

Research Article

Optimization Route of Food Logistics Distribution Based on Genetic and Graph Cluster Scheme Algorithm

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Abstract: This study takes the concept of food logistics distribution as the breakthrough point, by means of the aim of optimization of food logistics distribution routes and analysis of the optimization model of food logistics route, as well as the interpretation of the genetic algorithm, it discusses the optimization of food logistics distribution route based on genetic and cluster scheme algorithm.

Keywords: Food logistics, genetic and cluster scheme algorithm, optimization model

INTRODUCTION

In the distribution cost of food logistics, under the average level of our country, only the sum total of oil fee, fees for path and bridge, as well as the damage costs has been accounted for about 70% of the total cost of food logistics. While the international standard is: the cost of distribution logistics should not exceed 50% of the total cost. In the distribution process of food logistics, reasonably determining the optimization of logistics distribution route can save costs, speed up the flow of goods and increase business revenues (Koskosidis *et al.*, 1992). Therefore, it is very important for the optimization of the whole food logistics system to decide the optimization decision of food logistics distribution.

MATERIALS AND METHODS

The concept of food logistics: Food logistics refers to the circulation of food as commodity, with the improvement of social progress and the perfect concept of logistics, food logistics has more extensive scope including food transportation, food storage, food packaging, food preservation management and so on, which can affect food quality (Russell, 1995).

The target of optimization route of food logistics distribution: Reasonable food logistics distribution route can have great effect on the speed, cost and benefits, therefore, by adopting the scientific and reasonable method to determine the distribution route is a very important work in the distribution activities.

The option of target can be divided according to the specific requirements, the distribution level of the distribution center, the strength as well as the objective condition, which can be divided into the following options.

The highest benefit: In the choice of taking the benefit as the goal, it usually takes the current efficiency of the enterprise as the main factors to consider, which also keeps the long benefit in mind.

The lowest cost: It is difficult to check out the cost, but it is quite simplified compared with that takes the benefit as the goal. Under the condition where the cost and delivery routes have close relationship and the cost can play a decisive role in the final benefits. Thus, taking the minimum cost as the objective in fact is a choice of taking the benefit as the goal equally, which can be more practical and feasible.

The shortest distance: If the cost has strong relationship with distance and has little relationship

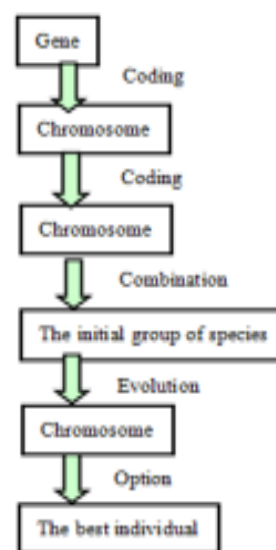


Fig. 1: The structural evolution of species

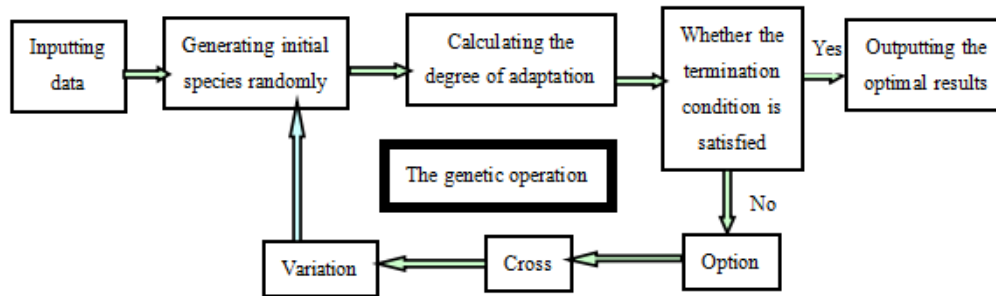


Fig. 2: The basic flow chart of genetic algorithm

with the other factors, then it can choose the shortest distance as the target, which can avoid many influential factors that can greatly simplify the calculation.

The most reasonable capacity of transportation:

When the capacity of transportation is full of pressure and under the circumstances that the capacity and cost or benefits are relevant to each other, in order to save the capacity of transportation and make full use of the current capacity. It can take the arrangement of transportation as the target to determine the distribution route without renting the external car or purchasing the new vehicles.

