Chapter 42
The Evaluation of College Students' Comprehensive Quality Based on Rough and ANN Methods

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Abstract The risk measure for enterprise technology innovation is a hotspot problem and the forward position of enterprise management, is a much subject overlapping edge research program, it is very difficult to research this problem. In this paper, based on Rough set theory and ANN method, Rough-ANN model for dynamic risk measure of enterprise technological innovation is established. It takes the advantages of the informational reduction principle of rough set theories and ANN predominance which has stronger concurrent processing, approach advantage and sort study capability. Thus the model may simulate the mankind's abstracting logic thinking and image intuitive thought to measure enterprise technological innovation risk. This model can identify the main attributes of technological innovation risk, reduce the information accumulate cost of risk measure, improve the efficiency of risk measure, make the sophisticated problem of technological innovation risk measure simplified. Therefore, this model has better practice operability. Theoretical analysis and experimental results show the feasibility and validity of the model. The research work supplies a new way for dynamic risk measure for technological innovation.

Keywords Comprehensive quality · Evaluation · Rough set · BP artificial neural network

42.1 Introduction

Nowadays colleges and universities endeavor to train talents with innovative mind, who are urgently needed with the development of our society. At present, push higher education forward to the quality-oriented education, practice work already

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J. Xu et al. (eds.), *Proceedings of the Seventh International Conference on Management Science and Engineering Management (Volume 1)*,
Lecture Notes in Electrical Engineering 241, DOI: 10.1007/978-3-642-40078-0_42,

enters a new dimension, but college students' character adjudication, especially comprehensive quality's evaluation are relatively weak [1–3]. Nowadays, College students' comprehensive quality evaluation patterns are almost produced by past exam-oriented education environment,have existed many shortage in evaluation aim, evaluation content and evaluation method,they are as follows: analysis and research almost focus on qualitative, pay little attention to quantitative analysis and existing evaluation index system is out-of-date. Those comprehensive quality,particularly moral and capacity quality required in existing evaluation index system can not meet the quickly developing demand, this problem already become a "bottleneck" [4–7], which has a further affect on strengthening and improving of quality-oriented education. Therefore, build a scientific, achievable college students' comprehensive quality evaluation system already become an important subject of quality-oriented education's theory and practice. Through the study of the current society, especially employer's requirement for college students, we design the college students' comprehensive quality evaluation index system, and build college students' comprehensive quality evaluation's Rough-ANN model. This model not only can avoid disturbance of human factors, but also can recover college student comprehensive quality's major feature attribute, reduce the costs during gather information for college students' comprehensive quality evaluation, and improve the efficiency, simplify the complexity college students' comprehensive quality evaluation task.

42.2 Establish College Students' Comprehensive Quality Evaluation Index System

College students' comprehensive quality evaluation is using scientific systematic method to make the judgment and evaluation of college students' comprehensive quality, on the basis of carefully analyze about the condition and developing state of college students' moral quality, professional ability, practical capability, physical and psychological quality. Therefore, before evaluating college students' comprehensive quality, we must build college students' comprehensive quality evaluation index system.

42.2.1 The Principle for Establishing the Evaluation Index System

There are many factors which influence college students' comprehensive quality, and the relationships of them are complex. Therefore, In process of building college students' comprehensive quality evaluation system, we must follow these principles below.

- Guiding principle. Evaluation index system should reflect quality-oriented education's basic requirement on college students, can guide students' cultivate and develop all-round quality, and has been good for encouraging all-around personal development morally, intellectually, physically and esthetically.
- Comprehensiveness principle. Evaluation index system should reflect related important content of quality-oriented education as far as possible, describe college students' comprehensive quality intension and feature from different levels and points, so that it could guarantee the evaluation accurately feeds back college students' comprehensive quality and quality-oriented education's effect.
- Level principle. We should set the index system according to progressive arrangement, compose a united whole which has a clear, connected, reasonable structure. And lower levels' specific evaluation index should analyze and explain to upper levels.
- Independence principle. Evaluation index should be relatively independent, that reflect one respect of student, there is no cross and similar phenomena involved between each index. And try to avoid duplication of information to take advantage of the evaluate effect of different indexes.
- Practicability principle. We could not be further from reality when designing the evaluation system, those evaluation indexes can obtain enough information in education practice, can quantified describe the state of evaluation object in education programmers, at the same time, try to simplify evaluation system.

