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COMPARISON AND ANALYSIS OF BENCHMARK FUNCTIONS USING ARTIFICIAL BEE COLONY (ABC) ALGORITHM

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Abstract: This Paper shows the details of ABC algorithm, which was proposed by Dervish Karaboga based on Foraging behavior of honey bees. This type of based on stochastic search method that mimics the natural evolution and social behavior of species. These types of algorithms were developed to arrive at near optimum solution of multimodal optimization problems. This paper also describes implementation of ABC algorithm on Complex benchmark functions like Sphere and Griewank function.

Keywords: ABC algorithm, Optimization algorithm, Benchmark functions



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INTRODUCTION

The ABC algorithm is swarm algorithm based on the foraging behavior of honey bee colonies. The bee colony contains three members: Scouts, onlooker and employed bees. The bee doing out random search is known as scout. The bee going to the food source which is visited by it previously is employed bee. The onlooker bee with scout is known as unemployed bee.[4]

The employed and unemployed bees search for the rich food sources around the beehive. The employed bees store the food source information and share the information with onlooker bees. The total food sources is equal to the number of employed bees and also equal to the number of onlooker bees. An employed bee whose solutions cannot be improved through a predetermined number of trials becomes scout and their solutions are abandoned [1, 3].

II. Fundamental of ABC [2]

Two Basic concepts, self-organization and division of labor, are necessary and sufficient properties to obtain swarm intelligent behavior such as distributed problem solving systems that self-organize and adapt to the given environment.

Self-organization can be defined as a set of dynamical mechanisms, which result instructors at the global level of a system by means of interactions with its components. These mechanisms organize basic rules for the interactions between the components of the system. The rules assure that the interactions are executed on the basis of purely local information without any relation to the global pattern. There are four basic properties on which self-organization relies: Positive response, Negative response, fluctuations and multiple interactions.

i)Positive Response is a simple behavioral “rules of thumb” that promotes the creation of favourable structures. Recruitment and reinforcement such as trail laying and following in some ant species or dances in bees can be shown as the examples of positive response.

ii)Negative response counterbalances positive response and helps to stabilize the collective pattern. In order to stop the saturation which might occur in terms of availability of foragers, food source exhaustion, crowding or competition at the food sources, a negative feedback mechanism is required.

iii)Fluctuations like as random walk & task, errors, switching among swarm individuals are essential for creativity and innovation. Randomness is often important for emergent structures since it enables the discovery of new solutions.

iv) In Common, self-organization requires a minimal density of mutually tolerant individuals, enabling them to make use of the results from their own activities as well as others.

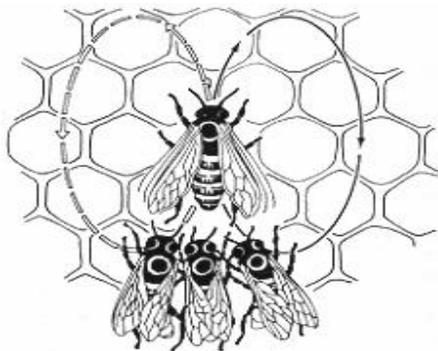
1. 3.3 Behaviour of honey bee swarm [6]

The minimum model of forage selection that leads to the emergence of collective intelligence of bee swarms contains three essential components: food sources, employed foragers and unemployed foragers and the model define two leading modes of the behavior: the recruitment to a nectar source and the abandonment of a source.

Food Sources: The food source depends on many criteria such as its closeness, its richness, and the ease of extracting this energy. For the sake of simplicity, the “profitability” of a food source can be represented with a single quantity.

Employed foragers: They are connected with a particular food source which they are recently exploiting or are “employed” at. They carry with them details about this particular source, distance and direction from the origin, the profitability of the source and share this information with a certain probability.

