Research on Multi-objective clustering Optimization of Logistics Distribution Line in E-commerce Environment

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Abstract: In order to improve the ability of logistics distribution line optimization, a multi-objective clustering algorithm based on particle cluster is proposed. The maximum density sparsity detection of logistics lines and adaptive optimization method are used to schedule logistics distribution routes, and the selection model of logistics distribution routes under e-commerce environment is constructed. Particle swarm optimization (PSO) algorithm is used to construct the multi-objective optimization model of logistics distribution line in e-commerce environment, and the global optimization characteristic of particle swarm optimization algorithm is used to optimize the logistics distribution route. The attribute of multi-objective sample set of logistics distribution line is standardized, the shortest optimization value of logistics distribution line is solved, and the multi-objective clustering is carried out according to the result of optimization solution. The particle swarm adaptive clustering method is used to realize the multi-objective optimal selection of logistics distribution routes. The simulation results show that this method has better performance in optimizing control of logistics distribution lines, the efficiency of logistics is improved, the loss of logistics lines is reduced, and it can improve the throughput performance of logistics lines.

Keywords: E-commerce; Logistics; Distribution routes; Multi-objective clustering; Scheduling

1. Introduction

With the rapid development of e-commerce, e-commerce has effectively promoted the development of e-logistics. With the development of cloud computing and big data processing technology, the electronic logistics information APP terminal is established on cloud computing platform to realize the optimized coverage of electronic logistics information, it has become the key technology to improve the ability of secure transmission and sharing of electronic logistics information. At present, electronic logistics is still in the primary stage of development, its function is mainly limited to the exchange of information, the relationship between electronic commerce and logistics depends on each other and promotes each other. Logistics distribution line optimization under electronic commerce, realizing information, modernization, socialization logistics distribution, logistics bottleneck problem of electronic commerce, mainly in the electronic commerce environment logistics distribution cost is too high, the speed is too slow[1-3]. It is necessary to optimize the logistics distribution path under the electronic commerce environment, reduce the logistics cost, meet the individualized demand, promote the logistics distribution to information, automation, and improve the ability of the logistics distribution route optimization and cluster analysis. It has great significance to study the multi-objective clustering optimization of logistics distribution routes in electronic commerce environment so as to promote the development of electronic commerce and electronic logistics[4].

The optimization of route selection and target clustering method for logistics distribution information in e-commerce environment has great significance for improving the efficiency of logistics lines[5]. In traditional methods, there are local adaptive weighted search methods, FCM clustering and fuzzy clustering algorithms, etc. for the route selection and multi-objective clustering methods of logistics distribution[6]. The flow distribution information uses the local adaptive weighted search method to realize the interaction and coverage of the logistics distribution information, constructs the data network distribution model of the logistics distribution information under the e-commerce environment, and carries out the characteristics extraction of the logistics distribution information and the construction of the information flow time series. The above method is used in the logistics distribution line scheduling. The problem of overspending is too large, the convergence of the information scale is slow. In reference[7], it proposes a clustering method for the target of logistics distribution line based on the K-Means multi source information resource scheduling. The hierarchical and modular architecture is used to control the distribution network, and the route selection of information is realized, multi-targets clustering is obtained, but this method needs to set the priority process of logistics distribution information, and there is a state distortion in the priority scheduling process, resulting in local convergence[8].

In order to solve the above problems, this paper proposes a multi-objective clustering algorithm for logistics distribution routes based on particle clustering. In this paper, the maximum density sparsity detection of logistics lines and adaptive optimization method are used to schedule logistics distribution routes, and the selection model of logistics distribution routes under e-commerce environment is constructed. PSO algorithm is used to construct the multi-objective optimization model of logistics distribution line in e-commerce environment, and the global optimization characteristic of particle swarm optimization algorithm is used to optimize the logistics distribution route. The attribute of multi-objective sample set of logistics distribution line is standardized, the shortest optimization value of logistics distribution line is solved, and the multi-objective clustering is carried out according to the result of optimization solution. The particle swarm adaptive clustering method is used to realize the multi-objective optimal selection of logistics distribution routes. Finally, the simulation experiments are carried out to demonstrate the superior performance of this method in improving the multi-objective clustering capability of logistics distribution lines.

