New logistics distribution route dispatching mode based on genetic algorithm-ant colony algorithm

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Abstract

For multi-target route optimization with constraint conditions, the mathematical model for logistics distribution route optimization is built to accelerate response speed of logistics enterprises to customers, improve service quality, and strengthen the satisfaction of customers, and a new algorithm with the combination of genetic and ant colony algorithms is proposed to solve the selection issues of such logistics route. Initial pheromone is formed with genetic algorithm, based on which the optimal solution is rapidly sought with ant colony algorithm, and complementary advantages are achieved between above two algorithms. Application examples and simulations are available for calculation, and the results show that such algorithm is practical and effective to optimize logistics distribution route.

Keywords: logistics distribution, genetic algorithm, ant colony algorithm, combination, optimization

1 Introduction

Genetic Algorithm (GA) is a bionic optimization algorithm first proposed by John H. Holland, professor of University of Michigan in 1975. Which is based on Darwin's biological evolutionism of "survival of the fittest" and Mendel's genetic variation theory of "biological genetic evolution is mainly dependent on the chromosome on which the genes from parents are orderly arranged", and simulates the biological evolution process.

Ant colony algorithm is a newly-developed bionic optimization algorithm for simulating the intelligent behaviour of ant colony [1] proposed by Italian scholar Dorigo M in 1991, which boasts such advantages as strong robustness, excellently distributed computation mechanism and easy to combine with other methods [2, 3].

The improvement strategy that GA and ant colony algorithm are combined is first proposed by Abbattista F et al. [4]. And good results are obtained from Oliver30TSP and Eilon50TSP simulation experiments; later, the ant colony algorithm is combined with GA to solve various optimization issues in discrete and continuous domains with good application effects achieved. GA and ant colony algorithm are combined by Ding Jian et al. [5] to solve combinatorial explosion and NP issues with excellent effects with respect to optimal performance and time performance. The algorithm in this paper is aimed to conduct clustering analysis, i.e. GA is combined with ant colony algorithm, and the initial clustering centre for data object is established by virtue of rapid and random groupment global searching capacity of GA. The clustering structure is perfected based on such characteristics as parallelism, positive and negative feedback and high solution efficiency of ant colony algorithm.

2 Basic principle and design concept of combined algorithm

With wide-range rapid global searching capacity, GA will produce massive redundant iteration for solution to a certain extent, and fail to fully use feedback information in the system with low solution efficiency. Due to random distribution of initial data object, insufficient pheromone and slow solution speed, the ant colony algorithm requires a longer searching time, and is easy to produce premature stagnation phenomenon when large optimization issues are solved, as shown in the speed-time curve of GA and ant colony algorithm in Figure 1 [6]. GA boasts higher convergence speed in the early stage (t_0~t_a time bucket), but the efficiency after ta is significantly reduced. Due to the randomness of data and its movement, the searching speed of the ant colony algorithm is slow, but the efficiency is significantly increased after a certain period of time. The basic thought of genetic algorithm-ant colony algorithm is that GA-based rapid global searching capacity and ant colony algorithm-based positive feedback convergence mechanism. GA is adopted in the early stages. The basic thought of which is that GA is available in the process before the algorithm, and the rapidity, randomness and global convergence of GA shall be fully utilized to produce the distribution of initial pheromone for

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relevant issues. The ant colony algorithm is adopted in the process after algorithm, and under the condition that certain initial pheromones are distributed, the parallelism, feedback and high solution efficiency of ant colony algorithm shall be fully utilized to achieve exact solution. Such two algorithms complement each other's advantages so as to obtain best time and optimization performance.

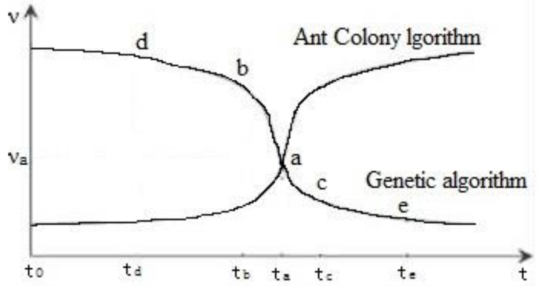

FIGURE1 Speed–time curve of GA and ant colony algorithm

2.1 ESTABLISHMENT OF LOGISTICS DISTRIBUTION MODEL

The goods are delivered from logistics centre to customers scattering in different geographic locations with various vehicles, in which the locations of logistics centre and each customer, customer demand, loading capacity of each distribution vehicle and maximum mileage are established for one distribution of each vehicle. It is required to reasonably arrange the distribution route of vehicle so that two object functions, i.e. total distribution distance and non-full load rate of distribution vehicle, can be optimized.

