Improved Ant Colony Algorithm for Evaluation of Graduates' Physical Conditions

LI Yan-xia[1], Li Lin[2] ZhaoYang [1]

(1 Dept.of Physical Education,Lang Fang Normal University, Hebei Langfang 065000；2 College of physical education and sports,Beijing Normal University，Beijing 100875)

donghaizhang2013@163.com

Abstract—: **The ant colony algorithm to optimize the fitness test time arrangements, and original ant colony algorithm has been improved, the improved selection strategies and pheromone adjustment guidelines to effectively improve the convergence speed of reconciliation performance; final for instance using a computer to calculate, and achieved good program**.

Keywords- ant colony algorithm; selection strategy; pheromone adjustment guidelines

I. INTRODUCTION

Fitness test question refers to the time constraints of a specific project under the conditions of the test, a number of individuals seeking to complete all test items shortest total time required for the issue. This issue contains a free job machine scheduling problem is NP-hard [1-2], apparently, can only seek approximate solution. This paper describes the basic ant colony algorithm search strategies, and further improved ant colony algorithm is appropriate, an improved selection strategies and pheromone adjustment guidelines, after the colony to work together to find the optimal scheme of arrangement.

Ant Colony Optimization (ACO) studies artificial systems that take inspiration from the behavior of real ant colonies and which are used to solve discrete optimization problems. In 1999, the Ant Colony Optimization metaheuristic was defined by Dorigo, Di Caro and Gambardella.

The first ACO system was introduced by Marco Dorigo in his Ph.D. thesis (1992), and was called Ant System (AS). AS is the result of a research on computational intelligence approaches to combinatorial optimization that Dorigo conducted at Politecnico di Milano in collaboration with Alberto Colorni and Vittorio Maniezzo. It was initially applied to the travelling salesman problem, and to the quadratic assignment problem [3,4].

Since 1995 Dorigo, Gambardella and Stützle have been working on various extended versions of the AS paradigm. Dorigo and Gambardella have proposed Ant Colony System (ACS), while Stützle and Hoos have proposed MAX-MIN Ant System (MMAS). They both have been applied to the symmetric and asymmetric travelling salesman problem, with excellent results. Dorigo, Gambardella and Stützle have also proposed new hybrid versions of ant colony optimization with local search.

II. BRIEF OF ANT COLONY OPTIMIZATION

Each of the test in any order, the first $i\left(i=1,2,\cdots,m\right)$ term physical fitness test electronic equipment have $n_i\left(i=1,2,\cdots,m\right)$ units, a single instrument can have up to $k_i\left(i=1,2,\cdots,m\right)$ individuals tested simultaneously. Existing N individuals to perform physical tests, each completion of the first $i\left(i=1,2,\cdots,m\right)$ tests required for the project time $d_{ij}\left(i=1,2,\cdots,m,j=1,2,\cdots,n\right)$. then how to arrange all the individuals in the shortest time to complete all test items? Fitness test problem can be described with a picture: where vertex set $v=\left\{1,2,\cdots,m\right\}$ represents fitness test items; each vertex i has $n_i\left(1,2,\cdots,m\right)$ a vertices , each vertex can contain both the sub $k_i\left(1,2,\cdots,m\right)$ road;Arc set A total of m (m-1) N arcs; each arc represents the j on the right end of the project i personally do time $d_{ij}\left(i=1,2,\cdots,m,j=1,2,\cdots,n\right)$ the child vertex does not exist between the arc. Problem requires the N vertices loop including m tall, making the rights of each loop and the smallest. ant colony algorithm and its improvement [5].

A. Basic ant colony algorithm

Ant colony algorithm (ant algorithm) is an Italian scholar Marco Dorigo and put forward a bionic optimization algorithm[3], it absorbs the behavior of ants foraging behavior, through internal search mechanism to solve discrete combinatorial optimization problems shown in Figure 1. Participating in routing ants find food source, in its path through the ants release a unique secretion - pheromone (pheromone), so that a range of other ants able to detect such information and thus influence their future behavior; when some paths through the growing number of ants, which leave pheromone traces (trail) is also increasing, so that pheromone intensity increases, then select the path of the ants naturally the higher the probability, which adds to the strength of the pheromone of the path. This selection process

978-1-4799-3435-5/14 $31.00 © 2014 IEEE
DOI 10.1109/ICMTMA.2014.82

is called autocatalytic behavior of ants (autocatalytic behavior).

