted value is î,$E(e^2)$ is called the squared error of the forecast. Among them, E is the mathematical expectation, and $\surd E(e^2)$ is called the squared standard deviation.

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$$e_m = i_m - \hat{i} \quad (5)$$

$$MSE = \frac{1}{y}\sum_{m=1}^{y} e_m^2 \quad (6)$$

As an estimate of $E(e^2)$, MSE is called sample Mean Squared Error, or Mean Squared Error for short. Similarly, √MSE is called the standard error of the sample mean square, denoted as RMSE, or simply the Root Mean Square

Error. The values of MSE and RMSE are between 0 and +∞. The larger the value, the less accurate the prediction.

Mean absolute percent error

- MAPE is the Mean Absolute Percentage Error, referred to as the Mean Percentage Error.[14]
- When the value of MAPE is less than or equal to 10 %, it is a high-precision prediction; when the value of MAPE is greater than 10 % and less than or equal to 20 %, it is a good prediction; when the value of MAPE is greater than 20 % and less than or equal to 50 %, it is a feasible prediction; when the value of MAPE is greater than 50 %, it is a wrong prediction.

Two-sided quotient

A more comprehensive indicator of forecast accuracy is a two-dimensional ratio measure, and the calculation process and indicators are as follows:

$$J = \sqrt{\frac{\frac{1}{x}\sum_{m=y+1}^{y+x} e_m^2}{\frac{1}{y}\sum_{m=1}^{y} e_m^2}} = \sqrt{\frac{\frac{1}{x}\sum_{m=y+1}^{y+x} (i_m - \hat{i}_m)^2}{\frac{1}{y}\sum_{m=1}^{y} (i_m - \hat{i}_m)^2}} \quad (7)$$

Loss function test

For a forecasting problem, there are y periods of data. The mth period is set to the prediction error of e_m and the loss caused by this error is called the error loss.[15] For the purpose of prediction, a loss prediction function c can be made, through which the economic prediction can be tested, as shown in the following formula:

$$c \equiv \frac{1}{y}\sum_{m=1}^{y} c(e_m) \quad (8)$$

Artificial neuron model

Artificial neural network is an abstraction, simplification and simulation of biological nervous system. A particular artificial neural network consists of many identical neuron models in parallel, and the network signal processing is carried out through the interaction between neurons.[16]

Artificial neuron is a simplification and simulation of biological neuron and it is also the basic processing unit of neural network

The input-output relationship can be simplified as:

$$M_m = \sum_{n=1}^{y} w_{nm} x_n - b_m \quad (9)$$

$$j_m = f(M_m) \quad (10)$$

Among them, i_n(n=1,2,…,y) is the input signal from other cells, b_m is the voltage of the neuron, w_{nm} is the connection density from cell n to cell m, y is the number of input signals, x is the output of the neuron, f(.) is the transfer function, sometimes called the displacement or reaction function. It is usually a binary function of 0 and 1 or a sigmoid function, both of which are nonlinear.

The transfer function can be a linear function, but it is usually a nonlinear function such as a step function or a sigmoid curve, and commonly used neuron nonlinear functions are listed as follows:

Threshold function

When j_n is 0 or 1, f(i) is a step function:

$$f(i)=\begin{cases}1 & i\geq 0\\ 0 & i<0\end{cases} \quad (11)$$

Sigmoid function

Sigmoid function is also called S-type function.(17,18)

$$f(i)=\frac{1}{1+\exp(-ai)} \quad (a>0) \quad (12)$$

The sigmoid curve tends to be a step function, usually with a value of 1, as it tends to infinity.

$$f(i)=\tanh(i) \quad (13)$$

In this paper, the excitation function of the following form is used:

$$f(i)=\frac{1-\exp(-ai)}{1+\exp(-ai)} \quad -1<f(i)<1 \quad (14)$$

Back Propagation (BP) network learning algorithm

After the BP network process is determined, the network should be trained using the input and output of the network m.odel. That is to learn and correct network parameters and parameters, so that the network can achieve a given input-output mapping relationship.(19,20)

Toward transfer of information:

It is assumed that the BP network has L levels in total. For a given sample P, the expected output of the network is:

$$Td=[Td1,Td2,\ldots,Tdp] \quad (15)$$

When the Pth sample is input, the functional characteristics of the jth neuron in the l(l= 1,2,….,L-1) the layer in the network are:

$$net_{np}^{(l)}=\sum_{m=1}^{n_{l-1}} w_{nm}^{(l)} o_{mp}^{(l-1)} - \theta_n^l \quad (16)$$

$$O_{np}^{(l)}=f_l(net_{np}^l) \quad (17)$$

Among them, W_{nm} is the connection density between neuron m and neuron n, and Y_{l-1} is the number of nodes in layer l-1.

