Research on Evaluation Model of the Urban Economy Based on Rough Set and Neural Network

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***Abstract*—For the shortage of the traditional evaluation methods of the urban economy, A new evaluation model proposed, establishing an index system of evaluation and decision table on city economy, and extracting important properties of input data from Rough Set and neural network, and evaluation indexes reduced as input of neural network to realize the city's economic strength evaluation , then, using programming with MATLAB and realizing the simulation of rough set and neural network evaluation model, at the same time, consistenting with traditional network model results.**

Keywords-rough set; neural network; urban economy; MATLAB; evaluation

I. INTRODUCTION

There are many methods for the analysis of the city's economic strength in recent years, such as grey clustering analysis [1] [2], principal component analysis [3], and fuzzy comprehensive evaluation and so on. Neural Network is capable of automated learning and adaptation, meanwhile, processed large amount of parallel data and distributed information storage. However, It is difficult to evaluate importance and redundant of parameters [4]. Rough Set (RS) is new mathematic method for processing uncertain and incompatible data and imprecise question. Data attributes reduction and the minimum expression of knowledge can be solved after critical information kept, and then find implied knowledge and potential law [5]. RS and Neural Network combine advantages of two methods and make up for deficiencies [6] [7].

In this paper urban economy strength evaluation model which is based on RS and Neural Network puts forward to achieve effective evaluation on the city in Guangxi, and methods complement to urban economic.

II. EVALUATION MODEL OF URBAN ECONOMY STRENGTH BASED ON RS AND NEURAL NETWORK

A. *Construction of the Urban Economic Strength Evaluation Index System*

According to the basic principles of the scientific, guide, comparability, operability, referring to the related data and researcher on urban economy index system, The article has selected economic indexes which reflecting the level of economic development and establishing evaluation indexes system of urban economy strength[8]. Choosed 13 indexes as followed: ① x1- Total Population(10000persons); ② x2- Gross Domestic Product(100 million yuan); ③ x3-Primary Industry(100 million yuan); ④ x4-Secondary Industry(100 million yuan); ⑤ x5-Industry(100 million yuan); ⑥ x6-Tertiary Industry (100 million yuan); ⑦ x7-Total Investment in Fixed Assets(100 million yuan); ⑧ x8-Total financial Revenue(100 million yuan); ⑨ x9-Budgetary Revenue(100 million yuan); ⑩ x10- Budgetary Expenditure(100 million yuan); ⑪x11-Resident Savings Account(10 000 yuan); ⑫x12-total retail trade(100 million yuan).

B. *The Urban Economic Strength Evaluation Process*

Neural network has the advantages that distributed storage and parallel processing, automated learning and organization, generalization, fault tolerance and robustness; however, when large quantity of data is input, it causes huge neural network structure, long training time, and training failure. At the same time, it is decreased network generalization due to the using samples being contradiction and randomness inevitably. Moreover, accuracy of neural network itself also affects the accuracy of the evaluation results.

RS is a significant tool of analyzing incomplete, inaccurate information system, preprocessing input data of neural network by using RS, extracting the key ingredient as input of the network, reducing ruleset, simplifying the structure of the neural network, shorten the training time, improving the generalization ability, therefore,it can heighten evaluation reliability on the urban comprehensive economic strength. After decision table is reduced by RS, which being a training sample set of neural networks [9]. RS-neural network model of urban economic strength evaluation process is shown in Fig 1:

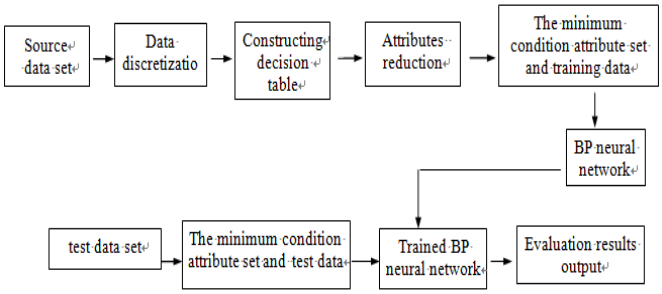

FIGURE I. EVALUTION PROCESS OF URBAN ECONOMY STRENGTH BASED ON RS AND NEURAL NETWORK MODEL.

