WEP Warwick Evans Publishing

International Journal of Global Economics and Management

ISSN: 3005-9690 (Print), ISSN: 3005-8090 (Online) | Volume 2, Number 3, Year 2024
DOI: https://doi.org/10.62051/IJGEM.v2n3.51
Journal homepage: https://wepub.org/index.php/IJGEM/index

Research on the Construction of Emergency Relief Center Site Selection Model Based on Firefly Algorithm

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ABSTRACT

Aiming at the problem of site selection of rescue center under multi-objective after natural disaster, this paper constructs a site selection model to minimize the freight cost and maximize the time satisfaction of disaster victims. Firstly, the site selection model framework will be constructed according to the objectives, secondly, the model framework will be set up with specific constraints, and finally, the improved firefly optimization algorithm (SGSO) will be applied to conduct virtual simulation experiments. The SGSO algorithm is only used with the theory of the set of good points for the algorithm to initialize the population, and at the same time, it combines the inverse chord function with the step convergence factor, and it designs a formula for updating the position of the individuals in the population. On the basis of passing 8 standard test functions, virtual simulation experiments are carried out, and it is concluded that the SGSO algorithm can effectively solve the multi-objective siting problem, and provide more ideas and guarantees for the future research.

KEYWORDS

Emergency aid; Site selection model; Firefly algorithm improvement; Swarm intelligence algorithm

1. INTRODUCTION

With the rapid development of the human science and technology era process, the environmental change is not only its own driving change, but also bear a series of changes brought about by human production and life, which leads to a variety of natural disasters occurring frequently around the world, to the global people's security has brought serious impact. Natural disasters mainly include droughts and floods, meteorological disasters such as typhoons, hailstorms and snow, geological disasters such as volcanoes, earthquakes and mudslides, oceanic disasters such as storm surges and tsunamis, as well as major bio-hazards, etc., and a variety of natural disasters befall the world almost every year. In recent years, environmental patterns have changed dramatically, the situation of global warming is grim, natural disasters occur frequently around the world, and people everywhere suffer from different degrees of destruction of their homes and diseases. Our country has a vast territory and complex climate pattern, which leads to the occurrence of various meteorological disasters. How to determine the location of the post-disaster relief center, how to reasonably allocate emergency supplies, build a time-sensitive emergency supplies transport chain, timely and effective distribution, to achieve the “first time” to solve the urgent needs of the affected areas, rescue the people in the disaster area, to protect the safety of life is the main research objectives and content of this topic. This topic research group intelligence algorithm, in the group intelligence algorithm selected and this topic is the most suitable firefly algorithm for research, at the same time on the firefly algorithm to improve, prediction and selection of a reasonable location of the rescue center, to prevent unnecessary casualties after the disaster phenomenon, to protect the people's life after the disaster safety.

Although the firefly optimization algorithm is an emerging algorithm, it has attracted extensive attention from many scholars at home and abroad due to its unique advantages. Scholars have carried out a series of in-depth research and improvement of the firefly algorithm, exploring its application potential in a number of practical areas. Through continuous research and practice, the firefly algorithm has been successfully applied in several fields, providing an effective optimization method for solving practical problems. Wang Fuyu [1] and others introduced the tangent function to improve the algorithm by changing the step size, increasing the local search capability of the algorithm to solve the Pareto solution, and realizing the mobilization of emergency supplies in the disaster area under the conditions of guaranteeing the satisfaction of the demand in the disaster area and the fairness of the rescue time; Fan Ling [2] used the weighted least squares method to compute the Cartesian distance of the two fireflies under the conditions of their activities, and updated the firefly's The spatial location to predict the distribution network load overload index to solve the photovoltaic distribution network load overload problem; Zeng Bing [3] and others for the shortcomings of the firefly algorithm Canon firefly algorithm for the introduction of vector matrices in the way of the firefly discrete initialization to obtain a discrete firefly algorithm to solve the field of assembly sequence planning; Liu Changping, Ye Chunming [4] use the ROV rule encoded as you go way to update the initialization of the firefly step and a local search strategy with interchangeable operations to solve the shop floor scheduling problem for minimizing the maximum completion time. In this project, we will propose an improvement strategy for firefly initialization in a novel way to complete a novel optimization of the firefly algorithm.

