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Application of Mathematical Methods in Computer Algorithms Under the Background of Internet

Lian Xue*

School of Computer and Computing Science, Zhejiang University City College, Hangzhou 310015, Zhejiang, China
**Corresponding author e-mail: xlmathzucc@126.com*

Abstract: *At present, the world's Internet technology has penetrated into every part of our lives. And Internet technology and computer technology complement each other, indispensable. At the same time, they are constantly developing together. Computer algorithm is the most basic and core content of programming, and mathematical method, as the most fundamental research method in computer algorithm, has a close relationship with the development of computer programming program code. With the development of computer technology, mathematical methods have been highly valued in the field of computer. The efficient combination of computer algorithm and mathematical method can realize the maximum utilization of computer algorithm. The logical thinking of mathematical method is embodied in computer algorithm. And in our learning life, we began to contact with the application of computer algorithms, and even contact with the relevant types of questions. The simplest example is a computer flow chart. As a compulsory education that our country attaches great importance to, the mathematical methods we learn also infiltrate into the computer algorithm. Enough to show the close relationship between them. Therefore, this paper mainly discusses the application of mathematical methods in the analysis process of computer algorithm, and through the analysis of this paper, provides suggestions and reference for the development of computer algorithm.*

Keywords: *Internet, Mathematical Method, Computer Algorithm, Method Application*

1. Introduction

There is an inseparable relationship between mathematical methods and computer algorithms. In the design process of computer algorithms, we generally apply mathematical methods to problem-solving ideas and program design. Mathematical methods are more and more closely related to other disciplines, especially the rapid development of the integration of computer and mathematics. Therefore, in computer algorithms, mathematical methods have been widely used, and constantly promote the development of computer algorithms [1]. With the research and analysis of computer algorithm, we will find that computer algorithm is an important form of application of mathematical methods in life. Mathematical method, as an inductive method, builds mathematical models and summarizes laws on the basis of strict logic to obtain results with the least amount of calculation [2-4]. Mathematical methods are logical, abstract and extensive. Logicality means that all elements must be logical in the application of mathematical methods. Abstractness means that in the process of learning mathematics, mathematical methods are used to simplify the characteristics of things, facilitate people's statistics and calculation, and enhance the scientificity and rationality of mathematical methods. Universality refers to the ubiquity of mathematical methods in life. In computer programming, with the aid of mathematical modeling, the efficiency of the program is realized by applying mathematical algorithms.

The computer algorithm mainly refers to the process that the computer transforms the input into the output according to the requirements. The computer algorithm is the content of the specific description of the calculation process executed by the computer. The computer algorithm has four main properties: first, the computer algorithm must be correct, only the correct and reasonable algorithm can output the input content; second, each step of the implementation process of the computer algorithm must be specific, not abstract and fuzzy; third, the computer algorithm is the implementation of each step, the order is determined, there is no uncertainty; fourth, the computer algorithm is the implementation of each step, The steps of computer algorithm are limited and can not fall into the infinite loop. Only the above four properties can be called computer algorithm. The more important computer algorithms

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include a * search algorithm, beamsearch, two partition search algorithm, data compression, etc. the existence of these algorithms makes the computer run better [5, 6]. Computer programming achieves different goals of practical work by compiling different computer languages. In the process of compiling practical programs, mathematical algorithms must give full play to the optimization of computer programming. It optimizes computer programming by fusing the idea of mathematical algorithm when writing programs, and continues to simplify language programs when writing programs.

As the basis of computer algorithm, mathematical method is of great significance in the development of computer technology [7]. In the development of computer technology, we should accelerate the combination of computer and mathematics, optimize computer algorithm to the greatest extent, and provide new development direction for computer algorithm [8]. We must accurately realize the importance of combining computer algorithm with mathematical thinking method, and emphasize mathematical thinking and computer algorithm analysis in this process [9]. Find the coupling point between mathematical thinking and computer algorithm. Promote the organic integration of computer algorithm and mathematical method, and promote the development and progress of computer algorithm [10].

2. Algorithm Establishment

2.1 Cuckoo search algorithm

If there is an n-dimensional bird's nest in the experiment, it is assumed that the solution to the problem is d-bird, X=($x_1, x_2, \dots, x_i, \dots, x_D$), x_i It represents the value of d-dimensional spatial component, and the formula for updating nest position is as follows:

$$x_i^{t+1}=x_i^t+ Levy(\lambda) \tag{1}$$

x_i^t and x_i^{t+1} denotes the component $x_i$of the solution respectively The t generation and $t+1$ generation of I, α is the step length, and levy (λ) represents $Levy$ flight. The calculation of step length α is shown in formula (2), where α_0 is a constant, x_{best} represents the global optimal solution of the whole population.