The following assumptions are proposed in the model Reference [7]:

1) the direction of goods is unidirectional, i.e. delivery only.

2) The loading capacity of each vehicle is limited and shall be greater than aggregate demand of customer in its transportation route;

3) With the demand of each customer known, required goods can only be delivered with one vehicle, and all customers shall be fully served.

4) With distances between distribution centre and each customer and between customers known, the maximum mileage of vehicle must be greater than the length of distribution route;

5) Each route is led from and to distribution centre;

The model building will involve the number of customers, customer demand, loading capacity of vehicle, number of vehicles and maximum mileage, etc. This Paper is based on the single object optimization model proposed in Reference [8], and specifies multi-target optimization model. For the sake of study, the following variable parameters are defined:

K: the number of vehicles in the distribution centre;
L: the number of customer points;
Q_k: loading capacity of vehicle, where (k =1,2,…,K);
D_k: maximum mileage of the vehicle;
Q_i: demand of customer points, where (i = 1,2, –L);
$d_{i\text{-}j}$: the distance between customer points i and j, wherein (i, j=1,2,...,L);
$d_{0\text{-}j}$: the distance between distribution centre and each demand point;
n_k: total number of customers served with vehicle k; when n_k=0, meaning k is not involved in distribution;
R_k: a set, which means the set of customer points served with vehicle k;
r_{ki}: an element of R_k in the set, which means that the sequence of such customer point in distribution route by vehicle k is i;
R_{k0}: distribution centre.

The optimization of logistics distribution vehicle route is such that relevant constraint conditions are met so as to minimize the total logistics distribution distance and maximize full load rate of vehicle. The model is as follows:

$$\min z_1 = \sum_{k=1}^{K}\left[\sum_{i=1}^{n_k} d_{r_{k(i-1)}r_{ki}} + d_{r_{knk}r_{k0}}\, sign(n_k)\right], \tag{1}$$

$$s.t.\ \sum_{i=1}^{n_k} d_{r_{k(i-1)}r_{ki}} + d_{r_{knk}r_{k0}}\, sign(n_k) \le D_k\,, \tag{2}$$

$$\sum_{i=1}^{n_k} q_{r_{ki}} \le Q_k\,, \tag{3}$$

$$0 \le n_k \le L\,, \tag{4}$$

$$\sum_{k=1}^{K} n_k = L\,, \tag{5}$$

$$R_k = \left\{ r_{ki} \,\middle|\, r_{ki} \in \{1,2,...,L\}, i = 1,2,...,n_k \right\}, \tag{6}$$

$$R_{k_1} \cap R_{k_2} = \varnothing, \forall k_1 \ne k_2\,, \tag{7}$$

$$sign(n_k) = \begin{cases} 1, (n_k \ge 1) \\ 0, (else) \end{cases}, \tag{8}$$

where Equation (1) means that the total target distribution distance is shortest; Equation (2) means that the length of each vehicle distribution route shall not exceed maximum mileage for one distribution; Equation (3) means that the sum of demand of each demand point on each vehicle distribution route shall not exceed its maximum loading capacity; Equation (4) means that the number of customer points on each route shall not exceed the number of total demand points; Equation (5) means that that each customer point can be better served; Equation (6) is the combination of customer points on each route; Equation (7) means that that each customer point is served with only one vehicle; Equation (8) is aimed to check whether vehicle k is involved in the distribution: if the number of customers served is ≥1, it means that vehicle k is involved, otherwise vehicle k is not involved.

2.2 STRUCTURE OF GA AIMING AT LOGISTICS DISTRIBUTION ROUTE OPTIMIZATION

GA is established to optimize logistics distribution route based on its characteristics.

