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ORIGINAL RESEARCH

A logistics distribution route optimization model based on hybrid intelligent algorithm and its application

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Abstract

Logistics distribution is the link that directly connects consumers in logistics activities. Among various logistics costs, distribution costs account for a large proportion. Reasonable vehicle routes in distribution have a significant impact on the service level, cost and benefit of logistics distribution. Optimizing vehicle routes using scientific and reasonable methods is an important research topic in the field of logistics distribution. Among them, the problem of optimizing the route of delivery vehicles with a time frame is the focus of current research. The latest intelligent optimization algorithms include tabu search algorithm, simulated annealing algorithm, ant colony algorithm and artificial fish swarm algorithm. The emergence of these algorithms provides new tools for solving the optimal transportation problem of delivery vehicles. The calculation of the vehicle allocation route problem using the time frame is more complicated and belongs to the NP-hard problem. This paper studies the construction of a vehicle allocation route problem model with a time frame. Based on fish swarm algorithm and ant colony algorithm, a hybrid optimization algorithm is proposed for the distribution route optimization problem. Aiming at the shortcomings of ant colony algorithm, we use artificial fish swarm algorithm to obtain the initial solution, select the pheromone update strategy, and improve the probability of state transition. At the same time, the ant colony algorithm is improved. The congestion concept in the fish school algorithm of the ant colony algorithm ensures that most ants are not affected by the pheromone concentration. Random optimization is carried out in the early stage of the optimization process, which increases. Aiming at the problem that the ant colony algorithm takes a long time to solve and tends to stagnation, the concept of transfer coefficient is applied to improve the calculation speed of the ant colony, and enhance the scanning ability and optimization ability of the algorithm. Taking Solomon's problem R101 as the basis of the example data, we wrote a calculation program in object-oriented C++ language, calculated and verified the hybrid artificial fish colony-ant colony algorithm. This is the algorithm; at the same time, some data of Solomon, after many verifications, show that the hybrid artificial fish colony ant colony

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algorithm is better than other heuristic algorithms. Finally, the various parameters of the proposed hybrid swarm intelligence algorithm are compared and analyzed, and the parameters used are described.

Keywords Logistics distribution · Vehicle routing optimization · Ant colony algorithm · Artificial fish swarm algorithm · Hybrid swarm intelligence algorithm

1 Introduction

Systematic and rational logistics management has become a favorable condition for enhancing the competitiveness of enterprises. Logistics distribution is a key activity in logistics management, which refers to the activity of delivering goods that meet the user's order requirements to the consignee in the fastest and low-cost manner possible in the business activities of the enterprise. In recent years, as the cooperative relationship between various links (purchasing, warehousing, sales and distribution, etc.) in the business activities of enterprises has become more and more complex, the requirements of enterprises on logistics distribution have become higher and higher, and a scientific and modern logistics distribution center has been established. The main contribution of this paper is to build the vehicle allocation route problem model with a time frame. Moreover, the fish swarm algorithm and ant colony algorithm, a hybrid optimization algorithm is proposed for the distribution route optimization problem.

After the Chinese government and enterprises gradually realized the social and economic benefits that the logistics industry can bring, they devoted a lot of hard work, manpower and material resources to the development of the logistics industry, but more than ten years have passed. And did not achieve the desired results. Not only did the third-party logistics die out, but even the distribution station as a pilot was a dead end in name. This situation did not change until the end of the last century. The distribution logistic functions are also known as sales logistic. Moreover, the planning, realization and control of movement goods are formulated by using this system. Meanwhile, the, link between sales of the company and logistic distribution are delivered thorough this function. The past 20 years have been a high-speed stage of rapid development of my country's logistics industry, but there is still a lot of gap compared with the logistics level of developed countries. The main manifestations are: the content of logistics distribution in the entire economic operation is low, but the logistics cost is high in the GDP; the level of logistics management is uneven, and the quality of logistics personnel is generally low. "One room, two vehicles, several people" It is a portrayal of many domestic logistics companies. These factors have made it difficult for my country's logistics industry to keep up with international standards. The backwardness of logistics is one of the problems brought about by China's long-term adherence to the extensive economic development model. How to reduce the total logistics cost is a task for various enterprises and governments in China to transform the economic development model. It is also used to measure the quality of the national economy. Sexual indicators can reflect the overall national strength of the country (Panta, 2010). Therefore, my country's State Council and various local governments have formulated various policies and plans that are conducive to the development of logistics in accordance. This will greatly improve the efficiency of my country's economic operation and increase its international competitiveness.