The Firefly Optimization Algorithm (GSO) models each potential solution in the search space as a firefly and starts the search process by randomly distributing these firefly individuals. The algorithm simulates the movement behavior of fireflies in reality, and through iteration, the fireflies gradually gather around the brightest individual to find the optimal solution to the problem. The following equations represent, from top to bottom, the fluorescein update stage, the individual firefly transfer stage, the individual firefly movement stage, and the dynamic decision domain update stage:

$$l_i(\mathrm{t}+1) = (1-\rho)l_i(t) + \gamma J\big(x_i(t)\big) \tag{1}$$

$$P_{ij}(t) = \frac{l_j(t)-l_i(t)}{\sum_{k\in N_i(t)} l_k(t)-l_i(t)} \tag{2}$$

$$x_i(t+1) = x_i(t) + s * \left[\frac{x_j(t)-x_i(t)}{\|x_j(t)-x_i(t)\|}\right] \tag{3}$$

$$r_d^i(t+1) = \min\left\{r_s, max\left\{0, r_d^i(t) + \beta(n_t - |N_i(t)|)\right\}\right\} \tag{4}$$

Where ρ represents the fluorescein volatility factor, γ represents the fluorescein update rate, $\mathrm{J}(x_i(t))$ represents the function value of firefly i at generation t, $N_i(t)$ represents the neighborhood of firefly i, $|N_i(t)|$ is the number of fireflies in the neighboring domain of firefly i, s represents the moving step size, $\| \blacksquare \|$ is the distance sign of Cartesian calculation, r_d^i is the dynamic decision-making radius, r_s represents the given perceptual radius, β and n_t represent the dynamic decision domain update rate and the threshold of the number of fireflies contained in the neighborhood set, respectively, both of which are fixed coefficients.

In 1909, Alfred Weber solved the problem of determining the location of warehouses by supplying them to multiple recipients and minimizing the sum of the distances between them, which evolved into the research field of “site selection problem”. Hotelling first proposed the impact of transportation distance on product competitiveness, through the linear location model of the site selection problem carried out a preliminary exploration. Subsequently, Hakimi further studied the center and median problems of site selection, which laid a solid foundation for the development of site selection theory. Since then, the siting problem has attracted extensive attention and research from scholars in various countries, and the distribution center siting problem has gradually become a research hotspot and achieved vigorous development. Zhu Jingjun (2021) used an immuno-optimization algorithm in his study to solve an optimization model that meets the characteristics of emergency logistics siting and, through the accurate operation of the algorithm, to quickly and efficiently determine the siting plan of emergency logistics centers, which in turn provides a strong basis for the siting decision of other emergency logistics centers [5]. Zheng Yan (2020) constructed an integer model and evaluation model for the emergency logistics center location problem, aiming to ensure the coverage and total time cost while using simulated neural network method and depth-first search method to solve the model. The results of site selection under single-objective and multi-objective models are compared, and example experiments are conducted to deeply analyze the influence of different models on site selection decisions and evaluate the relevant influencing factors [6].

On the basis of in-depth analysis of the post-disaster reality and the background of the development of the emergency relief center, the importance of the site selection problem of the emergency relief center is deeply recognized. To this end, a systematic study of the firefly algorithm is first carried out and a novel improvement strategy-SGSO algorithm-is proposed, which optimizes the step size by introducing an inverse string function and improves the location update formula, thus significantly enhancing the global search capability of the algorithm and further improving the convergence accuracy and speed. In order to verify its performance, this paper implements the algorithm in a computer environment using MATLAB, and at the same time verifies its excellent optimization ability by solving the function optimization problem. Secondly, this paper has systematically sorted out the relevant theories and common methods of distribution center siting, and discussed in depth the emergency center siting model. On this basis, an emergency center site selection model is constructed with comprehensive consideration of time-cost factors, providing a scientific basis for site selection decisions. In order to solve the model, the improved firefly algorithm (SGSO) is applied to the problem of site selection for emergency centers, and the final results are realized through programming, which verifies the operability of the theory.

2. ALGORITHM IMPROVEMENT

2.1. Initialization Optimization-Good Point Set (Mathematical Formula)

The traditional firefly algorithm is to take a random distribution of the initialization strategy, which will not only lead to the inability to traverse all the cases, but also cause the algorithm to be less accurate results. The main use of the good point set of this new initialization method, so that the initialization of the population can be uniformly distributed in the solution space to improve the accuracy of the algorithm. The theory of good point set is proposed by Hua Luogeng in the book “Application of Number Theory in Approximate Analysis” [7], which can effectively reduce the deviation and improve the accuracy of the population compared with randomly selected points. Figure 1demonstrates the comparison of the two initialization methods, the left side is the initial population generated by the random method and the right side is the initial population generated based on the theory of good point sets. From the figure, it is obvious that the initial population generated by using the theory of good point set has a more uniform distribution in the two-dimensional space, which can better cover the whole search space, thus ensuring the traversal of the optimization process and improving the stability of the algorithm.