2. Route Model and Information Extraction of Logistics Distribution

2.1. Route distribution model of logistics distribution in E-commerce environment

In this paper, the multi-tree network technology is used to construct the route distribution model of logistics distribution in electronic commerce environment. By solving the optimal solution of multi-tree Pareto, the planning of logistics distribution line under e-commerce environment is realized, and the base of logistics distribution is constructed. The optimal scheduling model of Particle Swarm optimization based on multitree hybrid genetic PSO is used to initialize N particles as $(X_1(0), X_2(0), \dots, X_N(0))$ of multi-objective model of logistics distribution line[9]. In the e-business environment, the optimal solution of logistics distribution line I is expressed as $V_i(t) = (v_{i1}(t), v_{i2}(t), \dots, v_{iD}(t))$. In the condition of multi-objective evolution, the optimal solution of logistics distribution line i is expressed as $p_i = (p_{i1}, p_{i2}, \dots, p_{iD})$. In the route search of logistics distribution, 0 indicates that the initial time of pheromone in this location is small. The method of label location of logistics link by layer is used to get the solution of pheromone near to and from the point of logistics distribution. Suppose the maximum iteration number is I_{max}, and the current iteration algebra is I_c. The objective clustering of logistics distribution line under the environment of electronic commerce is realized, and the weight ω of the objective clustering of logistics distribution is:

$$w = w_s - (w_s - w_e) I_c / I_{\max} \tag{1}$$

Suppose the location of distribution route particle i at $t+1$ is updated as follows:

$$x_i(t+1) = x_i(t) + v_i(t+1) \tag{2}$$

After the completion of an iteration, the pheromone of each distribution line target is updated globally[10], and the eigenvector of adaptive control of logistics distribution line is obtained as follows:

$$x^{(k)} = [x_1^{(k)}, x_2^{(k)}, \dots x_{N_{k-1}}^{(k)}]^T \tag{3}$$

$$s^{(k)} = [s_1^{(k)}, s_2^{(k)}, \dots s_{N_k}^{(k)}]^T \tag{4}$$

$$y^{(k)} = [y_1^{(k)}, y_2^{(k)}, \dots y_{N_k}^{(k)}]^T \tag{5}$$

Based on the above design, the information data structure model of logistics distribution in electronic commerce environment is constructed[11], and the scalar time series reconstruction is carried out, based on which the feature extraction is carried out, and the ready-made logistics distribution under distance electronic commerce environment is obtained. The distance of the target point is:

$$f(i) = d_S(i) + d_T(i) \tag{6}$$

Where, $d_S(i)$ is the equivalent distance between the nodes and the particles in the logistics distribution network under the e-commerce environment, it is called the equivalent distance of the front end. $d_T(i)$ is the equivalent distance between the particle and the target position, which is called the equivalent distance of the back end[12].

2.2. Multi objective feature information extraction of logistics lines

The distribution route scheduling is carried out by the maximum density sparse detection and adaptive optimization method of logistics lines, and the selection model of logistics distribution line is constructed under the environment of electronic commerce. The feature fusion scheduling method is used to extract the information, and the average degree of logistics distribution network under the environment of electronic commerce is constructed[13], and the logistics distribution information is established. The best solution vector frequency response is defined as:

$$G(w)=\exp\left\{-[\log(w/w_0)]^2/2[\log(s/w_0)]^2\right\} \quad (7)$$

When the time series of logistics distribution information is projected to the network, the statistics of logistics distribution information can be expressed as:

$$\begin{aligned} f_{\lg-M}(z) &= (f_{\lg}(z), f_{\lg-x}(z), f_{\lg-y}(z)) \\ &= (f_{\lg}(z), h_x * f_{\lg}(z), h_y * f_{\lg}(z)) \end{aligned} \quad (8)$$

Wherein, $f_{\lg}(z)=f(z)*F^{-1}(G(w))$, F^{-1} is expressed as fractional Fourier transform.