As an important part of logistics management activities, it is to be able to rationally use and dispatch transportation tools, optimize transportation routes, so as to achieve the most optimized vehicle distribution path, and reduce enterprise transportation and warehousing costs. In 1959, two scientists, Dantzig and Ramsel (Matos & Oliveira, 2004), in response to the requirements for optimal deployment of transportation vehicles in logistics management, abstracted logistics distribution activities on the basis of the traditional traveling salesman problem, and proposed a mathematical model of the vehicle routing problem. According to the different logistics constraints in reality, there are many models. Among them, the routing problem with time window is the most typical problem, and it is also a representative multi-objective problem with constraints that has the most research value. The mathematical model of the problem is similar to the typical traveling salesman problem, except that the vehicle capacity and service time (time window) are added to the constraints. The travelling sales man problem are coming under the algorithm which is based on the finding the shortest route between two nodes. Whereas, the points and the locations are focused more on this optimization. The optimization goal of the mathematical model is to achieve the lowest total cost of the entire logistics distribution under the conditions of meeting the two main constraints of vehicle capacity limitation and delivery service time. The tabu search algorithm are based on meta-heuristic optimization technique. Meanwhile, the memory structure, candidate solutions are evaluated by using this tabu search algorithm. The simulated annealing process are formed based on probabilistic technique. Moreover, the goal optimization techniques are involved in this process. It also controls the physical properties.

Logistics distribution is a systematic project involving many factors. In the logistics distribution, the combination of vehicle distribution routes is Whether it is reasonable or not is the main factor that affects the entire distribution cost, distribution speed and economic benefits, especially the completion of the distribution route under the condition of multiple users.

The hybrid swarm intelligence optimization algorithm is mainly introduced to collaborate the exploration capabilities into dynamic multi swarm particle. Reasonable and effective logistics distribution routes can not only bring direct economic benefits to both supply and demand parties, increase vehicle utilization and reduce logistics costs, but also generate many added values, such as alleviating traffic pressure and reducing exhaust gas generated during vehicle transportation. Pollution, the realization of urban environmental protection, etc. Combined with modern communication and traffic information processing platforms, logistics management personnel can easily obtain vehicle operation and road condition information in a timely manner, so as to more rationally perform vehicle scheduling, improve work efficiency, greatly improve the efficiency of logistics management decision-making, and further improve the modernization level of logistics management. Therefore, the route optimization problem of logistics distribution vehicles has been a hot topic in operational research, applied mathematics, network analysis, computer applications, and transportation in recent decades. It has become a topic for many scholars at home and abroad to study. It has been widely used in the fields of communications, production, national defense, biology, and computer applications. This article will focus on the vehicle routing problem in logistics distribution. The vehicle routing problem (VRP) is a combinatorial optimization and integer programming problem. Also, it is based on the finding the shortest route between two nodes. Whereas, the points and the locations are focused more on this optimization.

