Applied Mathematics Information Sciences
An International Journal

Evaluation of Water Conservancy Project Management Modernization Based on Improved intelligent algorithm

Yu-qin Gao[1,2], *Guo-hua Fang*[2], *You-peng Xu*[1], *Xin Zhang*[2] *and Li-jun Qu*[2]

[1]School of Geographic and Oceanographic Sciences, Nanjing University, Nanjing, China
[2]College of Water Conservancy and Hydropower, Hohai University, Nanjing China

Received: 20 Aug. 2012, Revised: 2 Dec. 2012, Accepted: 20 Dec. 2012
Published online: 1 May 2013

Abstract: An improved GA-BP Neural Network model for the evaluation of water conservancy project management modernization is established in this paper. It optimizes the initial weights and threshold of the improved BP neural network with the application of genetic algorithm. Depart from the ability of fast learning and global search, it can also effectively prevent BP neural network from getting into local minimum and obtaining unstable training results. An illustrative example, just as Taizhou Citation River, is analyzed to substantiate the reliability and rationality of the model with its actual water conservancy project management modernization data. Compared with other models, this model shows its superiority.

Keywords: modernization of water conservancy project management, genetic algorithm, improved BP Neural Network, GA-BP

1. Introduction

Water conservancy management is getting more and more attention in China considered as the infrastructure of national economical and social development. An systematic and scientific evaluation algorithm needs to carry the evaluation on water conservancy project management modernization besides an impeccable evaluation index system. Water conservancy project management is a complicated system engineering involving with management system, management method, management managers, exerting the social economic ecologic benefit and so on. Traditional evaluation methods such as expert evaluation method and commonly used composite index evaluation method can not accurately describe it [1,2]due to the complicated nonlinear relationship among the evaluation factors in the system. However, BP neural network has flaws of slow convergence rate and easily getting into local minimum. Xi-min Yuan and others combined genetic algorithm with BP neural network, and then used genetic algorithm to optimize BP neural network's initial weights and threshold [3]. They get good effects in the aspect of flood forecasting and atmospheric quality assessment. In this paper, GA will be used to optimize the improved BP neural network's weights and then the evaluation algorithm for GA-BP Neural Network of water conservancy project management modernization will be established.

2. Establishing the evaluation model of water conservancy management modernization based on improved GA-BP Neural Network

BP algorithm's training is based on the weight change principle of gradient descent errors, which inevitably causes the problem of getting into the local minimum. The genetic algorithm is adept to global search while it is weak in local accurate search. Consequently, the combination of genetic algorithm and BP algorithm can realize complementary strengths and will be conducive to better solve the problem [4,5]. According to guiding ideology mentioned above, the evaluation model is established according the fact of large- and middle scale water conservancy management in China.

2.1. Improvement of BP neural network

The adaptive adjustment of learning rate: the convergence properties and rate of BP algorithm largely depend on the

* Corresponding author e-mail: gyq_0909@163.com

learning rate η. The corresponding descent error of the network with the same initial weights will be different on account of different η. A larger η has to be selected as the initial value to train the network; if the network error is in a marked decline, keep the learning rate unchanged; if it indicates a gradual increase, reduce the learning rate by a certain proportion and continue to train. The discrimination of the network changing tendency should be conducted every certain number of training instead of every step. Momentum method: momentum method not only considers the function of the error in the gradient but also considers the impact of the variation trend on the error curve when modifying the weights of the network. Actually, it acts as a low-pass filter. According to the weight value formula of the steepest descent back-propagation algorithm, a value which is proportional to the previous weight regulating variable should be added to each weight regulating variable when the momentum filter realizes the change of parameters. The improved formula for BP momentum is described as formula 1:

$$\Delta\varpi(t+1) = \eta\frac{\partial E}{\partial\varpi} + m\Delta\varpi(t) \tag{1}$$

where: m is the momentum coefficient, and it usually varies between 0 and 0.9, η: learning rate, ϖ: momentum value.

Introduction of momentum leads the adjustment of weight to change toward the average of the bottom. It just indicates that the momentum item has the ability to buffer and smooth well in the network. Moreover, it also contributes to improve the stability of convergence process and adjust the network's convergence rate [5].

