Ant Colony Optimization Algorithm In Occupational Skill Testing Management System

Peng Yinghui

Tianjin University of Technology and Education , Tianjin 300222

185125778@qq.com

***Abstract*—This project for vocational skills certification examination in different professions, different types and different levels has developed vocational skills certification exam management system. Using Ant colony optimization (ACO)algorithm intelligently make skills identification papers has solved the multi-objective problem; so determine vocational skills certification examination test of the different professions, different types, different levels of difficulty with normal distribution, meet different groups requirements of vocational skills certification examination.**

Keywords—Occupational Skill Testing, Auto make test, multi-objective optimization problem

I. INTRODUCTION

Currently, the education system is widely used intelligence test paper system, greatly reducing the workload of all types of users to solve many practical problems, and make test paper quickly, high efficiency, wide range of knowledge covered various kinds of questions papers, the moderate difficulty factor, test students practical skills has been the goal of educators.

Making Paper in vocational skills certification exam management system for a long time, slow is still a common problem, it can't meet the vocational skills appraisal assessment of needs. So automatic paper-making strategy based on ant colony optimization algorithm is proposed in the appraisal of vocational skills exam.

II. THE THEORETICAL FOUNDATION OF INTELLIGENT TEST PAPER

Any system has a certain index system, vocational skills certification exam is no exception, each of the indicators are for the automatic test paper, optimizing these indicators in system management also prompted to optimize the system. Intelligent Test Paper Index System:

(1) Paper types: due to different needs of different users, papers usually was set to 5 kinds of questions: fill in the blank, single choice, alternative-answer questions, multiple choice, integrated application.

(2)Test questions relevant section: there is a correspondence between the sections of the course and the exam questions.

(3) Assessment knowledge: knowledge must be the focus point of the syllabus requirements.

(4) Difficulty factor: difficulty of the questions are not the same with different examination objects. The difficulty factor is calculated as $Pi = 1-R_i/n$, wherein, R_i is score averages for the title, pi is the coefficient of difficulty of the questions i, n is the total values of the question. Different types of the measured object have greater impact factors on the difficulty factor, so that there are different types of test questions due to different objects. It is more difficult to scientifically determine the coefficient of nuclear, not only with reference to the equation given above, but also with the proposition staff years of teaching experience to adjust the difficulty factor. Fuzzy five levels listed in the following table 1.

Paper difficulty degree is generally controlled at about 0.5, a few controlled between 0.3-0.7, the concentration distribution of the papers presented was basically normal, test scores have been referenced[1]. As a vocational skills assessment test, it is related to the student's diploma and degree certificates, so difficulty to control is critical.

(5) Answer time: time to complete the questions is required, including most students do questions and checking questions.

(6) Exposure: The number of questions is used.

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III. FUNCTION MODULE INTRODUCTION OF VOCATIONAL SKILLS CERTIFICATION EXAMINATION MANAGEMENT SYSTEM

Vocational skills certification exam management system should be developed, it's made of function bellow.

(1) Personnel management module: user information, department information systems, a variety of roles Management. The system includes three roles of administrators and teachers and students.

(2) Paper management module: The main assessment according to outline requirements, set questions types, degree of difficulty and combine algorithm to make test paper, and edit, audit paper and other operations. It can be divided into two ways of manual and automatic making test papers.

(3) Test item bank management module: assessing the papers have always generated. System analysis and test cases based on these, and then information is corrected for the next examination to provide the conditions for automatic making papers.

(4) The examination module: to provide normal exam for the candidates, in order to reflect the fair examination, the function of the second remaking test paper is realized in the same paper.

(5) Scoring Management Module: to judge the candidate's papers, including automatic evaluation system and manual assessment, namely questions objective judgment and assessment of subjective question in two parts.

(6) Performance management module: the main provider of student scores query. In addition, managers can also view results, analyze, export performance and other operations.

IV. VOCATIONAL SKILLS CERTIFICATION EXAM AUTOMATIC TEST PAPER PROBLEM MATHEMATICAL MODELING

In automatic test paper algorithm of vocational skills certification exam, the paper provided N kinds of questions, the total is M, who answered the papers to be tested in T minutes, paper included n sections, each part of the test questions fractional ratio $n_1 n_2$ ..... n_n; papers should include m kinds of assessment of knowledge, questions fractional ratio contained in all kinds of knowledge is $m_1 m_2$ ..... m_m; the difficulty level of the questions in the exam contains P, each difficulty ratio of questions in generated papers $p_1 p_2$ ..... p_p; papers is made up of q kinds of questions, the score ratio of all kinds of questions is $q_1 q_2$ ..... q_q, specific mathematical models is shown as following formula (1) (formula (1) is end of this paper).