2 Literature review

Many scholars at home and abroad have begun to optimize the distribution system of logistics enterprises (Bell & Mc Mullen, 2009; Leith & Takahara, 2008; Tatomir et al., 2008), and design appropriate distribution routes through a series of customer demand points to achieve the goals of low distribution costs, short total vehicle mileage and high vehicle utilization. There are two main types of algorithms to solve the logistics distribution routing problem: precise algorithms and heuristic algorithms (Hu et al., 2010; Kuo et al., 2008; Teodorovic & Lucic, 2009; Wen & Wu, 2009). Heuristic algorithm refers to an algorithm based on intuitive or empirical construction. Some traditional user interface design methods, such as UMLi (Wen & Wu, 2009), JUST-UI (Hu et al., 2010), FMP (Toth & Vigo, 2002), etc. generally adopt software engineering-based ideas, starting from user needs and problem domains, taking tasks as the center and forming various Different types of presentation models are used to express different levels of interface abstraction and interface models, and on this basis, editing, development and operation environments are established, and certain results have been achieved. The heuristic algorithm is designed to solve the problems which are created on the traditional methods. Meanwhile, the accuracy and precision of this algorithm are solved by using this algorithm. However, these interface design methods do not take into account the specificity of the interface layout and display under the control of multi-role authority, which affects the description ability of the model; the interaction-centric Post-WIMP (Khapre et al., 2020) interface model integrates all levels of interaction For separation, it fully considers the interactive characteristics of the Post-WIMP interface, so that the designer does not need to care about the connection between the device entity and the interactive behavior during the design process, and can flexibly select components, but it only pays attention to the way the user interacts with the interface. The abbreviation for WIMP is windows, icons, menus, pointer. Diversity does not take into account the diversity of user roles; GADEA, a user interface management expert system (UIMES), stores the demand information of special users in the user model (usermodel). Constructing an interface model improves the efficiency of constructing an interface that interacts with special users, but it only considers the diversity of user characteristics, and does not consider the issue of permission control for different users to access interface resources. Precision can be realized in quality measure, and recall as a measure of quantity. Higher precision algorithm are returns more relevant results than irrelevant ones, and high recall means that an algorithm returns most of the relevant results.

3 Research status of vehicle routing problem

The VRP problem was developed by experts in the field of operations research, simplex algorithm founder G. Dantzing and J. Ramser first proposed in 1959 (Bullnheimer et al., 1997), which is mainly used to solve a class of mathematical problems raised by the traveling salesman problem. It is defined as: It is known that there are several customers and a distribution station. The distribution station has several vehicles of a single vehicle type. A reasonable driving route is required to be able to complete the customer's cargo demand with the shortest path (lowest transportation cost) and the least number of vehicles. The main goal of this distribution vehicle routing scheduling is to deliver the optimal routes. Also, suggested to improve the set of locations.

In recent decades, a large number of enterprises and scholars at home and abroad have conducted a large number of in-depth studies on this problem, and have achieved fruitful academic results, such as Bodin in 1953. Golden et al. wrote an article reviewing the research progress of this issue and listed more than hundreds of related documents. These documents became early VRP research materials. Later, as the issue continued to be studied, the constraint model and conditions continued to change. You can refer to Altinkerner and Oavish for the recent progress of the research on VRP issues, A review article by Laporte, Salhi and others (Maniezzo et al., 2009). The solution to this problem has also greatly promoted the development of computer science. New models and algorithms are constantly being introduced. The theoretical research results are very rich. Now they are mainly used in the application of results, whether it is in the express delivery service industry and the transportation field. You can see the ideas and methods for solving this problem in the field of vehicle scheduling, academic industrial engineering, and computer network routing services. The benefits of routing and scheduling network are Reduced Operating Costs. Fuel is one of the biggest expenses to running a trucking company, Improved Visibility, Improved Customer Service, Improving Productivity.

