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The research of emergency managers' risk attitude based on genetic neural network

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Abstract: Since the 21st century, the sudden emergencies occurred around the world. The decision which emergency managers made in the emergency environment is actually a risk decision-making. And decision-makers will be affected by its risk attitude in the risk decision-making. The paper puts forward a kind of forecasting method of risk attitudes of emergency managers, which are influenced by various factors such as their own gender, age, training experiences, treatment experiences, actual average accuracy and self-confidence and so on. Based on the questionnaire results from Kunming and Wuhan, the above six factors were chosen as the input variables of the BP neural network model and the risk attitude values as the output variable. Genetic algorithm was used to optimize the weights and thresholds of the neural network and establish BP Neural network prediction model of emergency managers. The results of risk attitude value prediction show that the GA-BP is a more effective and accurate method to predict emergency managers' risk attitude, which can provide the reference for the risk managers' risk attitude prediction and more efficient management.

1. Introduction

In recent years, some of the sudden public events that are well known to the public are frequently erupted, which is no time to remind the human that sudden public events bring a lot of potential threats to people, and more and more emergency managers are in need to make appropriate decision in a short time. But the decision-making process is largely dependent on the individual judgment of the emergency manager. The decision-making of public emergencies is one of the important steps to deal with emergencies. It has special characteristics such as time urgency, high degree of uncertainty, social impact and centralized decision-making. These characteristics determine the decision-making behavior of emergency managers, especially decision-making attitude will be affected by a variety of factors.

In the genetic neural network established in this paper, the output variable is the risk attitude of the emergency manager. In general, the risk attitude is the choice of people when faced with uncertainty. In Kahneman and Tversky's Prospect Theor, three basic principles are proposed: (1) Most people are risk-averse when faced with "gains"; (2) Most people are risk-taking when faced with "loss" (3) People are sensitive to "loss" than "gains"[1]. Moreover, the characteristics of risk perception and risk behavior have been found in risk decision research. Weber, Blais, and Betz point out the significant differences in risk decisions in financial, health, entertainment, morality, and social, which is clearly reflected in the DOSPERT scale designed by Weber [2].

Many researchers at home and abroad are committed to the impact of risk attitude factors of decision-makers, that is, the input variables in the network. Hartog et al. (2002) found that there was a correlation between risk attitudes and personal traits [3]. Hu Xiao-xi and other studies have shown that women's executives decision-making behavior compared with men are more conservative and cautious [4]. The results of Croson and Gneezy's 2004 study also found that men and women were significantly different in risk-taking behavior [5]; According to Hambrick et al. (1984), age is an important factor influencing executives' risk attitudes [6]; Carlsson and Karlsson (1970), Vroom and Pahl (1971) have shown that older managers tend to taking less risky decisions [7]; Bantel and Jackson (1989) argue that higher qualifications of executives is more favorable to the company's strategic changes, etc.[8]. Bao Xing’s (2008) research shows that the risk attitude and the ability of the manager in the emergency management will affect the emergency cost and the operation cost, and there is an unclear correlation between them [9]. Russo and Schoemaker pointed out that experienced bridge athletes are more confident when bidding, but less inexperienced athletes often cannot win the bidding that they can win [10]. Grifin and Tversky (1992) find that people tend to be overconfident when answering questions that are extremely difficult [11].

Because the risk attitude of emergency managers is related to many factors, but not necessarily linear relationship, BP neural network model has a good effect in analyzing and dealing with nonlinear relationship, which can effectively show the relationship between input and output. However, in practical applications, the BP neural network shows the shortcomings of global network search ability, slow iterative convergence and partial optimal. By using the genetic algorithm to optimize the connection weight of the BP neural network model, the training speed of the BP neural network can be improved, and the network can overcome being trapped into the partial optimum.

2. Data Source and Index Selection

2.1. Data Source and Analysis of Questionnaire Reliability

The data sample of this paper is a questionnaire issued to emergency managers in Kunming and Wuhan. A total of 104 questionnaires were received, of which 98 were completed with all the experiments, and 3 questionnaires missing the second part of the questionnaire of the self-confidence measure of the experiment, 3 questionnaires missing the third part of the risk attitude coefficient of the experiment.

