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Model and Scheme Design on Intelligent Test Study Composimg of English Based on Genetic Algorithm

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Abstract: English education has become an important part of the education system, aiming at the current situation which is complicated about test study composition of English; genetic algorithm can be used in intelligent test study composition and scheme design. First of all, analyze the property indexes affecting the quality of test study, establish the mathematical model and make a detailed description of the model constraints; Then, design the basic process of genetic algorithm based on the representation of the genetic algorithm and explain each step of the process; Finally, design scheme of test study composition, including coding scheme design, produce initial population, adaptation to the function, selection operator, crossover operator, mutation operator, Algorithm terminates and so on. The content of this study early found groups which satisfy the conditions, so that the studys not only meet then need of diversity but also has a higher effectiveness.

Key words: English test, intelligent test study composition, scheme design, test study composition model, genetic algorithm

INTRODUCTION

With the reform and development of the education system, English education has become an important part of the education system; it is also an indispensable part of the future diversification education of system development. Currently, many schools are lack of English exam system, only in study form. Some schools use the examination system, but provide an interface to let teachers entry only, before the exam, the examination questions library selected questions typesetting generated studys, then the teachers print out for students to test use. The efficiency and safety of such an exam system are improved, but other disadvantages did not change. The traditional way is time-consuming, intelligent test study composition is the development trend of the future (Zhang *et al*., 2011).

The intelligent test study composition use artificial intelligence technology, the computer automatically select questions from question bank which meet the requirements of the studys and it is not only one of the core objectives examination system intelligent or semi intelligent operation, but also an important part of computer assisted instruction. The system of intelligent test study composition first needs to call the corresponding test study strategy, and design the test mode which meet the user requirements and has certain constraints, then select questions of test study. The quality and efficiency of intelligent test study mainly depends on the algorithm of test study composition. How to design the algorithm out of the question which is fast and well meet the requirements of the test questions is a global optimization and fast convergence problem (Liu *et al*., 2009). The genetic algorithm has properties of adaptive global optimization and intelligent search, good convergence, it can effectively solve the problem of large amount of calculation and it is very suitable for dealing with the problem of automatic test study composition. The design model and the scheme of intelligent test study composition, provides the support for the system of intelligent test study composition.

MATHEMATICAL MODEL OF TEST Study COMPOSITION

According to the characteristics of the system, or the number of dependent relationship, Mathematical models use mathematical languages to summarize or approximately express a kind of mathematical structure, with the aid of mathematical symbols portrays the relational structure of the system. A mathematical model is a basic work for the group volume system.

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Property indexes affecting the quality of test study: According to the CTT (Classical Test Theory), property indexes affecting the quality of Test study includes the following five (Li *et al*., 2008):

Difficulty: It is the degree of difficulty when the examinee answer specific questions encountered, and it is divided by scoring rate as the basis, commonly expressed difficulty factor:

$$q_i = 1 - R_i / n \quad (1)$$

In the formula above, for question I, q_i is the degree of difficulty, R_i is the average score, n is the perfect score. The overall difficulty of studys is expressed as:

$$P = 1 - \overline{X}/W \quad (2)$$

In the formula above, P is the difficulty value for the studys, $\overline{X}$ is the average score of all students, W is the perfect score. When the examination study is for medium difficulty, scores normally distributed; when there is a difficult time, a peak in the low-scoring area, negatively skewed distribution; when it is not difficult, a peak in the region score was positively skewed distribution.

Discrimination: It Is the index to measure the test for different levels of examinee identification ability level, is a measure of the difference between the ability of candidates and it is represented by the degree of correlation between test results and questions results. The test with good discrimination, have strong ability to identify candidates with different levels. Related degree is higher, the higher the degree of differentiation, the group is more reasonable. Generally use the grouping method level, formula is as follows:

$$D = \left(\overline{X_H} - \overline{X_L}\right)/k \quad (3)$$

In the formula above, D is the discrimination, $\overline{X}_H$ and $\overline{X}_L$ Were high and low grouping in the test on the average scores k is the perfect score. Discrimination is between -1 and 1, the greater the better value. Greater than 0.4 indicates well, 0.3 to 0.39 shows better; from 0.2 to 0.29 shows very good need to be modified, under 0.19 indicates very unreasonable.