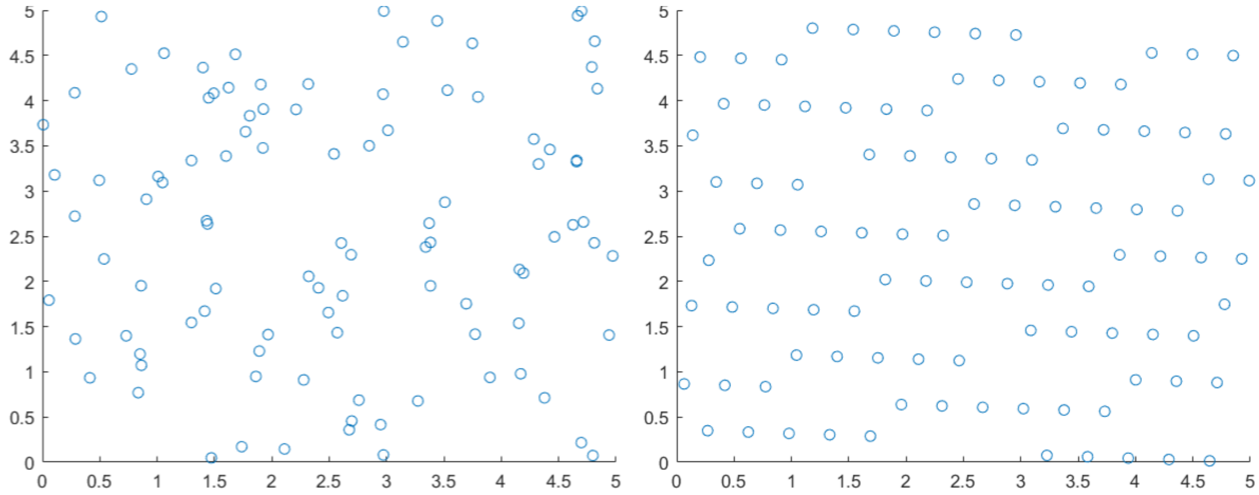

Figure 1. Comparison plot of population initialization

2.2. Step Size Optimization-Adaptive

In the traditional implementation of the firefly algorithm, individual fireflies move within their limited range through the perception and decision domains. However, as the iterative process deepens, fireflies gradually tend to gather around individuals with higher brightness. In this case, if the fireflies move beyond their decision radius, they may frequently jump out of the current optimal solution region and move in the opposite direction, forming the so-called oscillation phenomenon. This phenomenon will directly damage the accuracy of the algorithm and reduce its convergence speed.

In order to overcome this problem, this paper proposes a strategy to dynamically adjust the moving step size. Specifically, as the number of iterations increases, the moving step of the firefly decreases gradually. In this way, we aim to improve the accuracy of the algorithm and effectively avoid the occurrence of oscillation phenomenon. The inverse chord function y=arc sin(x), which conforms to this strategy, is explained as follows: when the independent variable x takes the value of 0.841, y reaches its maximum value of 1; and as the value of x gradually decreases, the value of y also decreases accordingly, and the rate of decrease gradually slows down. This feature makes the function an ideal choice for adjusting the step size of the firefly algorithm, and the step size is dynamically optimized as shown below:

$$s = \arcsin\left(0.841 * \frac{t_{max}-t}{t_{max}}\right) + s_0 \tag{5}$$

$$x_i(t+1) = x_i(t) + \left[\arcsin\left(0.841 * \frac{t_{max}-t}{t_{max}}\right) + s_0\right] * \left[\frac{x_j(t)-x_i(t)}{\|x_j(t)-x_i(t)\|}\right] \tag{6}$$

In the above equation, t_{max} ,t are the maximum number of iterations and the current number of iterations, respectively; s, $s_0$are the algorithm step size and fixed step size parameters, respectively, where is t_{max}, s_0 given parameters, and the position update of the ith firefly will no longer be used in the Eq. (3), but according to Eq. (6). The improved step size keeps decreasing, which makes the algorithm converge faster. Figure 2 shows the convergence trend of the step size when the initial step size s_0=0.5