4 Research status of swarm intelligence algorithm

VRPTW is an extension of the VRP problem. Scholars have proved that this is an NP-hard problem. Kolen et al. first proposed an accurate algorithm for solving VRPTW in 1987. They used a dynamic programming with state space relaxation to solve the lower bound of the problem. Afterwards, many scholars have successively proposed Lagrangian relaxation method, column generation method, branch pruning method, etc., The pruning methods are: Clean, thin and Raise In clean it resembles the Selective pruning to remove one or more of the following parts: dead, diseased, and/or broken branches. Thin: Selective pruning to reduce density of live branches. Raise: Selective pruning to provide vertical clearance. But accurate algorithms can only solve smaller-scale problems, and most of the above-mentioned accurate algorithms can only solve the number of customers $\leq$ 15 In VRPTW, after the problem scale increases, these precise algorithms are often powerless (Toth & Vigo, 2002). Russel proposed a hybrid heuristic method to solve the VRPTW problem, which is actually an improvement of the two-stage heuristic algorithm (Belenguer & Benavent, 2003). The basic idea of Lagrangian relaxation is too discrete the constraints into two groups, namely the easy constraints and the hard constraints, Also, remove the hard constraints from the constraint set of the mathematical programming model, by removing them to the objective function through a number of multipliers. Kontoravdis and Brad et al. used random numbers to determine the customers for the selection of initial customer points, and then inserted them into the parallel construction path, and proposed the GRASP heuristic solution (López-Sevillano et al., 2020). Homberger and Gehring used the rapid optimization ability of genetic algorithm. The genetic algorithm is one of the methods in heuristic search algorithm. Moreover, it is used to solve the problem which are created by the optimistic resources. It also, suggested employs the concept of genetic solutions. An evolutionary heuristic solution was proposed to solve the VRPTW problem (Smilowitz et al., 2003). Thangiah and Osman extended Osman's (1991) path exchange improvement method, using a hybrid search method of taboo search method and simulated annealing method (Khapre et al., 2020). For more detailed information about the VRPTW solution algorithm abroad, please refer to the review papers by Braysy and Gendreau and the doctoral thesis by Stcfan Ropke (Secomandi, 2000).

Based on this, this paper proposes a logistics distribution route optimization model based on hybrid intelligent algorithms to provide logistics enterprises with practical and efficient logistics distribution route optimization schemes.

5 Description of logistics distribution vehicle scheduling problem

The problem of logistics distribution vehicle scheduling is how to solve the problem of cargo delivery in a reasonable, efficient and low-cost manner (Deebak, 2020; Donati et al., 2007) The logistics distribution vehicle scheduling includes three key issues: (1) Which cargo boxes can be allocated on the same route; (2) On the same route Which types of vehicles are the cargo boxes installed on? (3) The unloading sequence of the cargo boxes on each distribution route (ie, the driving route). The ultimate goal of distribution vehicle routing scheduling is actually to find a transportation plan with the highest efficiency (which can not only meet the needs of customers, but also minimize the total transportation cost), which clearly stipulates the vehicle information (model, number of vehicles) that should be dispatched) and specific driving directions. In order to solve the problems created by vehicle routing algorithm, is to envelop the distance dimension. Also, the cumulative distance travelled by each vector are need to be estimated.

Combined with the actual situation of general small and medium logistics enterprises, it is assumed that the target logistics center has multiple distribution centers, and most of the business of each distribution center is unified delivery by the logistics center (Savelsbergh, 1985; Sornalakshmi et al., 2022).

For the convenience of constructing the mathematical model, suppose that the target logistics center has a total of K vehicle types. The vehicle type is represented by $k(k = 1, \ldots, K)$, the distribution center is represented by $i(i = 1, \ldots, n)$, and each task point is represented by $j(j = 1, \ldots, m)$. If the total cost is minimized as the goal, multiple distribution points can be used the mathematical model of the multi-vehicle logistics distribution problem is expressed as:

$$\min Z = \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{K} c_{ij} x_{ij}^{(k)}$$

$$\sum_{j=1}^{m} x_{ij}^{(k)} \leq a_i^{(k)} (i = 1, 2, \ldots, n)$$

$$\sum_{j=1}^{m} q_j \leq \sum_{i=1}^{n} \sum_{k=1}^{K} w(k) (j = 1, 2, \ldots, m;\ i = 1, 2, \ldots, n;\ k = 1, 2, \ldots, K)$$