42.2.2 The Way to Establish the Evaluation Index System

Based on the new requirements of employers and college students' feature, college students' comprehensive quality can be fall into five categories: moral quality, professional quality, humanistic quality, physical and psychological quality, capability quality. We can treat these five categories as the first-class index of college students' comprehensive quality evaluation. Then, according to the principle of establishing college students' comprehensive quality evaluation system, and reference relative literatures at home and abroad [8–11], we gradually decompose first-class indexes, and initially build the framework of college students' comprehensive quality evaluation index system, which include 5 first-class indexes, 11 second-class indexes and 54 third-class indexes. Then, we design questionnaire, ask interviewee (relative field expert, manager) to assess every evaluation index. Combined with expert opinions, the 11 third class indexes are canceled. At last, we build college students' comprehensive quality evaluation index system, which are shown in Table 42.1.

Table 42.1 The college students' comprehensive quality evaluation index system

First-class index	Second-class index	Third-class index
Moral quality	Politics quality	Politics theory level Politics attitude Scientific world outlook Experience as students leader
	Ethics quality	Ethics character Civilization accomplishment Study attitude Attitude toward manual labor
	Law and Discipline quality	Legal knowledge Law concept Abidance by law Abidance by the school rules
Professional quality	Professional theory	Public required course score Specialized course score
	Professional skill	Practical foreign language competence Computer application ability Literature search and data access quality Professional design quality
Humanistic quality	Humanistic theory quality	Social sciences knowledge Natural science knowledge Humanity quality train knowledge
	Humanistic practice quality	Social work Social practices Art competition award Self-cultivation
Physical and psychological quality	Physical quality	Fitness condition Sports score Participation in sports activities
	Psychological quality	Mental health condition Social adaptation Emotional coordination and control capacity
Capacity quality	General capacity	Written capacity Oral communication capacity Analysis & judgment capability Independent problem solving capacity Hands-on capacity Self-study capacity
	Special capacity	Interpersonal communication capacity Teamwork capacity Organization and management capacity Academic research capacity Technological innovation capacity Art innovation capacity

42.3 Rough-ANN Model of College Student Comprehensive Quality Evaluation

42.3.1 Overview of Rough Set Knowledge Reduction Method

Rough set theory is a mathematical theory analysis of data first proposed in the early 1980s by Polish mathematician Pawlak [12]. It is a new tool which deal with fuzzy and uncertainty knowledge of mathematical. Rough set theory has been widely applied in machine learning, knowledge discovery from the database, decision support and analysis. The main idea is under the premise of maintaining the same classification ability, export the decision-making and classification rules of problem by knowledge reduction. Knowledge reduction method is the kernel of the rough set theory. In knowledge base knowledge (attributes) are not equally important, even some of the knowledge is redundant [13]. The so-called knowledge reduction is to keep the same conditions of the known training library classification ability, delete irrelevant or unimportant knowledge.

Let $K = (U, R)$ is an information system where $U = \{u_1, u_2, \cdots, u_n\}$ is a finite non-empty individual Complete Works, $R = \{r_1, \cdots, r_m\}$ is a finite set of attributes, set $r \in R$ is an attribute on the U, the equivalence class of the Complete Works of U on the elements on the properties of r can be denoted by $[x]_r$, where $x \in U$.

Let $P \subseteq R$, $P \neq \varphi$, $P = r_{i1}, \cdots, r_{ik}$, all equivalence relation of P is $\cap P = \cap_{j=1}^{k} r_{ij}$, then $\cap P$ is an equivalence relation, denoted by IND(P), says this intersection is no clear relationship.

Let $r \in R$, if IND$(R) =$ the IND$(R - r)$, claimed that r is a reduction properties of R, otherwise r is an irreducible property of R. If $\forall r \in R$ are not reduction, called the set R is an independent set, otherwise the set R is related.

Q, R is independent and IND$(Q) =$ IND(P), claimed that the Q is simplified of the P. The collection of all non-Province attribute of P is called P nuclear, recorded as core (P). Detailed Rough set algorithms for reduction of knowledge please refer to Literature [14].

42.3.2 BP Artificial Network Architecture and Algorithm

A standard back propagation neural network is shown in Fig. 42.1. The first layer consists of n input units. Each of the n input units is connect to each of the r units in the hidden layer. The r output units of the hidden layer are all connected to each of the m unit in the output layer.

