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## A New Genetic Algorithm and Its Application in Evaluating Chorus Course

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### Abstract

*Implementing course evaluation is an effective way to improve university course management level, and how to evaluate university course is one of the difficulties and hot research fields for the researchers related. The paper takes university chorus course evaluation for example and presents a new model for evaluating university course evaluation based on data mining technology. First an evaluation indicator system of university chorus course evaluation with three grades is designed; Second, aiming at the shortages of the existing BP neural network algorithm of data-mining for evaluating innovation education performance, genetic and BP neural network algorithm are integrated and some improvements are advanced to speed up the convergence and simplify the structure and to improve evaluating accuracy of the original BP model. Finally the model is realized with the data from three universities and the realization of the experimental results show that the model can improve algorithm efficiency and evaluation accuracy and can be used for university chorus course evaluation practically.*

**Keywords:** course management, chorus course evaluation, genetic algorithm, BP neural network

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### 1. Introduction

Colleges and universities shoulder the divine mission of training the successors with high quality and high esthetic sentiment. To strengthen the training of musicianship and quality of university students is the modernized, technological and humanized demand of education. As an important subject of art education, music is considered to an important subject, is the contents of life-long education, is the education contents of the entire society, and is the education contents of schools, especially institutions of higher learning, a holy place for the emergence of talents. Hence, study on the education quality evaluation of university music course has also become one of the research hotspots in the industry, the research contents of which include the study on evaluation system of university music course and evaluation method. This paper will take university chorus course as example to carry out the study on evaluation indicator system of university chorus course and evaluation method [1].

### 2. Literature Review

As for the study on current literatures of university course education, this paper mainly summarizes from such three perspectives as evaluation contents, evaluation principles and evaluation methods. □ At present, as for the course evaluation contents, scholars at home and abroad have a variety of views. Huang Puquan and etc. consider that the contents of course evaluation are teachers, teaching conditions, teaching implementation process and teaching effects [1]. And Yang Jing's views are teaching syllabus, teaching materials, teachers, lab construction, teaching process and teaching effect evaluation [2]. Zhao HongGuang thinks that the evaluation contents shall include course planning, teaching reform, imparting knowledge and educating people, teachers, teaching materials construction, teaching status, teaching effects evaluation [3]. Zhang Hongwei and etc. consider that the contents of course evaluation include teachers, teaching conditions, teaching quality and teaching management. □ Currently, as to the course evaluation principles, scholars at home and abroad also hold different views[4]. Professor Yu Jinghuai thinks that the principles to be obeyed for course evaluation of colleges and universities are to meet the education teaching law, combine scientificity with feasibility, combine qualitative indicators with quantitative indicators and combine basic indicators with

characteristic indicators [5]. Zheng Xiaomei's view is directionality principle, objectivity principle, typicality principle, comparability principle, quantification principle and feasibility principle [6]. As for evaluation methods, Analytic hierarchy process, Fuzzy comprehensive evaluation, Data Mining evaluation are three mainstream methods and in which BP neural network evaluation, as a typical data mining method, is most welcomed by the most researchers for its high evaluation accuracy and powerful data mining ability. But BP neural network algorithm is easy to be trapped into defects like local minimum, over-learning, strong operation specialization which limited practical uses in engineering evaluation [7-9].

In the specific evaluation process of university chorus teaching, this paper, as for evaluation contents, mainly focuses on teaching management, course construction, teaching conditions, teaching process, teachers and teaching effects; as for evaluation principles, launching from such four aspects as experts' evaluation, internal evaluation, self-evaluation and social evaluation, obtaining evaluation data by adopting the above principles as for the data selection of specific evaluation indicators; as for evaluation method, genetic algorithm improved with BP neural network algorithm for universities to evaluate its chorus courses is presented to overcome the question of slow convergence speed of BP neural network.

### 3. Evaluation Indicator System Design

In order to improve the scientificity of university chorus teaching evaluation, we shall embody the abstract evaluation objectives. Indicators are one of the stipulations of objectives; they are specific, measurable and operable objectives. Only the indicator system formed by several specific indicators of systemization and close connection can reflect the entire objective, reduce the possibility of evaluation discrepancy caused by the difference of evaluators' level, perspective and impression, decrease the subjectivity of evaluation, and increase objectivity. It is thus clear that the establishment of evaluation indicator system is the key to guarantee the unified criteria, justice and objectivity of evaluation. Therefore, this paper, while establishing university chorus teaching evaluation indicator system, focuses on such principles for choosing indicators as conformity to teaching objectives, direct measurability and comparability of objectives and an evaluation indicator system is constructed with 6 first-class indicators, 12 second-class indicators, 25 third-class indicators according to practical situation as the observation point of evaluation, as shown in Table 1.