Cognitive level: Reflect the students' knowledge and ability to independently obtain. According to the cognitive goal from the low level to the sequence division advanced as memory, understanding, application, analysis, synthesis, evaluation and so on, there are some common in cognitive target in low level and less between high levels.

Reliability: Reflects the stability of the test results which is the credibility of test results by test scores and the actual level measurements. *X* means that test scores, *T* is actual level, then the test scores is the components from the actual level and absolute test error:

$$X = T + E \quad (4)$$

In the formula above, E represents the absolute test error. Thus the relative measurement errors can be drawn:

$$E' = (X - T)/T \quad (5)$$

As can be seen from the above equation, the bigger E' is, the larger the error between the test results and the actual level is, the lower the reliability of studys are; conversely, the smaller E' is, the lower the error between the test results and the actual level is, the larger the reliability of studys are

Validit: It is the test implementation measure target level and it also fits the test content and the test syllabus and syllabus. High validity test can accurately test the real situation of students to master and use of the knowledge and skills. The examination score validity is a very important exam in the design, according to the score to make inference or prediction accuracy. Validity is defined as:

$$r_y = \sigma_V^2 / \sigma_X^2 \quad (6)$$

In the formula above, σ_V^2 is the potential true score variance,

$$\sigma_X^2$$

is score variance that can be observed. In practical application, usually set an initial validity by experienced teachers according to the syllabus for each problem and then draw a validity based on the question situation. Each test validity because the exam continuous implementation needs to update and modify the system running test, after a period of time, each item in the library also obtained the practical validity, analysis of the principle of relative truth value set using the statistical validity, then get the value of each test validity.

Mathematical model of test study composition algorithm: Intelligent test study composition can be

described by mathematical models. To form a high-quality studys, there is need to satisfy the constraints, the examination time, the total score, the average difficulty, discrimination, questions proportional, ability level and so on. Each extract a test study questions the process, it is necessary to determine the parameters of the corresponding index. Judge the merits of the studys and fitness calculation is dependent on mathematical models (Chen and Lin, 2011).

In general, the organization of a study, it is usually to determine the value of the studys out, item difficulty, item number, distribution and knowledge levels of test parameters such as the ability to index. Combined with the actual situation of English exam, founded by nine core attributes of Intelligent Test mathematical model, constraints of a study into a nine-dimensional vector space:

Question (question number, scores, degree of difficulty, ability level, knowledge, questions, discrimination, answer time, frequency of use).

Question is decided by nine attributes, namely, by a 9 dimensional vector $(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9)$ the characteristics determine a Question. Thus, use matrix (n×9) for a set of n test questions studys:

$$S_g = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{19} \\ a_{21} & a_{22} & \cdots & a_{29} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{n9} \end{bmatrix} \quad (7)$$

Each attribute matrix satisfies the following constraints:

- Study total scores:

$$\sum_{i=1}^{n} a_{i2} = P$$

  P is requirements for the total score studys; the default is 100 points, personnel designated by the test study
- Study difficulty:

$$ND = \sum_{i=1}^{n} a_{i2}a_{i3} \Big/ P$$

  P is the total score studys
- Ability levels:

$$Z_j = \sum_{i=1}^{n} C_{i4}a_{i4}$$

  Z_j is the score of first j ability level, when $a_{i4} = j$, then $C_{i4} = 1$; when $a_{i4} \neq j$, then $C_{i4} = 0$. Each level includes the ability to understand, to grasp, flexible use and so on
- Knowledge points:

$$\sum_{i=1}^{n} C_{i5}a_{i5} = P_j$$

  P_j is the score of the first j knowledge points, Needs to be set by the user. If $a_{i5} = j$, then $C_{i5} = 1$; when $a_{i5} \neq j$, then $C_{i5} = 0$
- Question types:

$$\sum_{i=1}^{n} C_{i6}a_{i6} = M_j$$

  M_j is the test scores of j, Needs to be set by the user. When $a_{i6} = j$, $C_{i6} = j$, When $a_{i6} \neq j$, then $C_{i6} = 0$. At this stage of the English four levels of tests consists of six types, respectively, listening comprehension, reading comprehension, cloze test, error correction, writing and translation
- Discrimination:

$$\sum_{i=1}^{n} a_{i2}a_{i7} \Big/ P$$

  P is the study scores. Candidates will be obtained on each question scores from highest to lowest, divided into high and low groups. According scoring rate from high and low groups, obtain discrimination, discrimination of studys is each question of discrimination weighted average
- Answer time:

$$\sum_{i=1}^{n} a_{i8} = T$$

  T is the examination study answer time; the default is 120 minutes, designated by the test personnel

Test Study composition is essentially a multi-constraint optimization problem solving, the best conditions of the optimal solution is not unique. How to select the core constraint construction of test study

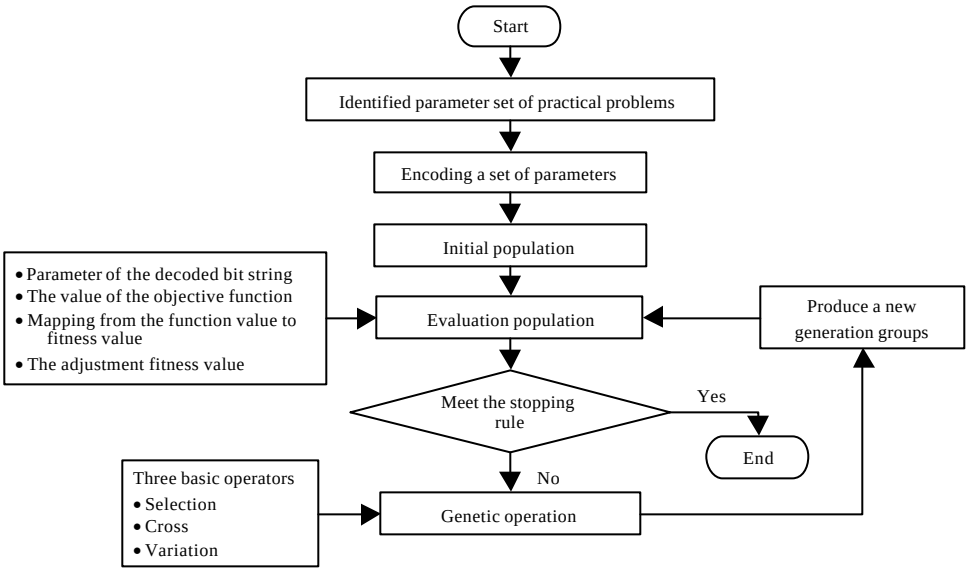

Fig. 1: Basic flow of genetic algorithm

model in numerous constraints is the key to design the test system. In addition, the construction of the test question also has an important impact on the system performance.

GENETIC ALGORITHM

Genetic algorithm is a calculation model which simulates natural biological evolution of the computing model, drawing on evolutionary reason perish by Darwin "natural selection, survival of the fittest" and the genetic theory of Mendel and it is efficient, parallel global search method. The solution process is from a number of feasible solution, from a population and then in accordance with the law and rules of crossover and mutation, genetic and natural selection of iteration to produce new individuals (New). The new individual joins the original population, in genetic iteration, until the optimal results (the best individual) comes. Optimal discriminated standard is determined by the limit of error allowed, when a new individual error is less than a given error, it is regarded as the optimal individual and genetic iterative stop. Because the genetic algorithm has parallelism, large amount of calculation problem of the model can effectively be solved (Li and Yan, 2010).