2.2. The initial weights used to optimize BP network with genetic algorithm

2.2.1. Chromosome encoding and the generation of initial population

Each chromosome in the initial weight population is generated according to the conventional methods with which neural network is used to generate the initial weights. Considering the number and feature of evaluation index of water conservancy project management modernization [6,7] chromosomes of the weight and threshold are coded with real-number which is generated between -1 and 1 randomly and uniformly. Normally, the population size P is as large as 200. Real number coding is a direct natural description of continuous parameter optimization problems, namely, the chromosome generates directly in the solution domain as a real vector. So, the genetic space turns into the problem space, and the chromosome reflects the characteristics and rules of the problem directly. In addition, the encoding becomes more flexible and convenient, there will be no encoding and decoding process. Moreover, real number coding can describe a larger region with high accuracy [8].

2.2.2. Fitness function

The design and learning of improved GA-BP neural network which is used to establish the evaluation of water conservancy project management modernization essentially is a multi-objective constrained optimization problem. It can be described as formula 2:

$$\begin{aligned}\min E(x) &= f\{x_1, x_2, \cdots, x_s\} \\ &= f\{w_1, w_2, \cdots, w_M, \theta_1, \theta_2, \cdots, \theta_K\}\end{aligned} \tag{2}$$

, where $E(x) = \sum_{t=1}^{q} (y_t - c_t)^2$.

It is willing to search out the network weight which makes square error of the network and to be the smallest in evolutionary generation. The network error in evolutionary generation is non-zero positive number, therefore the reciprocal of the objective function can be used as the fitness function. Fitness function can be described as formula 3:

$$F(x) = \frac{M}{E(x)} = \frac{M}{\sum_{t=1}^{q} (y_t - c_t)^2} \tag{3}$$

where, y_t and c_t are measured value and network output value of the sample respectively; $x_i (i = 1, 2, ..., S)$ represents a group of chromosomes, and it is also a corresponding weight; S is the length of chromosome and is the sum of all the weight value and threshold value. There are 34 secondary indicators in the evolution index system, and the number of neuron nodes in the hidden layer is identified by trial. The number of weights equals to the result of -equation $n \times p + p \times q$ and the number of offset values [9]; w_i is the i-th connection weight of network $(0 \le w_i \le 1, 1 \le w_i \le M)$; $\theta, (0 \le \theta \le 1)$is the j-th offset value of neurons offset value(threshold); M is the sum of the connection weights;

The connection weights of the neural network training include the connection weight w_{ij} between nodes of the input layer and the hidden layer, the connection weight w_{jt} between nodes of the hidden layer and the output layer, the neurons threshold θ_j on the hidden layer and the neurons threshold θ_t on the output layer, which deserves to be mentioned is that w_{ij} and w_{jt} are two-dimensional vectors. When solving the optimization problems with the genetic algorithm all connection weights must be turned into one-dimensional continuous vector and compile their numbers anew. Similarly, the connection weights that optimized with genetic algorithm must be transformed into w_{ij}, w_{jt}, θ_j and θ_t. Use formula 4 to complete the conversion [10]:

$$\begin{cases} x_{n(j-1)+i} = w_{ij} \\ x_{p(t-1)+j+np} = w_{jt} \\ x_{(n+q)p+j} = \theta_j \\ x_{(n+q+1)p+t} = \theta_t \end{cases} \tag{4}$$

where $i = 1, 2, ..., n$, $j = 1, 2, ..., p$,$t = 1, 2, ..., q$, n, p and q are the number of nodes on the input layer, the hidden layer and the output layer respectively.

2.2.3. Design of the genetic operators

The optimal reserved strategy and the random league are two main methods when choosing operators. The individuals in optimal reserved strategy do not participate in the crossover and variant operation, which have high fitness at present. Crossover operation is achieved by arithmetic crossover and the variant operator adopts uniform mutation. Variation operation is usually an effective mean of keeping the diversity of population [11].

3. Realization steps of algorithm

Step l: Use floating-point encoding to encode the chromosomes that are the connection weights of improved BP neural network. For a three-layer BP network, any complete set of weights W_i of neural network is $W_i, = \{\omega_{1,i}, \omega_{2,i}, b_{1,i}, b_{2,i}\}$, $i = 1, 2, ..., N$. It is equivalent to a chromosome. There 200 chromosomes like that, namely the population scale is 200.