1) Establishment of coding method: binary coding is adopted: "0" means distribution centre, and "1" means a customer ($L\times$"1" means L different customer(s)). Since the distribution centre is provided with k vehicle(s), there are k distribution routes at most, and each distribution route is led from and to distribution centre. L×"1"or K–1× "0" is randomly arranged in a chromosome (N+K–1 digit), which is corresponding to a distribution route scheme. For example, if 6 customers are served with 3 vehicles, the 8 characters, i.e. 6×"1" and 2×"0" (the distribution centre 0 from which the first vehicle is led is default for the reason that all vehicles are led from distribution centre) are randomly arranged to establish a logistics distribution scheme. There are 3 distribution routes in the distribution route scheme represented by chromosome 11011011: route a: (0) – 1 – 1 – 0; route b: 0 – 1 – 1 – 0; route c: 0 – 1 – 1 – 0.

2) Fitness evaluation: for the distribution route scheme corresponding to an individual, the advantages and disadvantages shall be judged: first, check whether constraint conditions for distribution are met; second, the object function value (i.e. the sum of each distribution route length) shall be calculated. According to the coding method determined based on the characteristics of distribution route optimization issues, the constraint conditions that each demand point can be better served with only one vehicle are met, and that the sum of demand of each demand point on each route shall not exceed the loading capacity of the vehicle, and the length of each distribution route shall not exceed the maximum mileage for one distribution are not met. For this reason, Equation (2) is converted into a part of transportation distance as follows Equation (10):

$$Z=\sum_{k=1}^{K}\left[\sum_{i=1}^{n_k} d_{r_{k(i-1)}r_{ki}}+d_{r_{knk}r_{k0}}\,sign(n_k)\right] +M\sum_{k=1}^{K}\max\left[\sum_{i=1}^{n_k} q_{r_{ki}}-Q_k,0\right], \quad (9)$$

where M is a large positive number, which means when the volume of freight of a vehicle exceeds the penalty coefficient of its maximum loading capacity, M is 1000000 in software design. The transportation distance is converted into fitness function: $F_i=\frac{\min z}{z_i}$, where F_i is the fitness of the i-th chromosome, min z is the target value of optimal chromosome in the current colony, and z_i is the target value of the i-th chromosome.

3) Selection operation: N individual(s) in the colony of each generation is arranged from big to small by fitness, and the individual ranking No.1 boasts optimal performance, and is copied to directly enter into the next generation and ranks No.1. N–1 individual(s) in the colony of next generation shall be produced with roulette wheel selection method [4] based on the fitness of N individual(s) in the colony of former generation. Specifically, it shall first calculate the sum (ΣF_j) of fitness of all individuals in the colony of former generation, and then calculate the proportion ($F_j/\Sigma F_j$) of fitness of each individual as the selection probability. With such selection method adopted, the optimal individual will survive to next generation, and the individual with larger fitness may have a greater chance to survive to next generation.

4) Crossover operation: for new colony produced from selection operation, N-1 individual(s), in addition to optimal individual ranking No.1, will be mated, crossed and reorganized based on crossover probability P_c. A crossover method similar to OX method [2] is adopted as follows:

a) randomly select a mating area in the parent individual, e.g. two parent individuals and mating areas are selected as A = 478563921, B = 834691257;

b) A′=4691478563921 and B′=8563834691257 that are obtained by putting B mating area in front of A, and A mating area in front of B;

c) the natural numbers identical to mating area in A′ and B′ shall be deleted in order after mating area so as to obtain two final individuals, i.e. A″=469178532, B″=856349127. Compared with other crossover methods, such method still can produce a certain variation effect under the condition that two parent individuals are identical, which plays a positive role in maintaining the diversification characteristics of such colony.

5) Variation operation: since the optimal sample is maintained in selection mechanism, the variation technology by continuous conversion is adopted to maintain the diversification of individuals in the colony, and make the individual change to larger extent in arrangement of the order. The variation operation is based on probability P_m, and the exchange time J is produced with random method once it occurs, and the genes of individuals required for variation operation are exchanged for J times (the location of exchanged gene is produced randomly).

2.3 ANT COLONY ALGORITHM RULE IN COMBINED ALGORITHM

1) Fitness function: the fitness functions in both ant colony algorithm and GA stages are identical.