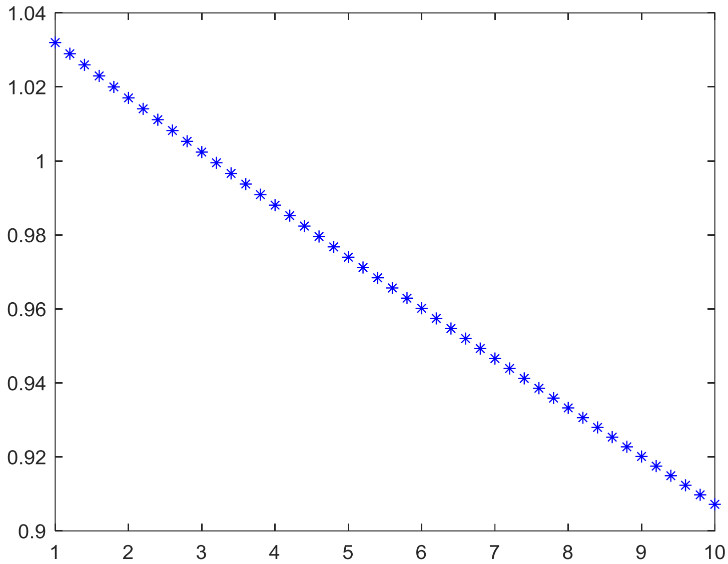

Figure 2. Step length convergence trend plot

2.3. Algorithm Performance Comparison Test

This subsection uses 8 functions to compare and test the algorithm performance of GSO and the improved firefly algorithm (SGSO), each algorithm is run independently for 50 times to get the optimal value, the worst value, the average value and the variance of the 8 functions to measure the algorithm, and at the same time, record the convergence images of the 8 functions in the finite number of iterations. In this subsection, the expressions of the test functions, the algorithm parameters and the experimental results are introduced in detail, and the rationality of the optimization of the algorithm is also demonstrated from various perspectives, such as the convergence speed and the accuracy of the optimization search.

The expressions and value ranges of the eight test functions are shown in Table 1.

Table 1. Test Function

Test function	Realm
$f1 = {x_1}^2 + {x_2}^2 - 0.3 * \cos(3\pi x_1) * \cos(4\pi x_2) + 0.3$	$\lvert x\rvert \leq 10$
$f2 = {x_1}^2 + {x_2}^2 + 25(sin^2 x_1 + sin^2 x_2)$	$\lvert x\rvert \leq 2\pi$
$f3 = 0.26 * (x_1^2 + x_2^2) - 0.482 x_1 x_2$	$\lvert x\rvert \leq 10$
$f4 = 0.5 + \frac{sin^2\sqrt{x_1^2 + x_2^2} - 0.5}{[1 + 0.0001(x_1^2 + x_2^2)]^2}$	$\lvert x\rvert \leq 10$
$f5 = \sum_{i=1}^{d} (x_1)^2 + 10\cos(2\pi x_i)^2 + 10$	$\lvert x\rvert \leq 5.12$
$f6 = (\lvert x_1\rvert - 5)^2 + (\lvert x_2\rvert - 5)^2$	$\lvert x\rvert \leq 10$
$f7 = (1.5 - x_1 + x_1 x_2)^2 + (2.25 - x_1 + x_1 {x_2}^2)^2 + (2.625 - x_1 + x_1 {x_2}^3)^2$	$\lvert x\rvert \leq 10$
$f8 = 100(x_1^2 - x_2)^2 + (1 - x_1)^2$	$\lvert x\rvert \leq 10$

In order to ensure the rationality and effectiveness of the algorithm test, the initial size of all populations is set to 100 and the number of iterations is set to 50, and the efficiency of SGSO is verified through the test function comparison experiment. The following Table 2 shows the correlation values obtained by iterating the above functions 50 times on the GSO algorithm and the SGSO algorithm. The optimal values obtained by running the SGSO algorithm 50 times are 1.725760E-59, 2.267992E-06, 7.953104E-05, 1.735180E-05, 6.440696E-06, 5.942832 E-06, 5.678892E-05 and 2.523008E-06, which are better than the optimal values obtained by running the GSO algorithm 50 times.

Meanwhile, Figure 3 compares the comparison between the minimum value of the algorithm's test function-number of iterations (left GSO right SGSO), and the SGSO algorithm outperforms the original GSO algorithm in terms of convergence accuracy as well as speed, which verifies the effectiveness of SGSO. In summary, in the above test functions selected, the SGSO algorithm has obvious improvement compared with the original GSO algorithm, which shows the reasonableness and effectiveness of the way of updating the step size and then optimizing the algorithm proposed in this paper.

Table 2. Table of 50 function runs

function	arithmetic	minimum value	optimum value	average value	variance
1	GSO	4.884981E-15	5.551115E-17	1.527667E-15	1.435132E-30
	SGSO	2.282538E-06	1.725760E-59	0	0
2	GSO	6.036173E-04	6.036166E-04	6.036169E-04	2.750270E-20
	SGSO	6.697196E+00	2.267992E-06	4.950535E-01	9.232185E-01
3	GSO	9.61248E-05	9.65153E-10	2.36429E-05	6.67928E-10
	SGSO	2.077010E+01	7.953104E-05	7.067927E-01	4.852499E+00
4	GSO	9.854029E-04	9.854029E-04	9.854029E-04	1.777023E-32
	SGSO	2.951615E+00	1.735180E-05	3.192780E-01	5.291560E-01
5	GSO	9.854029E-04	9.854029E-04	9.854029E-04	5.033409E-33
	SGSO	2.726276E+00	6.440696E-06	2.662895E-01	2.206909E-01
6	GSO	2.648127E-16	2.949325E-19	8.436259E-17	4.386926E-33
	SGSO	2.113941E+01	5.942832E-06	9.245915E-01	9.065764E+00
7	GSO	2.475483E-04	2.475483E-04	2.475483E-04	4.556885E-33
	SGSO	1.700705E+07	5.678892E-05	1.728164E+05	2.891991E+12
8	GSO	3.772404E-09	3.770083E-02	3.771258E-09	4.837651E-25
	SGSO	3.421570E+01	2.523008E-06	7.740713E-01	1.206176E+01

