An English Test Paper Grouping Method Based on Improved Gray Wolf Algorithm

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Abstract
Aiming at the problems of slow speed, low success rate and uncontrollable quality of traditional English test paper formation method, an automatic test paper formation method based on improved Gray Wolf algorithm was proposed. Firstly, the mathematical model of automatic test paper formation is analyzed. Secondly, the traditional gray Wolf algorithm is improved to improve the convergence speed of the algorithm. Finally, the improved grey Wolf algorithm is applied to the English test paper composition problem. The experimental results show that the improved algorithm has higher success rate and better quality of test paper.

Keywords: *Improved Grey Wolf Algorithm; Test paper formation; English Test Paper.*

1 INTRODUCTION

With the popularization of computer and artificial intelligence in the field of education, how to use computer technology [1] to compose a reasonable test paper to meet the needs of users is a research hotspot in the field of computer-aided education. In particular, English is an important subject in college, and the English test for Postgraduate enrollment (hereinafter referred to as "Postgraduate English Test") is an evaluation of students' learning effect and learning ability. Compared with the traditional method of paper formation, computer automatic paper formation can improve the quality and efficiency of paper formation to a certain extent.

The traditional paper examination generally needs five steps: manual paper composition, examinee examination, manual marking, score evaluation and paper analysis. Among them, manual paper composition directly determines whether the test paper can reflect the examinee's level truly and effectively, so manual paper composition is the key link in the examination work. However, it often takes a lot of time and energy for the teacher to set up a test paper that meets the requirements, such as meeting the requirements of moderate difficulty and excellent differentiation. In addition, manual paper composition requires a lot of paper, paper papers after the examination can not be reasonably preserved and utilized, resulting in a waste of paper. So from the standardization and environmental protection of paper group work, manual paper group has been unable to adapt to the needs of modern examination. Therefore, how to replace the manual to set up a meet the requirements of the test paper, is the difficulty and focus of the work.

With the advent of information age and intelligent age, computer aided examination has gained extensive attention in many countries. For example, the foreign TOEFL test; The domestic computer rank examination, the motor vehicle driving license subject one and subject four theory examination, etc. These computer-aided tests can reflect the examinee's real level scientifically and fairly. This shows, by the computer to complete the work is effective. Computer group paper is under the guidance of intelligent paper group algorithm, the computer automatically selects the test questions that meet the requirements, and sets up the test papers that meet the requirements. In computing unit paper, reasonable intelligent paper formation algorithm can effectively guide the computer intelligent paper formation, so that teachers can really get rid of the tedious paper formation work, and spend more time and energy on teaching research, so as to improve the quality of teaching.

In the field of education in our country, the examination is the best way to check and fill gaps, but also one of the most commonly used ways, is Feedback on students' learning. In the past, in order to check their teaching results, teachers are independent Class teachers manually set questions, in the classroom to students circle

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focus, this will cause students to study before the test, test The results also tend to the ideal state of the teacher, but can not achieve the ideal detection effect on students, students to teaching Jong's response to the situation was also not very realistic. Therefore, the traditional examination volume way, has been unable to meet today. The need of rapid development, need to improve, and the current examination system still has more defects in the test bank, test questions extraction is not Meet the standards, the final generated papers are not reasonable and so on. In view of the above problems, introduce computer tools to supplement Help, use intelligent paper group algorithm, design online examination system. The application of computer technology will greatly reduce classroom teaching. The workload of teachers gives teachers more time to think about how to teach, improve work efficiency, and utilize Computer answer, the realization of paperless examination form, and then save manpower and financial resources.

In order to improve the quality of paper composition, many scholars have carried out research on it. Huo Xiaojing [2] proposed an automatic test paper formation strategy based on improved harmony search algorithm, which improved the level of test paper formation. He Jianying [3] et al. proposed an intelligent paper formation strategy based on genetic algorithm, which established a weighted objective function for the paper formation process and optimized the paper formation performance. Peng Yunjian [4] et al. used analytic hierarchy process (AHP) and support vector machine (SVM) to organize test papers automatically, which improved the efficiency of organizing test papers. However, when the number of test questions is large, the above methods will lead to lower quality and performance of the generated test papers.