$x_{ij}^{(k)} \geq 0$ and is an integer, $i = 1, 2, \ldots, n;\ j = 1, 2, \ldots, m;\ k = 1, 2, \ldots, K$

In formula (1), $x_{ij}^{(k)}$ is the number of k cars that should be dispatched from point i to point j, which is a variable to be sought, $a_i^{(k)}$ is the number of k cars owned by distribution center i, q_j is the demand at task point j, and $w(k)$ is k the load capacity of the model car, c_{ij} is the cost from point i to point j, including fixed cost of dispatching the car and vehicle operating cost, that is, $c_{ij} = c_0 + c_1 t_{ij}$, c_0 is the fixed cost of the delivery vehicle, c_1 is the cost coefficient relative to the mileage, and t_{ij} is The running mileage of the delivery vehicle, if it is set to $c_1 = 0$, $c_0 > 0$, the model goal is to use the least number of vehicles.

The generation of the final target code needs to depend on each model in ACUI. First, take out the specific display form of the interactive objects on the interface and the layout information of the interface from the UIM. Secondly, take out the behavior description of the user interface from IM and combine it with the data information in DM to generate the relevant code of the user interface behavior (Chen et al., 2015). The interface modeling and code generation in ACU are aimed at all roles in the same role set, that is, on the basis of the same interface model, the page code for multiple roles is generated. The user interface methods which interact the expert system with prompts, command forms and so on.

In the process of interface code generation, the interface layout tree is pruned according to the different role permissions and attributes. The area where the use case group cannot be operated by the role is invisible on the interface, and then the pruned interface layout tree is traversed. Interface layout.

Then, according to the interface layout generated by Algorithm 2 and the interface display form set in UIM, the code is generated in the user interface automatic generation tool AUI. During the code generation process, for the interfaces corresponding to different roles, the generated code of the interface area can be directly called as a module without repeated generation. Only the code of the ungenerated interface area is generated, thereby further enhancing multi-role access the flexibility and efficiency of control interface development.

6 A logistics distribution route optimization model based on hybrid intelligent algorithm

The genetic speed algorithm is used to find the optimal solution, which overcomes the early convergence and the problem of low search efficiency. Therefore, the optimal distribution plan is sought in three stages:

The first stage: obtain an effective route plan for the delivery vehicle.

The second stage: use the economy method to expand the loop.

The third stage: Finally, the genetic algorithm is used to approach the optimal target as much as possible while maintaining the feasible solution in a moderate manner, and search in the neighborhood of the solution, which effectively overcomes the problems of premature convergence of the genetic algorithm and low search efficiency.

Aiming at the shortcomings of traditional interface design models that cannot well support multi-user access control modeling, based on the extended FMP model, this paper proposes a user interface ACU model for multi-user role access control. UM formalizes the relationship between roles and permissions (use cases). UIM defines the interface layout and display form according to different roles based on the data objects defined by DM and the interaction relationship defined by IM, and finally produces permissions that meet the role Access control page code. After modeling once, an interface that meets the requirements of multi-role access control can be generated. The establishment of this model improves the abstract level of interface design and enhances the description ability of the model.

In order to evaluate the usability of the user interface and verify the correctness and effectiveness of the work in this article, this section will use two methods to evaluate the work. Regarding the evaluation of usability, we need to pay attention to two points: one is reliability, whether repeated usability evaluations will produce consistent results; the other is validity, whether the evaluation results can reflect the real situation and expose real problems.

Because the whole process of OVID mainly involves three types of people, namely users, designers, and programmers. This section aims at these three groups of people, and evaluates the improvement work through these three dimensions to produce a more three-dimensional and scientific judgment on the subjective level.

Aiming at the role characteristics of these three groups of people, in this evaluation part, based on the development of two different interface prototypes, this article invited some students with non-computer professional backgrounds on campus, and those who have a certain understanding of design styles, And students who are familiar with the code in the laboratory, through the corresponding function introduction and prototype display of these three types of students, collecting their subjective impressions of the two user interface display effects and a series of corresponding feelings, and then get Compared with the traditional OVID, the improvement work of this article has a relatively good advantage in terms of guaranteeing availability.