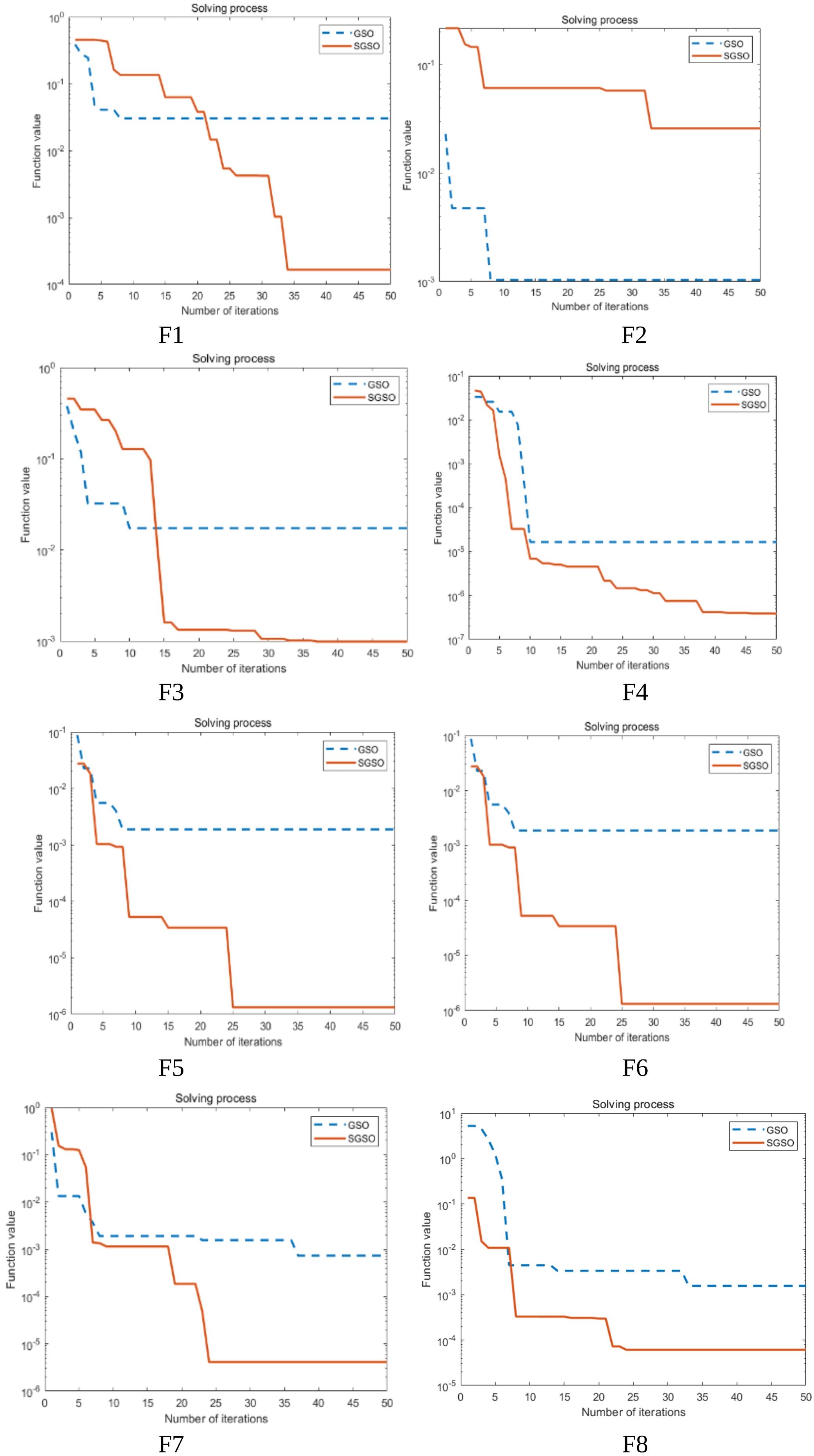

Figure 3. Test Function Iteration Chart

3. RESCUE CENTER SITE SELECTION MODEL

3.1. Statement Of The Problem

The issue of site selection was established in the early stages of a natural disaster, when emergency relief efforts were imminent. In this context, the establishment of an emergency relief center is a crucial part of the rescue work. This paper constructs a scientific and practical emergency relief center, whose status can be described as: abundant supplies, high road access and supplies can be satisfied.