BP is a supervised learning algorithm for multilayer networks [15, 16]. The algorithm aims at minimizing the MSE between the actual output of the network and the desired output. Gradient descent search is user in BP. In BP learning, a set of patterns of the form $< x_1, \cdots, x_n, y_1, \cdots, y_m >$, where $x_1, \cdots, x_n$ are the components

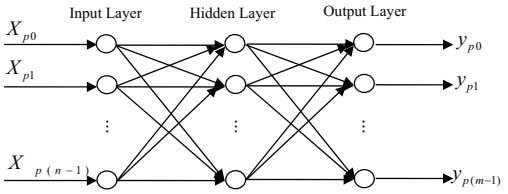

Fig. 42.1 The standard BP artificial neural network

of the input vector and $y_1, \cdots, y_m$ are the components of the desired output vector, is repeatedly given to the network until the learning of weights converges.

If the BP neural network has N units in each layer, The transfer function is the sigmoid function, $f(x) = \frac{1}{1+e^{-x}}$, the training samples involve M different patterns (X_p, Y_p), $P = 1, 2, \cdots, M$. Corresponding the Input sample P, let net_{pj} represents the input total of unit j, let O_{pj} represents the output value, that is:

$$\text{net}_{pj} = \sum_{j=0}^{N} W_{ji} O_{pj}, O_{pj} = f(\text{net}_{pj}).$$

The error between input values and output values is as following:

$$E = \sum E_p = \left(\sum (d_{pj} - O_{pj})^2\right)/2.$$

The revise connection weights of BP neural network are as following:

$$W_{ji} = W_{ji}(t) + \eta \delta_{pj} O_{pj} + \alpha (W_{ji}(t) - W_{ji}(t-1)),$$

$$\delta_{pj} = \begin{cases} f(\text{net}_{pj})(d_{pj} - O_{pj}), & \text{corresponding the output units,} \\ f(\text{net}_{pj}) \sum \delta_{pk} W_{kj}, & \text{corresponding the output units,} \end{cases}$$

where η represents the learning rate, it can increase convergence in speed, α represents the momentum coefficient. The value of a is a constant, it affects the connection weights of next step. Details of the traditional BP neural network algorithm can be found in the original paper by Tian and Gao [17].

42.3.3 The Basic Principles of Rough-ANN Model Construction

From Table 42.1, we know that many factors affect college students' comprehensive quality indicators. Correlation may exist between the data of these indexes, if regarding all of them as artificial neural network input variables will obviously increase the complexity of the network, reduce network performance, greatly increase the calculation of running time, and affect the accuracy of the calculation. Knowledge reduction in Rough set theory provides a good idea to solve this problem, we can reduce the expression of information attribute index, remove the redundant information and indicators, simplify the neural network training set, reduce the complexity

and training time of neural network system by Rough set theory. First compress third-level indicators of college students' comprehensive quality evaluation with the knowledge of reduction in the Rough Set Theory. Next, use the three level indicators as input variables of the BP network, and then study by the improved BP algorithm. The idea to do so is that, Rough set theory can start from the relevance of data x and found the data pattern to extract data rules, reduce data variable, but does not exist advantage in knowledge inference and prediction. However, neural network's earning ability, reasoning ability and classification ability are strong, also is good at extracting rules and information from large amounts of data, and has a good dynamic prediction function. Therefore, we would organically combine the two methods through learning from each other, in order to improve capabilities of artificial neural network to deal with complex issues, non-linear problems.

42.3.4 Design the Rough-ANN Model

During designing college students' comprehensive quality evaluation's Rough-ANN model, we firstly determine the comment level of college students' comprehensive quality comment. Then determine the assignment method of the third-class evaluation indexes. At last, build Rough-ANN model's three layers network structure.

(1) Confirm college students' comprehensive quality comment level

Let $V = \{v_1, v_2, \cdots, v_n\}$ represent the evaluation levels of college students' comprehensive quality. In this paper, set $n = 5$, establish 5 kinds of evaluation levels. Comment sets consist of evaluation levels is $V = \{v_1, v_2, \cdots, v_5\} = \{\text{excellent}, \text{fine}, \text{medium}, \text{passing}, \text{bad}\}$.

(2) Assignment method to evaluation indexes

In order to reflect objectivity and comprehensiveness of college students' comprehensive quality evaluation, avoid one-sidedness, during quantizing the third-class indexes of college students' comprehensive quality evaluation indicator system, we should combine students' self assessment, mutual evaluation and teachers' evaluation. At first, organize a assessment team, this group is made up of student, delegation of schoolmates, counselor and teachers. Then, ask the group member to assess the third-class indexes of evaluation object. Evaluation standard is as follows.