(1) The basic idea of ant colony optimization algorithm

Ant colony algorithm is similar as community search food process, ants looking for food process will continue to distribute pheromones, then the other ants on the trail after the ants can get to the pheromone, and re-select the path based on the obtained pheromone. Each ant distribute pheromone, to choose the path, and finally with the accumulation of information, through the collaboration between the multiple ants, ants can select an optimal path[2]. Throughout the algorithm, the most critical issue is the pheromone update.

As a heuristic search algorithm, ant colony algorithm to solve the optimal solution, but vocational skills certification exam test paper problem is a multi-objective to find the optimal solution, but also to ensure the item difficulty is moderate, not repetitive, covers a wide range of knowledge, therefore, in order to solve practical problems of the system, the existing ant colony algorithm to improve and optimize the accumulation of pheromone transfer from exposure (times of the subject is examed) to reduce questions examed over to increase the number of other questions , thereby increasing questions probability of being unselected[3].

(2) The ACO ideas and implementation

In vocational skills certification exam intelligent test paper based on Ant colony algorithm, each ant colony in a test database node moves from one node to another, constantly looking for a path, when all the ants are able to find a path correspondingly formed a set of papers. We can use an intelligent test paper process to diagram, suppose there are N item bank questions, the problem can be seen as a complete N nodes and N * (N-1) to the side of the diagram, denoted by G(V, E), where V represents the item pool of questions node (Test questions number), E represents the edge connecting nodes [2].

(3) The choice of the path of ants

At the current time, randomly generated M questions node and place the M ants, when everyone of ants will customize to select segment according to the amount of pheromone and heuristic factor of a given path, and move from one node down questions node. The procedure described above is repeated continuously, until the constraint condition is satisfied, ant at time t, ant k (k = 1,2, ... m)has transition probability P_{kij} (t) as follows formula (2) from node i (i = 1,2, ..., L) to node i+1 over the path of a [i,j].

$$Pkij(t)=\begin{cases}\dfrac{[Tij(t)]\alpha*[\eta ij]\beta}{\Sigma[Tij(t)]\alpha*[\eta ij]\beta} & \text{if } j\in Jk(i)\\ 0 & \text{else}\end{cases} \quad (2)$$

JK(i) represent ant k located i nodes is able to select a directed line segment combinations, η_{ij} represent ant to choose segment a [i,j] , α and β represent there is importance of factors of pheromone and heuristic in the line segment when ant k in the choice of the path.

(4) Pheromone is updated through continuous iteration, when M ants have found a path and indicate to find M feasible solution. This produces the optimal value in feasible solution M, if the optimal value better than the current, then update the optimal value, optimal solution updated, pheromones have to do the appropriate changes, and then, the ants K update the pheromone on its path in accordance with the formula (3):

$$T_{ij}(t+1)=(1-\rho)T_{ij}(t)+\sum_{k=1}^{m}\Delta T_{ij}{}^{k} \quad (3)$$

ρ (0 <ρ <1) is a [i,j] on evaporation coefficient of pheromone, $\sum_{k=1}^{m}\Delta T_{ij}{}^{k}$ indicates the pheromone increase of segment a[i,j] in this cycle ,that is to say, that ant k leave the amount of pheromone in segment a[i,j].

(5) Function Implement of the secondary test paper

In order to ensure the fairness of the online exam, the paper also uses a secondary test paper distribution mechanism, the original papers of the questions according to the kinds of questions randomly disrupted secondary reorganization distributed to candidates. This makes the content of the examination had the same to all candidates but with different order of items.

