Computer optimal path simulation planning of oil and gas storage and transportation based on similarity measurement of decision space

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Abstract. The optimal path of oil and gas storage and transportation has become an important issue of oil and gas transportation management, which has become an important research topic. By reasonably arranging the driving route of vehicles, enterprises can reduce their own transportation costs, which will optimize the objective function. By relying on the similarity measurement algorithm of decision space, we can optimize multiple objective functions of oil and gas storage and transportation, such as the number of vehicles, the total distance of the path, the total waiting time, vehicle service time, etc. Through the study of multiple route schemes, we can choose the optimal route simulation planning of oil and gas storage and transportation. First, we analyze the decision space similarity measurement algorithm. Then, the optimal path simulation planning of oil and gas storage and transportation is proposed. Finally, some suggestions are put forward.

Keywords: Decision space similarity measurement, oil and gas, optimal path simulation planning

1. Introduction
With the increasing specialization of logistics technology, multi batch and small batch logistics distribution has been developed rapidly[1]. With the maturity of logistics lines and vehicles, the pressure of urban traffic is increasing, which has caused many urban traffic problems, such as urban traffic congestion, vehicle noise, exhaust pollution, energy waste, vehicle mix, traffic accidents and so on. Oil and gas is an important transportation resource in China, which requires us to carry out oil and gas[2]. Therefore, the transportation is facing a severe urban traffic situation, and the logistics distribution path must be optimized. Efficient optimal route distribution will avoid many problems, such as backflow transportation, one-way transportation, circuitous transportation and empty driving,
which will reduce the distribution running time of vehicles and control the logistics transportation cost.

2. Similarity measurement algorithm based on decision space

2.1. Multi-objective evolutionary algorithm
The multi-objective evolutionary algorithm is a single objective optimization with uniform distribution in the target space[3]. Therefore, the multi-objective evolutionary algorithm is conducive to decision-maker selection, which will be lower than the multi-objective genetic local search algorithm and non dominated sorting genetic algorithm. In the multi-objective evolutionary algorithm, Zhang Qingfu proposed three decomposition strategies, including weighted sum approach, Chebyshev approach and boundary intersection approach[4]. This paper adopts Chebyshev decomposition strategy.

The multi-objective problem can be defined as Formula 1.

$$\minimize F(x) = (f_1(x),..., f_m(x))^T$$

$x \in \Omega$

(1)

Among them, $\Omega$ is the decision (variable) space, $F: \Omega \rightarrow R^m$ is composed of m objective functions. The set of objective functions can be defined as $\{F(x)|x \in \Omega\}$. So, $\Omega$ can be described as $\Omega = \{x \in R^m | h_j(x) \leq 0, j = 1,...,m\}$, $h_j$ is a continuous function.

According to Chebyshev decomposition strategy, we can get formula 2.

$$\minimize g^\ast(x | \lambda^\ast, z^\ast) = \max_{1 \leq i \leq m} (\lambda_i | f_i(x) - z_i^\ast|)$$

(2)

Among them, $\lambda = (\lambda_1,..., \lambda_m)^T$ and $\sum_{i=1}^{m} \lambda_i = 1$.

Through the decomposition strategy, we can decompose a multi-objective optimization problem into a group of single objective optimization with uniform weight vector distribution, which will get a group of Pareto optimal solutions.

If $\lambda^1,...,\lambda^N$ is a set of evenly distributed weight vectors, $z^\ast$ is a reference point.

By Chebyshev method, we can decompose it into N single objective optimization problems, which will get the objective function of the j-th subproblem, as shown in Formula 3.

$$g^\ast(x | \lambda^j, z^\ast) = \max_{1 \leq i \leq m} (\lambda_i | f_i(x) - z_i^\ast|)$$

$x \in \Omega$

(3)

Among them, $\lambda^j = (\lambda_1^j,..., \lambda_m^j)^T$ and $\sum_{i=1}^{m} \lambda_i^j = 1$.

In one run, we will optimize these N objective functions to the minimum.

2.2. Neighborhood construction method in decision space
Jaccard similarity coefficient is to calculate the ratio of intersection and union of two sets, as shown in formula 4.
\[ J(A, B) = \frac{|A \cap B|}{|A \cup B|} \] (4)

Therefore, if the elements between two sets are the same, the intersection of the two sets is the same as the union set, then \( J(A, B) = 1 \). On the contrary, if there is no common element between the two sets, the intersection of the two sets is empty, then \( J(A, B) = 0 \).

The individual of the problem is represented as a set of directed arcs \((u(i, k), u(i+1, k))\), and \((u(i, k), u(i+1, k))\) represents the k-th vehicle from the i-th customer point to the i+1-th customer point. Then the expression of a solution R is as the formula 5.

\[ R = \bigcup_{i=0}^{N_i} \bigcup_{k \in R} \{u(i, k), u(i+1, k))\} \] (5)

The similarity \( \zeta_{RQ} \) between solution R and solution Q is shown in formula 6.

\[ \zeta_{RQ} = \frac{\sum_{i \in V} \sum_{j \in V} y_{ijR} y_{ijQ}}{\sum_{i \in V} \sum_{j \in V} \text{sgn}(y_{ijR} + y_{ijQ})} \] (6)

3. Architecture of software system

3.1. Architecture of the system

Oil and gas storage and transportation optimal path simulation planning is divided into two layers of interface service management system and data processing system[5]. Its software architecture can be divided into three parts: interface service management, data acquisition and data processing output. Among them, the interface service management part mainly includes drawing mechanism management, button protection mechanism management, user data acquisition and intermediate data exchange management[6]. The output part of data processing mainly deals with data acquisition and path generation. The data acquisition part is used to connect the data exchange between the interface service management system and the data processing system, which will realize the reading of the server data. The specific software system architecture is shown in Figure 1.
3.2. Interface service management system
The interface service management system (U layer) in the software is mainly responsible for the input and output of interface management data, including the input of error prevention information, and the input and reception of data from DP layer. The interface service management system is shown in Figure 2.

3.3. Data processing system
Data processing system mainly realizes data processing and transmission, which requires data acquisition and calculation, path processing system and intermediate data exchange management. Through the system, we can generate data, such as adjacency matrix, path length, time and speed, which will achieve the global optimal path. The data processing system is shown in Figure 3.

4. Conclusions
With the continuous improvement of science and technology, oil and gas storage and transportation will gradually become an important basic industry of the national economy, which will become an important symbol to measure the comprehensive national strength and modernization of the country. Based on the similarity measure of decision-making space, we can optimize multi-objective problems, which will be decomposed into a group.
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