Step1: Original data selected. Analyze data, select original sample set and form original decision table. The paper has selected 13 indexes as above.

Step2: Continuous data discretization. Bisection method can be used in this paper.

Step3: Form final decision table.

Step4: Determination of BP neural network evaluation model structure. It includes input layer, hidden layer and output layer, in hidden layer(n2) and input layer(n1):n2=2*n1+1. The economic evaluation grade divides into five grades: 1(lowest), 2(lower), 3(moderate); 4(higher); 5(highest),input sample expected value: lower(1，0，0，0，0)，low(0，1，0，0，0), middle(0，0，1，0，0),high(0，0，0，1，0),higher（0，0，0，0，1）. Therefore, the number of nodes of the output layer is 5.

Step5: Training of BP neural networks. Standardized data processing methods are as follows:

$$x'_i = (x_i - x_{\min}) / (x_{\max} - x_{\min})$$

x'_i: Standardized value; x_i: Target value; $x_{\max}$:Maxium of evaluation indexes;

$x_{\min}$: Minimum of evaluation indexes; i: The number of evaluation indexes.

Step6: The urban economic strength evaluation process.

III. APPLICATION

The paper has choosed 13 cities in GuangXi as example to construct RS-neural network model(except for ChongZuo city) in the light of evaluation system above mentioned[10] [11]. The related data is shown in table1:

Urban economic strength decision table is shown in table2:

According to decision table definition:

$$Ind(R) = \{(x, y) \in U \times U : r \in R : r(x) = r(y)\} \quad (1)$$

$$A_R(X) = \frac{|R^-(X)|}{|R^-(X)|} \quad (2)$$

In the type: AR(X) is approximation accuracy

$$\mu RX(x) = \frac{|X \cap R(X)|}{|R(X)|} \quad (3)$$

In the type: μRX (x)∈ [0， 1],value of μRX (x) is conditional probability, xis confidence level of X, RS approaching as follow:

R-(X) ={x∈U:μRX(x)=1} R-(x)={x∈U:μRX(x)>0} (4)

Let, suse MATLAB to realize RS- neural network evaluation model. Data in table3. Perform reduction with MATLAB RS function. The conclusion is realized [12].

C=[2,3,1,3,2,3,1,2,2,2,2,2;3,3,5,2,2,3,1,2,2,2,3,2;3,2,4,2,2,2,1,1,2,2,2,1;...

5,3,5,2,2,3,2,2,2,2,2,2;5,2,4,2,2,2,1,2,2,2,3,2;5,3,4,3,3,2,1,2,2,2,3,2; ...

2,1,3,1,1,2,1,1,1,2,1,1;5,2,5,2,2,2,1,1,1,2,1,1;2,1,2,1,1,1,1,2,1,2,2,1;...

5,2,5,2,2,1,1,2,1,2,1,1;5,5,4,5,3,5,5,5,4,5,5,5;5,5,2,5,5,4,3,5,4,5,5,3;4,4,3,4,4,4,3,4,3,5,4,3];

D=[4;3;2;2;2;2;1;2;1;2;5;4;4];

X=[C D]; c=1:13; d=14;

Y=redu (c, d, X)

Operating results are, Y=1，2，3，therefore,x1,x2,x3 can not be reduced, representing total population, Gross Domestic Product, Primary Industry. Three indexes are important data and factors reflecting city economic development level.

Three indexes extracted of five cities in table1.as learning sample data set, certain training parameters can be trained. In this paper, BP neural network uses LM algorithm, the maximum training step is 1000, and 0.00001 squared error, hidden layer transfer function for tansig function, the output layer transformation function for logsig function. Research results are shown in Table3, it is obvious that BP neural network is absolutely capable of learning to identify these five samples, fitting 100%, which indicates that the BP neural network has established between the complex nonlinear model evaluation criteria and evaluation level[13] [14]. In this case, trained the neural network has "simulated" and "memoried" "function" relationship between the input and output variables, it can be used to evaluate the urban economy.

According to the network acquired, the three indexes of remaining eight cities conduct the data standardization as the input of BP neural network, also evaluate BP network trained. In the light of how close the output value from the expected value, evaluation results obtained are shown in Table 4:

As can be seen from above network parameters and evaluation results, Evaluation model has corresponded with city economic development level and present condition. It is shown index system and RS-BP neural network evaluation model has a certain practical reference value.