The hierarchical structure model of logistics distribution information is constructed. According to the link allocation rule of logistics supply chain nodes, the Riesz transformation of logistics data can be expressed as follows:

$$f_R(z)=\begin{pmatrix} f_x(z) \\ f_y(z) \end{pmatrix}=\begin{pmatrix} h_x * f(z) \\ h_y * f(z) \end{pmatrix} \quad (9)$$

Where, $f(z)$ is the scalar time series of input logistics information, and * is convolution operation. There are two feature sampling points in the cloud computing platform of logistics supply chain. The two dimensional statistical feature quantities of (t_a, y_a) are $H_x=-jw_x/\|w\|$ and $H_y=-jw_y/\|w\|$, and the center weight vector is $w=(w_x,w_y)$. If and only if:

$$y_c < y_a+(y_b-y_a)\frac{t_c-t_a}{t_b-t_a} \quad (10)$$

For the characteristic information $f(z)$ input into the logistics supply chain network, adaptive equalization scheduling method is used to obtain the output logistics supply chain equilibrium control model as follows:

$$f_M(z)=(f(z), f_x(z), f_y(z)) \quad (11)$$

Wherein, $f(z)$ is the degree of a particular logistics supply chain node, which is expressed as the real value part of the feature extraction output, and $f_x(z)$ and $f_y(z)$ are the envelope amplitude and spectrum components of the characteristic sampling sequence of the logistics distribution line respectively. According to the result of feature extraction, the selection model of logistics distribution route in electronic commerce environment is constructed[14].

3. Multi-objective Clustering Optimization of Logistics Distribution Routes

3.1. PSO algorithm global optimization control

On the basis of using the method of maximum density sparsity detection and adaptive optimization of logistics route, the optimal control of logistics distribution route is carried out. In this paper, a logistics multi-objective optimization model based on particle cluster is proposed. PSO algorithm is used to construct a multi-objective optimization model of logistics distribution line in electronic commerce environment[15]. The multi-objective clustering algorithm of logistics distribution line gives the sample set $X=\{x_1,x_2,\ldots, x_n\}$ of N data points, finds k cluster center $\{a_1,a_2,\ldots, a_k\}$, and sets up the object. The characteristic sample points of multi-objective clustering lines of flow distribution lines are divided into k-class $c_j'(i=1,2,\mathbf{L}\,k)$, $c_j'=\frac{1}{|C_j|}\sum_{X\in C_j}X$, according to the similarity with clustering centers. According to the fuzzy clustering principle, the adaptive optimization of network points of logistics distribution centers is carried out, and the results of logistics distribution are obtained. The Euclidean distance between each point and the cluster center is divided into the cluster center with the smallest distance. The new clustering center is calculated and the maximum sparse scheduling in the process of logistics distribution is obtained according to the particle swarm optimization method. Where $|C_j|$ is the number of data points in the j class, the sample points are reorganized based on the objective function clustering method. According to the shortest path control, the optimal allocation criterion function $J=\sum_{i=1}^{k}\sum_{x\in c_j}d\left(x-c_j\right)$ of the logistics distribution line is obtained, but when the control function reaches the minimum, it iterates until the center of the cluster converges. Thus, the variance of particle swarm global fitness of logistics distribution route clustering in e-commerce environment is obtained:

$$s^2=-\sum_{i=1}^{n}\left(\frac{f_i-f_{avg}}{f}\right)^2 \quad (12)$$

Where n is the number of distribution particles in electronic commerce environment, f_i is the fitness of the i particle, f_{avg} is the average fitness of the optimal allocation of logistics distribution routes in e-commerce environment, and when $s^2<m$, m is a certain threshold.