Representation of genetic algorithm mathematical: Use of genetic algorithms to solve the problem, it must be expressed as easy to handle form. Usually SGA (Simple Genetic Algorithm) expressed. SGA was defined as an 8-tuple.

$$SQA = (C, E, P_0, M, \Phi, \Gamma, \Psi, T) \quad (8)$$

C: Individual coding (binary symbol strings, arrays and other forms)
E: Individual fitness evaluation function. For different problems, the fitness function is defined differently
P_0: Initial population
M: Population size, the number of chromosomes in the population and generally 20-100, according to the actual situation to determine the exact number
Φ: Selection operator, SGA use proportional selection operator
Ψ: Controlled crossover frequency of use, in order to achieve the optimal solution of the most promising areas and generally use larger frequency
Γ: Control the use of frequency of mutation operator
T: Algorithm termination conditions, the general default termination evolution algebra 100-500

Genetic algorithm has a very wide range of application scope, dealing with problem in the form of complex and diverse. Different problems, fitness function, initialization of population, population size, encoding rules and stop optimized conditions are different, but the basic is the deformation of SGA representations.

Basic process of genetic algorithm

The basic process of the genetic algorithm is shown in Fig. 1 (Malekzehtab *et al*., 2013).

According to Figure 1, the basic steps of the genetic algorithm are as follows:

- **Step 1:** In the initial size of N group, each gene value of the chromosome use a random number generator to generate and meet the scope definition. The evolving algebra Generation = 0
- **Step 2:** Use evaluation function to evaluate all chromosome groups and adaptation values were calculated for each chromosome and then save the maximum fitness value chromosome Best
- **Step 3:** Use roulette selection algorithm to select groups of chromosomes operation, resulting in the same scale as N populations
- **Step 4:** Accordance with the probability P_c , chromosomes from the population were selected for mating. For each of the two parent chromosomes, make exchange part of the gene, resulting in two new daughter chromosomes, offspring chromosomes instead of the parent chromosomes into the new population. No mating chromosomes directly copied into a new species
- **Step 5:** In accordance with the probability of P_m, make a mutation operation to the new population chromosomal gene and gene numerical variation are changed. The mutation replaces the original chromosome in the new group, the one that do not mutated directly come into the new population
- **Step 6:** The mutation one replace the original population groups and recalculate the fitness value of each chromosome group. If the maximum fitness value of the group is larger than the Best fitness value, then the maximum fitness value replace the Best
- **Step 7:** The evolving algebra Generation plus 1, if Generation exceeds the maximum number or Best achieve the specified error requirement, the algorithm terminates, otherwise it returns Step 3

DESIGN SCHEME OF TEST STUDY COMPOSITION

Composition design involves the following seven areas:
Coding scheme: This study uses the natural number encoding scheme. Using direct coding questions in the item bank, each segment represents a type code independent and sections (Liang, 2011). The item number, composed of representatives of chromosome gene and a chromosome represents a test. The chromosome length is the number of questions in the test study. Because each test, the number of test questions can be different, so the chromosome use variable length coding method.

Generate the initial population: In order to improve the search efficiency of the algorithm, when it comes to the initial population generation, according to the test parameters on the topic quantity constraint demands from the test database, selected from the question bank in different types of test questions which agrees with the knowledge point range constraint questions randomly, will be selected for the number of chromosomes, the population size set generation several chromosome form the initial the population.

Assume that the initial population size is m, Initial one is TD and an initial population can be described as the following form:

$$TD = (a_1, a_2, \cdots, a_m) \tag{9}$$

In the formula, $a_i (i = 1, 2, \cdots, m)$ is the population in an individual and that stands for test studys. Genetic algorithm implementation process is set out from this group, in accordance with the rules of genetic evolution generations of evolution, finally find out the most qualified individuals, namely the optimal solution.

Design fitness function: To illustrate the adaptability of chromosomes, chromosome introduces a measure for a function called the fitness function. Genetic algorithm is to calculate the fitness function of the individual in the population is currently selected action probability, is an index of evaluation of the merits of the individual, also called evaluation function. How to set the fitness function directly affects the direction and genetic algorithm iteration convergence speed and ability to meet the objectives optimal solution. GA fitness function is not continuously differentiable constraints can be set area, in order to ensure good performance of the individual to adapt chance of being selected, the value of the fitness function must be non-negative, the design as simple as possible, so that calculations the time complexity of the minimum. In this study, design fitness function based on mathematical modeling of composition Algorithmic.
Select the operation: Roulette wheel selection is a kind of the calculation method based on "random", the basic idea is that the higher the fitness function value of the chromosome is, the greater the probability to be selected, but it can't guarantee the adaptability of the highest members will be able to go in the next generation, it just has the largest probability to be selected. When the initial population is n, individual fitness is F_i, the probability of individuals are selected to the next generation of group is:

$$P_i = F_i \Big/ \sum_{i=1}^{n} F_i \quad (10)$$

Use a piece of the pie chart, to show fitness scores about the number of n individuals in a population. Population in each group volume scheme (chromosome) specifies a small piece of the pie chart, the size of the block and is directly proportional to the fitness score, the higher the score, the group plan corresponding to the bigger area of pizza, in order to select a scheme would have to rotate the wheels, until the wheel stops, stopped where pieces of the above, the team selected its corresponding volume scheme.

Crossover operation: Each pair of screened individuals paired off, uniform crossover and the conditions on each of the individual will be used, namely two match each individual gene are set according to the crossover probability P_c. Ensure that the individual is still meaningful exchange, produce two new individual. Specific steps are as follows: Monitoring the two individuals to see if they have the same pairing Question. If so, then the respective retain the same question number and record the number of questions; if not, in addition to the same question number, for the individual genes of the two pairs of the different bits. Question, generate a random number r, between [0,1], if $r<P_c$ and meet the exchange condition, ensure that the exchange of each individual genes not to repeat after knowledge, the exchange of the gene on sequence, otherwise no exchange.

Mutation: Mutation operation is starting right from the partial adjustment of individual populations, effectively maintain the diversity of population and improve the local search ability of genetic algorithms, genetic algorithms to prevent premature stagnation (Oreski and Oreski, 2014). Regulations based on self-adaptive mutation probability P_m is:

$$P_m = \begin{bmatrix} b\times(f/f_{max}) & f < f_{avg} \\ b & f \geq f_{avg} \end{bmatrix} \quad (11)$$

In the formula, f_{max} is the maximum value of the function of group fitness, f_{avg} average of fitness function for the group, f is the larger individuals in the two cross-adaptation function values ,b is the probability coefficient, $b \leq 1$.

Mutation in two steps: First, for each individual in the population, produces a range of [0,1] length coding sequence of random strings $R = \{r_1, r_2, \cdots, r_k\}$ of length 1;then, for $r_i < P_m$, take the mutation operation i of Gene, Judge its section and the types of gene of the corresponding segment, the questions to be selected in item number range, a randomly generated test sequence, if the item number newly produced already exists in the code string, then regenerated; otherwise, the new sequence substitution test number of the original gene.

Algorithm terminates: The termination condition of genetic algorithm, in theory, is to find the optimal solution and the closest target value. Normally this optimal solution is not known, therefore, genetic algorithm in the actual application, must be set in advance good convergence criterion, to terminate the process of evolution, not endless evolution. The termination of genetic algorithm is usually given a maximum number of iterations, when evolution to the maximum number of iterations and may terminate the algorithm; or by determining the optimal population values ??for several generations had no obvious changes, may also terminate the algorithm.

CONCLUSIONS

Due to the diversity of English education level, learning mode and complexity of learning groups, it turn out that organization and management of the English exam is very heavy, so intelligent test study composition as an important research direction of modern education, is the effective way to solve these problems, is an important measure to realize teaching test scores form apart, it can promote the teaching reform and improve the teaching quality (Hou, 2005). Because the genetic algorithm implements the parallel global search, the search space is large and the search process to the optimal solution may contain the direction of adjustment of the search space, so it is easy to find the optimal solution. GA can effectively solve the problem of intelligent test study composition, compared with other methods, early found the group that meet the conditions and it meet the need of diversity of the examination study at the same time has higher effectiveness. This study studies the mathematical model and set design. Setting volume rationality and performance of the system and algorithm has yet to be in practice, there sill need to constantly improvement (Soares *et al*., 2013). In this study, intelligent test study composition is a sub-system of intelligent teaching system; the subsequent also need other subsystems in the research of intelligent teaching system, then form a perfect intelligent teaching system and provide a good teaching platform for students and teachers.

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