2) Route selection strategy:

$$j=\begin{cases}\arg\max\limits_{j\in allowedk}([\tau_{ij}(t)]^{\alpha}[\eta_{ij}(t)]^{\beta}), & if\,(q<q_0)\\ s, & else\end{cases}, \quad (10)$$

$\tau_{ij}(t)$ is the amount of information on (i,j) at t time route, wherein $\eta_{ij}(t)$ is $F_i = \frac{\min z}{z_i}$, and q_0 is a preset variable in (0,1), which is larger in the early stage of algorithm, but with the development of algorithm, q_0 is gradually reduced. q is a random variable.

$$s = \begin{cases} \frac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}(t)]^{\beta}}{\sum_{s \in allowedk} [\tau_{is}(t)]^{\alpha}[\eta_{is}(t)]^{\beta}}, & j \in allowedk \\ 0, & else \end{cases}. \quad (11)$$

3) Setup rule for initial pheromone value: a set of optimal multicast tree solution is obtained from GA, which has great significance on optimal solution, so the concentration of route pheromone on such multicast tree is strengthened, and initial pheromone value is set as $\tau_0 = \tau_C + \tau_G$, wherein τ_C is a pheromone constant, and τ_G is the pheromone value obtained from GA. There are m sets of routes for the colony produced after iteration, and n set(s) of routes in front of fitness value are selected. For the pheromone on each route, the formula and pheromone constant τ_C are added to obtain the distribution τ_0 of initial pheromone in the ant colony algorithm.

4) Rules for updating pheromone: the pheromone is updated with ant cycle model, i.e. the pheromone of ant with shortest route can only be modified and added in one cycle, and thus, the track renewal equation for all routes is adopted:

$$\tau_{ij}(t+1) = \rho\tau_{ij}(t) + \sum \Delta\tau_{ij}^{k}(t). \quad (12)$$

3 Combining algorithms for logistics route optimization

Step 1: Initialize the network node and start to encode routing character of the network from source node.
Step 2: Optimize the GA route to generate initial population, and reserve the colony with the highest fitness via selection, crossover and inheritance operations of GA; after the genetic iterations reaches to specified maximum, n group(s) colony with higher fitness generate(s) the initial distribution of pheromone: $\tau_0 = \tau_C + \tau_G$.
Step 3: Initialize the tabu list, tabuk and allow list allowedk. Add the source node into tabuk and all rest nodes into allowedk, and use the source route method to put m ant(s) on the source node.
Step 4: Select the route. Flood ants on links except those between nodes in the tabuk according to ant species. Mark as the k batch ants, and select one route according to Equation (10) and (11).
Step 5: Update the pheromone. Locally update the pheromone of such route through which each ant passes according to the Equation (12). Delete j in the allowedk and add it in the tabuk.
Step 6: For k (k=1, 2, …, M), if there is a target node in the allowedk, turn to Step 4; otherwise, the flooding shall be finished, and the k batch ants are dead.
Step 7: When the algorithm is in a halted state, the current optimal solution shall be saved. It shall judge whether it is lower than the reference value; if so, the result shall be output; otherwise, turn to Step 3.
Step 8: If the algorithm achieves the specified iterations, the result shall be output; otherwise, turn to Step 3.

Algorithm process is showed as Figure 2:

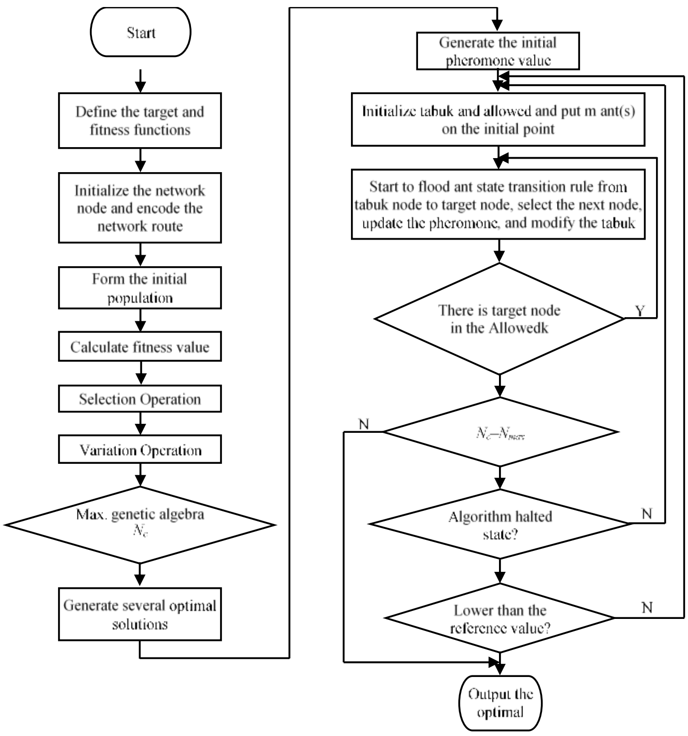

FIGURE 2 Algorithm process flow chart

4 Simulation experiment results

The new algorithm, with the combination of GA and ant colony algorithm for logistics distribution route optimization, sets the GA iterations as 50 and initial pheromone values [10] τ_C of all routes in the ant colony algorithm as 60; the pheromone value converted from GA result is programmed with C language by adding 2 via the route and updating the track $\rho = 0.8$ and $Q = 1000$; the calculated example results are analysed and compared.

Example: Some distribution centre is used as an example, and it shall assume that the distribution centre assigns 5 trucks to 30 customers, the maximum loading capacity of each truck is 10t, and the maximum mileage for each distribution is 50km. The coordinates and demands for 30 customers (to-be distributed locations) are shown in the Table 1, in which the number of 0 represents the distribution centre.

The shortest distance for each iteration process is obtained from 15 iterations of the computer, as shown in the Table 2; wherein the minimum value of all shortest distances is 204.99km, namely that the shortest mileage of this distribution example is 204.99km, and the optimal route corresponding to the distribution scheme is:

Route 1: 0→20→11→4→14→19→22→1→7→23→0

Route 2: 0→16→26→17→5→21→28→30→0;

Route 3: 0→12→6→25→2→15→0;

Route 4: 0→29→8→27→0;

Route 5: 0→9→18→10→24→13→3→0.

TABLE 1 Distance between the Distribution Center and Demand Point/km, and the Demand of each Demand Point Q/t