Model of optimization route of food logistics: The development of the algorithm theory of optimization route can transfer a lot of new optimization route problems of logistics distribution into mathematics problems and be solved, so as to obtain the optimal solution finally, which can also be applied to the practical problems. This study chooses to use the genetic algorithm to solve the problem of optimization route with the constraints of time window in the enterprise during the period of logistics distribution (Thangiah *et al.*, 1996).

The interpolation of genetic algorithm: Genetic algorithm is to simulate the evolution process of the species from low level to high level, starting from the random initial species groups to start searching, which is based on the principle of survival of the fittest, by applying genetic operation to realize the iterative process of re-engineering the structure of the individualist in the species groups, each iteration transform can obtain new result, each result can be obtained through the assessment of an adaptation function, this process can be repeated, until the result converges to an approximate value (Fig. 1). Thus, the genetic algorithm has a paralleled computer system which is an inherent advantage, which can get the optimal solution in solving the combinatorial optimization problems.

The basic procedures of genetic algorithm: Studying on the basic steps and procedures of the solution of

genetic algorithm can understand the calculation principle of the genetic algorithm more clearly when it is calculated, which can make the searching process of genetic algorithm more clearly (Osman, 1993). The first step is to input data, then randomly generated initial species groups, the second step is to calculate out the initial species groups through the fitness function, the third step is when the initial species groups meet the fitness, it can calculate out the optimal value of the output; if it cannot satisfy the termination condition, it can go on with selection, cross, variation and generate new initial species groups, which can be circulated calculated until fitness can satisfy the termination conditions and output the optimal results. The basic procedures of genetic algorithm, which can be shown in Fig. 2.

RESULTS AND DISCUSSION

The optimization route of food logistics distribution based on genetic algorithm:

This study uses the genetic algorithm to optimize the logistics distribution route for the distribution process, which can reduce the operating costs of food in the project of logistics and distribution.

When the distribution region and the distribution center as well as the distribution node are known, the distribution center can distribute all the distribution nodes that are required to be distributed. First of all, it should meet the demand of the constraint of time window that is required with time by the nodes, which can complete the distribution task of all the goods. Secondly, the weight of the cargo of each vehicle shall not exceed its carrying capacity. In this case, determining the number of the delivery vehicles, the route of each car can make the whole process of distribution with the minimum cost.

Operating cost function of the vehicles:

$$Z_1 = \sum_i \sum_j \sum_k C_{ij} X_{ijk}$$

- Z_1 : Operating costs of the vehicles
- C_{ij} : The traveling distances from the distribution node i to the distribution node j

X_{ijk} : Choosing the variable from the distribution node i to the distribution node j by vehicle k

The penalty function of vehicle load: During the process of solving the solution in the mathematical description, the fourth hypotheses specified to use the vehicles with the same model and the quantity of the distribution cannot exceed the limitation of its capacity, which shall not exceed its carrying capacity. Thus, in the process of logistics distribution, it must consider the penalty cost of vehicle load when the demand exceeds the constraint of the delivery vehicle load, the penalty function of the vehicle load can be established as follows:

$$Z_2 = D \sum_i^n \max \left[\sum_{k=2}^{v+1} \delta_i Y_{ki} - \theta, 0 \right]$$

- Z_2 : The penalty cost of vehicle load
- D : The penalty coefficient, it is large enough positive real number
- I : The code of the delivery mission
- δ_i : The demand of the distribution node i
- Y_k : The selection variable of vehicle k in arriving at the node i
- θ : The load of the distribution vehicle
- V : The number of the distribution nodes

In the research of the optimization route of logistics distribution problem with soft time window, if the distribution vehicle can arrive at a earlier distribution node i , then the distribution vehicles should wait at this distribution node, which may happen the loss of the opportunity cost; if the delivery vehicles are late for arrival at the distribution node i , the completing the distribution task is delayed, which can cause a certain loss to the company, but the limit of the loss can be acceptable.

The penalty cost function with mathematical model of logistics distribution route problem with time windows:

$$Z_3 = M \sum_{i=1}^n |\min [S_i - ET_i, 0]| + M \sum_{i=1}^n |\min [LT_i - S_i, 0]|$$

- Z_3 : The cost of time penalty
- M : The coefficient of penalty

Considering the above factors, the mathematical model of optimization route can be set up as follows:

$$Z = Z_1 + Z_2 + Z_3$$

Core graph cluster scheme: Core Groups Graph Cluster (CGGC) scheme is an ensemble strategy for graph clustering. The basic idea of this method is

combining several different clustering results to help confirm the final partitioning. If all the clustering results agree that a pair of nodes belong to the same cluster, it is probably right, otherwise, a second consideration is required. An improvement to this method which is called the CGGCi scheme is made by performing the k-partitioning iteratively until a 'best' initial partitioning is achieved. As Algorithm 1 shows, in every new clustering, some more nodes or groups of nodes have been merged or rearranged. With the succeeding iterations, every new clustering is likely to produce more accurate information on the route structure. These steps are no other than the modularity optimization procedures.