Step 2: Generate the initial population randomly with the inter-cell generation method.

Step 3: Evaluate the individual performance according to the fitness function. The fitness function $f(x)$ is defined as the square of the objective function, it can be described as $f(x) = (E(X))^2$.

Step 4: Generate the offspring population from father population through operations such as selection, crossover and mutation.

Step 5: If the offspring population achieved the maximum evolution algebra or meet the set requirements of $E(x) = \sum_{t=1}^{q} (y_t - c_t)^2$, please decode the optimal individual. Then take it as the optimal initial weight of BP network and switch to the next step; otherwise, switch to **Step 3**.

Step 6: Set learning rate η, momentum coefficient m, allowable error ε and maximum training times N of BP neural network, and cycle step is set as $I = 1$.

Step 7: Put the standardization sample into network to train BP network and adjust the network weights, then calculate the output value of network and the total error $E(x)$.

Step 8: If $E \leq \varepsilon$, where ε is the accuracy of network training, then the training is over and switch to the next step; otherwise, take the connection weight optimized this time as the initial weight for next training, and adjust the network weight and offset value to switch to **Step 7**.

Step 9: Output the network connection weights that meet the training accuracy.

Step 10: Evaluate the level of water conservancy project management modernization of the object being evaluated, and calculate the results of evaluation.

The program flow chart of improved GA-BP artificial neural network evaluation algorithm for water conservancy project management modernization is shown in figure 1and it is realized with the application of MATLAB software.

4. Example analysis

Taizhou Citation River is located at the border of Yangzhou and Taizhou in Jiangsu province, and it is south from the Yangtze River and is connected with the New Tongyang Canal in north. The length is 24 km, the width is 80 m and the average excavation depth is 8m. Taizhou Citation River Water Hydro-junctio is a commonweal water conservancy project with comprehensive functions like irrigation, drainage, shipping, and with the main function of diversion, and the strategic project to develop ‘the eastern Jiangsu on the benefit of what cover the northern Jiangsu. It is also sea’ in Jiangsu province.

According to the current status of domestic water conservancy project management, The evaluation index system of water conservancy project management modernization is established after many discussions. The system is a third-grade evaluation index system consisting of 34 second-grade indexes and 9 first-grade indexes. the neural network model is built for water conservancy project management. evaluation based on the selected indexes which include 34 input layer nodes, 6 hidden layer nodes and one output layer node.

4.1. The results of improved GA-BP algorithm

Each dimensionless index of data sample is listed in Table 1 :dimensionless index of data sample.

C1= {0.93, 0.95 , 0.93 ,0.84 , 0.75 , 0.85 , 0.94 , 0.85 , 0.85 , 0.93}
C2= { 0.85 , 0.85 , 0.95 ,0.85 , 0.75 , 0.86 , 0.90 , 0.80 , 0.88 , 0.95}
C3= {0.94 ,0.95 , 0.95 , 0.94 ,0.84 , 0.80 , 0.91 , 0.75 , 0.90 , 0.92}
C4= {0.95 , 0.95 , 0.90 ,0.93 , 0.85 , 0.65 , 0.90 ,0.65 , 0.85 ,0.95}
C5= {0.94 , 0.85 , 0.85 , 0.95 , 0.94 ,0.95, 0.94 , 0.87 , 0.90 , 0.96}
C6= {0.85 , 0.95 , 0.91 , 0.92 , 0.85 , 0.85 , 0.90 , 0.85 , 0.90 ,0.94}
C7= {0.92 , 0.95 , 0.95 , 0.95 , 0.92 , 0.93 , 0.95 , 0.80 , 0.90 ,0.98}