3.2. Model Assumptions

The following assumptions will be made in order for the model to be more relevant to real life:

(1) The affected areas are all within the distribution area;

(2) The distance between the affected points and the relief centers adopts Cartesian distance;

(3) The capacity of the relief center is certain and can meet the demand of each affected point;

(4) There is only one relief center for distribution in each disaster-stricken point, which accepts point-to-point distribution of materials without secondary distribution;

(5) The quantity of material demanded at the disaster-stricken point is known.

(6) The cost of transportation per unit of goods is a fixed value

(7) Information on the construction cost of the relief center and other fixed costs is known;

(8) The roads between the affected points are clear;

From the problem description the virtual site selection model can be shown in Figure 4.

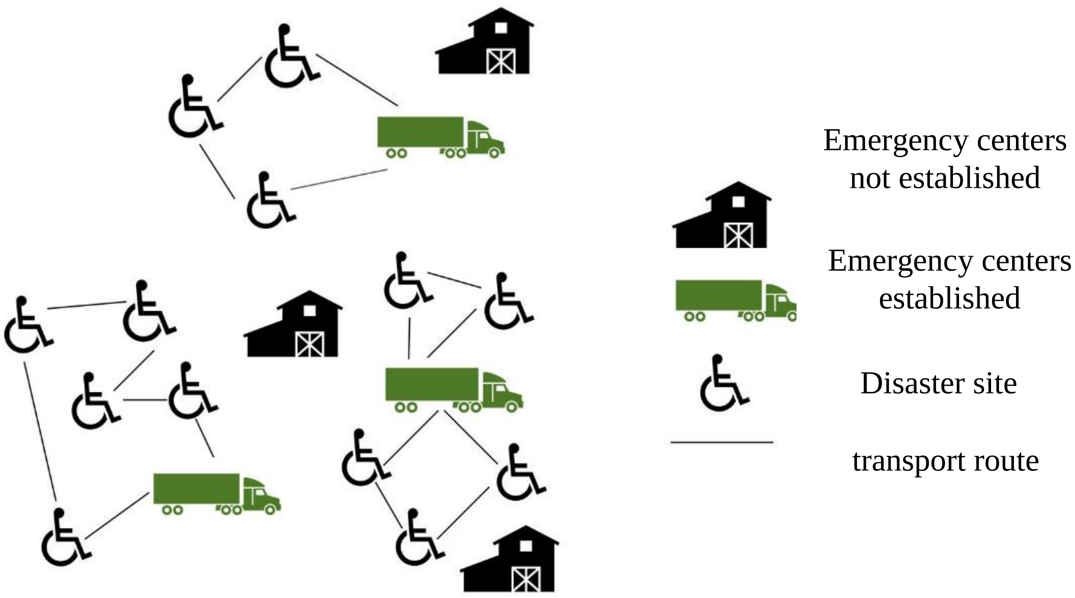

Figure 4. Site Selection Mockup

3.3. Modeling And Parameter Definition

When natural disasters occur, the goal of establishing an emergency relief center location model is to achieve rapid response and effective relief to the disaster area by optimizing the layout of the emergency relief center. Therefore, the model will aim at minimizing the distribution cost and maximizing the time satisfaction in the disaster area to ensure that it can reach the disaster area quickly and provide effective help in emergency situations on the basis of minimizing the rescue cost.

Based on the above assumptions, the model can be fitted as follows: h points are selected as the location of rescue centers from r alternative rescue center points, and based on meeting the distribution service demand of the disaster demand point w in the region, the location coordinates of each disaster point i are (x_i, y_i), and the fixed cost of the selected rescue centers, the minimum of the sum of the distribution cost between the demand points, and the maximum satisfaction of meeting the demand points are the objective functions, the fixed cost of the selected rescue centers, the minimum of the sum of the distribution cost between the demand points, and the maximum satisfaction to the demand points are the objective functions of the model. As the objective function:

$$\min Q = \sum_{j\in R}\sum_{i\in W} pd_{ij}s_{ij} + \sum_{j\in R} Z_j F_j \tag{7}$$

$$\max F = \sum_{i\in W}\sum_{j\in R} Z_j F_{ij} d_{ij} f(t_{ij}) \tag{8}$$

$$f(t_{ij}) = \begin{cases} 0 \ , t_{ij} > U_i \\ \frac{U_i - t_{ij}}{U_i - L_i} \ , U_i < t_{ij} < L_i \\ 1 \ , t_{ij} < L_i \end{cases} \tag{9}$$

Where R is the set of alternative relief centers, j denotes the jth relief center point, and h relief centers are determined to be built; W denotes the set of disaster-affected points, i denotes the ith disaster-affected demand point; s_{ij}denotes the Euclidean distance from the disaster-affected point i to the relief center point j; d_{ij}denotes the amount of material transported; $D_i$denotes the amount of material needed for the disaster-affected demand point i; p denotes the cost of transportation per unit; F_j denotes the construction fixed cost; t_{ij} is the time needed to transport the supplies from the disaster-affected point i to the relief center point j; M is a constant representing a very large positive number, which can be used as the capacity of the emergency relief center to a certain extent; L_i is the longest waiting time within the acceptable range; and $U_i$is the shortest waiting time in the state of extreme dissatisfaction.