Unemployed foragers: They are continually watch out for a food source to work. There are two types of unemployed foragers: scouts, searching the environment near to the nest for new food sources and onlookers waiting in the nest and establishing a food source through the information shared by employed foragers. The mean of scouts are averaged over conditions is around 5-10%



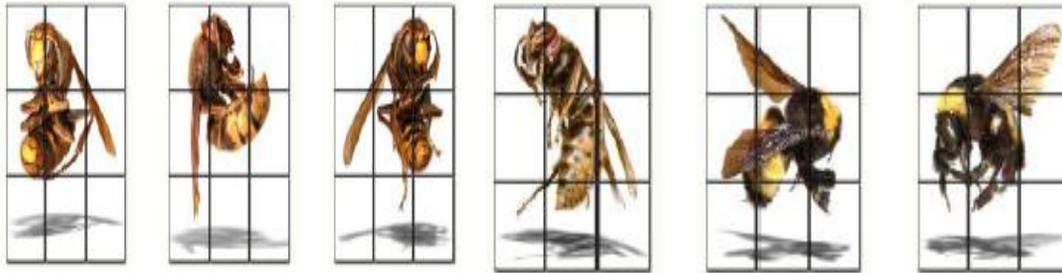


Figure 1 Waggle dance of bees

2. III. Pseudo code of ABC algorithm [2]

1. To initialize the population of solutions
2. To evaluate the population
3. To Produce new solutions for the employed bees
4. To apply the greedy selection process
5. To calculate the probability values
6. To produce the new solutions for the onlookers
7. Apply the greedy selection process between them
8. To determine the abandoned solution & Change it with new random solution
9. Last memorize the best solution which is achieved up to so far