C8= {0.85 , 0.85 , 0.95 , 0.91 , 0.85 , 0.80 , 0.90, 0.80 , 0.90 , 0.98}
C9= {0.93 , 0.95 , 0.93 , 0.95 , 0.93 , 0.80 , 0.90 , 0.83 , 0.85, 0.98}
C10= {0.95 , 0.95 , 0.95 , 0.65 , 0.85 , 0.65 , 0.85 , 0.75 , 0.75 , 0.95}
C11= {0.93 , 0.95 , 0.94 , 0.95 , 0.95 , 0.85 , 0.85 , 0.80 , 0.90 , 0.95}
C12= {0.95 , 0.85 , 0.85 , 0.93 , 0.85 , 0.85 , 0.85 , 0.75 , 0.85 , 0.92}
C13= {0.92 , 0.95, 0.85 , 0.85 , 0.84 , 0.75 , 0.85 , 0.75 , 0.90 , 0.95}
C14= {0.95 , 0.95 , 0.94 , 0.85 , 0.85 , 0.75 , 0.90 , 0.85 , 0.90 , 0.98}
C15= {0.94 , 0.95 , 0.95 , 0.88 , 0.75 , 0.65 , 0.88 , 0.80 , 0.90 , 0.95}
C16= {0.95 , 0.95 , 0.93 , 0.93 , 0.85 , 0.77 , 0.90 , 0.80 , 0.89 , 0.93}
C17= {0.95 , 0.85 , 0.95 , 0.88 , 0.85 , 0.75 , 0.85 , 0.87 , 0.85 , 0.95}
C18= {0.93 , 0.95 , 0.94 , 0.75 , 0.65 , 0.65 , 0.75 , 0.65 , 0.75 , 0.94}
C19= {0.85 , 0.95 , 0.90 , 0.90 , 0.94 , 0.85 , 0.90 , 0.80 , 0.90 , 0.98}
C20= {0.95 , 0.95 , 0.90 , 0.90 , 0.85 , 0.86 , 0.87 , 0.85 , 0.88 , 0.95}
C21= {0.92 , 0.95 , 0.90 , 0.90, 0.85 , 0.85 , 0.90 , 0.86 , 0.90 , 0.96}
C22= {1.00 , 0.90 , 1.00 , 0.85 , 0.90 , 0.90 , 0.94 , 0.80 , 0.85 , 1.00}
C23= {1.05 , 0.95 , 1.05 , 1.00 , 0.93 , 0.91 , 0.95 , 0.84 , 0.84 , 0.94}
C24= {1.00 , 1.00 , 1.00 , 0.90 , 0.90 , 1.00 , 0.90 , 0.78 , 0.90 , 0.95}
C25= {1.00 , 1.00 , 1.00 , 1.00 , 1.00 , 1.00 , 1.00 , 0.90 , 1.00 , 1.00}
C26= {1.00 , 1.06, 1.00 , 0.98 , 0.89 , 0.92 , 1.00 , 0.89 , 1.00 , 0.93}
C27= {1.36 , 1.19 , 1.00 , 0.88, 0.75 , 1.00 , 1.00 , 0.88 , 0.87 , 0.95}
C28= {0.94, 0.95 , 0.95 , 0.90 , 0.90 , 0.90 , 0.94 , 0.80 , 0.90 , 0.98}
C29= {0.94 , 0.90 , 1.00 , 1.00 , 0.89 , 0.95 , 1.00 , 1.00 , 0.84 , 0.96}
C30= {2.35 , 1.00 , 1.00 , 0.94 , 0.89 , 0.81 , 1.00 , 0.63 , 0.75 , 0.93}
C31= {0.33 , 0.81 , 1.00 , 1.00 , 0.50 , 0.50 , 0.50 , 0.50 , 0.94 , 0.95}
C32= {0.89 , 0.94 , 1.00 , 0.63 , 0.75 , 0.75 , 0.75, 0.57 , 0.90 , 0.94}
C33= {0.82 , 0.96 , 0.78 , 0.34 , 0.98 , 1.00 , 0.65 , 0.10 , 0.85 , 0.95}
C34= {0.93, 0.94, 0.95, 0.94, 0.93, 0.95 , 0.95, 0.85, 0.90 , 0.98}

Expected output (Value of evaluation) is {0.93 , 0.94, 0.94, 0.86, 0.87, 0.84, 0.87, 0.75, 0.88, 0.96 }.

