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Study on Logistics Center Location Decision Model Based on Improved Genetic Algorithm

Shujing Liu [1, a]

[1] Department of Transportation Management , Hebei Jiaotong Vocational & Technical College, Hebei Province, Shijiazhuang City, 050035

[a] email

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Abstract. In terms of analysis and design of logistics system, location logistics centers often need to be supported by modeling or quantitative methods. There are many ways to solve this problem, but when the scale of the problem is relatively large, these traditional methods will encounter difficulties to some extent. This paper proposes the improved genetic algorithm to solve this issue, and combined with the case model to obtain the solution of the problem.

Introduction

Logistics center location is to point to a number of supply outlets and a number of needs of the economic region of the network. The best logistics center location scheme will achieve the best benefit that goods are transferred to demand outlets through the logistics center. Nowadays, one of the major issues to consider in developing logistics industry is to build a reasonable logistics platform, so the logistics center location problem is critical. Under the existing objective conditions, how to establish the logistics center with the minimum logistics costs, optimal social benefit and the best customer service quality, is worthy of in-depth study.

In terms of solving optimization issues, genetic algorithm has a great advantage. To apply the improved genetic algorithm in logistics center location problem, and obtain the best location of logistics centers, is the core issue of this paper.

Construction of Location Decision Model

Logistics center location belongs to is a minimum cost problem, that is, the optimization problem that realizes the sum of transportation cost, variable cost and fixed cost to be the minimum. It includes single logistics center location and multi logistics center location, and the latter is studied in this paper.

Model assumptions. From all the given point address set in one area, choose a certain number of addresses to establish a logistics center, and thus set up a series of distribution areas. In order to facilitate the establishment of mathematical model, so that the model would not be too complicated but has a certain practicality, we consider the following model assumptions:

a) Choose a new logistic center within a certain range;

b) Do not consider the expansion of the logistic center;

c) Just need to consider the distribution of one product, that is, this system model is a location problem of single product and multi logistics center;

d) Adopt the same means of transport between all points of the system;

e) The system contains two levels of transport;

f) One logistics center can be supplied by a number of suppliers, and a user's needs can also be provided by a number of logistics centers;

g) Transportation cost is proportional to the amount of transportation;

h) The capacity of the logistics center can meet the user's requirements;

i) The user's needs are aggregated by region, and it is a constant;

j) The unit transportation costs between each logistics center and supply points, each user and logistics centers are constant, as well as the unit management costs of the logistics center.

Model establishment. For the location problem of logistics center, its model and algorithm are very complex, so it is not suitable to deal with linear models, but discrete form is relatively suitable. The objective function is to choose a certain number of points from the selected location as the best distribution center, to ensure that transportation cost, product management cost and fixed investment cost of logistics center to be the minimum. Its mathematical model can be expressed as follows:

$$\min E = \sum_{k=1}^{l}\sum_{i=1}^{m} c_{ki}W_{ki} + \sum_{i=1}^{m}\sum_{j=1}^{n} h_{ij}X_{ij} + \sum_{k=1}^{l}\sum_{i=1}^{m} g_i \sqrt{W_{ki}}/2 + \sum_{i=1}^{m} z_i F_i \quad \mathbf{(1)}$$

Constraint conditions:

$$A_k - \sum_{i=1}^{m} W_{ki} \geq 0, \qquad (k = 1,2,...,l) \quad (2)$$

$$M_i - \sum_{k=1}^{l} W_{ki} \geq 0, \qquad (i = 1,2,...,m) \quad (3)$$

$$\sum_{i=1}^{m} X_{ij} - D_j \geq 0, \qquad (j = 1,2,...,n) \quad (4)$$

$$\sum_{i=1}^{m} X_{ij} - \sum_{k=1}^{l} W_{ki} = 0, \qquad (i = 1,2,...,m) \quad (5)$$

$$W_{ki} \geq 0, \quad X_{ij} \geq 0, \quad (k = 1,2,...,l;\ i = 1,2,...,m;\ j = 1,2,...,n) \quad (6)$$

In the above formula,

E - total costs;

l - number of supply points;

m - number of selected logistics center;

n - number of users;

W_{ki} - transport volume from the supply point k to logistics center i;

X_{ij} - transport volume from the logistics center i to user j;

F_i - fixed investment cost of logistics center i;

c_{ki} - unit transportation cost from logistics center i to user j;

g_i - the unit management cost of transfer product of logistics center i;

z_i - integer variable, when $z_i=1$, it indicates the logistics center i is chosen; when $z_i=0$, it indicates the logistics center i is not chosen;

A_k - supply capacity of the supply point k;

M_i - construction capacity of the selected logistics center i;

D_j – demand volume of the user j.