Table 1. Evaluation Indicator System of University Chorus Course

Target Hierarchy	First-class Indicator	Second-class Indicator	Third-class Indicator
University chorus course evaluation	Teaching management	Teaching organization	Setting of training objectives Teaching syllabus
		Teaching implementation	Implementation of teaching contents Implementation of teaching management Teaching inspection Teaching evaluation Teaching supervision
		Teaching monitoring	Selection of chorus teaching materials Selection of chorus tracks Arrangement of chorus skills
	Course construction	Teaching contents	Design of teaching objectives Arrangement of teaching progress Construction of teaching venues Music teaching equipment
		Design of teaching documents	Interactive methods Teaching design Training method of chorus skills
	Teaching conditions	Teaching facilities	Chorus skill test Teaching ability
	Teaching process	Teaching methods	Teaching attitude Teachers structure Teachers training
		Teaching skill test	Students' Individual skills Chorus skills
	Teacher factors	Teachers' teaching	Music accomplishment
		Teachers construction	
	Teaching effects	Mastery of chorus skills	
		Music quality	

#### 4. Research Method

From the perspective of the characteristics of neural network BP and genetic algorithm, the training of BP algorithm is based on the weight modification principle of error gradient descending, inevitably having the problem of falling into local minimum point; genetic algorithm is good at global search, while insufficient in local accurate search. Therefore, the combination of making use of genetic algorithm to optimize the initial weight and threshold of neural network with using neural network algorithm to finally complete network training realizes the complement of advantages, beneficial for better solving practical problems [9].

##### 4.1. Specific Steps to Improved Genetic Algorithm with BP Neural Network

An ANN (Artificial Neural Networks) model can be described by the connecting method of finite parameters such as neuron, network layers, neuron number of each layer and neuron, weight of each connection and transfer function. So we can encode an ANN model and realize the learning process of neural network with genetic algorithm.

###### (1). Parameter Setting

Input population size  $P$ , network layers (not including input layer), neuron number of each layer. Genetic algorithm has excellent robustness towards the setting of these parameters; changing these parameters won't exert great impact on obtained results.

###### (2). Initialization and Evaluation

Randomly generate initial population  $P = (x_1, x_2, \dots, x_n)$ , any  $x_i \in P$  being a neural network weight, which is comprised of a weight vector and a threshold vector, weight vector being  $n$ -dimensional real vector,  $n$  being the number of all the connection weights, threshold vector also being  $n$ -dimensional real vector (not including neuron of input layer). Each network weight  $x_i$  is equal to a chromosome; there are  $N$  such chromosomes, i.e. population size. The neurons are numbered from the bottom to the top, from the left to the right (including input neuron).

According to corresponding neural network of randomly generated weight vector and threshold vector, as for the given input set and output set, calculate the global error of each neural network, as genetic algorithm can only evolve towards the direction of increasing fitness. So the fitness function can be formed according to Formula 1 and Formula 2, among which  $f_i$  is the adaptive value of the  $i$ th individual,  $i = 1, 2, \dots, N$  being the number of chromosome,  $k = 1, 2, \dots, n$  being the number of nodes of output layer,  $p = 1, 2, \dots, m$  being the number of learning samples,  $v_{pk}$  being the output value of the  $k$ th node while inputting the  $P$ th training sample,  $T_{pk}$  being the anticipated output value.

$$f_i = 1/E_i \quad (1)$$

$$E_i = \sum_{p=1}^m \sum_{k=1}^n (v_{pk} - T_{pk}) \quad (2)$$

###### (3). Selection Operator

This paper adopts the mass selection operator combining spinning roulette wheel strategy with optimal retention strategy. Selecting process takes the spinning roulette wheel as basis, which is a kind of playback random sampling method. All the selections are to select good individual according to individual fitness from current population in the light of certain criterion to enter the next generation population, the basic ideal of which is that the selective probability of each individual is equal to the ratio of its fitness to the individual fitness among the entire population. The higher the individual fitness is the greater the possibility to be selected is and the greater the probability to enter next generation is. However, due to random operation, the selection error of this method is relatively big, sometimes even making the individual with high fitness be selected. In order to improve the convergence of genetic algorithm, this paper adopts optimal retention strategy, selecting individual with the largest fitness as seeded player, directly retaining to the next generation. Substitute the worst individual in the population with the

optimal individual recorded by the preceding generation while forming new population every time, so as to preventing the individual with optimal fitness in current population from being destroyed.