Decision variables: $Z_j$is a 0-1 variable, which takes 1 if an emergency center is established at the point, and 0 otherwise; F_ij is a 0-1 variable, which takes 1 to indicate that there is a supply and demand relationship between the emergency center and the affected point; and 0 otherwise.

The objective function (7) is expressed as the minimum cost cost, so that the transportation cost and fixed cost cost are minimized; the objective function (8) represents the maximization of satisfaction, in which $f(t_{ij})$is the satisfaction function, based on the literature [8] under the study makes the satisfaction measurable. The constraints are as follows:

$$F_{ij} \le Z_j,\ \forall i \in W;\ j \in R \tag{10}$$

$$\sum_{j=1}^{r} d_{ij} \ge D_i,\ \forall i \in W \tag{11}$$

$$\sum_{j=1}^{r} Z_j = h \tag{12}$$

$$\sum_{i=1}^{w} d_{ij} \le MZ_j,\ j \in R \tag{13}$$

$$\sum_{j=1}^{r} F_{ij} = 1,\ \forall i \in W \tag{14}$$

$$Z_j, F_{ij} \in \{0,1\}, \forall i \in W;\ j \in R \tag{15}$$

Constraints: constraint (10) indicates that supplies can be transported to the disaster-affected demand point only if the alternative relief center point has been constructed; constraint (11) indicates that the quantity of supplies transported must be able to satisfy the quantity of demand at the disaster-affected point; constraint (12) represents the selection of h points to be used as emergency relief centers; constraint (13) indicates that the emergency relief center is established at a candidate emergency relief center if the center provides services to the demand point; constraint (14) the affected demand point is only supplied by a unique relief center; constraint (15) represents that Z_j, F_{ij} are both 0-1 variables.

3.4. Simulation Experiment

In this paper, it is assumed that there are 20 disaster sites after a natural disaster, and three of the six alternative relief center sites are selected as emergency relief center sites. The algorithm and model fixed-value parameters are shown in **Table 3**; the information of each disaster area is shown in **Table 4**; and the construction cost of the alternative rescue centers is shown in **Table 5**, Alternative center location information is shown in **Table 6**:

Table 3. Fixed parameter table

Parameter name	parameterization
Population size n	n=100
Initial step size s_0	s_0=0.5
$Fluorescein\ volatilization\ factor\ \rho$	ρ=0.4
$Fluorescein\ update\ rate\ \gamma$	γ=0.05
Dynamic decision domain update rateβ	β=0.08
Number of iterations	Max=100

Table 4. Disaster Area Information Sheet

demand point	$x_i,$	y_i	quantity demanded Q	$U_i,$	L_i
1	419.20	972.70	108.00	2.43	1.43
2	452.65	1006.13	107.00	2.52	1.52
3	486.11	1033.99	107.00	0.29	0.00
4	348.12	1042.34	88.00	0.58	0.00
5	382.96	1075.77	87.00	9.28	8.28
6	417.81	1105.02	96.00	0.22	0.00
7	286.79	1121.74	108.00	0.50	0.00
8	296.54	1171.88	107.00	1.07	0.07
9	299.33	1215.06	107.00	1.77	0.77
10	384.36	1194.17	88.00	0.75	0.00
11	410.84	1220.63	87.00	9.48	8.48
12	310.48	1262.42	96.00	0.07	0.00
13	330.00	1298.63	95.00	0.28	0.00
14	437.32	1247.10	88.00	9.01	8.01
15	465.20	1272.17	87.00	5.33	4.33
16	360.66	1320.92	96.00	0.51	0.00
17	388.54	1347.39	95.00	5.97	4.97
18	621.31	1170.49	112.00	6.16	5.16
19	645.01	1195.56	111.00	3.60	2.60
20	553.01	1235.95	100.00	5.36	4.36

Table 5. Alternative Center Construction Cost Sheet

Alternative drop-in centers	1	2	3	4	5	6
construction cost F_j	10000	15000	13500	18000	19000	12000

Table 6. Table of alternative center locations

Alternative center point	x_i,	y_i
1	304.930048	1038.99
2	388.5618	1124.74
3	328.625696	1199.17
4	363.472184	1250.10
5	388.5618	1348.39
6	447.103936	1238.95