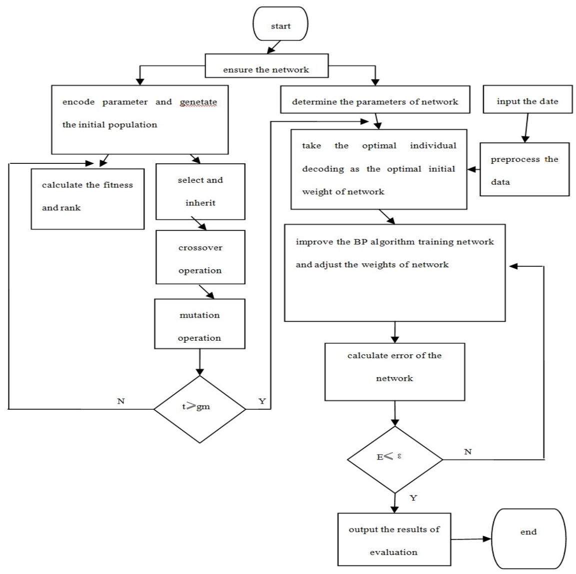


Figure 1 The program flow chart of improved GA-BP artificial neural network evaluation algorithm for water conservancy project management modernization.

Set the relevant parameters of improved GA-BP algorithm as follows: BP neural network parameters: $m = 0.9$; $l = 0.025$; $\eta = 0.8$; $P = 200$.

Genetic algorithm parameters: objective function: minimum sum of the squared error; the population scale $P = 200$; weights space initialization $b = [0, 1]$; selection probability $P_s = 0.05$; crossover probability $P_\varepsilon = 0.1$; mutation probability $P_m = 0.05$.

Train the data of sample and meet precision requirements after 64 steps learning. Error analysis is shown in Figure 2:

Invite 10 experts to give scores for the evaluation index system of Taizhou Citation River Water conservancy management modernization evaluation.There are fives grades that are excellent, fine, moderate, qualified, disqualified and the corresponding scores are $(0.9 - 1.0)$, $(0.8 - 0.9)$, $(0.7 - 0.8)$, $(0.6 - 0.7)$, $(0.4 - 0.59)$. According to conventional processing method, the results of transaction of the scores given by experts are shown as bellows:

The values of qualitative indexes of Taizhou Citation River Water conservancy management modernization evaluation index system

Criterion layer: Rationality and advancement level of water conservancy project management system:

Index layer and its value:

Index of accurate rationality of conduit unit classification qualitative, 0.95

Index of advancement and implementation degree of

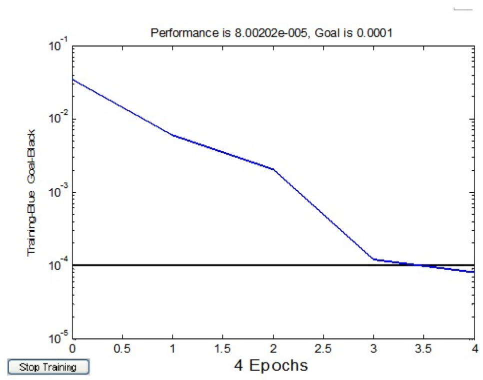


Figure 2 Error assay plan of improved GA-BP algorithm for Taizhou Citation River Water conservancy management modernization evaluation.

management and maintenance separation scheme, 0.85
Index of realization arriving of management personnel basic maintenance and safeguard funds, 0.95
Index of advancement of management mechanics(internal performance)C4, 0.95

Criterion layer: Normalization of water conservancy project management

Index layer and its value:

Standardized index of completement and execution of water conservancy engineering checking and monitoring system, 0.85
Standardized index of completement and execution of water conservancy engineering maintenance project management system C6, 0.95
Executive index of water conservancy project control scheme and the operating system, 0.95
Perfect index of all kinds of plans of water conservancy project, 0.85
Perfect index of all rules and post responsibility system of public administration, 0.95
Perfect index of mechanism of talents training and incentive technology, 0.95

Criterion layer: The level of automation and information of water conservancy project management means

Index layer and its value:

Index of water conservancy project management informatization, 0.95
Index of advancement of water conservancy project safe monitoring automatic system, 0.85
Index of advancement of brake-station engineering automatic monitoring system, 0.95
index of advancement of regime forecast and water conservancy project operating scheduling system, 0.95

Criterion layer: The level of legal environment of water conservancy project management

Index layer and its value:

Index of completement of management delimitation, 0.95
Perfect index of management according to the laws(the case of river-related construction project approval and the level of construction project management), 0.95
Index of quality construction force of water politics censorial personnel, 0.85
Index of public participation and public service degree of water conservancy project management, 0.95