In order to ensure the reliability of the questionnaire and the consistency of the survey, this paper uses SPSS to analyze the reliability of the questionnaire. The data processing of the results is shown in Table 1 below:

Table 1. Reliability statistics

Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of items
0.744	0.605	11

Through its reliability analysis we can infer that the internal consistency coefficient of the questionnaire is 0.744, and the internal consistency coefficient based on the standardized item is 0.605, which indicates that the questions of the questionnaire can basically express the original intention and will not cause the ambiguity and the obtained data basically effective.

Table 2. Total statistics

	Removed average scale	removed scale variance	Corrected total correlation	The square of multiple correlations	removed scale Cronbach's Alpha values
Gender	10.3226	29.110	0.210	0.078	0.766
Age	8.5065	23.792	0.400	0.293	0.725
Marital status	11.2112	24.588	0.830	0.826	0.705
Education level	10.3511	13.672	0.926	0.969	0.605
Years of work	10.2889	13.041	0.926	0.969	0.608
Unit nature	11.0842	22.466	0.783	0.702	0.683
Job level	11.1231	23.309	0.847	0.821	0.690
Regularly attend the training	10.0402	27.885	0.014	0.081	0.762
Whether have been handled such incidents	9.8822	29.835	0.297	0.142	0.780
Actual average correct rate	11.1813	28.175	0.029	0.041	0.754
Self-confidence	10.7112	28.814	0.203	0.104	0.759

In this reliability analysis, we also found that the Cronbach's Alpha values after each variable have been deleted are above 0.6 that are greater than the critical of 0.5, indicating that the set of questions in the questionnaire has good internal consistency and can reflect the degree of measurement of the influence factors of decision-making quality of emergency managers and the relationship between self-confidence level and risk attitude. Therefore, this paper considers the design and results of the questionnaire to be effective.

2.2. Sample Description and Index Selection

The questionnaire consists of three parts, each of which tests the different aspects of the subject. In the first part, the basic information of the subjects' personal characteristics is tested. According to the relevant research at home and abroad, combined with the availability of data, this paper focuses on the subjects' gender, age, and whether they have received training. The second part tests subjects' decision-making behavior in four different types of emergencies. Emergency management field covers a wide range. In general, it can be divided into social security, natural disasters, public health, and accident disaster class. From the different sub-areas, whether the subjects have experiences in dealing with emergency, and the level of manager's self-confidence as well as the actual average accuracy can be obtained through the test. The third part tests the risk attitude of the subjects. With reference to Weber scale, this paper designed a table based on the emergency fields. In the test, γ is the risk attitude coefficient, and the value is in the range of (0,1). γ is equal to 1 indicates that the risk is neutral. The smaller the γ is, the stronger the degree of risk aversion.

In the three parts of the questionnaire, the previous two parts of the questionnaire served as input value of genetic neural network, and the third part of the questionnaire results served as output value for effective prediction.

3. Basic Principles of Genetic Neural Network

BP neural network optimized by genetic algorithm can be divided into three steps: determination of BP neural network's structure, weights and thresholds optimized by genetic algorithm, BP neural network training and prediction. Among them the topology of the BP neural network is determined by the number of input/output parameters of the sample, so that the number of parameters optimized by genetic algorithm can be determined. Then the coding length of the population can be determined. When the parameters of BP neural network are optimized by genetic algorithm, the weights and thresholds are known as long as the network structure is known. And the weights and thresholds of the neural network are usually determined by random initialization [-0.5, 0.5] interval of the random number. The initialization parameters has a great impact on the network training, but cannot be accurately obtained. For the same initial weight value and threshold, the network training results are the same. The introduction of genetic algorithm is to optimize the best initial weights and thresholds.

Genetic algorithm optimization of flow BP neural network is shown as below:

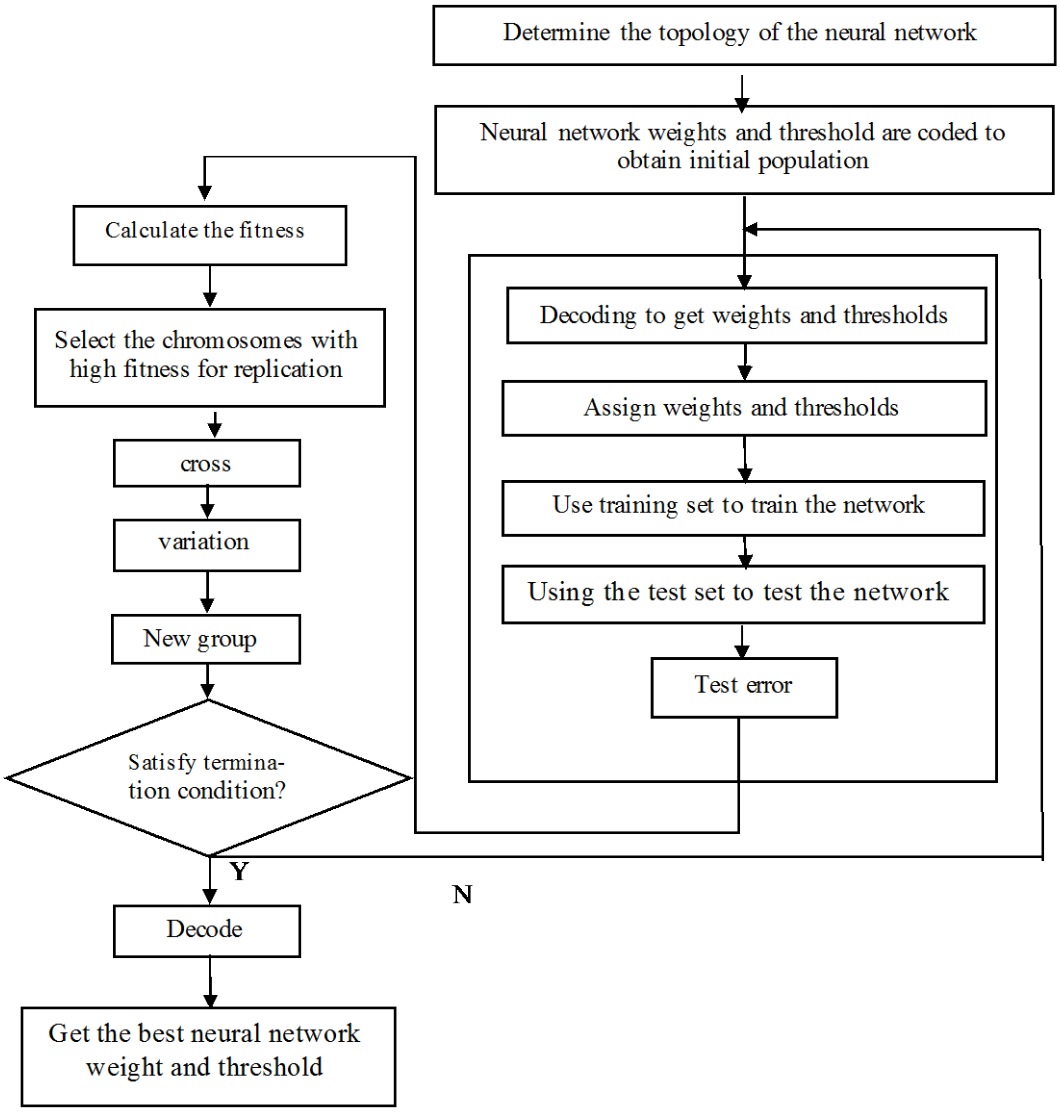

Figure 1. The flow chart

4. Predictive Examples Based on Genetic Neural Networks

In this example, we select the complete 208 datum, and the first 188 data are chosen as a training set, the last 20 data are served as a test set to predict. With gender, age, whether to participate in training, whether there is treatment experience, self-confidence level and the actual average accuracy is used as the influencing factor of the risk attitude of the emergency manager, and the risk attitude value is taken as the output value of the genetic neural network.

The establishment of the network topology is reasonable or not, which directly affects the accuracy, objectivity and adaptability of the network model. The determination of network topology generally includes network layer number, input layer, hidden layer, output layer and so on. In the GABP model established in this paper, the designing of network structure is based on the experience to determine the number of layers of the neural network, usually three layers.

(1) The number of input layers

Through the previous analysis, 6 evaluation indicators were identified, which were the gender, age, training experiences, treatment experiences, self-confidence level and the actual average accuracy of six. And each index corresponds to the neural network input layer of neurons, so the number of neurons in the neural network input layer is 6.

(2) The number of output layers

The final requirement of this paper is to predict the risk attitude of the emergency manager. The result of the final model output is the risk attitude value of the model. Therefore, the number of nodes in the output layer is 1.

(3) The number of hidden layer nodes

In the three-layer network, there are approximate relationships between the number of hidden layer neural networks and neurons in the input layer:

$$n_2 = 2 \times n_1 + 1 \tag{1}$$

In this case, there are six input parameters, so here is a value of 13, that is, there are 13 hidden layers.

