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Research on IRP of Perishable Products Based on Mobile Data Sharing Environment

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ABSTRACT

Inventory routing problem (IRP) has always been a hot issue. Due to its particularity, perishable products have high requirements for inventory and transportation. In order to reduce the losses of perishable goods and improve the storage efficiency of perishable goods, based on the general inventory path problem, this paper further has studied the IRP of perishable goods. In addition, in the process of product distribution and transportation, there are a lot of real-time product information generated dynamically. These real-time mobile data must be shared by the whole distribution network, which will also dynamically affect the efficiency of IRP research. On the basis of some assumptions, the mathematical model has been established with inventory and vehicle as constraints and the total cost of the system as the objective. In view of the particularity of perishable inventory path problem, this paper proposed an improved differential evolution algorithm (IDE) to improve the differential evolution algorithm from two aspects. Firstly, the population has been initialized by gridding and the greedy local optimization algorithm has been used to assist the differential evolution algorithm, with these measures to improve the convergence speed of the algorithm. Then, the accuracy of the algorithm is improved by the adaptive scaling factor, two evolution modes and changing the constraints of the problem. Then the improved algorithm has been used to solve the inventory path problem. The results of numerical experiments show that the algorithm is effective and feasible and can improve the accuracy and speed up the convergence of the algorithm.

KEYWORDS

Accuracy of the Algorithm, Convergence Speed of the Algorithm, Differential Evolution Algorithm, Inventory Routing Problem

1. INTRODUCTION

Inventory-routing problem (IRP) is the key to determine the inventory strategy and distribution strategy. The purpose of inventory strategy is to determine the distribution target and quantity of goods for each planning period, and distribution solves the centralized scale effect of logistics and the scattered demand of customers, and the purpose of distribution strategy is to determine the distribution route of goods. IRP tries to minimize the sum of inventory costs and distribution costs. IRP is an integration of inventory issues and distribution issues that needs to be addressed on the same platform at the same time. Because these two questions are opposite and contradictory to each other, in the pursuit of the minimum inventory cost, it will inevitably bring the maximum distribution cost; on the contrary, if the pursuit of the minimum distribution cost, it will inevitably bring the maximum inventory cost. But at the same time, solving these two problems is a very difficult event. Both of them are N-P difficult

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problems. Especially when the number of customers in distribution is large and the demand of each customer is random, the optimal strategy of IRP problem is often very complex, and the solution of the problem often makes the quantity of distribution and the distribution room. Distribution routes lack stability. The value and freshness of perishable products are highly correlated, which is a special population of IRP. Due to the prolongation of perishable products over time, the freshness of products will decrease and the deterioration degree will increase. Therefore, the timeliness, temperature control and other preventive measures of perishable products distribution require higher requirements, resulting in higher distribution costs. As a result, the goods will be seriously damaged and depreciated in value. Therefore, it is more urgent and realistic to study the IRP of perishable products.

In addition, in the process of distribution and transportation, there are many mobile dynamic data, which must be shared by all nodes in time to update the distribution inventory plan in time. Therefore, the research data and the research object cannot be separated from the dynamic environment. Moreover, terminal logistics has the characteristics of service area distribution, various media and weak value added, so it often leads to poor information communication. How to improve information sharing, and how to improve the level of distribution service in such an environment, become the problems. In this paper, an improved differential evolution algorithm is used to find the approximate optimal solution of the IRP problem for perishable products.

In the available literature, (Yu Li, Shuhua Zhang and Jingwen Han, 2017) studies an inventory level model that (Samira Mirzaei and Abbas Seifi, 2015) established an inventory path optimization model based on freight cost, inventory cost and sales loss cost. Combined with simulated annealing and tabu search, he designed a meta heuristic algorithm. (Bhattacharjee, et al., 2007) established a multi-period ordering and pricing model, and solved a deteriorating product with a fixed period by using two different heuristic algorithms. (Levin Y, 2006) and others assume that the demand of perishable products obeys Poisson distribution, and that the retailer’s dynamic pricing strategy under the condition that demand will be affected by price. (Goyal and Giri, 2001) firstly reviewed the inventory status of perishable goods. During this period, the research on supply chain theory reached a new height.

(Donselaar M, V,Woensel, T.V and Broekmeulen R, 2006) Through theoretical analysis, it is proved that the sum of inventory cost and distribution cost under the optimal strategy of partitioning customers is 98.5% optimal. Zoning can effectively simplify the problem and reduce the difficulty of the problem, so this paper also uses the idea of fixed zoning, and does not need to spend a lot of cost for low probability events. (Alvareza A, Jean-Franc, Ois Cordeaub and Jansb R, 2019) proposed Branch-and-cut algorithms and hybrid heuristic solution method to solve inventory routing problem in which goods are perishable . (Herbon A and Devapriya P, 2017)studied the inventory distribution optimization of fresh products from the perspective of supply chain operation management. (Wenhui Zhang, Qiqi Miao, Feng Guan, et al. 2018)Based on the time window of perishable products acceptable to customers, a mathematical model was established aiming at the lowest distribution cost. The distribution area was divided by scanning algorithm in advance, and the optimal path was solved by genetic algorithm. (Ming, wang yong and YH Li. 2018) designed decision variables based on a customer’s seven requirement attributes,and proposed a fuzzy clustering method for grouping customers and improved a fuzzy genetic algorithm that was used to solve the proposed total cost model.

In solving IRP problems, because of the complexity of the problem itself, when the scale of the problem itself is large, it is a very difficult event to find the optimal solution. (Rafie-Majd Z, Pasandideh S H R and Naderi B, 2017) tried to solve IRP problems by using heuristic variable neighbor search intelligent method. IRP is solved in two stages. Firstly, heuristic variable neighbor search is adopted. In this stage, the inventory cost is not considered. The purpose is to obtain a feasible initial solution. Then the second stage iteratively optimizes the initial solution and achieves very good results. (Mjirda A, Jarboui B, Macedo R and Hanafi S., 2017) tried to use heuristic tabu search intelligent algorithm to solve the shortest inventory path problem, and compares the operation effect of the algorithm with that of the original Lagrange relaxation algorithm, which proves that this method has obvious superiority.

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