Criterion layer: Operation level of water conservancy project security management

Index layer and its value:

Perfect index of Pre-arranged plan against water conservancy project accident, 0.95
Perfect index of report system, 0.95
Index of implementation of responsibility system(establishing a network with security officer), 0.95

And the scores of quantitative indexes are shown as bellows:

Quantitative indexes of Taizhou Citation River Water conservancy management modernization evaluation index system

Criterion layer: The extend of facilities in good condition and function reach the standard of water conservancy projects

Index layer:

Intact rate of engineering pipe (including observation facilities);Target value=100; Present value=90; Realized value=0.90

Rate of maintenance and curing; Target value=95; Present value=90; Realized value=0.95

Standardized rate of the ability of engineering design; Target value=100 Present value=100 Realized value=1.00

Criterion layer: The level of water ecological environment protection around water conservancy projects

Index layer:

Cleaning rate; Target value=100; Present value=100; Realized value=1.00

Green coverage rate C26; Target value=90; Present value=95; Realized value=1.00

Rate of the management of water loss and soil erosion; Target value=80; Present value=85; Realized value=1.19

Rate of water meeting quality standard in water functional area;Target value=100; Present value=100; Realized value= 1.06

Criterion layer: Performance of management and development of water management units

Index layer:

Efficiency of engineering operation; Target value=100; Present value=95; Realized value=0.95

Rate charge of water and other costs; Target value=100; Present value=90; Realized value= 0.90

Rate of resource utilization of land development; Target value=95; Present value=95; Realized value= 1.00

Rate of profit and loss of conduit unit business projects; Target value=8; Present value=6.5; Realized value=0.81

Criterion layer: The scientific and technological level of human resources and the reasonable degree of structure

Index layer:

Rate of adaptation to functional requirements of the business technology quality,structure and number of on-the-job personnel; Target value=90; Present value=85; Realized value=0.94 Proportion of junior college or above personnel Target value=50; Present value=48; Realized value= 0.96

According to the well trained network, the results of evaluation is gotten after inputting the values of dimensionless indexes. The actual output value of the model is 0.934. On the basis of evaluation standard of water conservancy project management modernization, Taizhou Citation River has basically realized the target of modernization.

4.2. Comparison with the output results and the training of classical BP algorithm

Calculate the sample in BP network with the same parameters and then accuracy requirement will be achieved after 104 steps learning (Figure 3).

According to the trained network, get the results of evaluation after inputting the evaluation index dimensionless values of Taizhou Citation River. The actual output value of model is 0.941. On the basis of evaluation standard of water conservancy project management modernization, Taizhou Citation River Water has basically realized the target of modernization .

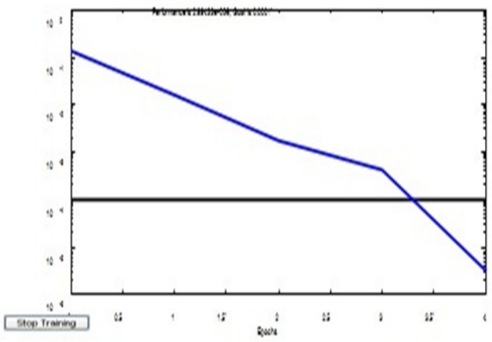


Figure 3 Error assay plan of BP algorithm of Taizhou Citation River water conservancy project management modernization evaluation.

5. Conclusion

The evaluation method of improved BP-GA neural network water conservancy project management modernization possesses good advantages such as global optimization, fast convergence speed, objective and accurate evaluation results. Genetic algorithm optimizes the initial weights and threshold in comparison with BP algorithm. It also solves the problem of unstable training results and reduces the possibility of getting into local minimum greatly. Water conservancy project management is a complicated system engineering involving with system, management method, management managers, exerting the social economic ecologic benefit and so on. It is a typical non-linear mapping problem with many indexes involved. Improved GA-BP neural network algorithm which is applied to water conservancy project management modernization evaluation can provide the evaluation values with specific output results. So it can supply managers with good decision support and has promising application prospects.

Acknowledgement

The paper is supported by the Fundamental Research Funds for the Postdoctoral of Jiangsu Province(Grant Nos. 1201004B). The author is grateful to the anonymous referee for a careful checking of the details and for helpful comments that improved this paper.