6.1 Solving the shortest path based on Floyd algorithm

The traditional Floyd algorithm obtains the shortest distance d_{ij} between any two nodes in the weighted adjacency matrix $D(n)$ by iterative extremes. This paper not only calculates the shortest distance between any two nodes, but also uses a two-dimensional array r to record all pairs of nodes The shortest path direction between, r_{ij} indicates that on the path from node i to node j, node i is the node that should be reached first, so as to lay the foundation for calculating the savings in the second stage. The algorithm for Floyd algorithm is In Step 1: Initialize the shortest paths between any 2 vertices with Infinity., In Step 2: Find all pair shortest paths that use 0 intermediate vertices, then find the shortest paths that use 1 intermediate vertex and so on., In Step 3: Minimize the shortest paths between any 2 pairs in the previous operation.

After obtaining the shortest path information between any two points, find the leaf nodes $(o- > k(k = 1, 2, \ldots, n))$ of each shortest path spanning tree, and the path from the distribution center to each shortest path leaf node is the original vehicle delivery path set. The ant colony algorithm is used to discovery the finest paths which are truly based on the behavior of the ant. Also, it is callable of searching the food from the largest distance.

6.2 Consolidation of paths based on economy method

The economy method is a heuristic algorithm proposed by Clarke and Wright:

If the distribution center delivers deliveries to customers i and j respectively, then two trips are required, and the round-trip routes are $o- > i- > o$ and $o- > j- > o$, respectively, and the total distance is $y_1 = 2\left(d_{o_i} + d_{o_j}\right)$, but if it is changed to use one vehicle to circulate delivery to two users. Then only one trip is needed, the route taken is $o- > i- > j- > o$, and the total delivery distance is $y_1 = \left(d_{o_i} + d_{o_j} + d_{ij}\right)$. We assume that these three points are not in a straight line, then $\left(d_{o_i} + d_{o_j}\right) > d_{ij}$ holds. The total distance savings is $y = \left(d_{o_i} + d_{o_j} - d_{ij}\right) > 0$.

When loop expansion, first select the connection point i and point j with the largest savings to form a loop $o- > i- > j- > o$, and then select the largest savings from the remaining savings, and merge a path starting or ending with another node o into the current loop, and so on, until all feasible mergers are completed. The result of route merging using the economy method is that the total route length is shortened, that is, the total distance of the delivery route is optimized.

6.3 Path optimization based on genetic algorithm

In the genetic algorithm, a number of digital codes, namely chromosomes, of the problem to be solved are randomly generated to form an initial population; a numerical evaluation is given to each individual through the fitness function, individuals with low fitness are eliminated, and individuals with high fitness are selected Participate in genetic manipulation. After genetic manipulation, individuals gather to form a new population of the next generation, and then carry out the next round of evolution to this new population.

After solving in the first two stages, the distribution merged route set is obtained, the number of various box pairs on each route after the merge is recorded, and the number of boxes on each vehicle is counted. In this stage, the genetic algorithm is used for the distribution The path is optimized, the process is as follows:

(1) N paths of initial gene sequences, and use the set of N paths for which the total cost (evaluation cost) is calculated as the initial population s.
(2) Sort the populations by the estimated cost of the path.
(3) Randomly select two paths a, b among the first K paths of the population s.
(4) According to the preset probability, the a and b paths are randomly mutated, and a new delivery path $s[i], s[i+1]$ is generated.
(5) Calculate the distribution cost of $s[i], s[i+1]$, and compare it with the path in the population s, and eliminate the two paths with the highest distribution cost.
(6) Judge whether the population s has reached the preset number of evolutions, if it reaches, the calculation is terminated, otherwise, go to step (3).
(7) Select the best path $s[0]$ in the offspring population as the return result.
(8) All the boxes are allocated to the delivery vehicles according to the optimal path.

