Simulated Annealing Optimization Bat Algorithm in Service Migration Joining the Gauss Perturbation

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Abstract. Bat algorithm is an optimization method inspired by the echo-location bats to search in nature, hunt prey behavior, combining multi-agent system and evolution mechanism. To improve the search results of BA algorithm, this paper proposes a gauss perturbation bats optimization algorithm based on simulated annealing (SAGBA). Firstly, the bionic principle, optimization mechanism and characteristics of the bat algorithm are analyzed and the algorithm optimization process are defined; Then the idea of the simulated annealing is put into bat optimization algorithm, and Gaussian disturbance is carried out to some individuals using the bat algorithm and strengthen the ability of the bat algorithm jumping out of local optimal solution. Finally, conduct simulations are respectively compared in 20 typical benchmark test functions among bat optimization algorithm, simulates annealing particle swarm algorithm and SAGBA algorithm. The results show that SAGBA algorithm not only increases the global convergence, but convergence speed and accuracy are better than other two algorithms.

Keywords: Bat algorithm, Simulated annealing, Gauss perturbation, The simulation, Optimization

1 Introduction

Most decisions in the field of engineering technology, economic management, and other problems can be summed up in optimization problem; its quality decides strengthens and weakness of decision scheme[1]. Traditional optimization methods such as linear programming, dynamic programming, etc., or the optimization problem with constraints (such as the objective function is continuous and differentiable), or because the attributes of optimization problem (e.g., NP problem) can only solve the small problem, for large, strong constraints, the nonlinear such optimization problems is difficult to solve, or the effect not good[2,3]. Swarm intelligence algorithm is a new evolutionary computation technique developed in recent years, is easy to implement, suitable for parallel processing, strong robustness, etc. [4], the typical algorithms such as ant colony algorithm and particle swarm optimization algorithm, the former is the bionic simulation of ant colony foraging behavior, the latter is for the birds feeding

behavior reflects the simple simulation of the social system, both in the field of continuous optimization and combinatorial optimization be widely applied.

2   Proposed Algorithm

(A) Algorithm steps

Bats are the only mammals with wings, and they have advanced echo positioning capability [9]. Most of the miniature bats are insectivores' animals. Miniature bats using acoustic echo-location in detecting prey and avoiding obstacles, and finds himself located in the habitat of cracks in the dark. These bats emit a loud voice, and then hear from the surrounding objects reflected echo.

For different bats, their pulse is associated with the strategy of hunting. Most bats through a filter with a short and high frequency signal scan around, while the other bats frequently use echolocation of fixed signals. The signal bandwidth changes depending on the kinds of bats, and often increasing through using more harmonic.

Using the some echo-location characteristics of the ideal micro in bats, the bats idealized rules are as follows

All bats use feel difference of echolocation to judge the difference between food, food and swim around obstacles;

Bats in speed VI, position the xi and fixed frequency f_{min} (or wavelength λ) random flight, with different wavelength λ (or frequency f) and volume A0 to search for prey. They will automatically according to the proximity of prey to adjust their pulse wavelength (or frequency)

Although the volume changes different under different forms, here assumes that the volume from a big A0 (positive) changes to the minimum A_{min}.

Based on the rules of the ideal, the basic steps of the bat algorithm (BA) can be summarized as follows

Initialization bat populations x_i and v_i (I = 1, 2... n)

The initial frequency f_i, pulse rate r_i and volume A_i

While (t $\prec$ maximum number of iterations)

By adjusting the frequency , generating new solutions, at the same time, according to the formula (1) to (3) to update the velocity and position

If (rand> r_i)

Select a solution concentration from these optimal solution

In the choice of the near optimal solution generate a local solution

end if

Generate a new by randomly flight

If (rand $\prec A_i$ & f (x_i) $\prec$ f (x_*))