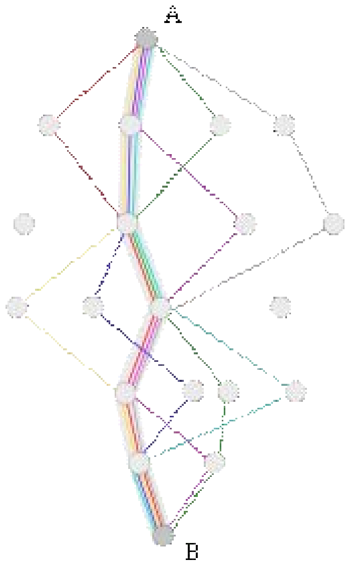

Figure 1 The illustration of Ant Colony Optimization

Ant colony algorithm is used to solve the initial travel VENDOR (TSP) Problem: The TSP problem is represented as a complete graph, where vertices represent cities; located in the ant colony number M, $d_{ij}\left(i,j=1,2,\cdots,n\right)$ between the vertices i and j, the path length; Let $B_i\left(t\right)$ at time t i the number of ants in the vertex, there $M=\sum_{i=1}^{n}B_i\left(t\right)$, $\tau_{ij}\left(t\right)$ represents the arc at time $t\left(i,j\right)$ the residual amount of information; initial time $\tau_{ij}\left(0\right)=C$ (C is a constant, usually taken as 0),Equivalent to the amount of information on each path is equal;ant $k\left(k=1,2,\cdots,m\right)$ in the movement process, according to the amount of information on each path determined transfer direction, ant k at time t from the vertex i to j with probability is

$$p_{ij}^{k}\left(t\right)=\frac{\left[\tau_{ij}(t)\right]^{\alpha}\left[\eta_{ij}\right]^{\beta}}{\sum\left[\left[\tau_{ij}(t)\right]^{\alpha}\left[\eta_{ij}\right]^{\beta}\right]},\ j\in \text{allowedk}$$

where allowed = {n-tabuk} represents the next step allows you to select the ant k vertices, tabuk record ant k through vertex, η_{ij} expressed by the vertex i to vertex j, desired degree. When $\eta_{ij}\rangle 0$, the neighborhood at the ant i moves according to the probability p_{ij} neighborhood j probability; when $\eta_{ij}\leq 0$, the ants do i neighborhood search, the search radius r; α,β denote ants during exercise, the accumulated information and heuristic factor. Let pheromones retention coefficient ρ (0 <ρ <1) <, it reflects the strength of pheromones persistence; while 1-ρ indicates the passage of pheromones degree. After Δt hours, ants complete one cycle,Each arc (i, j) to refresh the information on the amount of hormone formula

$\tau_{ij}(t+\Delta t)=\rho\tau_{ij}(t)+\Delta\tau_{ij}(\Delta t)$,There

$\Delta\tau_{ij}\Delta(\Delta t)=\sum_{k=1}^{m}\Delta\tau_{ij}^{k},\Delta\tau_{ij}(\Delta t),\Delta\tau_{ij}^{k}$ denote all m ants and ant k in this cycle Δt time the arc (i,j) amount of pheromone left. $\Delta\tau_{ij}^{k}$ The formula is

$$\Delta\tau_{ij}^{k}=\begin{cases}R/L_k, \\ 0,\end{cases}$$

If the first ant in this cycle through the arc (i,j),Wherein R is a constant, L_k ant k denotes the cycle in the path length traversed, that $L_k=\sum_{(i,j)\in tabu_k}d_{ij}$ 。

These various parameters appearing in the formula R, C, α, β, ρ test methods used to determine the optimal combination; $\tau_{ij}\left(t\right)$, $\tau_{ij}\left(t+\Delta t\right)$ and $p_{ij}^{k}\left(t\right)$ forms of expression can be determined according to the specific problem.

B. Improved Ant Colony Algorithm

In this paper, the following aspects of the basic ant colony algorithm [4-5] make improvements. Basic ant colony algorithm in the structure solution process, using probability random selection strategy. This selection strategy makes evolutionary slower. Feedback principle aimed at strengthening the better performance of the solution, but it is prone to stagnation and, therefore, this article from the selection strategies were modified: the use of deterministic and random selection strategy combining, and dynamically adjust the search process for determining sexual selection probabilities; when the search to a certain algebra, the search direction has been basically established, then appropriate to increase the probability that a randomly selected, in order to facilitate a more complete search solution space, which can effectively overcome the lack of basic ant colony algorithm. k at time t ant selects the next target, select the target in accordance with the following strategies

$$j=\begin{cases}p_{ij}^{k},q\leq q_0, \\ h,q>q_0,\end{cases}$$

The formula, h is allowed randomly selected target, q (0,1)

uniformly distributed random number, $q_0 \in (0,1)$; as the

search progresses, can dynamically adjust the value of q_0. This improvement can not only speed up the convergence, saving search time, but also to overcome premature stagnation behavior, help find a better solution, is conducive to solving large-scale optimization problems.