The siting simulation simulation experiment is solved by MATLAB R2018b software, the hardware environment is Intel(R) Core(TM) i5-10200H CPU @ 2.40GHz dual-core processor, the running memory is 8GB, the software environment is Windows10 system 64-bit, the convergence curve of the virtual simulation experiment is shown in **Figure 5** and siting scheme is shown in **Figure 6.**

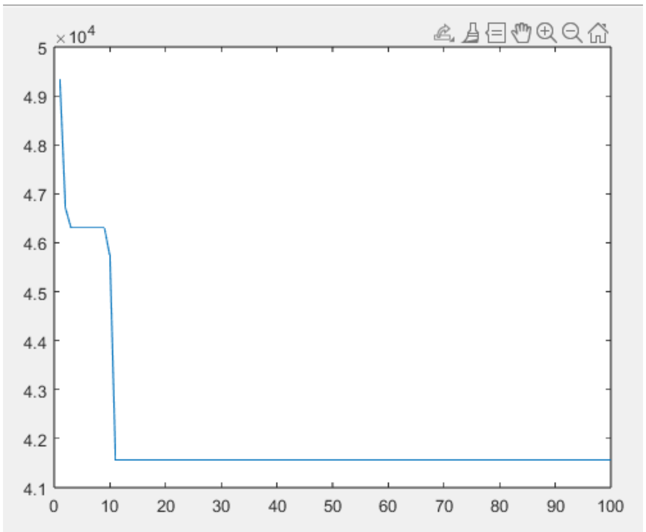

Figure 5. convergence plot

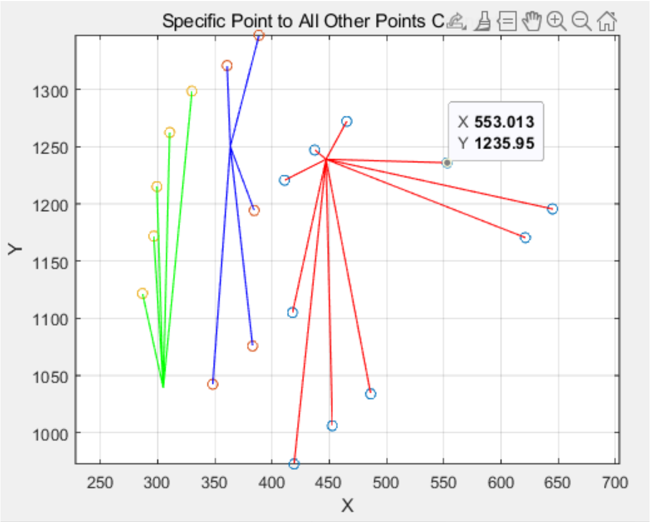

Figure 6. Site selection program map

The model of site selection scheme is shown in **Figure 7** below, the first line represents the site selection of the rescue center, in this result 1, 4, 6 is selected, the second line represents the path connection between the affected point and the rescue center; the second line 1 represents the distribution of relief materials by the rescue center 1; the second 1 represents the selection of the 4th point as the 2nd rescue center for distribution, and the third 1 represents the selection of the 6th point as the 3rd rescue center for transporting the materials. From this analysis, salvage center 1 transports 7, 8, 9, 12, 13, and transports salvage materials; salvage center 2 transports materials to salvage centers transporting 4, 5, 10, 16, and 17, and salvage center 3 transports materials to 1, 2, 3, 6, 11, 14, 15, 18, 19, and 20.

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Figure 7. Site Selection Operating Model

4. SUMMARY

This paper focuses on the siting problem of emergency relief centers in the context of natural disasters, aiming to realize the practical application of multidisciplinary cross-fertilization with the help of artificial intelligence technology. Through in-depth exploration of the literature review, it is found that traditional site selection methods have limitations in dealing with complex spatial relationships and multiple constraints. In view of the unique advantages of the firefly algorithm in solving such problems, the algorithm is selected as the main tool for solving the siting problem of emergency centers.

In the implementation process, this paper takes the site selection model in the virtual scene as an application example. Firstly, based on the traditional firefly algorithm, the theory of good point set is introduced to ensure the uniform distribution of the initial population in the solution space. Secondly, the step size is dynamically adjusted by introducing the inverse string function to further optimize the location update strategy of the firefly population and form the improved SGSO algorithm. In order to verify the feasibility and effectiveness of the algorithm, we use eight test functions for empirical analysis. Finally, when constructing the site selection model, we fully consider the post-disaster natural environment factors and the psychological condition of the disaster victims, and take the time satisfaction and the freight cost of materials as the main constraints. By using the virtual environment data for experiments, the final site selection results are obtained, which provide a solid theoretical foundation and practical guidance for solving the problem of emergency relief center site selection.

ACKNOWLEDGEMENTS

Funded by the Innovation and Entrepreneurship Training Program for College Students of Anhui University of Finance and Economics (202210378339)

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