3.2. Multi-objective clustering of distribution routes

Combined with the global optimization characteristic of particle swarm optimization algorithm, the optimal selection of logistics distribution route is carried out, and the attributes of multi-objective sample set of logistics distribution line are normalized, and the distribution line data set among n data points is obtained. The difference degree matrix is $n\times n$, which is the matrix is:

$$D=\begin{bmatrix} 0 & d(1,2) & d(1,3) & \cdots & d(1,4) \\ d(2,1) & 0 & d(2,3) & \cdots & d(2,n) \\ d(3,1) & d(3,2) & 0 & \cdots & d(3,n) \\ \vdots & \vdots & \vdots & 0 & \vdots \\ d(n,1) & d(n,2) & d(n,3) & \cdots & 0 \end{bmatrix} \quad (13)$$

$$d(i,j)=\sqrt{\left(\left|x_{i1}-x_{j1}\right|^2+\cdots+\left|x_{id}-x_{jd}\right|^2\right)} \quad (14)$$

By calculating the distance between C_1 and C_2 of any data point in D, the difference matrix between $d(X_i,C_1)$, $d(X_i,C_2)$, the third cluster center C_3 is $\max(\min(d(X_i,C_1),\min(d(X_i,C_2)))$.

According to the result of solving the optimization solution, the multi-objective clustering is carried out, and the dimension of the K_{-th} clustering center is obtained:

$$\max(\min(d(X_i,C_1),\min(Xi,C_2),\cdots,\min(d(X_i,C_k)))) \quad (15)$$

For the delayed data point X_i of the logistics distribution line, the k initial cluster centers can be automatically determined by analogy. In this paper, the multi - objective optimization selection of the logistics distribution line is realized by using the particle swarm adaptive clustering method, and the implementation flow is shown in figure 1 .

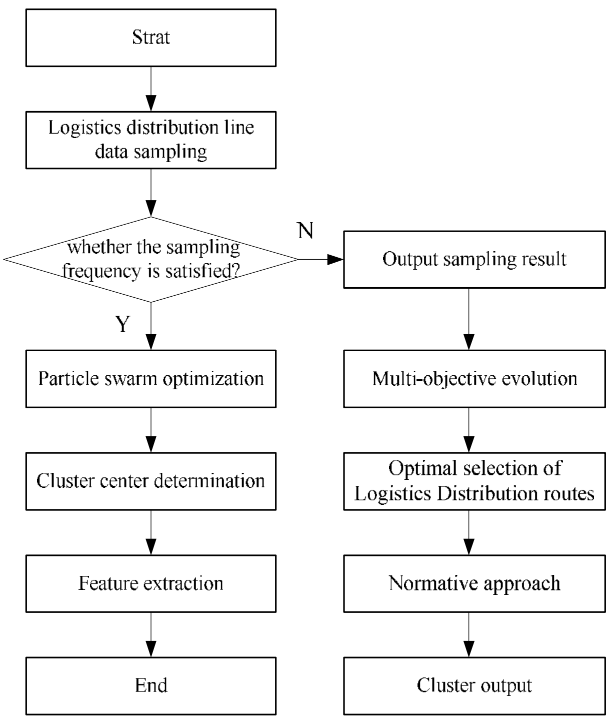
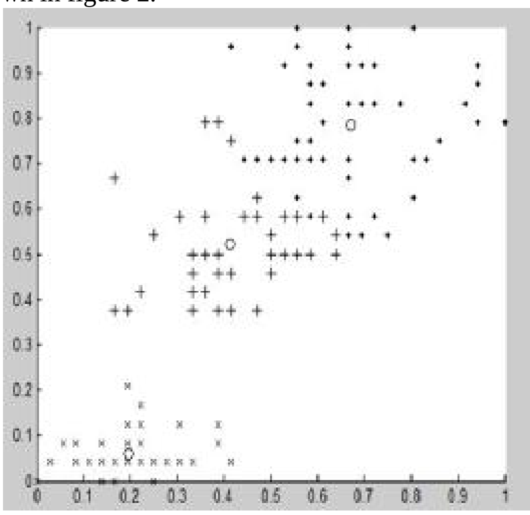