Ant colony algorithm reinforce positive feedback mechanism through better solution, but prone to stagnation into local optimal solution. To address this issue, we use adaptive pheromone method to dynamically adjust the allocation of pheromone. In the fall into local optimal solution, a path on the pheromone in the number of absolute advantage, so this paper pheromones were the maximum and minimum limits, such as the provisions $\tau_{ij}(t)_{\min} = 0.05,\ \tau_{ij}(t)_{\max} = 20$, the maximum limit to prevent a route pheromone concentration is too large, the minimum limit cannot prevent the search path traversed by the late pheromone concentration is too low, so that poor route is strengthened.

III. ALGORITHM AND EXAMPLES

Fitness tests using ant colony algorithm arrange the steps of:

Step 1 fitness test information into a chart;

Step 2 M ants randomly from the graph any vertex departure;

Step 3 ants choose the next state transition rules based on point, and ultimately back to the beginning, the formation of a viable circuit;

Step 4 to calculate the ants get a viable loop right and save the optimal solution, and according to the objective function, according to the guidelines for adjusting the pheromone each point to be adjusted;

Step 5 determines whether or iteration conditions (ie the set of iterations or minimum objective function), if satisfied, then the search is complete; if not satisfied, return to step 2, re-executed until it meets ICM.

Algorithm can be used in step 4 pheromone basic ant colony algorithm tuning guidelines, may also have improved ant colony algorithm pheromone adjustment guidelines.

IV. SIMULATION RESULTS

A fitness test, including height and weight, standing long jump, vital capacity, grip strength, and step test of five projects by electronic instrument automatically measure, record and store information; including height and weight measuring instrument has three sets, standing long jump, spirometry measuring instruments each one, grip strength test and measurement instruments each step 2, step test each instrument a test five individuals. There are 7 people (numbered 1-7) to take the test, carried out various projects, the average time required for the test are shown in Table 1.

Tab.1 Average time required to do different physical fituen tests (unit / second)

Number	Height and weight	Standing Long Jump	FVC	Grip	Step test
1	19.7	93	93	38	110
2	19.7	93	93	38	110
3	19	89	89	36.5	110
4	12	45	45	20	47
5	15	65	65	27.5	68
6	15	63	63	27.5	68
7	11	41	41	17.5	47

Using the basic ant colony algorithm, select the parameter α =10, β =10, ρ =0.8, the initial number of ants is 70, the maximum number of iterations is 100, 10 runs, runs approximately 50 seconds after the scheme of arrangement and the people waiting to get time table 2.

Tab.2 Test process of every person and waiting time (unit / second)

Number	Testing Process					Wait Time
1	4→	1→	3→	2→	5	153
2	3→	1→	2→	4→	5	96
3	1→	2→	4→	5→	3	72
4	2→	4→	1→	3→	5	89
5	3→	1→	2→	4→	4	24
6	4→	5→	1→	2→	3	117
7	1→	5→	3→	4→	2	43

Using improved ant colony algorithm, and select the same parameters, run about 38 seconds after the scheme of arrangement and the people to get the waiting time are shown in Table 3.

Tab.3 Optinal test process of every person and waiting time (unit / second)

Number	Testing Process					Wait Time
1	4→	1→	5→	2→	3	121
2	3→	1→	2→	4→	5	38
3	1→	2→	4→	3→	5	67
4	2→	4→	1→	3→	5	93
5	3→	1→	2→	4→	4	61
6	4→	1→	5→	2→	3	53
7	1→	5→	3→	4→	2	15

V. CONCLUSIONS

In this paper, original ant colony algorithm is proposed to improve the adaptive selection strategy, adaptive pheromone adjustment criteria, effectively overcome the original colony algorithm convergence speed, easy to be confined to local minimum defects. Examples show that the improved ant colony algorithm relative to the original algorithm, the convergence speed performance of reconciliation has improved to some extent.

REFERENCES

[1] Zhang Xiao, "An ejection chain approach for the generalized assignment problem," INFORMS Journal on Computing, 2001(5).(in Chinese)

[2] Li fang, "A new version of ant system for subset problems," Doctor Degree thesis. Wuhan, Hunan, China: Wuhan University. 2009.4. (in Chinese)

[3] C.W. Aardal. An ant colony optimization algorithm for the redundancy allocation problem (RAP). IEEE Transactions on Reliability, 2011, 39:201-225.

[4] D. Martens, B. Baesens, T. Fawcett . Editorial Survey: Swarm Intelligence for Data Mining. Machine Learning, 2011, 8:11-19.

[5] Wang mingming, Cheng Xin, Extended Ant Colony Optimization Algorithm for Power Electronic Circuit Design. Beijing: the book concern of Perking University, 2000.