References

[1] YQ. Gao, GH, Fang, Chunhui Han etc. Joural of China Three Gorges University.44,2009(4).

[2] YQ, Gao, GH, Fang, XF Huang etc. Water Resources and power, 111, 2011 (2).

[3] XM Yuan. Applications of Neural Network and Genetic Algorithm in Science Fields. 2002.

[4] SL Kuai, HZ Zhang, Journal of Shenyang University. 43, 2006 (2).

[5] LQ Han. Theories, Chemical Industry Press. 2007.

[6] DY Zhang. Tsinghua University Press. 2006.

[7] GH Fang, YQ Gao, WX Tan etc. International Conference on Engineering Management and Service Sciences. 2009.

[8] JL Jin. Genetic Algorithm and It's Applications to Water Science [D]. 1998.

[9] KL Zhou, YH Kang. Model of Neural Network and It's MATLAB Simulation Program Designing [M]. 2005.

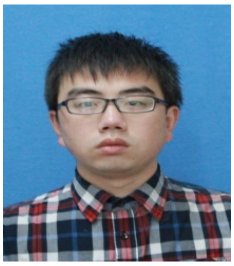
[10] WU Xiang-Hu, QU Ming-Cheng, Liu Zhi-Qiang. Appl. Math. Inf. Sci. 1-8, 2011 (4).

[11] Ning Zhang. Appl. Math. Inf. Sci.. 129 2012 (1).

Dr. Yu-qin Gao, female, born in 1978.She obtained her PhD from Hohai university (China). Now she worked at Postdoctoral Workstation of Nanjing University. She is an active researcher on evaluation of water resources and soil and water conservation of national development and construction projects as well. She has constructed a index system of water project management modernization based on the fact of China with her research team. Until then, she edited a total of 3 teaching materials or monographs, delivered more than 20 papers, including 1 in the SCI, 4 in the EI.

Fang Guohua, female, Han ethnic group, born in Anhui province in September 1964 is a professor and doctoral supervisor of Hohai University as an expert of evaluation of water resources and soil and water conservation of national development and construction projects as well. She is also a member of the special committee of planning and design of water conservancy in Jiangsu Provincewhich is a branch of Jiangsu Water Conservancy Association and playing a role in the special committee of water conservancy of Jiangsu Hydropower Association, engaging in teaching and scientific research of water planning and utilization, planning and optimization scheduling of water conservancy and hydropower system, water conservancy economyproject management and other relative aspects. Until then, she edited a total of 10 teaching materials or monographs, delivered more than 100 papers, including 3 in the SCI, 11 in the EI, and 80 in the Key Journal of China.

Xu Youpeng, Professor in hydrology, PhD supervisor. He was majoring in geography in college and graduated from Nanjing University in 1982, then obtained a master's degree in the Chinese Academy of Sciences in 1985, and he got his PhD in physical geography in Nanjing University. Since then, he has undertaken the teaching and research work in hydrology, water resources and water environment in Nanjing University, and hosteded or undertaken a number of national key research projects. He also obtained a number of influential achievements on the impacts of urbanization on hydrology, water resources and environment, water resources assessment and protection, basin flood control and sustainable water resources utilization in China, and won 4 scientific progress awards at provincial and ministerial level. He has published more than 100 papers in the core journals and written 4 books such as "the impacts of urbanization on drainage network and hydrological process in the Yangtze River Delta region". His main research fields include: Basin flood simulation and flood hazard mitigation, hydrologic effects of urbanization, the impacts of LUCC on hydrological processes, watershed ecology and water environment protection, the laws and carrying capacity of watershed hydrology and water resources etc.



Zhang Xin, Graduate student in water conservancy and hydropower engineering. He was majoring in water conservancy and hydropower engineering in the undergraduate stage at Hohai University from 2008 to 2012, then was admitted to the Graduate School of Hohai University in the autumn of 2012. Now his main research fields include: water resources planning and utilization.

Qu Lijun, Graduate student in water conservancy and hydropower engineering. She was majoring in water conservancy and hydropower engineering in the undergraduate stage at Hohai University from 2007 to 2011, then was admitted to the Graduate School of Hohai University in the autumn of 2011. Now her main research fields include: water resources planning, water conservancy modernization, and engineering management.