(4) Other parameters set

The BP neural network's structure is 6-13-1, that is, the input layer has 6 nodes, the hidden layer has 13 nodes, and the output layer has 1 node, a total of 6 * 13 +13 * 1 = 91 weight, 13 + 1 = 14 thresholds, so the number of parameters optimized by genetic algorithm is 91 + 14 = 105. In other network parameter settings, the training times epochs = 1000, training goal = 0.01, learning rate lr = 0.1. The parameters of the genetic algorithm needed in the genetic neural network are shown in the following table:

Table 3. Other parameters set

NIND	MAXGEN	PRECI	GGAP	PX	PM
40	50	10	0.95	0.7	0.01

Running the GABP code, the resulting evolution curve and the training error curve are shown as below:

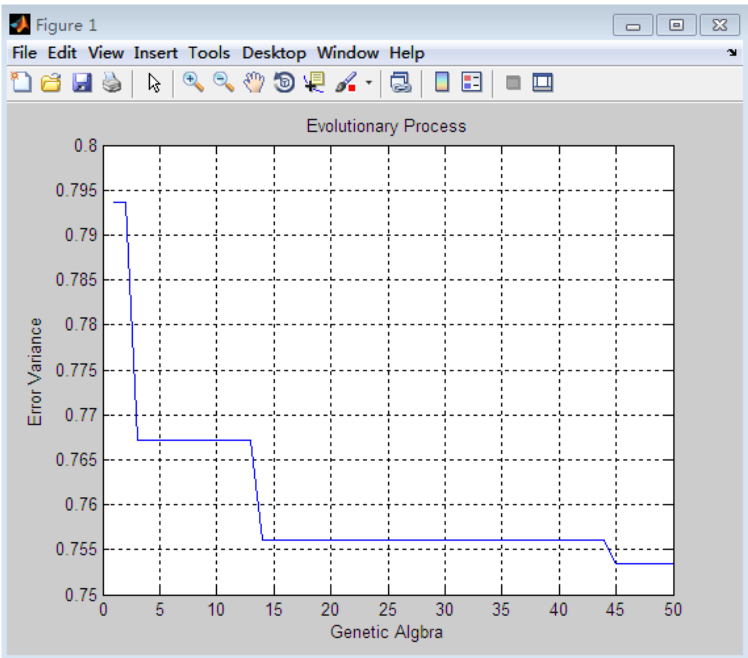

Figure 2. Evolution curve

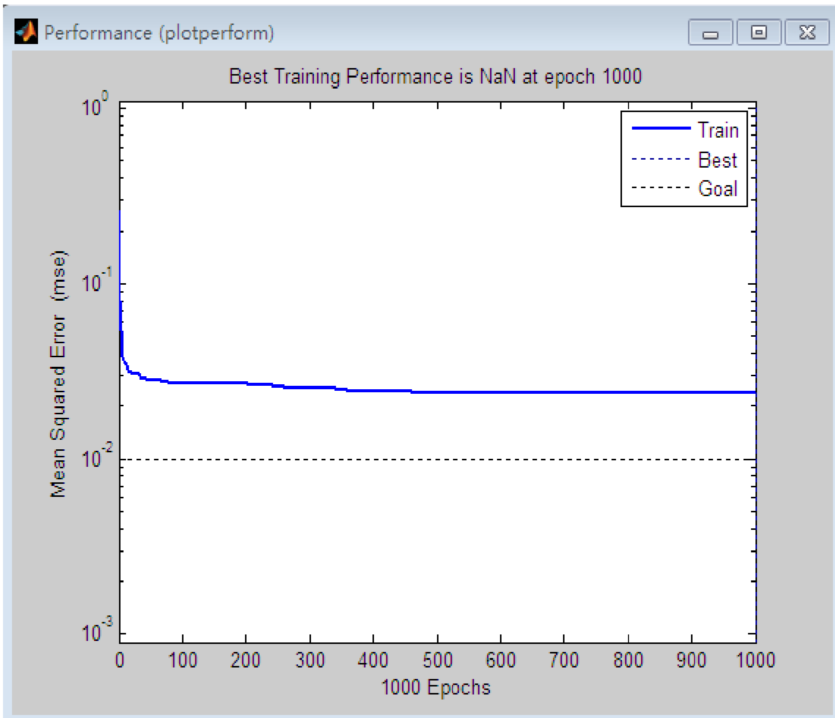

Figure 3. Training error curve

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1、The random weights and thresholds
Prediction of test sample:

Y1 =

  Columns 1 through 11

    0.6083    0.4791    0.5761    0.6467    0.6398    0.4620    0.4791    0.6529    0.4828    0.2266    0.7191

  Columns 12 through 20

    0.6448    0.3515    0.6448    0.6448    0.4465    0.4568    0.6801    0.7827    0.6945

The simulation error of test sample:1.0352
The simulation error of training sample:3.0422
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Figure 4. Test results using random weights and thresholds

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2、The optimized weights and thresholds
Prediction of test sample:

Y2 =

  Columns 1 through 11

    0.8198    0.7871    0.7926    0.6342    0.4866    0.8290    0.7871    0.6561    0.4603    0.0328    0.5542

  Columns 12 through 20

    0.4439    0.3569    0.4439    0.4439    0.5172    0.5802    0.5609    0.7925    0.5071

The simulation error of test sample:0.75345
The simulation error of training sample:2.1596
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Figure 5. Test results using optimized weights and thresholds

From the fitness function curve and the training error curve, it can be seen that the fitness function is not changed after the evolution of the individual 14 times, and the training error curve tends to be gentle soon. It can be also seen that the genetic algorithm improves the convergence speed and error precision of the BP neural network. The effect is outstanding.

From figure 4 and figure 5, it can be seen from the comparison of the two prediction results that the error of the test sample after optimization of the initial weight and the threshold is reduced from 1.0352 to 0.75345, and the error of the training sample is reduced from 3.0422 to 2.1596. The test results of BP network training and test sample have been relatively improved.

5. Conclusion

In the field of emergency, a risk prediction model based on genetic neural network is proposed to explore the influencing factors of current managers' risk attitude and its prediction. The neural network has strong self-learning, adaptive and fault tolerance, as well as connection weights and thresholds optimized by genetic algorithm, which can weaken the human factors in the evaluation, improve the accuracy and authority.

The prediction example also shows that the error of both training set and test set are produced by using genetic neural network to operate, indicating that the use of genetic neural network can significantly improve the neural network prediction accuracy. And the fitting effect is better than neural network, but also can solve the neural network exists into the partial optimal point and the slow convergence of the problem.

The prediction of the risk attitude of the genetic algorithm for emergency managers will effectively improve the management quality and efficiency of emergency managers. Because the gender, age training experiences, treatment experiences are easy to obtain, and self-confidence level and the actual accuracy can also be obtained through simple testing, so it can be predicted by genetic neural network. According to the forecast results we can understand the risk attitude of each manager and according to the different results we can select the appropriate positions and departments for each manager, so that people can do their best and give full scope to the talents.

6. Reference

[1] Tversky A and Kahneman D 1985 the Framing of Decisions and the Psychology of Choice. *Springer US*, **211**453-458

[2] Weber E U, Blais A R and Betz N E 2002 a domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors *Journal of Behavioral Decision Making*, **15**263–290

[3] Hartog J, Ferrer-I-Carbonell A and Jonker N 2002 Linking Measured Risk Aversion to Individual Characteristics *Kyklos*, **55**3-26

[4] Hu Xiaoxi 2015 Female executives involved in enterprise management will affect the earnings management of listed company’s decision-making it? *China Certified Public Accountants*, **5** 66-71

[5] Croson R and Gneezy U 2004 Gender differences in preferences. *Journal of Economic Literature*, **47**448-474

[6] Hambrick D.C. and Mason P.A. 1984 Upper Echelons:the Organization as a Reflection of Its Top Managers. *Academy of Management Review*, **9**193-206

[7] Carlsson G, Karlsson K 1970 Age,Cohorts and the Generation of Generations *American Sociological Review* **35**710-718

[8] Bantel K.A and Jackson S.E 1989 Top management and innovations in banking: Does the composition of the top team make a difference? *Strategic Management Journal* **10**107-124

[9] Bao Xing, Ji Jianhua 2008 Strong Management of Large Service Operation System Capability Considering Manager's Risk Attitude *Journal of Systems Management*, **18**555-561

[10] Russo J.E and Schoemaker P.J.H 1992 Management Overconfidence *Sloan Management Review/ Winter* **33**7-17

[11] Griffin D and Tversky A1992 The weighing of evidence and the determinants of confidence *Cognitive Psychology*, **24**411-435