$$\alpha = \alpha_0(x_i^t - x_{best}) \tag{2}$$

Levy (λ) is a random number and obeys Levy distribution, as shown in formula (3)

$$Levy(\lambda)=\frac{\emptyset\times\mu}{|\gamma|^{\frac{1}{\lambda}}},1\leq \lambda \leq 3 \tag{3}$$

The values of μ and ν random numbers λ are in the range of [1,3], and the value of ϕ can be obtained according to (4)

$$\varphi = \left\{\frac{\Gamma(1+\lambda)\times\sin\left(\pi\times\frac{\lambda}{2}\right)}{\Gamma\left\{\left[\frac{1+\lambda}{2}\right]\times\lambda\times2^{\frac{\lambda-1}{2}}\right\}}\right\}^{\frac{1}{\lambda}} \tag{4}$$

The new location is updated as in formula (5)

$$x_i^{t+1}=x_i^t + (x_j^t - x_k^t) \tag{5}$$

Where R is the random number between (0,1), x_j^t、x_k^t is the two selected nest locations.

2.2 Ant colony optimization algorithm

Let there be n cities in the TSP to be solved. At first, m ants are randomly placed in n cities. At this time, the pheromone quantity on each path is the same, which is denoted as τ_{ij}=c。 Each ant chooses the next city according to the amount of pheromone on the road and the distance between cities. At t, the probability of ant K transferring from I to j isp_{ij}^k(t) is as follows:

$$p_{ij}^k(t)=\begin{cases}\frac{[\tau_{ij}(t)]^2[(\eta_{ij}(t)]^\beta}{\sum_{s\in j_k(i)}[\tau_{is}(t)]^\alpha[\eta_{is}(t)]^\beta} \\ 0, otherwise\end{cases} \tag{6}$$

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[$j_k(i)$={1,2,…,n} - $tabu_k$]Represents the city that ant K can choose next. $tabu_k$records the city ant K currently walks through, that is, forbidden city. All n cities joined in $tabu_k$, the ant K goes around the city. In equation (6), $\eta_{ij}(t)$The transfer of the representation of the expectation from it (I) to j. When all ants circled the city, pheromone messages were updated according to equations (7) and (8)

$$\tau_{ij} = (1-\rho)\tau_{ij} + \Delta\tau_{ij} \tag{7}$$

$$\Delta\tau_{ij} = \sum_{k=1}^{m} \Delta\tau_{ij}^{k} \tag{8}$$

ρ (0 < ρ < 1) denotes pheromone evaporation; 1 - ρ represents pheromone residue; and $\Delta\tau_{ij}$ is the increment of pheromone from city I to city J. $\Delta\tau_{ij}^{k}$is the pheromone left on ij by the kth ant. If the ant K does not pass through the edge ij, $\Delta\tau_{ij}^{k}$ is 0. $\Delta\tau_{ij}^{k}$ is:

$$\Delta\tau_{ij}^{k} = \begin{cases} \frac{Q}{L_k}, if\ the\ k\ ant\ used\ edge(i,j) in\ its\ tour \\ 0, otherwise \end{cases} \tag{9}$$

Q is pheromone strength; L is pheromone strength L_k is the path of the kth ant in the current loop.

Sum of path lengths f(π_i) The shortest function f (π) is defined as follows:

$$f(\pi) = \sum_{i=1}^{n-1} D(x_i, x_{i+1}) + D(x_n, x_1) \tag{10}$$

Wherex_i is the ith city visited, x_{i+1} is the i+1 visited city, $D(x_i, x_{i+1})$ denotes the Euler distance between two cities, assuming that the coordinates of the two cities are(x_1, y_1) And (x_2, y_2)Then the distance calculation is shown in formula (11)

$$D=\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \tag{11}$$

2.3 Optimization of cuckoo search method

When the mathematical method is applied to the computer algorithm design, the algorithm has the advantages of less control parameters, simple structure and easy implementation, but it has slow convergence speed and easy to fall into the local optimal problem, this paper makes some optimization, proposes a mutual learning search optimization algorithm based on the same mathematical method, according to the characteristics of cuckoo and ant colony optimization algorithm, establishes a double interactive learning model, through cuckoo and ant colony optimization learning each other's optimization and their own shortcomings. In addition, the reinforcement learning strategy is introduced into CS algorithm to optimize the initial resolution of nesting, find the speed and improve the resolution.

3. Modeling Method

3.1 Interactive learning cuckoo search algorithm model

CS algorithm submits the set of optimized solutions to ACO algorithm, which increases the richness of ACO algorithm solution and effectively avoids the defect that ACO algorithm is easy to get local optimal solution but can not give full consideration to it. In CS, the reinforcement learning method is added to balance the relationship between global and local search, and the initial solution is continuously optimized. The global optimal solution G ^ best is set and submitted to the subgroup. The subgroup absorbs the information and continues to explore more solutions to provide the initial solution for the high-level. Through cooperative optimization and effective integration of the optimal solutions of both sides, the ACO algorithm is easy to fall into the local optimal problem, the quality of the solution is improved, and the shortcomings of CS algorithm, such as lack of information in the initial stage, slow optimization speed and convergence speed are solved.

