Advance Journal of Food Science and Technology 8(2): 131-134, 2015
DOI:10.19026/ajfst.8.1480
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: November 21, 2014 Accepted: January 8, 2015 Published: May 10, 2015

Research Article

Food Emergency Logistics Mode Based on Improved Particle Swarm Algorithm

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Abstract: This study analyzes the principle and calculating steps of Particle Swarm Arithmetic first, then put forward improved Particle Swarm Arithmetic and states the steps of iteration calculation using improved Particle Swarm Arithmetic specifically. Based on it, in terms of the principles of the shortest transportation time and the cheapest transportation expenses, we establish the mathematical model of food logistics and combined with the real data and uses improved Particle Swarm Arithmetic to calculate, making an optimal decision in the end. Now the food logistics in our country is far from perfect and there are still lots of issues to be solved and much laws constructed, so as to developing food transportation in our country in a higher speed.

Keywords: Food logistics, food transportation, particle swarm arithmetic

INTRODUCTION

The development of a new generation of logistics industry, has resulted in a gradually increase of distribution vehicles in logistics industry, but at the same time, it also has brought more automobile exhaust, increased pollution and air quality index has decreased gradually. Modern logistics industry is an important component of China's economic development, in order to achieve common sustainable development of economy and environment, it is necessary to reduce energy consumption while increasing the green area (Krainyukov *et al*., 2010). The energy consumption in the logistics industry is mainly in the distribution process, in order to achieve low consumption of the energy, it will be dedicated to solve the distribution route optimization problem, using reasonable and effective algorithm to realize the logistics distribution path optimization is the important foundation of sustainable development and the ultimate goal (Changjiang, 2007).

Food logistics have the characteristics of emergency logistics. It prepared food for possible emergencies contingency plans and quickly corresponds logistics activity when emergencies occur, in order to ensure the food safety supply: in order to study how the distribution center location, how to set up supplies demand address and how to allocate distribution center and demand center, how to reach the highest efficiency of space and time (Wei *et al*., 2003), this paper introduced the problem description to the food emergency logistics and the Particle Swarm Optimization (PSO) algorithm is adopted to problems are calculated, finally get the distribution of the distribution center, needs the most reasonable scheme.

Food logistics emergency logistics prepared food for possible emergencies contingency plans and quickly when emergencies occur in the corresponding logistics activity, to ensure the food safety supply (Xie, 2013): in order to study how the distribution center location, how to set up: supplies demand point and how to allocate distribution center and demand point, to reach the highest efficiency of space and time, this paper introduced the problem description to the disaster area food emergency logistics and USES the Particle Swarm Optimization (PSO) was calculated to the problem, finally get the distribution center, needs, some of the most reasonable scheme.

MATERIALS AND METHODS

The principle of particle swarm algorithm: Particle swarm algorithm is a kind of optimization method based on population optimization (Liu *et al*., 2013); this method has been successfully applied to solve the continuous domain problem. Kennedy has proposed a kind of PSO based on a discrete binary (Thomas, 2002), that define the particle velocity is Change the position for particle probability. The results show that the PSO algorithm modified to solve the optimization problems of discrete function. Based on the biological change speed suddenly when it is interference by outside or is discovered by new targets. This study introduces the adaptive mutation strategy. This method improves the efficiency of the algorithm (Zhifeng, 2009).

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Description of path optimization problem: The shortest path problem can be described as: A commodity salesman will sell goods go through a number of cities, the salesman start from a city, after go through all the cities, he needs to return to the starting. The question is that how to choose the path so that the total travels distance is the shortest.

The mathematical model for the traveling salesman problem is:

$$\min \text{COST} = \sum_{i-1}^{n} d_{t_i}, t_{i+1} \tag{1}$$

The standard particle swarm algorithm: Particle swarm optimization algorithm mainly simulates foraging behavior of bird cluster, through the teamwork of the bird flock to achieve optimization purposes. In PSO algorithm, each particle makes use of best position itself and information provided by global optimal solution of whole particle swarm, continues to fly in the solution space and achieve the purpose to find the optimal solution. The No. i particle is best position (individual extremum) found so far:

$$\sum_{i \in S} \sum_{k \in M} y_{ijk} = 1, \forall j \in N \tag{2}$$

So far the best position found of whole particle swarm (global extremum):

$$t_{ik} = t_{jk} + t_{jik} y_{jik}, \forall i, j \in S, \forall k \in M \tag{3}$$

The whole particle swarm update their flight speed and position by individual and global extremum and search for the optimal solution in the solution space. PSO algorithm, its each particle changes the speed and position by the following formula:

$$t_{ik} \le l_i, \forall i \in N, \forall k \in M \tag{4}$$

$$y_{ijk} = \{0,1\}, \forall i, j \in S, \forall k \in M \tag{5}$$

In formula (4),

w = The inertia weight factor
c1 and c2 = Learning factors
r1 and r2 = Two independent random number between (0, 1)

Mutation particle swarm optimization algorithm: Each particle of groups aggregation degree change according to fitness value of the particles, therefore we introduce the concept of fitness variance.