Swarm intelligence optimization algorithm is an algorithm [5] that simulates the living behavior of social species in nature and can be used to solve engineering optimization problems. Among them, Mirjalili et al. proposed the Gray Wolf optimization algorithm (GWO) in 2014 [6] inspired by the hunting behavior of gray wolves, and realized the purpose of optimized search by simulating the hunting process of gray wolves searching, surrounding and attacking prey.

In order to improve the quality and performance of automatic test paper formation, this paper improves the traditional GWO algorithm, and applies the improved grey Wolf optimization algorithm to the automatic test paper formation process of the Entrance Examination English, so as to further improve the quality and efficiency of paper paper generation.

2 MATHEMATICAL MODEL OF PAPER - FORMING PROBLEM

Intelligent test paper formation refers to the automatic selection of qualified test questions by the computer according to the intelligent test paper formation algorithm according to the user-specified test paper formation parameters, such as test number, test difficulty and distinction. Therefore, to build a test paper composed of M questions, first of all, all the test attributes need to be considered. The core attributes of each test question include six aspects. It is assumed that A1 represents the question number, A2 represents the question type, A3 represents the question difficulty, A4 represents the question distinction, and A5 represents the question score.

In the postgraduate English test paper, there are four types of questions, which are cloze, reading comprehension, translation and writing.

For the first question, its core attributes can be represented as $(a_{i1}, a_{i2}, a_{i3}, a_{i4}, a_{i5})$. There are 9 questions (1 cloze test, 5 reading, 1 translation, 2 composition) in the test paper, and the whole question can be described by an objective matrix OM. Where a_{ij} represents the jth attribute of the ith question.

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{15} \\ a_{21} & a_{22} & \cdots & a_{25} \\ \cdots & \cdots & \cdots & \cdots \\ a_{91} & a_{92} & \cdots & a_{95} \end{bmatrix} \tag{1}$$

OM shall meet the following constraints:

(1) Total score of the paper: total score of the paper refers to the comprehensive score of each question in the paper. In the postgraduate English test paper, the total score is 100 points.

$$\sum_{i=1}^{m} a_{i5} = 100 \tag{2}$$

(2) Question quantity refers to the sum of all question types in the paper

(3) The difficulty of the paper: the difficulty of the paper depends on the difficulty of the questions in the paper.

$$D_p = C_p \sum_{i=1}^{m} \frac{C_{3i} a_{i3}}{N_p} \tag{3}$$

Assuming that e_i represents the error between the actual value of the ith constraint condition and the

expected value, F represents the objective function, and represents the weight of each constraint condition, then the objective function of the paper formation problem is:

$$\min F = \min(e_1\omega_1 + e_2\omega_2 + e_3\omega_3 + e_4\omega_4 + e_5\omega_5) \tag{4}$$

3 GREY WOLF ALGORITHM AND ITS IMPROVED STRATEGY

3.1 Basic Grey Wolf Algorithm

Gray Wolf Optimization (GWO) algorithm [28] is a new swarm intelligence optimization algorithm, which is inspired by the strict social hierarchy and predation behavior of gray Wolf populations in nature. The gray Wolf population in nature is divided into four grades, from the lowest to the highest order are α Wolf, β Wolf, δ Wolf, ω Wolf. α Wolf, β Wolf, δ Wolf are the gray Wolf leadership, and there is only one Wolf in number, which plays a leading and decision-making role in the hunting of wolves. The rest are ω wolves, which cooperate with the gray Wolf leadership to search for prey. The core of the algorithm is to make use of different positions of ω wolves in the process of hunting prey, and compare them with the positions of upper wolves, so as to give the upper wolves a better position, and finally achieve the purpose of optimizing. Supposing that there is N Wolf in the gray Wolf population and search in the d dimensional space, then the position of the i gray Wolf is $\boldsymbol{x}_i = [x_{i,1}, x_{i,2}, \cdots, x_{i,d}]^{\mathrm{T}}$. The specific algorithm is described as follows.