O_{np}^(l-1) is the current input of neuron n, O_{np}^(l) is the output of neuron n, and f_l is a nonlinear differentiable non-decreasing function, which is generally taken as a sigmoid function, namely:

$$f_l(i)=\frac{1}{1+e^{-i}} \quad (18)$$

For the output layer, there are:

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$$O_{np}^{(L)} = f_L(net_{np}^{(L)}) = \sum_{m=1}^{yL-1} W_{nm}^{(L)} O_{mp}^{(L-1)} - \theta_n^L \quad (19)$$

$$E_p = \frac{1}{2}\sum_{n=1}^{x}(T_{ndp} - \hat{T}_{np})^2 \quad (p = 1,2,..P) \quad (20)$$

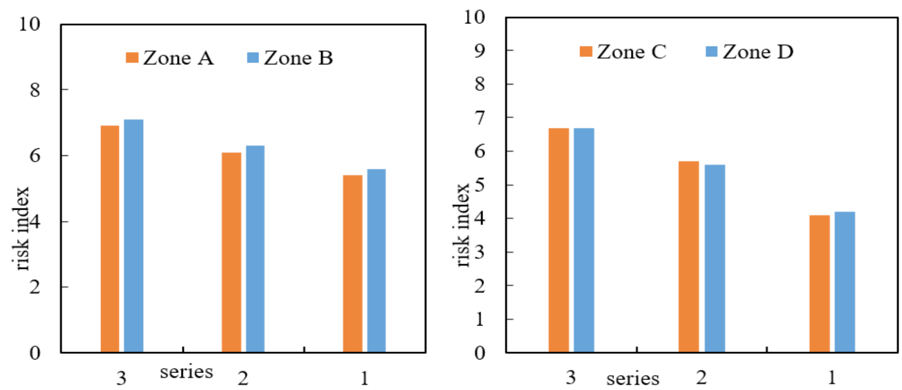
Among them, m is the number of output nodes.
The total error of the network is obtained as:

$$E = \sum_{p=1}^{p} E_P \quad (21)$$

Impact of artificial intelligence on regional economic growth forecasting models

Predictive risk index test

The first-level, second-level, and third-level risk index tests are conducted on 4 regions to observe the difference between the economic growth prediction model based on artificial intelligence and computer vision model and the traditional economic growth prediction model in the risk index test, and the results are shown in the figure 3.

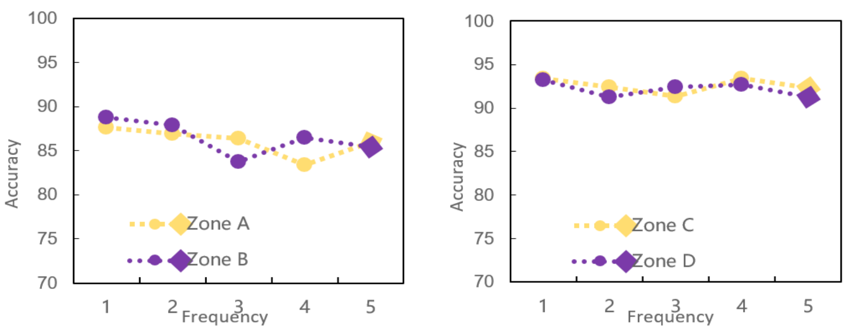


A. Zone A and zone B risk index B. Zone C and zone D risk index

Figure 3. Risk index test

In figure 3, figure A shows the test results of the risk index of areas A and B, and figure B shows the test results of the risk indexes of areas C and D. Due to the different economic conditions in each region, the results of the test would also be different. However, it can be seen from the figure that with the increase of the risk level, the risk index of area C and area D is obviously lower than that of area A and area B. The three-level risk index of the four regions is not much different, with region A being 6,9, region B being 7,1, region C being 6,7, and region D being 6,7.

Prediction accuracy test



A. The accuracy of zone A and zone B B. The accuracy of zone C and zone D

Figure 4. Prediction accuracy test

The prediction accuracy affects the final prediction result. The higher the accuracy, the better the development of the region. 5 predictions are made for each region, and the difference between the predicted results and the actual results is calculated, as well as the difference between the economic growth prediction model based on artificial intelligence and computer vision model and the traditional economic growth prediction model in the prediction accuracy test is observed, and the results are shown in figure 4.

In figure 4, figure A is the prediction accuracy rate of area A and area B, and figure B is the prediction accuracy rate of area C and area D. The prediction accuracy of region C and region D is significantly higher than that of region A and region B, and the accuracy of the four regions is not stable. Among them, the average prediction accuracy of area A is 86,4, the average prediction accuracy of area B is 86,46, the average prediction accuracy of area C is 92,582, and the average prediction accuracy of area D is 92,164.

Prediction time test

The two models are tested for prediction time and the economic data of 4 regions are extracted for testing. The economic data are 100, 500, 1 000 and 2 000. The time required for different economic data tests is tested and the difference between the two models is observed, and the results are shown in figure 5.