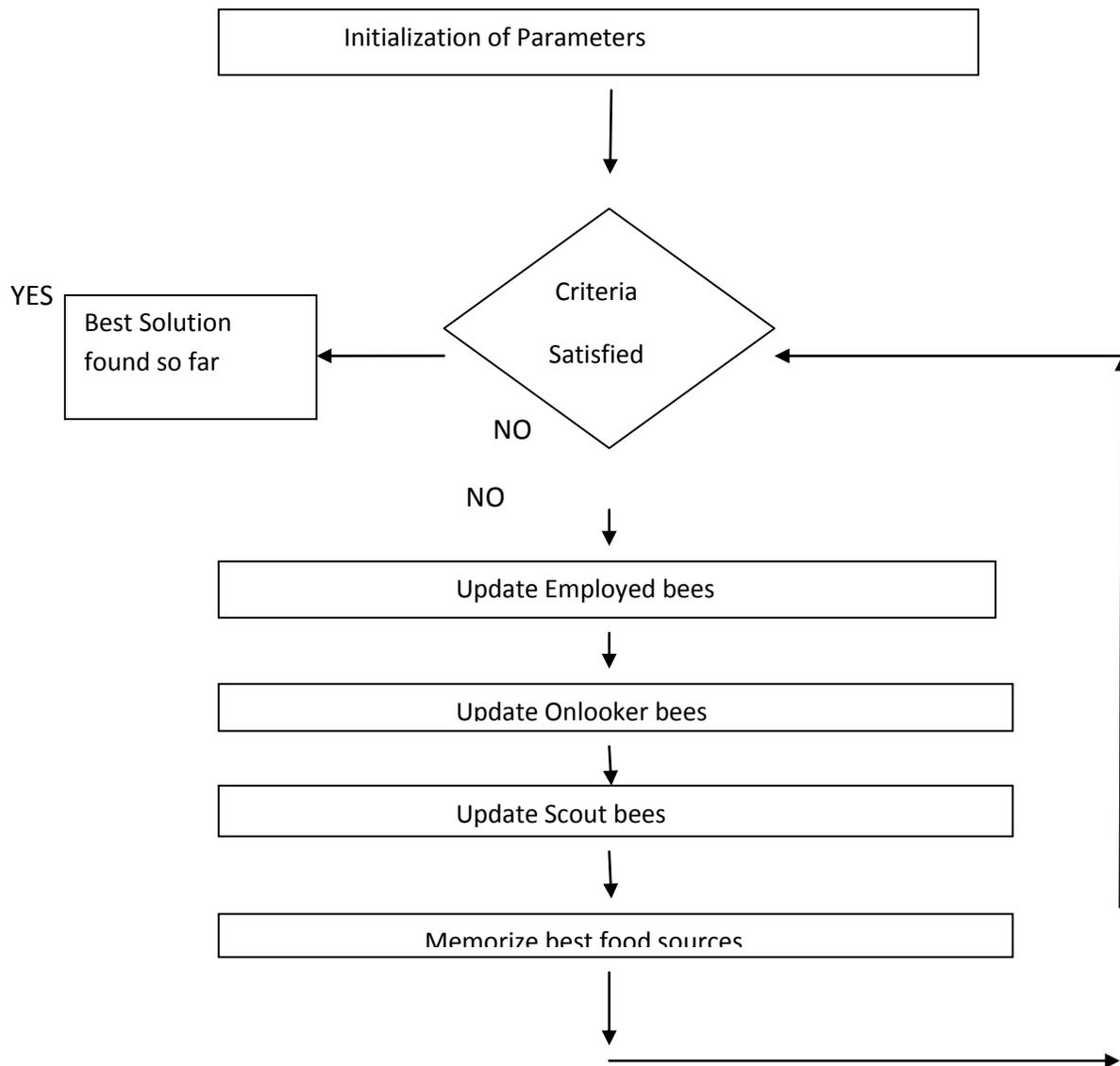


Figure 2 ABC working principle

IV Procedure of ABC [4]

The ABC consists of four main phases

1) Initialization Phase: The food sources whose population size is SN, are randomly generated by scout bees. Each food source represented by x_m is an input vector to the optimization problem, x_m has D variables and D is the dimension of searching space of the objective to be optimized. The initial food sources are randomly produced.

$$x_m = l_i + rand(0,1) * (u_i - l_i) \quad (1)$$

2) Employed bee Phase :

Employed bee flies to a food source and finds a new food source with in the neighbourhood of the food source. The higher Quality food source is memorized by the employed bees. The food source information stored by employed bee will be shared with onlooker bees. A neighbour food source is determined by following equation.

$$v_{mi} = x_{mi} + \phi_{mi} (x_{mi} - x_{ki}) \quad (2)$$

The Fitness is calculated by following formula

$$fit_m(x_m) = \begin{cases} \frac{1}{1+f_m(x_m)}, & f_m(x_m) > 0 \\ 1 + |f_m(x_m)|, & f_m(x_m) < 0 \end{cases} \quad (3)$$

3) Onlooker bee Phase :

Onlooker bees calculates the probability of food sources by observing the wagle dance in the dance area and then select a higher food source randomly. After that onlooker bees carry out randomly search in the neighborhood of food source. The quantity of a food source is evaluated by its profitability of all food sources

$$p_m = \frac{fit_m(x_m)}{\sum_{m=1}^{SN} fit_m(x_m)} \quad (4)$$

Onlooker bees search the neighborhood of food source according to below equation

$$v_{mi} = x_{mi} + \phi_{mi} (x_{mi} - x_{ki}) \quad (5)$$

4) Scout Phase :

If the profitability of food source cannot be improved and the times of unchanged greater than the predetermined number of trials, which called "limit", the solutions will be abandoned by scout bees. Then the new solutions are randomly searched by scouts bees. The new solution will be discovered by following equation.

$$x_m = l_i + rand(0,1) * (u_i - l_i) \quad (6)$$

V SIMULATION AND RESULTS

Here I have used two benchmark functions namely sphere and Griewank[2]

1) Sphere function:

$$f1(x) = \sum_{i=1}^D x_i^2$$

$$x \in [-100, 100]$$

2) Griewank function:

$$f2(x) = \frac{1}{4000} (\sum_{i=1}^D x_i^2) - (\prod_{i=1}^D \cos(\frac{x_i}{\sqrt{i}})) + 1$$

$$x \in [-600, 600]$$

The parameter used in this algorithm is population size, Limit, Maximum cycle[5] .Here it is taken 100 population size, no of cycle is 1000.