IV. CONCLUSIONS

This evaluation method has preprocessed neural network input data, eliminated redundant information, extracted key ingredients to reach simplifying the network structure; this can shorten the training time, to improve the recognition accuracy. Of course, the evaluation of the city economic strength is a complex system problems, it must be further study in the future on how to choose a more comprehensive index and a more efficient algorithm.

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TABLE I. CITY ECONOMIC DEVELOPMENT LEVEL INDEX VALUE.

Cities \ Indexes	x1	x2	x3	…	x10	x11	x12	Evaluation grade
WuZhou	34.01	62.11	1.31	…	8.86	47.66	29.16	higher
BeiHai	52.90	82.26	18.07	…	9.54	55.8	30.51	moderate
FangChengGang	47.44	45.17	11.77	…	4.90	26.86	17.03	lower
QinZhou	119.34	75.16	35.38	…	7.31	34.47	31.20	lower
GuiGang	167.58	47.82	14.48	…	6.50	44.27	21.56	lower
YuLin	89.70	57.04	11.57	…	7.65	79.56	39.96	lower
BaiSe	32.71	29.86	5.83	…	2.71	21.30	8.67	lowest
HeZhou	90.37	50.88	18.21	…	2.88	23.02	16.16	lower
HeChi	31.23	26.44	3.75	…	2.31	25.99	13.74	lowest
LaiBin	96.67	50.96	16.35	…	4.05	13.92	8.77	lower
NanNing	140.39	269.06	10.75	…	27.86	290.64	159.76	highest
LiuZhou	94.38	179.94	3.80	…	19.71	166.88	74.63	higher
GuiLin	69.09	127.82	6.40	…	16.37	138.15	65.98	higher

TABLE II. CITY ECONOMIC STRENGTH DECISION TABLE.

U(cities)	C(condition attributes)							D(decision attributes)
	x1	x2	x3	…	x10	x11	x12	
WuZhou	2	3	1	…	2	2	2	4
BeiHai	3	3	5	…	2	3	2	3
FangChengGang	3	2	4	…	2	2	1	2
QinZhou	5	3	5	…	2	2	2	2
GuiGang	5	2	4	…	2	3	2	2
YuLin	5	3	4	…	2	3	2	2
BaiSe	2	1	3	…	2	1	1	1
HeZhou	5	2	5	…	2	1	1	2
HeChi	2	1	2	…	2	2	1	1
LaiBin	5	2	5	…	2	1	1	2
NanNing	5	5	4	…	5	5	5	5
LiuZhou	5	5	2	…	5	5	3	4
GuiLin	4	4	3	…	5	4	3	4

TABLE III. BP NEURAL NETWORK LEARNING RESULTS.

grades	Desired output					BP network actual output				
1	1	0	0	0	0	0.9876	0.0000	0.0023	0.0000	0.0000
2	0	1	0	0	0	0.0000	0.9986	0.0000	0.0012	0.0001
3	0	0	1	0	0	0.0000	0.0000	0.9999	0.0003	0.0000
4	0	0	0	1	0	0.0002	0.0000	0.0003	0.9989	0.0013
5	0	0	0	0	1	0.0000	0.0007	0.0000	0.0000	0.9992

TABLE IV. CITY ECONOMIC EVALUATION RESULTS.

Cities	Network output					Evaluation results
WuZhou	0.0146	0.0000	0.0000	0.9625	0.0001	4(higher)
FangChengGang	0.0000	0.9795	0.0000	0.0006	0.0000	2(lower)
QinZhou	0.0000	0.9980	0.0012	0.0000	0.0000	2(lower)
YuLin	0.0000	0.0002	0.9999	0.0000	0.0000	2(lower)
BaiSe	0.9998	0.0000	0.0027	0.0000	0.0000	1(lowest)
HeZhou	0.0008	0.9648	0.0000	0.0000	0.0000	2(lower)
LaiBin	0.0000	0.9999	0.0034	0.0000	0.0000	2(lower)
LiuZhou	0.0000	0.0000	0.0000	0.9887	0.0019	4(higher)