6.4 Optimization process of logistics distribution route based on hybrid intelligent algorithm

The logistics boxes are allocated to n distribution centers. For the kth (k initial value is 1) distribution center, the shipping routes and costs from k to m destinations are initialized by directly delivering each box to the destination; again, For the i-th (initial value of i) delivery destination of distribution center k, use the economy method to solve the combined route and route delivery cost from distribution center k to destination i; then, select the next (th i + 1) delivery destinations and do the same process until all delivery destinations are in the combined path set, and use genetic algorithm to optimize the combined path set to generate the most from the distribution center k to the destination set m the best distribution path set. Finally, select the next ($k+1$) distribution center and do the same processing as the distribution center k to get the best distribution path set from n distribution centers to m destinations.

7 Experimental results

The relevant data are as follows:

(1) The cost per kilometer for the large, medium and small models is 4yuan, 3 yuan, and 2 yuan respectively.

(2) The fixed fees for dispatching cars for the large, medium and small models are 400 yuan, 350 yuan, and 300 yuan respectively.
(3) The statistics of the number of boxes sent to each destination are shown in Table 1. For ease of presentation, the three digits in the table represent the number of large, medium and small boxes, and it is assumed that the number of each box sent to the same destination does not exceed 9.

According to the above data, the logistics distribution path optimization model based on the hybrid intelligent algorithm proposed in this paper is used for processing. The results of the path merging using the saving method in the second stage are shown in Table 2. The required vehicles are 4 vehicles and the total mileage is 2670 km. The cost is 8795 yuan.

The distribution route plan derived from this model provides logistics enterprises with more intuitive and specific decision support, and fully demonstrates the superiority of this model in solving the problem of logistics distribution route selection. In statistics routes the author has convey two model namely middle model and small model. Moreover, the delivery routes for these two models are 0- > 2- > 6- > 4- > 5- > 0, 0- > 3- > 0, 0- > 7- > 8- > 9- > 10- > 1- > 0, 1- > 10- > 12- > 11- > 0. Whereas, the total distance of these routes is 700, 184, 906, 581.

Table 1 Statistics of boxes sent to each destination

Destination, place of shipment	C	D	E	F	G	H	I	J	K	L	M
A	100	200	101	010	201	100	001	101	010	000	000
B	01	000	000	000	101	000	010	100	010	100	100

Table 2 Statistics of boxes sent to each destination

Line number	Model	Delivery route	Total distance	Total volume	Cost
1	Big	0- > 2- > 6- > 4- > 5- > 3- > 0	785	33.1	3540
2	Middle	0- > 7- > 8- > 9- > 0	625	20.7	2225
3	Small	0- > 10- > 1- > 0	679	7.2	1568
4	Small	1- > 10- > 12- > 11- > 0	581	13.72	1492

Table 3 Statistics of boxes sent to each destination after optimization

Line number	Model	Delivery route	Total distance	Total volume	Cost
1	Middle	0- > 2- > 6- > 4- > 5- > 0	700	25.65	2450
2	Small	0- > 3- > 0	184	7.42	668
3	Middle	0- > 7- > 8- > 9- > 10- > 1- > 0	906	27.9	3068
4	Small	1- > 10- > 12- > 11- > 0	581	13.72	1462

8 Conclusion

Research the problem of distribution route selection under dynamic demand, and establish a distribution route optimization model based on hybrid intelligent algorithm. The model uses the Floyd algorithm to solve the shortest path between distributed points, and then uses economic laws to expand the loop. On this basis, genetic algorithm is used to find the optimal distribution path. This not only makes up for the shortcomings of economic methods, but also overcomes the problems of early convergence and low search efficiency of genetic algorithms. This model realizes the complex distribution route optimization processing, significantly reduces the distribution cost of the distribution center, and the actual use effect is good. The overall goal of the logistics distribution optimization model is to have the lowest logistics transportation cost, and the transportation path is the key factor that determines the logistics cost.