i	*j*																														
	0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*	*27*	*28*	*29*	*30*
0	0.00	18.36	18.02	9.43	12.16	9.89	7.28	15.00	14.00	10.63	15.62	9.05	7.21	14.76	14.31	5.09	5.00	10.00	12.04	15.65	5.09	16.28	18.38	3.16	19.10	11.70	5.00	14.31	11.04	2.24	12.16
1	18.36	0.00	29.01	18.44	12.37	17.46	22.13	2.00	9.00	27.02	32.20	15.00	20.61	31.38	8.94	15.52	12.73	18.79	28.42	8.60	13.60	21.21	4.12	13.60	35.61	25.50	11.31	6.00	23.85	15.62	26.40
2	18.02	29.01	0.00	16.55	17.11	27.80	11.31	27.02	30.67	19.70	20.22	14.03	10.82	17.12	21.21	14.87	22.36	27.66	20.25	22.36	16.76	34.06	28.16	20.12	23.02	7.21	24.70	29.83	26.40	20.25	25.55
3	9.43	18.44	16.55	0.00	19.72	5.38	7.07	24.41	22.56	3.16	6.40	15.65	9.22	5.38	22.80	12.20	13.93	14.32	4.00	24.21	13.45	20.25	27.66	12.53	10.00	9.49	14.14	23.41	10.82	10.77	9.22
4	12.16	12.37	17.11	19.72	0.00	19.65	13.45	10.44	16.97	21.93	26.07	4.24	11.31	24.21	4.12	7.61	12.37	20.40	23.26	5.38	7.07	25.63	11.04	11.04	29.68	15.26	15.52	15.00	23.02	13.00	24.33
5	9.89	17.46	27.80	5.38	19.65	0.00	16.64	16.76	9.90	14.03	19.23	17.89	17.03	20.00	20.02	14.42	7.28	1.41	5.38	21.00	13.42	6.40	20.88	8.94	21.84	21.09	4..12	12.20	6.71	7.81	10.29
6	7.28	22.13	11.31	7.07	13.45	16.44	0.00	20.25	21.09	10.00	13.00	9.22	2.24	14.32	17.03	6.71	12.16	16.40	11.04	18.44	8.54	22.80	22.82	10.05	16.55	4.47	13.93	21.02	15.26	9.49	14.87
7	15.00	2.00	27.02	24.41	10.44	16.76	20.25	0.00	9.22	25.49	30.61	13.00	18.68	29.68	7.21	13.60	11.40	18.03	26.90	7.07	11.70	21.02	4.12	12.04	34.06	23.54	13.42	6.32	22.82	14.14	25.24
8	14.00	9.00	30.67	22.56	16.97	9.90	21.09	9.22	0.00	22.47	27.86	17.49	20.40	27.89	10.63	15.81	9.00	11.31	23.77	15.65	13.93	12.37	13.04	11.04	30.87	25.32	8.54	3.00	17.03	12.04	20.00
9	10.63	27.02	19.70	3.16	21.93	14.03	10.00	25.49	22.47	0.00	5.38	18.03	12.04	6.08	24.70	14.32	14.42	13.00	1.41	26.08	15.26	18.44	29.00	13.45	8.60	12.65	13.93	23.70	8.54	11.40	6.40
10	15.62	32.20	20.22	6.40	26.07	19.23	13.00	30.61	27.86	5.38	0.00	21.95	15.23	3.16	29.21	18.60	19.72	18.11	4.12	30.61	19.85	23.09	33.97	18.60	3.60	14.03	19.31	29.07	13.04	16.64	10.20
11	9.05	15.00	14.03	15.65	4.24	17.89	9.22	13.00	17.49	18.03	21.95	0.00	7.07	20.00	8.06	4.00	10.81	18.38	19.31	9.43	4.47	24.19	14.56	8.94	25.55	11.18	13.89	16.15	20.10	10.44	21.02
12	7.21	20.61	10.82	9.22	11.31	17.03	2.24	18.68	20.40	12.04	15.23	7.07	0.00	13.04	15.00	5.10	11.70	16.97	13.15	16.40	7.07	23.34	21.02	9.49	18.79	5.00	13.89	20.02	16.55	10.29	19.42
13	14.76	31.38	17.12	5.38	24.21	20.00	14.32	29.68	27.89	6.08	3.16	20.00	13.04	0.00	27.59	16.97	19.31	19.03	5.38	29.00	18.44	24.51	32.80	17.89	6.08	11.18	19.42	28.79	14.56	16.15	12.08
14	14.31	8.94	21.21	22.80	4.12	20.02	17.03	7.21	10.63	24.70	29.21	8.06	15.00	27.59	0.00	10.63	13.04	21.00	26.08	1.41	9.43	25.50	7.00	12.37	25.61	19.23	16.00	12.80	24.51	14.56	26.25
15	5.09	15.52	14.87	12.20	7.61	14.42	6.71	13.60	15.81	14.32	18.60	4.00	5.10	16.97	10.63	0.00	7.81	14.76	15.65	12.04	2.00	20.81	16.12	5.67	22.20	10.05	10.63	15.13	16.12	6.71	17.03
16	5.00	12.73	22.36	13.93	12.37	7.28	12.16	11.40	9.00	14.42	19.72	10.81	11.70	19.31	13.04	7.81	0.00	8.06	15.81	14.14	6.40	13.42	15.26	2.24	23.02	16.49	3.16	9.49	11.70	3.16	13.89
17	10.00	18.79	27.66	14.32	20.40	1.41	16.40	18.03	11.31	13.00	18.11	18.38	16.97	19.03	21.00	14.76	8.06	0.00	14.03	22.02	13.93	6.40	22.13	9.49	20.61	20.81	5.00	13.60	5.83	8.06	8.94