Table 1 Sphere Function Mean value

Function	Statistic	500 cycle	600 cycle	800 cycle	1000 cycle
Sphere	Mean	44.43	25.50	0.13	0.049

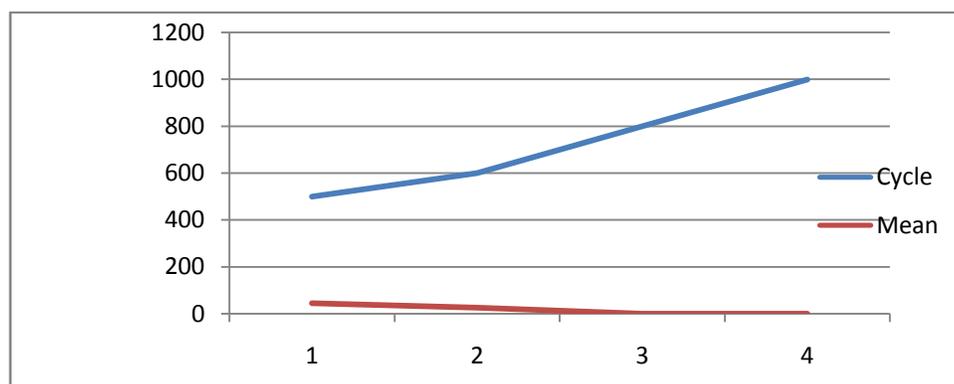


Figure 3 Sphere function

Table 2 Griewank function Mean value

Function	Statistic	50 cycle	100 cycle	500 cycle	1000 cycle
Griewank	Mean	47.26	38.19	1.5006	0.2634

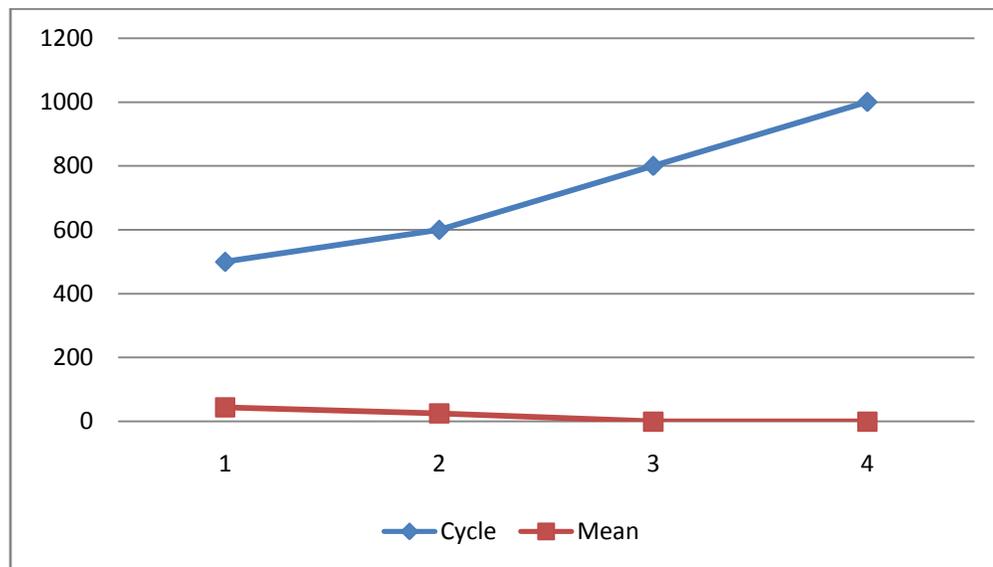


Figure 4 Griewank function

VI CONCLUSION AND FUTURE WORK

In this Paper we tested algorithm on two benchmark function and we get optimum value with increasing the no of cycle. In future we will tested on other benchmark function. This algorithm can further be used for the dynamic deploy ment of wireless sensor network.

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