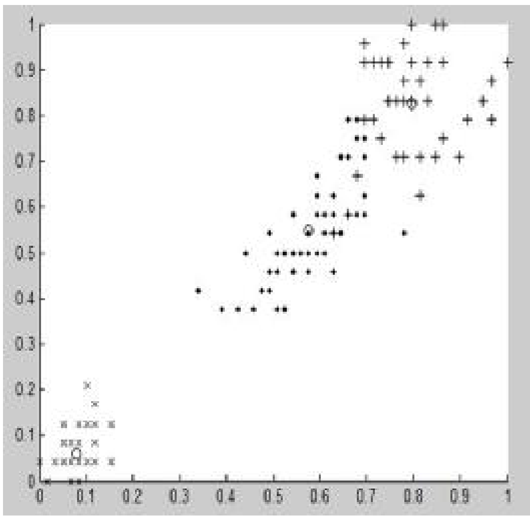
Figure 1. Flow chart of multi-objective clustering optimization algorithm for logistics distribution routes

4. Simulation Experiment and Performance Analysis

In order to verify the performance of this algorithm in the realization of physical distribution route optimization and target clustering, the simulation experiment is carried out. In the experiment, the artificial data set of logistics distribution line is taken as the test set, and the iris sample in the large logistics database is used as the test set. This set is a data set test ε=2.21, MP=37.69, when testing the wine data set, ε=20.3, MP=47.65. each sample has 4 attributes. The number of logistics distribution lines is 100, and the number of nodes is 1024. Different methods are used for clustering analysis, and the results of target clustering of logistics distribution lines are compared as shown in figure 2.



(a) k-means



(b)Proposed algorithm

Figure 2. Comparison of target clustering results of logistics distribution routes

Figure 2 shows that the clustering performance of multi-objective optimization of logistics distribution line is better by using this method in electronic commerce environment. The efficiency of logistics distribution is tested, and the comparison results are shown in figure 3. The analysis figure 3 shows that the efficiency of this method is higher than that of other methods.

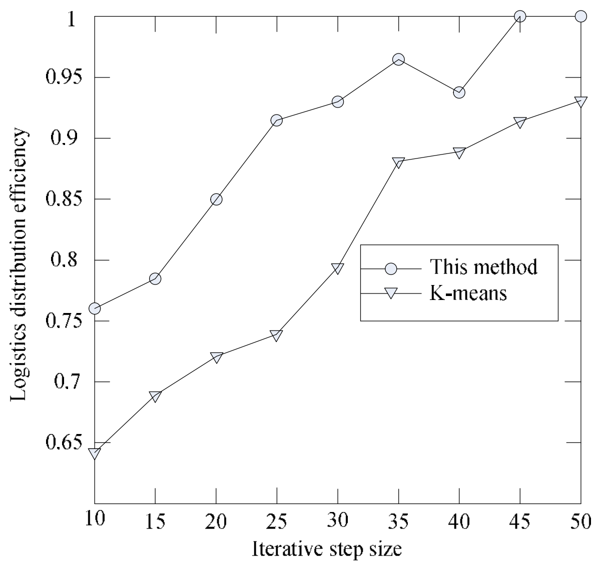


Figure 3. Testing of logistics distribution efficiency

5. Conclusions

In this paper, a multi-objective clustering algorithm based on particle cluster is proposed. In this paper, the maximum density sparsity detection of logistics lines and adaptive optimization method are used to schedule logistics distribution routes. The selection model of logistics distribution routes in e-commerce environment is constructed, and the particle swarm optimization algorithm is used to carry out the electronic commerce loop. In this paper, the multi-objective optimization model of logistics distribution line is constructed, and the global optimization characteristic of particle swarm optimization algorithm is used to optimize the logistics distribution route. The attribute of multi-objective sample set of logistics distribution line is standardized. In order to solve the shortest optimization value of logistics distribution route, multi-objective clustering is carried out according to the result of optimization solution, and the multi-objective optimization selection of logistics distribution route is realized by particle swarm adaptive clustering method. The research shows that the method has better performance in optimizing control of logistics distribution lines, it can improve logistics efficiency, reduce the loss of logistics lines, and improve the distribution efficiency of logistics lines. It shows good application value in practice.

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