Suppose one group member considers the evaluation index x_i is "bad", then its score will be u_1 $(u_1 \in [0,1])$; considers the evaluation index x_i is "passing", then its score will be u_1 $(u_1 \in [0,1])$; and so on.

Suppose the group has f members, the member a $(a = 1,2,\cdots,f)$ gives u_a score to index x_i $(i = 1,2,\cdots,43)$, then the evaluation value xv_i of index x_i is:

$$xv_i = \frac{1}{f}\sum_{a=1}^{f} u_a.$$

(3) Rough-ANN model structure

According to the traditional BP neural network structure, we divide Rough-ANN model for college students' comprehensive quality evaluation into three layers:

- Input layer: Firstly, give values to three layers indicators of college students' comprehensive quality evaluation index system. Then, use the knowledge reduction method in Rough Set Theory to remove redundant indicators, take the three layers indicators as input variables of neural network.
- Hidden layer: As for the selection of the hidden layer, please refer to literature [18] that have mentioned-BP neural network dynamically adjusted learning algorithms, firstly, set up hidden layer nodes large, let network self-regulated learn, and finally get the right size of hidden layer nodes.
- Output layer: College students' comprehensive quality is divided to: excellent, fine, medium, passing, bad. So, in artificial neural networks, respectively, we use the output vector $(1,0,0,0,0),(0,1,0,0,0),(0,0,1,0,0),(0,0,0,1,0),(0,0,0,0,1)$ to describe. Therefore, the neural network's output layer nodes are 5.

42.3.5 Basic Algorithm of Rough-ANN Model

Combine Rough Set Theory with ANN method, we establish college students' comprehensive quality Rough-ANN model, the basic algorithm procedure is as follows:
Step 1. According to the college students' comprehensive quality comment set, combined with the assignment way of evaluation index give values to three indicators of college students' comprehensive quality evaluation, then, use knowledge reduction method in Rough Set Theory to remove redundant indicators, and take the three layers indicators as input variables of the neural network.
Step 2. Set neural network output layer node as 5, and initialize other parameters of network (including a given study accuracy ε, the provisions of the iterative step number M_0, hidden nodes limit r, learning parameters b. The initial hidden nodes should be appropriate to take a large number).
Step 3. Enter the learning sample, make the sample parameter values into the $[0,1]$.
Step 4. Random values between $[-1,1]$ are assigned to the initial weight matrix.
Step 5. Use dynamically adjusted algorithm to train BP neural network, in order to ensure weight matrix between each layers.
Step 6. Judge whether the number of iterations exceed the prescribed number of steps or meet the learning accuracy requirements or not. If yes, terminate the algorithm; if no, return to Step 5 and keep learning.
Step 7. Give values to the evaluation object's comprehensive quality three layers evaluation index, process the data and make it into $[0,1]$.
Step 8. Input processed data to the trained BP neural network and calculate the output.
Step 9. According to the output results, combined with college students' comprehensive quality evaluation set, make the evaluation of the object's comprehensive quality condition.

42.4 Empirical Research

We use Rough-ANN model built in this paper to evaluate college students' comprehensive quality. We randomly select 16 students from management engineering major of Sichuan University, they are: student S_1, student S_2 student $S_3, \cdots$, student S_{16}. Previous 12 students are taken as a training sample of the Rough-ANN model, and the after 4 students as forecast sample.

42.4.1 Knowledge Reduction of College Students' Comprehensive Quality Evaluation Index

Use the method which is introduced in Sect. 42.3.4 of this paper, we get the estimated values of evaluation index x_i $(i = 1, 2, \cdots, 43)$ of previous 12 students (student S_1, student S_2, student $S_3, \cdots$, student S_{12}).

In order to simplify evaluation index x_i $(i = 1, 2, \cdots, 43)$ by Rough method, we should transform estimated value of each index, the standard of transform is as follows: when the estimated value of index x_i is in $[0, 1]$, the score of x_i will be 1, when the estimated value of index x_i is in $(1, 2]$, the score of x_i will be 2. And so on, when the estimated value of index x_i is in $(4, 5]$, the score of x_i will be 5.