Bottom

(1) Initialize the ant colony, set the parameters: the total number of ants m, randomly divided into n subgroups, ncmax = 2000.

(2) According to formula (6), the optimal solution is found, and the pheromone is updated

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according to equation (7).

(3) (12) was used to calculate the fitness of all ants in each subgroup.

The cuckoo search algorithm is discretized. Therefore, the fitness function is defined as:

$$f = \sum_{i=1}^{n-1} D(x_i, x_{i+1}) + D(x_n, x_1) \tag{12}$$

(4) The optimal solution of N subgroups is submitted to the highest level, and the ants are randomly divided.

(5) Taking the optimal solution of N subgroups as the starting position of N nests, the algorithm parameters are initialized.

(6) According to equation (15), the path length is updated, and equation (1) is used to update the position of bird's nest, and the fitness of each nest is calculated.

The average value of fitness f_{avg}, the weighted fitness f is selected from f_c:

$$f_c = \frac{1}{3} f_{best} + \frac{2}{3} f_{avg} \tag{13}$$

Using the above parameters, set the convergence factor λ, and the calculation formula is as follows:

$$\lambda = f_c - f_{best} \tag{14}$$

The smaller λ is, the more concentrated the bird's nest position is, and the solution tends to convergeδ

$$\delta = 1 - \frac{1}{1.5 + \exp(-\lambda)} \tag{15}$$

(7) The bird's nest P_k is found according to the probability (16) If the random number is greater than P_k. According to equation (17), the position of the bird nest is updated, and the updated fitness is calculated. If it is better than the current fitness, it is replaced.

$$P_k = \frac{1}{n} + \gamma \frac{n-l}{n(n+1)} \tag{16}$$

$$x_i^{t+1} = x_i^t + r_1(x_i^t - x_{best}^t) + r_2(x_i^t - x_k^t) \tag{17}$$

x_{best}^t is the best location of the nest, x_k^t is a random position, $r_1 \in (0,1), r_2 \in (0,0.5)$

4. Evaluation Results and Research

Since ilcsa is based on CS algorithm, in order to deeply understand the advantages of ilcsa, ilcsa will be compared with CS algorithm. ACS algorithm is an excellent intelligent iterative mathematical method. Compared with ACS, it can better reflect the performance superiority of ilcsa. In order to facilitate comparison, the two algorithms set the same parameters, set the absolute reference group, the maximum number of iterations is set to 2000 times, and the TSP instance is optimized 20 times. The comparison results are listed in Table 1. Opt represents the theoretical optimal solution of the example, best and AVG represent the optimal solution and average solution of the algorithm respectively, and dev represents the optimal solution deviation. The calculation formula of the optimal solution deviation is as follows:

$$Dwv = \frac{Best - Opt}{Opt} \times 100\%$$

It is easy to know from the information in Figure 1 that ilcsa needs the least number of iterations to find the optimal solution in the same example of two different algorithms. Taking ch130 as an example, ilcsa needs 159 iterations to find the optimal solution, and CS needs 643 iterations, which is almost 4 times of ilcsa. Compared with ilcsa, CS algorithm has a slower collection speed. In small-scale computing examples, ilcsa can find the best solution and collect it quickly. In large-scale problems, ilcsa can collect computing examples of different attributes more quickly due to the introduction of reinforcement learning strategy. The feasibility of strategy plays a good role in the optimization speed.

Table 1. Comparison results of optimized cuckoo algorithm and traditional cuckoo algorithm

TSP	Opt	ILCSA			CS		
		Best	Avg	Dev	Best	Avg	Dev

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Eil51	427	427	428.2	0	429	431.5	0.46
Berlin52	7543	7543	7566.3	0	7543	7567.4	0
St70	676	676	678.4	0	676	680.1	0
Eil76	539	539	541.5	0	540	549.1	0.18
Pr76	108160	108160	108256.2	0	109086	109747.3	0.84
KroA100	21283	21283	21296.4	0	21283	21380.6	0
KroB100	22142	22142	22216.8	0	22185	22263.4	0.18
Pr107	44304	44304	44503.0	0	44383	44393.5	0.17
Ch130	6111	6122	6197.3	0.17	6131	6202.4	0.32
Lin318	42030	42155	42533.1	0.28	436997	43888.6	3.96