To accept the new

Increase the value of r_i and decrease the value of A_i

end if

The bat sort, find the optimal solution x_*

end while

An obvious simplify of the bat algorithm is to estimate time delay and the three dimensional terrain with unlimited tracks. Although its application in the geometry calculation is very good, because we are faced with the most is a multidimensional problem, rarely use it in practice. In addition to these simplifying assumptions, we can also use some approximation. Usually, the range of frequencies f is $[f_{\min}, f_{\max}]$ corresponding to the wavelength range is $[\lambda_{\min}, \lambda_{\max}]$. For example, a frequency range is [20 kHz, 500 kHz], corresponding to the range of wavelength is from 0.7 mm to 17 mm

(B) The movement of virtual bats

In the simulation, we must use the virtual bats. In the searching space of a d, t moment, in bat algorithm, update the position x_i^t and speed v_i^t of the Bat I according to the following formula

$$f_i = f_{\min} + (f_{\max} - f_{\min})\beta \tag{1}$$

$$v_i^t = v_i^{t-1} + (x_i^{t-1} - x_*)f_i \tag{2}$$

$$x_i^t = x_i^{t-1} + v_i^t \tag{3}$$

f_i For frequency, $\beta \in [0,1]$ is a random variable of uniform distribution on, x_* for the current global optimal position, it is the optimal position after searching all the bats and getting the position of the comparison. $\lambda_i f_i$ Is increment speed, we can accord the needs of specific issues, fixed a factor λ_i (or f_i), at the same time using another factor f_i (or λ_i) to adjust the speed of change

For local search, once selected a solution in the current optimal solution, so every bat' new solution according to the local data processing for random walk is：

$$x_{new} = x_{old} + \varepsilon A^t \tag{4}$$

Which $\varepsilon \in [-1,1]$ is a random number; $A^t = A_i^t$ is the average volume of all the bats in the same period. Bat speed and position update steps some similar to the standard particle swarm optimization [10]. To a certain extent, BA can be regarded as a standard particle swarm optimization is combined with the balance of the strengthening of local search; the balance is controlled by the volume and incidence rate of the pulse

(C) The volume and pulse rate

The volume A_i and pulse rate r_i updated according to the following iterative process. When bats locate prey, will reduce the volume, pulse rate will increase at the same time, the volume change in any convenient value. For example, for the sake of simplicity, available $A_0 = 1, A_{\min} = 0$, assumptions, $A_{\min} = 0$ and means that a bat just find their prey and temporarily stop any sound. Update the formula is:

$$A_i^{t+1} = \alpha A_i^t, \quad r_i^{t+1} = r_i^0[1 - \exp(-\gamma t)] \tag{5}$$

α and γ as constants. In fact, α is similar to a cooling factor of the cooling process in the simulated annealing earlier discussed in this book. For $0 < \alpha < 1, \gamma > 0$, we have to arbitrary

$$A_i^t \to 0, \quad r_i^t \to r_i^0, \unicode{x5f53} t \to \infty \tag{6}$$

The simplest case is that $\alpha = \gamma$, in the implementation, we use the $\alpha = \gamma = 0.9 \square 0.975$

3   Conclusion

This paper analyzes theoretically in the bat algorithm, and this algorithm absorbs the bat by ultrasound to search in the nature. The behavior of the predator prey characteristics, using the evolutionary approach to implement the agent's behavior in order to achieve the purpose of optimization. Simulated annealing algorithm combined with a bat optimization algorithm, to gauss perturbation of bats individuals, further search to retain the individual "elite". Along with the advancement of evolutionary process, the temperature is gradually reduced; accept the risk of poor solution gradually reduced, so as to improve the convergence of the algorithm. The convergence of the simulation results show that the proposed algorithm is superior to the other two algorithms in different degree, at the same time shows the SAGBA algorithms in continuous space and the feasibility and effectiveness of discrete space optimization, has a good application prospect. Because the bat algorithm optimization theory and application research is still in the initial stage, many problems has yet to be constantly explore and solve by people, such as involved in the algorithm of parameter Settings, the convergence of the algorithm analysis and the theoretical basis of the organic combination with the rest of the group of intelligent optimization algorithm, such as the study SAGBA algorithm compared with other optimization algorithms, and further research SAGBA algorithm in the application of multi-objective programming problems, these are the further research work to do.

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