#### (4). Selection Operator

Improved Adaptive Crossover Probability and Mutation Probability. In the parameters of genetic algorithm, the selection of crossover probability  $P_c$  and mutation probability  $P_m$  is the key to influence the behavior and performance of genetic algorithm, exerting a direct impact on the convergence of algorithm. In the simple genetic algorithm, as the values of  $P_c$  and  $P_m$  are constant, it is not efficient enough to solve multivariable complication optimization problems, having the problems of prematurity or misconvergence. Srinivas and etc. put forward adaptive genetic algorithm, AGA, the basic idea of which is that the individual with fitness higher than average fitness in the population adopts the smaller crossover probability  $P_c$  and mutation probability  $P_m$ , aiming at retaining individual with favorable structure so as not to be destroyed and to enter the next generation; as for individual with fitness lower than average fitness, using higher crossover probability and mutation probability to facilitate the elimination of such individual. Although this method is improved compared with simple genetic algorithm, there are still some problems. For example, while the fitness is close to the largest fitness, the crossover probability and mutation probability are; while equal to the largest fitness, the crossover probability and mutation probability are zero, which makes AGA undesirable in the early stage of evolution. As in the population of early stage of evolution, more optimal individuals are in an unchangeable state, and the favorable individual at this time is not always the globally optimal solution, which is easy to make the evolution tend to be locally converged [ 4]. Hence, this paper, based on this, adopts improved adaptive algorithm, making the individual crossover probability and mutation probability of largest fitness in the population be not zero, as shown in Formula 3 and Formula 4, in which  $f_{avg}$  represents the average fitness of population of each population;  $f_{max}$  represents the largest fitness in the population;  $f'$  represents larger fitness of two individuals to be crossed over;  $f$  represents the fitness of individual to be mutated in the population.  $P_{c1}$ ,  $P_{c2}$ ,  $P_{m1}$  and  $P_{m2}$  are design parameters, which are 0.9, 0.6, 0.1, 0.001 respectively.

$$P_c = \left\{ \begin{array}{ll} P_{c1} - \frac{(P_{c1} - P_{c2})(f' - f_{max})}{f_{max} - f_{avg}}, & f' \geq f_{avg} \\ P_{c1} & f \leq f_{avg} \end{array} \right\} \quad (3)$$

$$P_m = \left\{ \begin{array}{ll} P_{m1} - \frac{(P_{m1} - P_{m2})(f' - f_{max})}{f_{max} - f_{avg}}, & f' \geq f_{avg} \\ P_{m1} & f \leq f_{avg} \end{array} \right\} \quad (4)$$

Improved AGA not only keeps the adaptive advantage of AGA but also conquers the shortage of slow evolution of population in the early stage, having favorable optimization function.

Crossover Operator. First, in the population, according to the crossover probability  $P_c$  obtained in □, randomly select certain quantity of chromosomes as parents, and randomly select a breakpoint, exchanging the gene strand on the right (or top) of the breakpoints of parents, generating new filial generation; finally, substitute the paternal chromosome with filial generation chromosome, generating new population.

Mutation. Similar to the selection of paternal generation in crossover process, as for each selected chromosome to be mutated, in order to get better mutation, multiple mutation is permitted. While mutating, first randomly generate a vector with the same dimension as each weight and threshold of chromosome, and add to the selected vector to be mutated. As to the

result of each mutation, restore neural network and carry out performance evaluation. If the descendant is better than paternal generation, the mutation of paternal generation shall be ended; otherwise, carry out next mutation on paternal generation, until finding out descendant better than paternal generation.