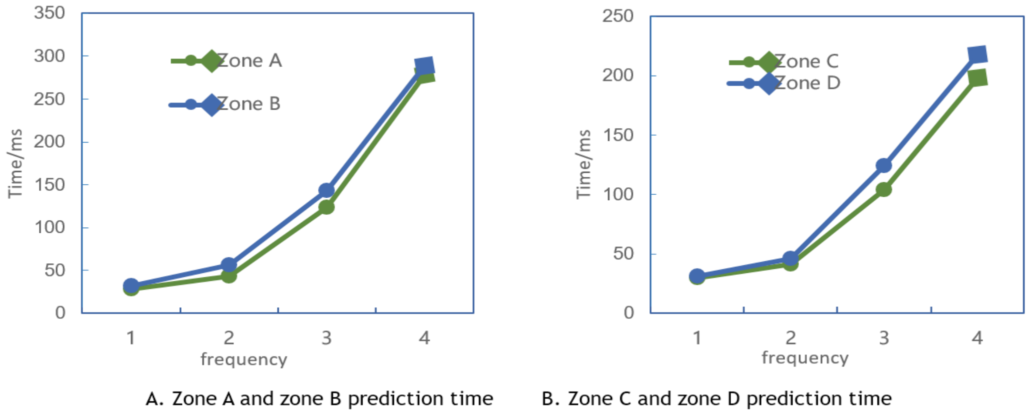


Figure 5. Prediction time test

In figure 5, figure A is the predicted time of economic growth of area A and area B, and figure B is the predicted time of economic growth of area C and area D. When the economic data is 100, the prediction time of the four regions is not much different: The region A is 28, the region B is 32, the region C is 30, and the region D is 31. When the economic data is 500, the forecasting time of area C and area D is slightly lower than that of area A and area B: Area A is 43, area B is 56, area C is 41, and area D is 46. When the economic data is 1000, the forecast time of area C and area D is significantly lower than that of area A and area B: Area A is 124, area B is 143, area C is 104, and area D is 124.

User satisfaction test

Differences in the satisfaction scores of users using the two prediction models are observed, and the results are shown in figure 6.

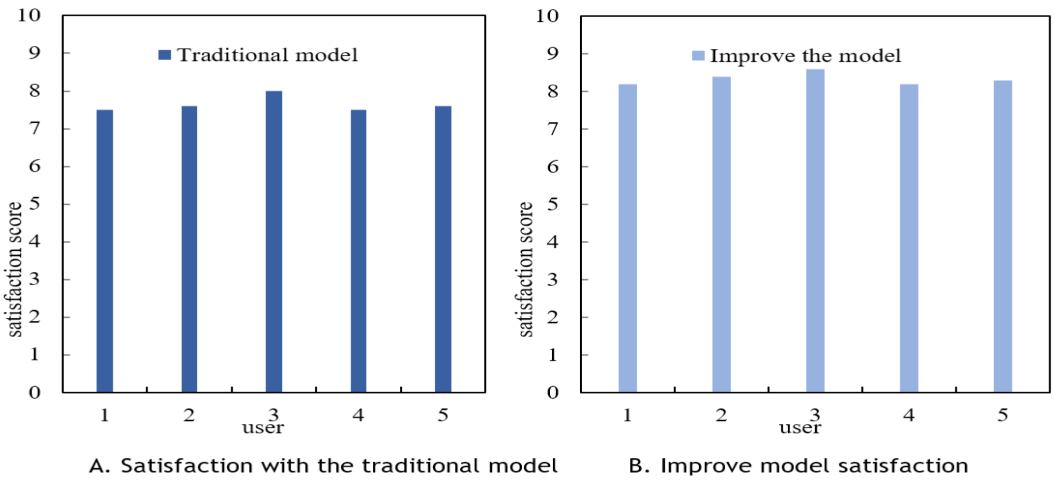


Figure 6. User satisfaction test

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In figure 6, figure A is the user satisfaction test result using the traditional regional economic growth prediction model and figure B is the user satisfaction test result using the economic growth prediction model based on artificial intelligence and computer vision models. The average satisfaction of users in figure A is 7,64 and the average satisfaction of users in figure B is 8,34, with a 9,16 % increase in satisfaction. To sum up, the economic growth prediction model based on artificial intelligence and computer vision model is more satisfactory to users than the traditional regional economic growth prediction model.

CONCLUSIONS

An accurate economic growth forecast for a region can well understand the future economic growth of the region, which is more conducive to promoting the development of the local region. In order to optimize the traditional regional economic growth forecasting model, this paper applied artificial intelligence and computer vision technology to the regional economic growth forecasting model, and improved the regional economic growth forecasting model. Through experiments on the two models, it was found that the economic growth prediction model based on artificial intelligence and computer vision model had lower risk index, higher prediction accuracy and faster prediction speed, which was more satisfactory to users.

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CONFLICT OF INTEREST
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