Algorithm 1: Core Groups Graph Cluster Iteration Scheme:

- Step 1 :** Set P^{best} to the partition into singletons and set \hat{G} to G
- Step 2 :** Create a set S of k (fairly) good partitions of \hat{G} with initial base algorithm $A_{initial}$
- Step 3 :** Identify the partition \hat{P} of the maximal overlaps in S
- Step 4 :** If \hat{P} is a better partition than P^{best} , set $P^{best} = \hat{P}$, create the graph \hat{G} induced by \hat{P} and go back to Step 2
- Step 5 :** Use final base algorithm A_{final} to search for a good partition of \hat{G}
- Step 6 :** Project partition of \hat{G} back to G

Our louvain multilevel refinement iteration method: Core Groups Graph Cluster Scheme and its iterative version. Rotta R and Noack A have confirmed that the Louvain multilevel refinement algorithm can do graph clustering on large scale networks in short computing time. As is showed by Ovelgönne M and Geyer-Schulz A, iteration is a good method for optimizing the modularity function. Inspired by the discussed algorithms above, we try to modify the Louvain multilevel refinement algorithm and introduce its iterative version.

In detail, the basic idea of our method is to run Louvain multilevel refinement route detection algorithm in an iterative way to achieve a higher modularity optimization quality. In our method, the output result acquired by each iteration step is used as input for the subsequent iteration. Before this, we need to modify the Louvain multilevel refinement algorithm itself by changing its input parameters. We begin with assigning each node in to its own cluster and then run Louvain multilevel refinement algorithm. After the first implement, we run the algorithm a second time, starting with the first iteration's partition result. In the second iteration, individual nodes could move and search between the communities obtained by the first iteration. Subsequently, we run the algorithm a third time,

starting with the result obtained by the second iteration. The rest may be carried out by analogy.

In theory, it is possible to obtain higher modularity optimization quality by executing more iterations of the algorithm. The iteration approach can be terminated until the modularity optimization quality does not improve any more. In practice, the approach can be terminated after a certain number of iterations in which the iteration number is selectable. When running the algorithm in an iterative way, the algorithm keeps searching for probability to increase route structure quality and modularity value by both getting new route structure and searching nodes from one route to another. The main approaches of our iterative method are showed in Algorithm 2.

Algorithm 2: Louvain Multilevel Refinement Iteration Method:

Input: A, k

// A is a nEdge*2 matrix in which each line denotes the pairs of nodes that the edge connects

// k denotes the number of iterations

Output: $Q_{\max}, A_{\text{asig}}$

// Q_{\max} denotes the maximal modularity of the k iterations

// A_{asig} is a nNodes*1 matrix in which each row denotes the assignment of each node to communities

$P^{\text{best}} \leftarrow$ the partition of singletons

$Node^{\text{start}} \leftarrow$ Node [0], $Q_{\max} \leftarrow 0, i \leftarrow 1$

Repeat:

// run the modified LMR algorithm to get P and Q

$(P, Q) \leftarrow$ LMR ($P^{\text{best}}, Node^{\text{start}}$), $i \leftarrow i+1$

if $Q > Q_{\max}$ then

$P^{\text{best}} \leftarrow P, Q_{\max} \leftarrow Q$

end if

//run a random method to get the next iteration's start node

$Node^{\text{start}} \leftarrow$ Rand-Start-Node (P)

until $i > k$

// get A_{asig} from P^{best} and output

$A_{\text{asig}} \leftarrow P^{\text{best}}$, output A_{asig} and Q_{\max}

CONCLUSION

With the prosperity of market economy, the logistics industry developed rapidly, more and more companies see the important role of logistics in enterprise production and sales process. This study is based on the research of logistics theory, optimizing the logistics and distribution of food enterprises of the enterprises, studying the prediction analysis model as well as the method of the demand of food logistics, by using genetic algorithm, it can calculate out the distribution route of the food enterprise, ultimately, according to the mode of logistics distribution of food enterprises, it can design out the optimization procedure of the distribution based on the application of Internet of Things.

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