1) Prey location determination

In the process of hunting, the prey is closer to the gray Wolf leadership. Therefore, the ω Wolf can determine the prey position according to the position of the gray Wolf leadership, as shown in Equation:

$$\begin{cases} \boldsymbol{D}_\alpha = \left|\boldsymbol{C}_1 \cdot \boldsymbol{X}_\alpha(t) - \boldsymbol{X}(t)\right| \\ \boldsymbol{D}_\beta = \left|\boldsymbol{C}_2 \cdot \boldsymbol{X}_\beta(t) - \boldsymbol{X}(t)\right| \\ \boldsymbol{D}_\delta = \left|\boldsymbol{C}_3 \cdot \boldsymbol{X}_\delta(t) - \boldsymbol{X}(t)\right| \\ \boldsymbol{C}_i = 2 \cdot \boldsymbol{r}_2 \ , \ i = 1, 2, 3 \end{cases} \tag{5}$$

Where, $\boldsymbol{X}_\beta(t)$ $\boldsymbol{X}_\alpha(t)$ and $\boldsymbol{X}_\delta(t)$ are the position vectors of α Wolf, β Wolf, δ Wolf leadership; $\boldsymbol{D}_\alpha$, $\boldsymbol{D}_\beta$, $\boldsymbol{D}_\delta$ are the distance vector between ω Wolf and prey; $\boldsymbol{X}(t)$ is the current Wolf position vector; $\boldsymbol{C}_1$, $\boldsymbol{C}_2$ and $\boldsymbol{C}_3$ are coefficient vectors, respectively representing the search distance weights between ω wolves and α Wolf, β Wolf, δ Wolf. $\boldsymbol{r}_2$ is the random vector of the interval in $[0,1]$.

2) Grey Wolf position updated

When the positions of α Wolf, β Wolf, δ Wolf leadership are determined, the prey around the leadership should be rounded up, as shown in Equation:

$$\begin{cases} \boldsymbol{X}_1(t+1) = \boldsymbol{X}_\alpha(t) - \boldsymbol{A}_1 \cdot (\boldsymbol{D}_\alpha) \\ \boldsymbol{X}_2(t+1) = \boldsymbol{X}_\beta(t) - \boldsymbol{A}_2 \cdot (\boldsymbol{D}_\beta) \\ \boldsymbol{X}_3(t+1) = \boldsymbol{X}_\delta(t) - \boldsymbol{A}_3 \cdot (\boldsymbol{D}_\delta) \\ \boldsymbol{X}_4(t+1) = \dfrac{\boldsymbol{X}_1(t+1) + \boldsymbol{X}_2(t+1) + \boldsymbol{X}_2(t+1)}{3} \\ \boldsymbol{A}_i = 2a \cdot \boldsymbol{r}_1 - a \ , \ \ i = 1, 2, 3 \\ a = 2 \cdot (1 - \dfrac{t}{T_{\max}}) \end{cases} \tag{6}$$

Where, $\boldsymbol{X}(t+1)$ is the updated position vector of ω Wolf; $\boldsymbol{A}_1$, $\boldsymbol{A}_2$ and $\boldsymbol{A}_3$ are coefficient vectors, respectively representing the position distance weights between ω wolves and α Wolf, β Wolf, δ Wolf. $\boldsymbol{r}_1$ is the random vector in the interval [0,1]; $T_{\max}$ is the maximum number of iterations.

When the prey stops moving, the gray Wolf population will attack the prey in order to find the optimal value. When a, $\boldsymbol{A}$, $\boldsymbol{C}$ change occur in the corresponding interval, the gray Wolf population will update its position every iteration until it approaches and finds the prey (optimal value).

3.2 Improved Grey Wolf Algorithm

3.2.1 Tent chaos mapping

Tent mapping is a piecewise chaotic mapping function, and its mathematical expression is shown in Equation:

$$X_{n+1} = \begin{cases} \dfrac{X_n}{a} & (0 \le X_n < a) \\ \dfrac{1 - X_n}{1 - a} & (a \le X_n < 1) \end{cases} \tag{7}$$

Where: a is the constant of $[0,1]$. If $X_{n+1} > 1$, the return value of X_{n+1} is 1. If $X_{n+1} < 0$, the return value is 0.