18	12.04	28.42	20.25	4.00	23.26	5.38	11.04	26.90	23.77	1.41	4.12	19.31	13.15	5.38	26.08	15.65	15.81	14.03	0.00	27.46	16.64	19.23	30.41	14.87	7.21	13.34	15.23	25.06	9.22	12.81	6.71
19	15.65	8.60	22.36	24.21	5.38	21.00	18.44	7.07	15.65	26.08	30.61	9.43	16.40	29.00	1.41	12.04	14.14	22.02	27.46	0.00	10.82	26.30	6.08	13.60	34.20	20.59	17.03	13.04	25.71	15.81	27.51
20	5.09	13.60	16.76	13.45	7.07	13.42	8.54	11.70	13.93	15.26	19.85	4.47	7.07	18.44	9.43	2.00	6.40	13.93	16.64	10.82	0.00	19.72	14.42	4.47	23.43	12.04	9.43	13.15	16.00	6.08	17.26
21	16.28	21.21	34.06	20.25	25.63	6.40	22.80	21.02	12.37	18.44	23.09	24.19	23.34	24.51	25.50	20.81	13.42	6.40	19.23	26.30	19.72	0.00	25.08	15.26	25.02	27.20	10.30	15.30	10.05	14.21	13.00
22	18.38	4.12	28.16	27.66	11.04	20.88	22.82	4.12	13.04	29.00	33.97	14.56	21.02	32.80	7.00	16.12	15.26	22.13	30.41	6.08	14.42	25.08	0.00	15.62	37.48	25.63	17.46	10.05	26.83	17.80	29.15
23	3.16	13.60	20.12	12.53	11.04	8.94	10.05	12.04	11.04	13.45	18.60	8.94	9.49	17.89	12.37	5.67	2.24	9.49	14.87	13.60	4.47	15.26	15.62	0.00	22.02	14.32	5.00	11.18	12.16	2.24	13.93
24	19.10	35.61	23.02	10.00	29.68	21.84	16.55	34.06	30.87	8.60	3.60	25.55	18.79	6.08	25.61	22.20	23.02	20.61	7.21	34.20	23.43	25.02	37.48	22.02	0.00	17.26	22.36	32.25	15.13	20.00	12.04
25	11.70	25.50	7.21	9.49	15.26	21.09	4.47	23.54	25.32	12.65	14.03	11.18	5.00	11.18	19.23	10.05	16.49	20.81	13.34	20.59	12.04	27.20	25.63	14.32	17.26	0.00	18.38	25.02	19.21	13.93	18.36
26	5.00	11.31	24.70	14.14	15.52	4..12	13.93	13.42	8.54	13.93	19.31	13.89	13.89	19.42	16.00	10.63	3.16	5.00	15.23	17.03	9.43	10.30	17.46	5.00	22.36	18.38	0.00	10.00	10.00	4.47	12.04
27	14.31	6.00	29.83	23.41	15.00	12.20	21.02	6.32	3.00	23.70	29.07	16.15	20.02	28.79	12.80	15.13	9.49	13.60	25.06	13.04	13.15	15.30	10.05	11.18	32.25	25.02	10.00	0.00	13.60	19.10	21.93
28	11.04	23.85	26.4	10.82	23.02	6.71	15.26	22.82	17.03	8.54	13.04	20.10	16.55	14.56	24.51	16.12	11.70	5.83	9.22	25.71	16.00	10.05	26.83	12.16	15.13	19.21	10.00	13.6	0.00	10.05	3.16
29	2.24	15.62	20.25	10.77	13.00	7.81	9.49	14.14	12.04	11.40	16.64	10.44	10.29	16.15	14.56	6.71	3.16	8.06	12.81	15.81	6.08	14.21	17.80	2.24	20	13.93	4.47	19.10	10.05	0.00	11.70
30	12.16	26.4	25.55	9.22	24.33	10.29	14.87	25.24	20.00	6.40	10.20	21.02	19.42	12.08	26.25	17.03	13.89	8.94	6.71	27.51	17.26	13.00	29.15	13.93	12.04	18.36	12.04	21.93	3.16	11.70	0.00
Q		1.59	0.21	1.78	1.29	1.25	1.69	0.17	0.01	0.71	1.15	0.75	0.59	1.03	1.39	0.98	0.73	0.05	1.58	0.54	1.91	0.62	1.32	0.15	1.33	0.71	1.05	0.15	0.93	0.22	0.97

TABLE 2 Simulation Result

iterations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Zmin/km	209.719	209.817	209.479	207.935	208.397	207.668	209.848	206.826	207.659	205.742	204.99	207.062	208.967	205.833	208.967

5 Conclusions

The optimal route for logistics distribution is effectively solved by logistics route optimization model built in the Paper, and two optimal targets are considered: shortest total distance of logistics distribution and maximum full load rate of vehicle. The partial optimal solution is avoided by ant colony algorithm effectively, and the searching speed of ant colony algorithm is greatly improved by GA with a strong robustness. The decision maker can select the optimal route combining with the current optimizing target according to optimal route set. The example demonstrates that this algorithm is an effective method for logistics route solution and good in the application prospect.

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