#### (5). Immigration Operator

It is found through the test that in the search process of genetic algorithm, the individual with highest fitness in the population at present is possible to participate in crossover and mutation calculation, just with small probability; on the contrary, the lower the fitness of the individual is, the larger the probability to be selected to participate in crossover and mutation is, but the generated individual fitness is very low, and the global search performance on algorithm is not obviously increased. Therefore, this paper introduces immigration operator which is a good method to avoid prematurity. In the immigration process, it can only accelerate the elimination of bad individual, but also increase the diversity of solution, further meeting the evolutionary mechanism of creatures. Immigration operator eliminates the worst individual with certain elimination rate (generally 15%~20%) in the evolutionary process of each generation, and generates part of excellent immigrants to supplement the population.

Excellent immigrants here are mutated and generated through the multiple crossovers on those individuals to be eliminated. Thus, not only fully retain the good gene genetic pattern of paternal generation but also guarantee the diversity of population, improving the optimization searching performance of GA.

#### (6). End of Operation

If the network error meets the requirement or reaches certain evolution generations, the evolution shall be stopped and the evolution result shall be outputted otherwise, turn to Step (3).

### 4.2. Process of Improved Algorithm

The process of the improved algorithm can be depicted as follows.

- (1) Initial Population, including the population size and the initialization of each weight (generate according to the method for neural network to generate initial weight), and encode it;
- (2) Calculate the selection probability of each individual and sort them;
- (3) Select good individual to enter next generation population according to spinning roulette wheel selection strategy;
- (4) In the new generation population, select adaptive individual to carry out crossover and mutation operation according to adaptive crossover probability and mutation probability to generate new individual;
- (5) Insert the new individual into the population and calculate the fitness of new individual;
- (6) Immigration operator operation. Judge whether there is "prematurity phenomenon", if there is, immigration strategy shall be adopted and turn to step 2;
- (7) If the satisfactory individual is found, it shall be ended; otherwise, turn to 2.
- (8) After reaching required performance indicator, decode the optimal individual in final population, then the optimized network connection weight can be obtained.

### 5. Results and Analysis

Experimental data come from database of 30 Chorus teachers of Xian Conservatory of Music (referred to as XCM), and Central Conservatory of Music (referred to as CCM) and Shanghai Conservatory of Music (referred to as SCU) and 900 students from the same three universities. Limited to paper space, the evaluation of intermediate results is omitted here, only providing parts of (secondary) evaluation results and final comprehensive evaluation results, see table 2 and table 3, and in which the average evaluation results of the teachers of each university.

As for the performance of the presented algorithm, this paper also realizes the application of the ordinary BP neural network[9] and ordinary genetic algorithm [6], evaluation performance of different algorithms is shown in Table 3. In table 3 evaluation results of training effects of different students are selected and compared with artificial evaluation to calculate the evaluation accuracy. And the calculation platform as follows: hardware is Dell Poweredge R710, in which

processor is E5506, memory 2G, hard disk 160G; software platform is Windows XP operating system, C programming language environment.

Table 2. Evaluation Results of First Grade Indicators and Final Evaluation

	Teaching Management	Course Construction	Teaching Conditions	Teaching Process	Teachers	Teaching Effects	Final Evaluation
XCM	4.101	4.276	3.671	3.998	3.712	4.226	4.207
SCM	4.119	4.371	4.410	4.198	4.401	4.550	4.382
CCM	4.323	4.361	4.443	4.223	4.621	4.654	4.493

Table 3. The Application Performance of Different Algorithms

Algorithm	Algorithm in This Paper	Ordinary BP Neural Network Algorithm	ordinary Genetic algorithm
Accuracy Rate	95.77 %	88.66%	68.82%
Time Consuming(S)	16	571	24

## 6. Conclusion

The evaluation of university course education is a complicated and multi-factor system problem, the study on which has certain difficulty. So, this paper, on the consideration of actual characteristics of university chorus course, designs a set of evaluation indicator system of the course, and put forward a university course evaluation model based on improvement genetic algorithm according to the evaluation requirement of multi-factor complicated system. Test results indicate the engineering practicability of the evaluation model on university chorus course evaluation. Model in this paper is also applicable to different evaluation indicator systems established for different courses. Hence, model in this paper has universal applicable value. In the next study, we shall pay attention to the combination of generality with individuality of evaluation indicator system as well as the robustness of evaluation methods.

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