Then, according to Rough theory knowledge simplify algorithm, we can clear away redundant information and indexes in the evaluation system. This process contains two steps: first, remains only one index between the evaluation indexes which have the same value; then calculate the evaluation indexes nuclear, delete redundant indexes according to the indexes nuclear, find the smallest simplification of the indexes. From the final reduction results can be seen, the original 43 third-class indexes, be reduction for 28 third-class indexes. They are as follows: politics theory level, scientific world outlook, ethics character, study attitude, work attitude, abidance by the school rules, public required course score, specialized course score, practical foreign language competence, computer application ability, social sciences knowledge, social work, social practices, art competition award, participation in sports activities, mental health condition, social adaptation, emotional coordination and control capacity, written capacity, oral communication capacity, independent problem solving capacity, hands-on capacity, self-study capacity, interpersonal communication capacity, teamwork capacity, organization and management capacity, technological innovation capacity.

42.4.2 Rough-ANN Model

According to result of index knowledge reduction, neural network use 28 input variables (i.e. input layer take 28 nodes), and the middle hidden layer take bigger, here

we take 65 nodes, the output layer for 5 nodes, the network structure is 28-65-5. Then, initialize the network (take the error limit $\varepsilon = 0.0002$, learning rate $b = 0.5$, iteration steps $M_0 = 20000$), Next, convert 28 indexes (the remaining indexes after knowledge reduction) of the 12 students (student S_1, student S_2, student $S_3, \cdots$, student S_{12}) to $[0,1]$ (each estimated value should be divided by 10). Then input processed data as the study sample data to the neural network, train the network by the improved BP algorithm, the network structure is automatically adjusted to 28-37-5 (28 input layer nodes, 37 hidden layer nodes, 5 output layer nodes) after training, at the same time we get optimize network weights matrix. The inference results (output) of the network study sample are shown in Table 42.2.

It can be seen from the Table 42.2, network inference results of the study sample and the actual results are exactly the same, which indicates the feasibility and effectiveness of the Rough-ANN model for college students' comprehensive quality evaluation.

Table 42.2 Network inference output

Student	Comprehensive quality condition	Sample output	Network inference output	Network evaluation result
Student 1	excellent	(1,0,0,0,0)	(0.9997,0.0223,0.0926,0.0659,0.0057)	excellent
Student 2	fine	(0,1,0,0,0)	(0.0023,0.9896,0.0069,0.0258,0.0045)	fine
Student 3	medium	(0,0,1,0,0)	(0.0023,0.9896,0.0069,0.0258,0.0045)	medium
Student 4	medium	(0,0,1,0,0)	(0.0156,0.2133,0.9324,0.0854,0.0576)	medium
Student 5	passing	(0,0,0,1,0)	(0.0037,0.0052,0.0029,0.9998,0.1462)	passing
Student 6	excellent	(1,0,0,0,0)	(0.9339,0.0085,0.0879,0.0562,0.0021)	excellent
Student 7	passing	(0,0,0,1,0)	(0.025,0.3451,0.0385,1.007,0.0032)	passing
Student 8	bad	(0,0,0,0,1)	(0.0461,0.0867,0.0346,0.0086,0.9358)	bad
Student 9	excellent	(1,0,0,0,0)	(1.0073,0.0521,0.0024,0.0745,0.0125)	excellent
Student 10	fine	(0,1,0,0,0)	(0.0471,1.0035,0.0239,0.1456,0.0086)	fine
Student 11	bad	(0,0,0,0,1)	(0.4667,0.3568,0.0051,0.0022,1.0001)	bad
Student 12	fine	(0,1,0,0,0)	(0.0643,0.0035,0.0142,0.0094,1.0021)	fine
Student 13	Measuring degree		(0.9967,0.0262,0.0013,0.0037,0.0126)	excellent
Student 14	Measuring degree		(0.0013,0.0337,1.0016,0.0069,0.0052)	medium
Student 15	Measuring degree		(0.0067,1.0021,0.0037,0.0591,0.0011)	fine
Student 16	Measuring degree		(0.0723,0.9915,0.0137,0.0031,0.0346)	fine

42.4.3 Evaluation of College Students' Comprehensive Quality

With the trained neural network, we evaluate the comprehensive quality of the students $(S_{13}, S_{14}, S_{15}, S_{16})$ of Sichuan University.

Use the method which is introduced in Sect. 42.3.4 of this paper, we get the estimated values of 28 third-class indexes(remaining index after knowledge simplify) of these students (student S_{13}, student S_{14}, student S_{15}, student S_{16}).