As for the constraint conditions, Formula (2) means that the total product amount cannot be exceed the total amount of its supply capacity from supply point *k* to each logistics center; Formula (3) means that the total supply amount obtained from logistics center *i* cannot exceed its construction capacity; Formula (4) means that the supplied product amount from each logistics center to user *j* should meet the user's needs; Formula (5) means that the total amount of goods in and out of logistics center *i* should be balance.

Improved Genetic Algorithm Steps

The improved genetic algorithm in this paper provides common framework for solving complex optimization problems. For the logistics center location problems in this paper, it can be configured to solve the problem of genetic algorithm as the following steps:

a) Determine the decision variables and various constraints, that is, determine the individual's phenotype and solution space of the problem.

b) Establish optimization model, that is, determine the type of the objective function (to solve the maximum or minimum of the objective function?) and its mathematical description form or quantization method.

c) Determine the chromosome coding method that represents the feasible solution, that is, determine genotype of the individual and search space of genetic algorithm.

d) Determine the decoding method, that is, determine corresponding relation or conversion method from individual genotype X to individual phenotype Y.

e) Determine quantitative assessment method of individual fitness, that is, determine the conversion rule from objective function f(X) to individual fitness F(X).

f) Determine the related operating parameters of genetic algorithm.

Combined with the above steps, here we design the flow diagram of the improved genetic algorithm, as shown in Fig. 1 as follow.

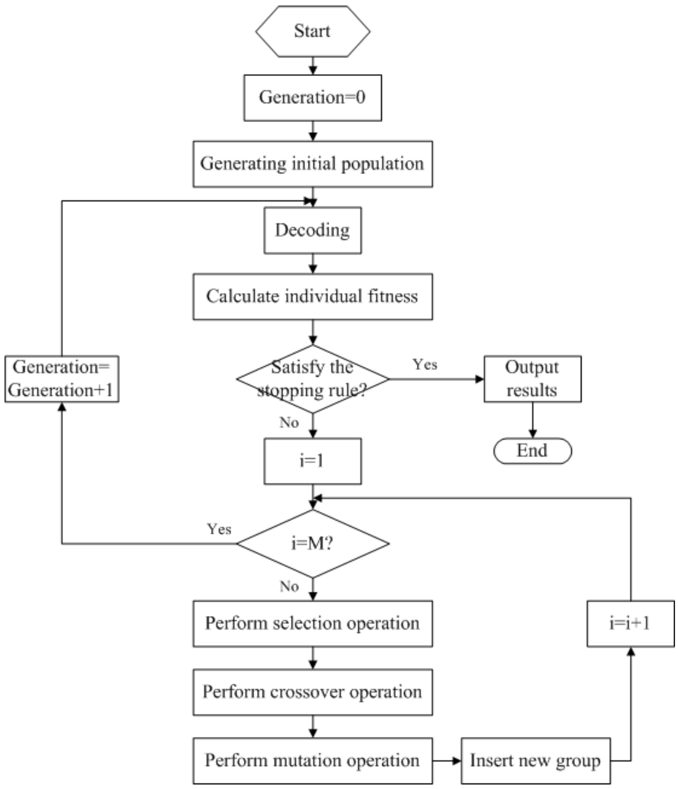

Fig. 1. Data mining for multimedia teaching

Case Analysis

Case information. There are two factories, whose production capacities are A_1=40(units), A_2=50(units), as shown in Tab.1.

Tab.1 Unit transport cost to logistics center and production capacity

Unit transport costs		Logistics center						Production capacity
		1	2	3	4	5	6	
Factory	1	7	7	8	12	11	7	40
	2	14	12	9	6	8	12	50

There are 8 users, whose demand volume is D_j=(j=1,2,…,8), as shown in Tab.2.

