CHAPTER 5

5.ANT LION OPTIMIZATION (ALO) ALGORITHM

5.1 1NTRODUCTION

Inspired by the hunting mechanism of antlions in nature, a novel nature-inspired technique, namely Antlion Optimization was first presented by S. Mirjalili[14] et al. . Two significant stages: the larvae stage and the adult stage exist in the lifecycle of the antlions, which are responsible for hunting prey and reproduction, respectively.

Moreover, this algorithm consists of two populations: sets of antlions and ants. The ants perform the capacitors positions in free space, and the antlions perform the hidden positions. When an ant has a fittest solution than that of antlion, this means that antlion has caught the ant and consumed it. This antlion becomes the fittest and named as the elite.

5.2 INITIALIZATION OF OPERATION

The positions of ants and antlions are initially created with random numbers under dimensions and limits which modeled as:

$$x_{ij} = rand[0,1] \, . \left(x_j^{max} - x_j^{min}\right) + x_j^{min}$$
$$\forall i \in \{1,2,\dots,n\}, \; j \in \{1,2,\dots,d\} \qquad \text{(7)}$$

Where X_j^{max},X_j^{min} and are the upper and lower boundaries of the control variables.

The OF determines the antlions initial fitness and arranges them. The fittest antlions positions and optimal solutions are saved as the elite.

5.3 FIVE MAIN STEPS OF ALO ALGORITHM:

During searching for the optimal solution, there are five main steps are modeled mathematically in hunting the pray which proposed[15] as:

i. the random walk of ants

ii. building traps

iii. entrapment of ants in traps

iv. catching preys

v. re-building traps

(i) Cone Shaped Trap

Fig:5.1

(ii) random walk of ants in ant-lion's trap

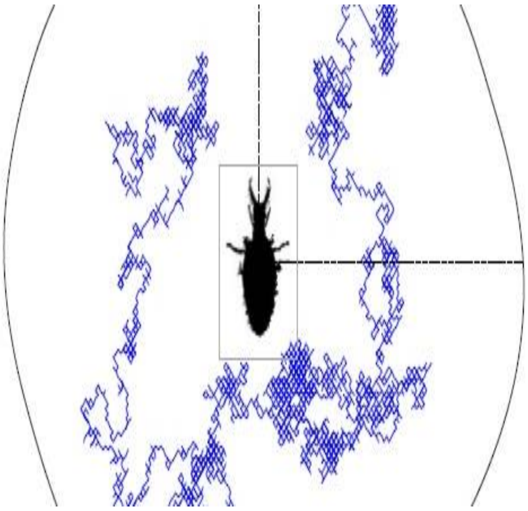


fig:5.2

(iii) catching the pray

Fig:5.3

(iv) entrapment of ants

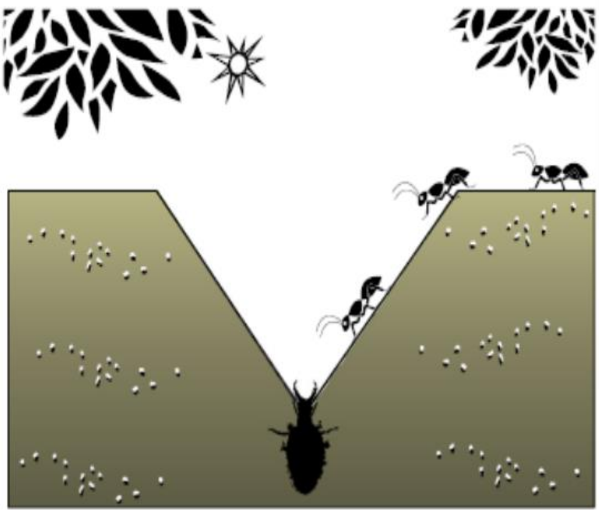


fig:5.4

5.3.1 ANTS RANDOM WALK:-

Ants improve their positions in searching for foods in free space every iteration which is given as:

$$x(t)=[0,\mathrm{cumsum}(2r(t_1)-1),\mathrm{cumsum}(2r(t_2)-1),.,\mathrm{cumsum}(2r(t_n)-1)] \quad \text{(8)}$$