Therefore, the overall goal of the logistics distribution route optimization model is to minimize the transportation distance, which needs to meet the needs of all customers, and each customer must have and only one delivery vehicle responsible for delivery, and the demand of all customers on each delivery route does not exceed the route. The load of the delivery vehicle, the total distance traveled by the vehicle is less than the maximum travel distance of the vehicle at one time, and the total number of customers of each transport vehicle does not exceed the total number of customers required by the logistics center for the delivery of goods. Based on the establishment of a mathematical model of logistics distribution path optimization, the logistics distribution path optimization model is constructed through the steps of coding design, initial group setting, fitness evaluation, screening of optimal individuals, cross-reorganization operations, mutation operations, and mountain climbing algorithm operations. And it is solved by the hybrid genetic algorithm, which has certain guiding significance.

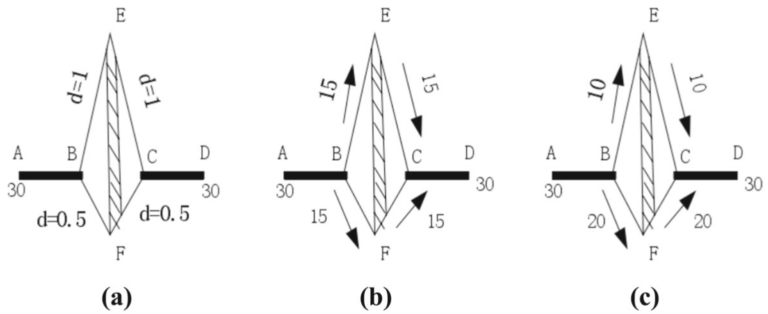

Fig. 1 Schematic diagram of ant colony foraging search

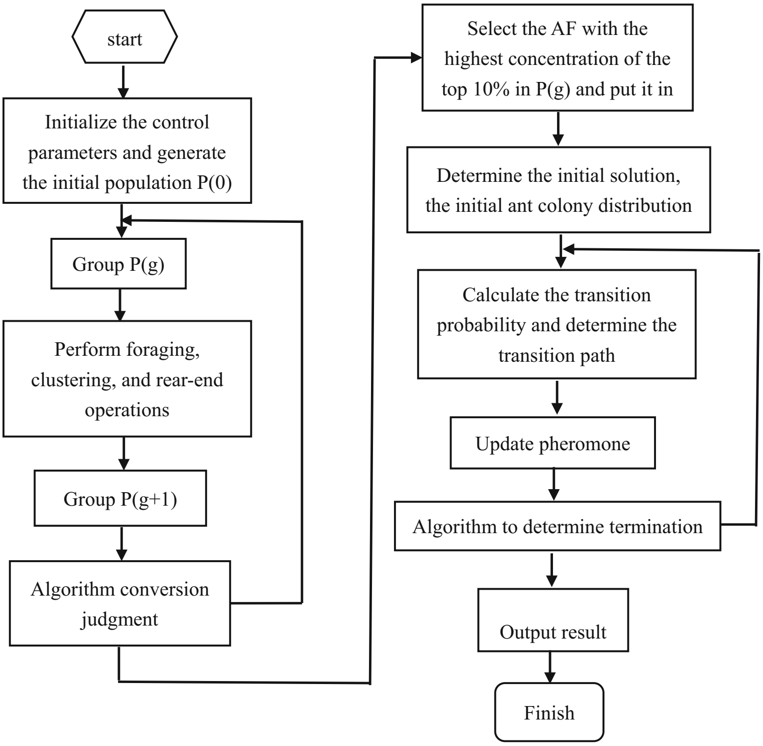

Fig. 2 Hybrid artificial fish school-ant colony algorithm process design diagram

Author's contributions QG are author of the manuscript. They have read and approved the manuscript.

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Declarations

Conflict of interest Not applicable.

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