More important is the order of the candidates adjacent papers differ throughout the examination, in order to avoid plagiarism, and thus reflects the examination of the fairness

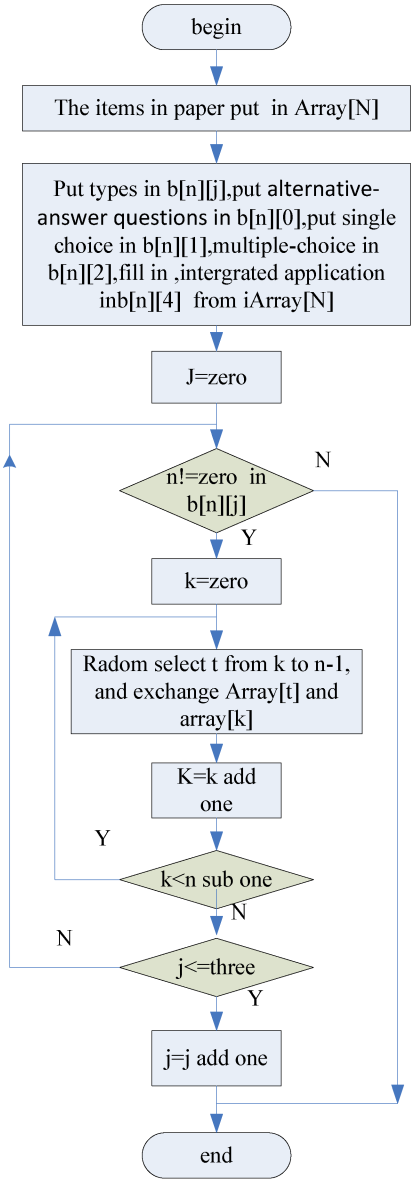

fig 1. Implementation of secondary test paper

and impartiality[4].

A paper is composed by the n test questions, it will disrupt the order of questions, the program flow chart is shown in fig 1.

(6) Questions about operating in handling formulas and charts

Especially machinery and automotive trades operating problems has a large number of charts in vocational skills identification papers, in order to allow users to browse fastly the contents of formula and icon of the chart, so try to onvert

charts and formulas and so on into JPEG or GIF format image files and uploaded to the exam systems in the design process, for this type of questions, add pictures fields into table when designing database, and image correspond to the subject each, the corresponding image will be selected when subject can be selected , the user can see and click original picture while browsing to thumbnails[5].

V. SYSTEM IMPLEMENTATION

In using Microsoft visual studio 2010 environment winform way, relying on the SQL Server 2008 back-end database management system to realize the different types of vocational skills certification examination question bank management system. Generating vocational skills identification papers, including mechanical turner, fitter machinery, automobile assembly workers, maintenance workers, and other types of editorial review. Wherein the test paper database has fill-in, single choice, multiple choice and integrated application 100 questions each, through specific simulation experiments and found that the improved ant colony algorithm can automatically generate moderate difficulty paper covering range of knowledge, student test scores is good using this papers.

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Table 1. Hierarchy of Difficulty

Hierarchy of difficulty	Easy	little Easy	Middle	little Difficult	Difficult
Range	0.0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0
Degree	0.1	0.3	0.5	0.7	0.9

$$C_{1(Ai1)}(x)=\sum_{Ai1(x)\in A11}A(xi):\sum_{Ai1(x)\in A12}A(xi):\ldots:\sum_{Ai1(x)\in A1n}A(xi)=n_1:n_2:\ldots n_n$$
$$C_{2(Ai2)}(x)=\sum_{Ai2(x)\in A21}A(xi):\sum_{Ai2(x)\in A22}A(xi):\ldots:\sum_{Ai2(x)\in A2m}A(xi)=m_1:m_2:\ldots m_m$$
$$C_{3(Ai3)}(x)=\sum_{Ai3(x)\in A31}A(xi):\sum_{Ai3(x)\in A32}A(xi):\ldots:\sum_{Ai3(x)\in A3p}A(xi)=p_1:p_2:\ldots p_p$$
$$C_{4(Ai4)}(x)=\sum_{Ai4(x)\in A41}A(xi):\sum_{Ai4(x)\in A42}A(xi):\ldots:\sum_{Ai4(x)\in A4q}A(xi)=q_1:q_2:\ldots q_q \quad (1)$$

Constraint condition: SUM=M ;Num=N;Time=T, best value $f(x)=\begin{cases}C_{1(Ai1)}(x)\\C_{2(Ai2)}(x)\\C_{3(Ai3)}(x)\\C_{4(Ai4)}(x)\end{cases}$

paper total constraint $M(x)=\sum_{i=1}^{n}ni(x)$; Test Time constraint $T=\sum_{i=1}^{n}ai$

paper degree of difficulty constraint $p(i)=\sum_{i=1}^{n}pi/n$