Then, convert these estimated values of 28 third-class indexes to $[0, 1]$ (each estimated value is divided by 10), put the processed data into neural network calculating, the output has been shown in the last 4 lines of Table 42.2. According to the maximum membership degree principle, and combined with college students' comprehensive quality comment set, we can find this 4 students' evaluation results are excellent, excellent, fine, fine. The results are in accord with the real condition.

42.5 Conclusion

With the analysis of requirement for college students' quality in this quickly developing society, and According to these principles of guiding, comprehensiveness, level, independence, practicability, a set of college students' comprehensive quality evaluation index system has been established. This index system reflects college students' comprehensive quality condition, and their difference in moral quality, intellectual quality, physical and esthetical quality, also it generally shows all the important content relative with quality-oriented education. On this basis, combined with Rough Set theory and ANN, we have established Rough-ANN model of college students' comprehensive quality evaluation, this model not only acquires the major feature attributes of college students' comprehensive quality, but also cancels redundancy information and reduces the costs of gather comprehensive quality evaluation information. At the same time, it reduces neural network's complicacy and train time, improves neural network learning ability, reasoning ability and classification ability, achieves a dynamic evaluation for overall level of comprehensive quality of students. The experimental results show that the model is feasible and effective, provides a new way for early dynamic warning of the risk of technological innovation. The experimental results indicates, the evaluation method established in this paper is scientific and effective, it can reflect college students' comprehensive quality correctly, and has considerable practical value.

Acknowledgements This research was supported by the education discipline of National Natural Science Foundation for Young Scientists, China, No. CIA110139.

References

1. Chen W (2012) College students' comprehensive quality state analyze and evaluation research. Jiangsu College, Zhen Jiang 13–33 (In Chinese)
2. Wang H, Li H, Jia P (2011) Scientific establish college students comprehensive quality evaluation system guiding personnel training. Chinese Adult Education (11):41–42 (In Chinese)

3. Wei Y (2013) Comprehensive quality evaluation model for college students based on fuzzy decision-making. Applied Mechanics and Materials 263(1):3453–3456
4. Wang Z, Sun J (2012) Research on the evaluation of the colleges and universities of physical education students' comprehensive quality with uncertain linguistic variables. Journal of Convergence Information Technology 7(14):412–418
5. Wang Y, Chen C (2012) Based on the agent students comprehensive quality fuzzy assessment expert system. In: Proceedings of the 2012 24th Chinese Control and Decision Conference 3132–3135 (In Chinese)
6. Xu M (2008) The design of college students comprehensive quality evaluation system. Shandong Teacher-Training College, Ji Nan 10–31 (In Chinese)
7. Zhao S, Wang D (2009) Reflect on college students' comprehensive quality evaluation system. Changchun Technician Aacademic Journal (Social Sciences Version) (4):624–626 (In Chinese)
8. Zhu M (2012) Explore college students' comprehensive quality in practice. Weaponry Industry Press, Beijing (In Chinese)
9. Zhang Y (2009) Thinking about evaluation system of completing college students' comprehensive quality. Science and Technology Information (15):141–142 (In Chinese)
10. Maden K, George DK (2006) A longitudinal assessment of college student engagement in good practices in undergraduate education. Higher Education 42(3):65–72
11. Stratta P, Daneluzzo E (2003) Subjective cognitive valuation in a university student population by cognitive failure questionnaire. Schizophrenia Research 60(1):159–160
12. Zhang W, Wu W, Liang Y (2001) Rough set theory and method. The Science Publishing Company, Beijing 35–55 (In Chinese)
13. Pawlak Z (1998) Rough set theory and its application. Cybernetics and Systems 29(1):661–688
14. Li L, Cheng H, Lu B (2002) Discover and research of data sketchy and rule based on bulge rough set. The Science Publishing Company Academic Journal 32(6):201–206 (In Chinese)
15. Zhang L (1995) Artificial neural network's model and its applications. Fudan College Press, Shanghai (In Chinese)
16. Han L (2002) Theory, design and application about artificial neural network. Chemical Industry Press, Beijing (In Chinese)
17. Tian J, Gao M (2006) Research and application about artificial neural network algorithm. Beijing Institute of Technology Press, Beijing (In Chinese)
18. Li X, Xu J (2002) Improvement the model of dynamically adjusted algorithm train BP neural network. Chinese Management Science 12(6):68–72 (In Chinese)