Set the number of particle swarm particle is n, the fitness value of the ith is f_i, particle swarm the current average value is f_{avg}, the fitness variance of groups is defined as:

$$\sigma^2 = \sum_{i=1}^{n} \left(\frac{f_i - f_{avg}}{f} \right)^2 \tag{6}$$

Group fitness variance reflects the degree of convergence for all particles, the value is smaller, the particle aggregation degree is higher; On the contrary, the concentration of particles is lower. σ^2 is computed according to formula (7):

$$f = \max \left\{ 1, \max \left\{ \left| f_i - f_{avg} \right| \right\} \right\} \tag{7}$$

At the same time, Algorithm is introduced into adaptive learning factor c1 and c2 in evolution. c1 and c2 are computed according to formula (8):

$$\begin{cases} c_1(t) = 4 * \dfrac{f_a(t) - f_g(t)}{f_a(t)} \\ c_2(t) = 4 - c_1(t) \end{cases} \tag{8}$$

In the formula, f_g (t) is adaptive value of The optimal location global, f_α (t) is The current average adaptive value for particles.

Algorithm process:

Step 1 : Initialize the population size such as particle position vector and the velocity vector, calculating the fitness of particles.
Step 2 : Update the Pbest and Gbest of the particle according to Formula (2) and (3).
Step 3 : If stopping condition is met, the algorithms return to step 10, otherwise return to step 5.
Step 4 : After Bmax generation in continuous evolution, population variation mechanism according to the speed variation If it's no improvement.
Step 5 : Calculate the average speed of all particle and the adaptive value of particle swarm according to Formula (8). Set p_{best} of the particle as current optimal position for the individual, the g_{best} is set to best position of entire particle population in initial population; If the particle fitness is better than individual extremum, then individual extreme p_{best} is set to new position, if the particle fitness is better than global extremum, the global extremum g_{best} is set to the new location.
Step 6 : Computing community fitness variance σ^2 according to formula (6).
Step 7 : Generate a random number r $\in$ [0, 1], if r<pm, algorithm will Perform mutation; Otherwise return to step 5.
Step 8 : According to the type (4) with type (5) update the particle's speed and position.
Step 9 : The number of iterations adds 1 and algorithm return to step 4.

Step 10: Output gBest, End of the algorithm.
Mathematical model is as follows:

$$Min \quad Z = \sum_{i=0}^{n}\sum_{j=0}^{n}\sum_{k=1}^{m} c_{ij} x_{ijk} + Fm \tag{9}$$

$$ST: \sum_{i=1}^{n} q_i y_{ik} \le Q, k = 1,2,\cdots,m \tag{10}$$

$$\max \sum_{i=1}^{n} q_i y_{ik}, k = 1,2,\cdots,m \tag{11}$$

$$\sum_{i=0}^{n}\sum_{j=0}^{n} c_{ij} x_{ijk} \le L, k = 1,2,\cdots,m \tag{12}$$

$$\sum_{k=1}^{m} y_{ik} = 1, k = 1,2,\cdots,n \tag{13}$$

$$\sum_{k=1}^{m} y_{0k} = m \tag{14}$$

$$\sum_{i=1}^{n} x_{ijk} = y_{jk}, j = 1,2,\cdots,n, k = 1,2,\cdots,m \tag{15}$$

$$\sum_{j=1}^{n} x_{ijk} = y_{ik}, i = 1,2,\cdots,n, k = 1,2,\cdots,m \tag{16}$$

$$x_{ijk}(x_{ijk} - 1) = 0, i = 1,2,\cdots,n, \\ j = 1,2,\cdots,n, k = 1,2,\cdots,m \tag{17}$$

$$y_{ik}(y_{ik} - 1) = 0, i = 1,2,\cdots,n, \\ k = 1,2,\cdots,m \tag{18}$$

Constraint (9) ensures the minimum total cost optimization goal; Constraint (10) ensures that distribution vehicle amount is no greater than the sum of the vehicle's weight; (11) a delivery vehicle distance cannot exceed the maximum range of vehicles; (12) distributes delivery vehicle distance cannot exceed the maximum range of vehicles; (13) represents the customer only by a vehicle to its distribution services. (14) Distribution center sending out M cars. (15), (16) represent the relationship between the two variables. (17-18) are cancellation loop vehicle distribution path.

RESULTS AND DISCUSSION

The analysis of experimental results: Using MATLAB 7.0 software to make the six examples in international standard database TSPLIB simulation experiments, the number of particles group: N = 100; maximum inertia coefficient W max = 0.99, the minimum inertia coefficient W min = 0.09, learning factor c1 = 2, c2 = 1.5126. The initial mutation probability Pm = 0.05. Taking Chn31, Oliver30 for example, Fig. 1 is mutation Particle Swarm Optimization (GBPSO) to find Chn31 optimal path and convergence curve.