Tab.2 Unit transport cost to users and user demand volume

Unit transport costs		Logistics center							
		1	2	3	4	5	6	7	8
Factory	1	5	11	3	8	5	10	11	11
	2	14	16	8	9	4	7	4	4
	3	10	11	3	5	2	5	9	5
	4	15	13	9	6	7	2	10	2
	5	9	7	3	2	6	5	12	8
	6	13	15	9	9	5	8	4	6
User demand volume		10	10	10	15	5	15	10	15

There are 6 selected addresses in logistics center, and their fixed costs, unit product management costs and construction capacity is shown as Tab.3.

Tab.3 Unit transport cost to users and user demand volume

Logistics center	1	2	3	4	5	6
Fixed costs	75	30	30	100	75	30
Unit product management costs	75	80	75	80	70	80
Construction capacity	25	10	10	40	25	10

The problem is to determine several logistics centers and the transport volume, to ensure the total costs to be the minimum, including transportation cost, product management cost and fixed cost.

Solving results. For the logistics center location problem above, combined with the genetic algorithm steps and the flow chart, we utilize the improved genetic algorithm to solve it. The specific process includes coding scheme, lifting constraint, fitness function and genetic manipulation, and then we determine the genetic parameters as: group size M=60, termination algebra T=400, maximum crossover rate $P_{c\ max}$=1.0, minimum crossover rate $P_{c\ min}$=0.5; Mutation rate P_m=0.3.

Then according to the algorithm flow chart, we adopt C++ programming language to compile the program to realize the above solving process. This program is based on the improved genetic algorithm, which incorporates the following three aspects of knowledge:

a) We use hybrid parallel coding method to compile the program;

b) Adopt the Cosine descent method to process the crossover rate;

c) Use the improved penalty function method to remove the constraint conditions.

The three aspects aim to improve the genetic algorithm. Here we have to omit the specific algorithm program, but to give the running result of the program as follow:

gen=400, pp=33, avg=2360.260465, best=2280.107533, chromosome=010111

W[k][i]=1.000000 4.080000 0.000000 7.520000 18.200000 3.520000
0.000000 1.490000 0.000000 28.040000 4.300000 4.290000

X[i][j]= 0.000000 0.000000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.190000 2.720000 0.910000 0.810000 0.345000
4.140000 0.160000 0.640000 0.000000 0.000000 0.000000 0.000000
0.000000 0.000000 0.000000 0.000000 4.290000 0.650000 0.120000
3.885000 4.520000 4.575000 8.310000 1.515000 1.080000 4.160000
0.030000 4.125000 2.545000 3.420000 5.330000 3.300000 3.530000
2.700000 0.790000 0.340000 0.165000 0.130000 0.040000 1.940000

pass[i]= 0.000000 9.9150000 0.000000 35.560000 23.990000 9.635000

In the running result, gen, pp, avg, best respectively represent termination algebra, optimal individual quantity, total cost average, total cost minimum; chromosome=010111 means that select the number 2, 4, 5, 6 alternative addresses as the optimal logistics centers; W[k][i], X[i][j] respectively represent the aforementioned decision variables W_{ki} and X_{ij}; pass[i] represents transport volume of logistics center.

References

[1] Min H, Ko H J, Chang S K. A genetic algorithm approach to developing the multi-echelon reverse logistics network for product returns[J]. Omega, 2006, 34(1):56-69.

[2] Lee J E, Gen M, Rhee K G. Hybrid Priority-based Genetic Algorithm for Multi-stage Reverse Logistics Network[J]. Industrial Engineeering & Management Systems, 2009, 8(1):14-21.

[3] Shi L, Fan H, Gao P, et al. Network Model and Optimization of Medical Waste Reverse Logistics by Improved Genetic Algorithm[M]// Advances in Computation and Intelligence. Springer Berlin Heidelberg, 2009:40-52.

[4] Mao X. Improved Site Design is based on the Best Logistics Center Genetic Algorithm[J]. New Technology & New Process, 2014.

[5] Juan L I. Location of Logistics Distribution Center Based on Cloud Adaptive Genetic Algorithm[J]. Value Engineering, 2015.

[6] Hua Z C, Xin H, Wei Z. Logistics Distribution Routing Optimization Algorithm[J]. Applied Mechanics & Materials, 2014, 513-517:1740-1743.