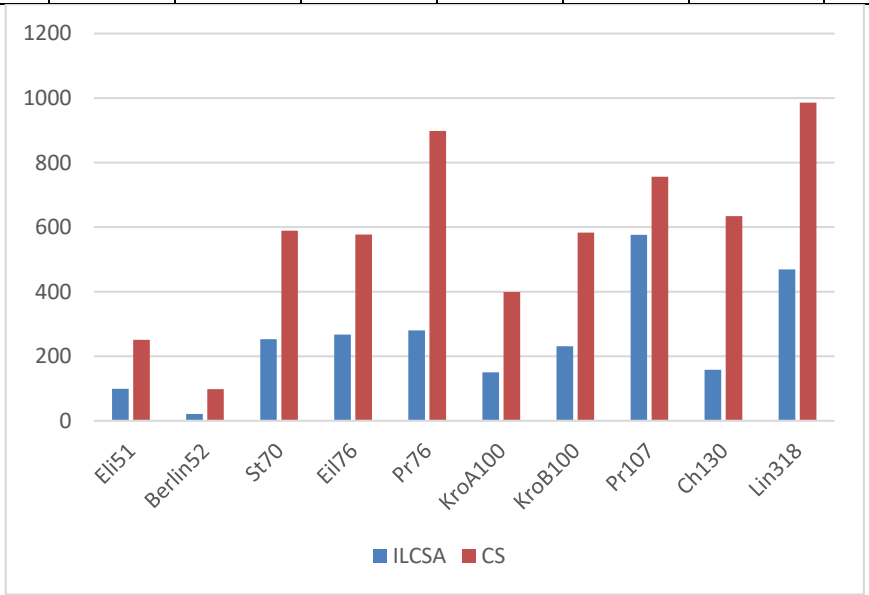

Figure. 1 Comparison of convergence rates

As shown in Figure 1, with the rapid increase of the number of cities, the number of ilcsa iterations will increase, but the growth trend is relatively flat. It can be seen that ilcsa algorithm has good stability in solving TSP cases of other scales. Combined with table 1 and figure 1, ilcsa, which compares the diversity and collection speed of solutions, has a larger solution space, a powerful ability to search for the best solutions around the world, and can collect the best solutions faster than the previous more classic solutions. Intelligent optimization algorithm has more advantages.

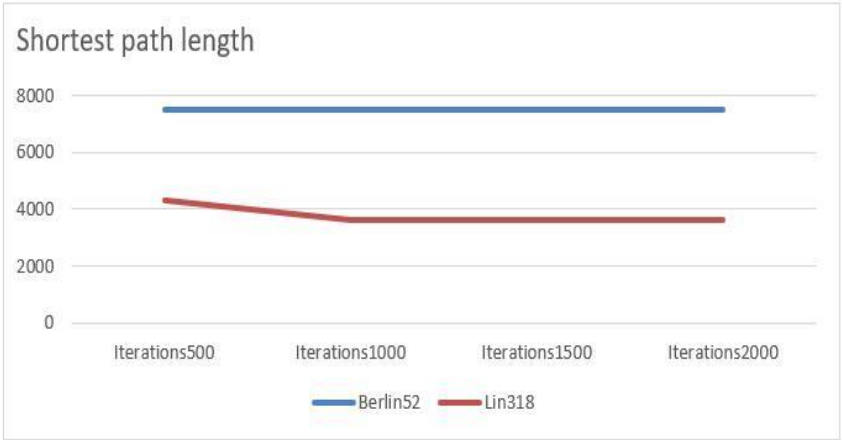

Figure 2. TSP case optimal path curve

In Figure 2, under the same ilcsa optimization, the shortest path length of berlin52 is much larger than that of lin318 algorithm, and the berlin52 algorithm is more stable than lin318 algorithm under the same number of iterations. It is not difficult to draw a conclusion from Figure 2 that with the blessing of ilcsa, the shortest path length and the number of iterations between different algorithms are also different. Therefore, we should design and optimize different computer algorithms on the basis of

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different mathematical methods in combination with the actual situation, so as to obtain the optimal solution, so as to achieve the purpose of minimum fluctuation under the influence of the shortest path and the most iteration times, that is, the most stable.

5. Conclusion

With the entering of the 21st century, China's socio-economic level and the level of science and technology have been rapid development, computer network has been popularized in many fields, in order to better help our country to improve computer technology in the information age, we need to timely analyze the application of mathematical methods in computer algorithm. Through the study of this paper, we clear the importance of mathematical methods in computer algorithms, mathematical methods are the basis of computer algorithms, and the application of mathematical methods to computer algorithms can greatly simplify our calculation steps, improve our calculation efficiency, and promote the development of computer algorithms. We should continue to improve the degree of computer-based optimization algorithm in the application of high-speed information flow. To maximize the utilization of Internet resources, the use of mathematical methods will help us to better study computer algorithms, and to the development of science and technology in China.

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