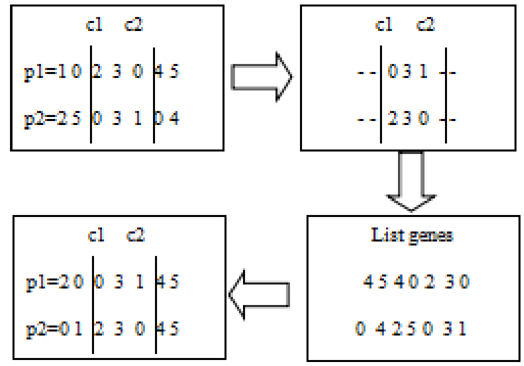

Fig. 1: Mutation particle swarm optimization (GBPSO)

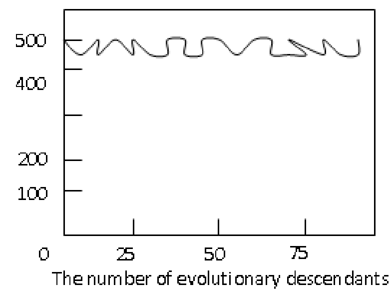

Fig. 2: Path optimization curves

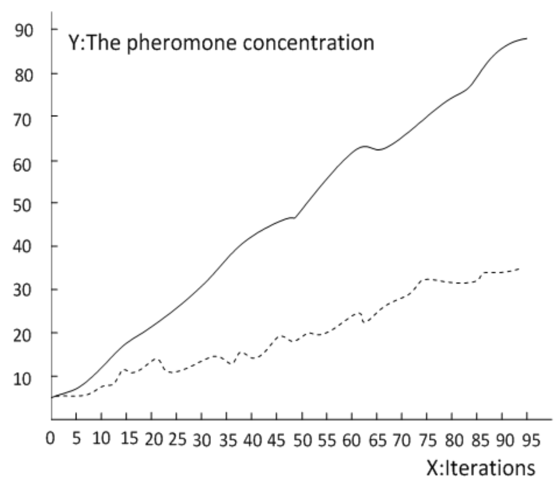

Fig. 3: The optimization path of logistics distribution

Six example of the standard database TSPLIB is tested in this study, the algorithm and standard particle swarm algorithm are compared. The results are shown in Table 1.

It is known from Table 1, blackbody is the best result for two algorithms in table. PSO algorithm has only better performance on the instance A280, GBPSO i have the best performance in the remaining five

Table 1: Comparison of experimental results of the two algorithms to solve TSP problem

Calculation example	Optimal solution PSO	Optimal solution GBPSO	Average solution PSO	Average solution GBPSO	Standard variance PSO	Standard variance GBPSO	Iterations number
Att48	33966	33524	34512.80	33981.20	212.50	54.90	50
Eil51	435	426	449.50	425.90	23.70	5.00	50
Chn31	15398	15377	16902.40	15380.60	406.60	134.30	50
Oliver30	654.4	423.3	777.40	459.40	11.70	7.70	50
Tsp225	3919	3916	3934.43	3920.36	19.55	7.29	150
A280	2579	2579	2584.60	2582.40	12.20	12.60	300

instances, judging from the average and variance, the performance of GBPSO algorithm (Shi and Jinwei, 2009) is more superior to the standard algorithm.

In order to verify the effectiveness of particle swarm algorithm, it is the main application of MATLAB to verify it. Setting the parameter values in the model are to meet:

$$\begin{aligned} &C_{\theta}(0.0000, 0.1666, 0.0555)\\ &C_{\rho}(0.0150, 0.0050, 0.0016)\\ &C_{p_{\tau}}(0.6180, 0.1273, 0.0424)\\ &C_{p_{m}}(0.1000, 0.0333, 0.0111) \end{aligned} \tag{19}$$

Mainly through the logistics distribution routing problem of completes simulation experiment, which provides the optimal solution is 426, its evolution path results are shown in Fig. 2.

Using software to simulate the optimal path for the instance, which is the optimal solution, is shown in Fig. 3.

CONCLUSION

In this study, in accordance with the principles such as minimal transportation time and cost. We described and modeled the food emergency logistics problems in and adopted the improved particle swarm algorithm to solve it to obtain the optimal distribution plan of the distribution center and the demand points. In order to achieve the goal of energy saving and emission reduction in logistics delivery vehicles, to achieve a low cost low exhaust pollution in logistics distribution path optimization, that is to find the reasonable application of algorithm optimize the path. In view of the shortages of existing genetic algorithm and ant colony algorithm which have the characteristics of some limitations, such as ant colony algorithm's convergence slow, easy going, the characteristics of such as genetic algorithm premature convergence in the process of path optimization, process complex, integrating and improving the ant colony algorithm and genetic algorithm in order to solve food logistics route optimization problem. Logistics distribution, to achieve energy conservation and emissions reduction of the vehicle and the purpose of the low consumption low exhaust pollution, the key problem is to realize the logistics distribution path optimization in transportation. Genetic algorithm and ant colony algorithm has some limitations, the particle swarm algorithm combined the two algorithm is more flexible and more widely applied. And examples verify the effectiveness of the proposed algorithm, it can solve the slowing down defects of loop iteration in the early period of the ant colony algorithm to search, has a good application in practice.

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