3.2.2 Nonlinear control parameter strategy

To coordinate the global search capability of the algorithm and local development ability, a non based Sigmoid function Linear control parameter strategy is proposed.

$$a = a_{initial} - \frac{a_{initial} - a_{final}}{1 + e^{-10(\frac{1}{T\max} - \frac{1}{2})}} \quad (8)$$

4 INTELLIGENT PAPER GENERATION BASED ON IMPROVED GRAY WOLF ALGORITHM

The step of generating the paper based on Improved Grey Wolf Algorithm is shown as follows.

Step 1: Coding. The paper is coded with real number.

Step 2: The paper is initialized with tent chaos and the wolves represent the paper.

Step 3: The fitness function is calculated.

Step 4: The parameter a, A and C is are updated and the best location of the paper is found.

Step 5: All paper is updated with the parameter a.

Step 6: If the termination requirements are met, the optimal solution is output. Otherwise, go to Step 3.

5 EXPERIMENT

5.1 Data Comparsion Experiment

In order to test the performance of IGWO algorithm, two typical single-peak and multi-peak test functions are used and compared with GSA algorithm and basic GWO algorithm. The test function expressions are shown in Equations:

$$f_1(x) = \sum_{i=1}^{n} |x_i| + \prod_{i=1}^{n} |x_i| \quad (9)$$

$$f_2(x) = \frac{1}{4000} \sum_{i=1}^{n} x_i^2 - \prod_{i=1}^{n} \cos(\frac{x_i}{\sqrt{i}}) + 1 \quad (10)$$

The value range and optimal solution of different test functions are shown in Table 1, and parameter Settings of different algorithms are shown in Table 2.

Table 1 Test function

Fun	Name	D	Range	fmin
f_1	Schwefel	30	[-10,10]	0
f_2	Griewank	30	[-600,600]	0

Table 2 Parameter settings of different algorithms

Algorithm	Parameter
GSA	$Alpha = 20, G0 = 100, Rnorm = 2, Rpower = 1$
GWO	α goes linearly from 2 to 0. $r_1, r_1 \in [0,1]$
IGWO	α goes linearly from 2 to 0. $r_1, r_1 \in [0,1]$
	$c_1 = c_2 = 2, \omega = 0.5 + rand()/2$

The maximum number of iterations of the algorithm was set to 500, and the population size was set to 50. For the test function, when the number of iterations is constant, the average value can reflect the optimization accuracy of the algorithm, while the optimal value and standard variance can reflect the stability and robustness of the algorithm. In order to avoid the deviation caused by a single run result, the experiment separately ran the two test functions for 30 times, and summed and averaged the optimal value, average value and standard variance of each test function. The comparison of test function optimization results is shown in Table 3.

Table 3 Comparsion of optimization results of different test functions

Fun	Algorithm	Best	Ave	Std
f_1	GSA	6.56e-6	0.346	8.135
	GWO	9.23e-16	1.5632	5.346
	IGWO	5.63e-19	1.157	3.55
f_2	GSA	6.22e-6	1.56	10.74
	GWO	5.3211e-14	0.333	0.114
	IGWO	0	0.1125	0.002

5.2 Paper Generation Experiment

The environment of the experiment is shown as follows: Intel i7-4790, Windows 7 operation system, Matlab 2017b software.

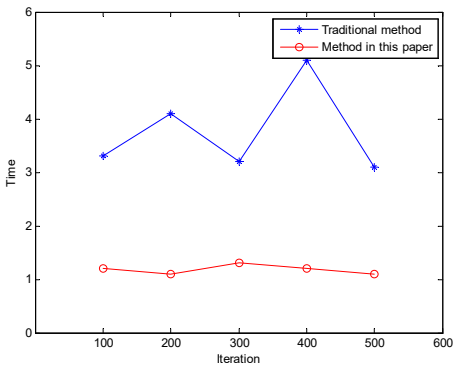

Figure 1 Time analysis

The result is shown in Figure 1. It can be concluded that the efficiency of paper grouping based on the Improved Gray Wolf Algotithm is higher than traditional algorithm.

6 CONCLUSION

In this paper, an improved grey Wolf optimization algorithm is proposed and applied to the automatic test paper formation problem of postgraduate English entrance examination. Firstly, the improved strategy is proposed, and then the intelligent test paper is tested under different parameters. The results show that the test paper generated by the improved grey Wolf optimization algorithm is of high quality. In the future, the algorithm can be applied to automatic paper formation in other subjects.

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