Where

cumsum= cumulative sum of series numbers

n = iterations number

r(t) = random number which is modeled as $r(t)=\begin{cases}1 & if\ rand > 0.5\\ 1 & if\ rand \leq 0.5\end{cases}$

This updating is tied to a range of upper and lower boundaries. To keep it between these ranges, the identified equation must be applied as:

$$X_i^t = \frac{(X_i^t - a_i)*(d_i^t - c_i^t)}{b_i - a_i} + c_i \quad \text{(9)}$$

where $a_i$is the lowest number of ants walks

b_i is the topmost number of ants walks in each iteration

c_i^t is the lowest variable of a changed function at t^th^ iteration

d_i^t is the topmost variable of a changed function at t^th^ iteration.

5.3.2 AREA OF TRAP STRUCTURE:-

The volume of the trap is direct proportional to the degree of antlion hunger by applying a roulette wheel which is given as:

Accumulation = cumsum (Weights)

$$\mathrm{Weights} = \frac{1}{sort\,(M_{OAL})} \quad \text{(10)}$$

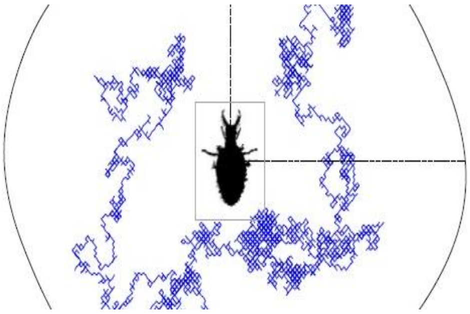
where, cumsum is the cumulative sum of series numbers

Weight is an array which determines the degree of antlions' fitness by arranging them according to preference and is an array which saves the antlions fitness.

5.3.3 ENTRAPING THE ANT:-

Fig.3.5 illustrates the confused ants which are fallen in the trap of one chosen antlion only.

Fig: 5.5



The random walk boundaries of ants are reduced during approaching from antlions' digs. This process can be modeled as:

$$c_i^t = Antlion_j^t + c^t$$
$$d_i^t = Antlion_j^t + d^t \qquad \text{——(11)}$$

Where

c^t,d^t are the lowest and topmost numbers of all variables in the current iteration, respectively.

c_i^t,d_i^t are the lowest and topmost numbers for the i^{th} respected to c^t,d^t variables.

$Antlion_j^t$ is the position of antlion for j-th in free space for the current iteration.

5.3.4 SLIDING OF ANT INSIDE TRAP :-

After entering the circle receding of chosen antlion, it pushes the sand behind ants to slide down the ants towards the bottom of the cone where the antlion exists. The modeled equations are written as:

$$c^t = \frac{c^t}{I} \;, d^t = \frac{d^t}{I}$$
$$I = 10^w * \frac{t}{T} \qquad \text{——(12)}$$

where t is the current iteration, T is the maximum number of iterations, I is a ratio which is varied respected to the current iteration t and W is a constant which is varied respected to the current iteration as follows:

$$w = \begin{cases} 2 & t > 0.1 \times Ni\_max \\ 3 & t > 0.5 \times Ni\_max \\ 4 & t > 0.75 \times Ni\_max \\ 5 & t > 0.9 \times Ni\_max \\ 6 & t > 0.95 \times Ni\_max \end{cases}$$

5.3.5 CONSUMING PREY & RE-MODIFYING TRAP:

The final step of hunting, is while an ant reaches the bottom, the antlion catches it with its jaws then enter it inside the sand and consumed it (means that when the ant become fitter or has a better solution than the antlion, it takes its best solution to tie themselves up with ants). The mathematical model of this operation is offered as:

$$Antlion_j^t = Ant_j^t \quad , if \;\; f(Ant_j^t) > f(Antlion_j^t) \qquad \text{——} \textbf{(13)}$$

Where

$Antlion^t_j$ is the position of antlion for j-th as a selected one at the t-th iteration.

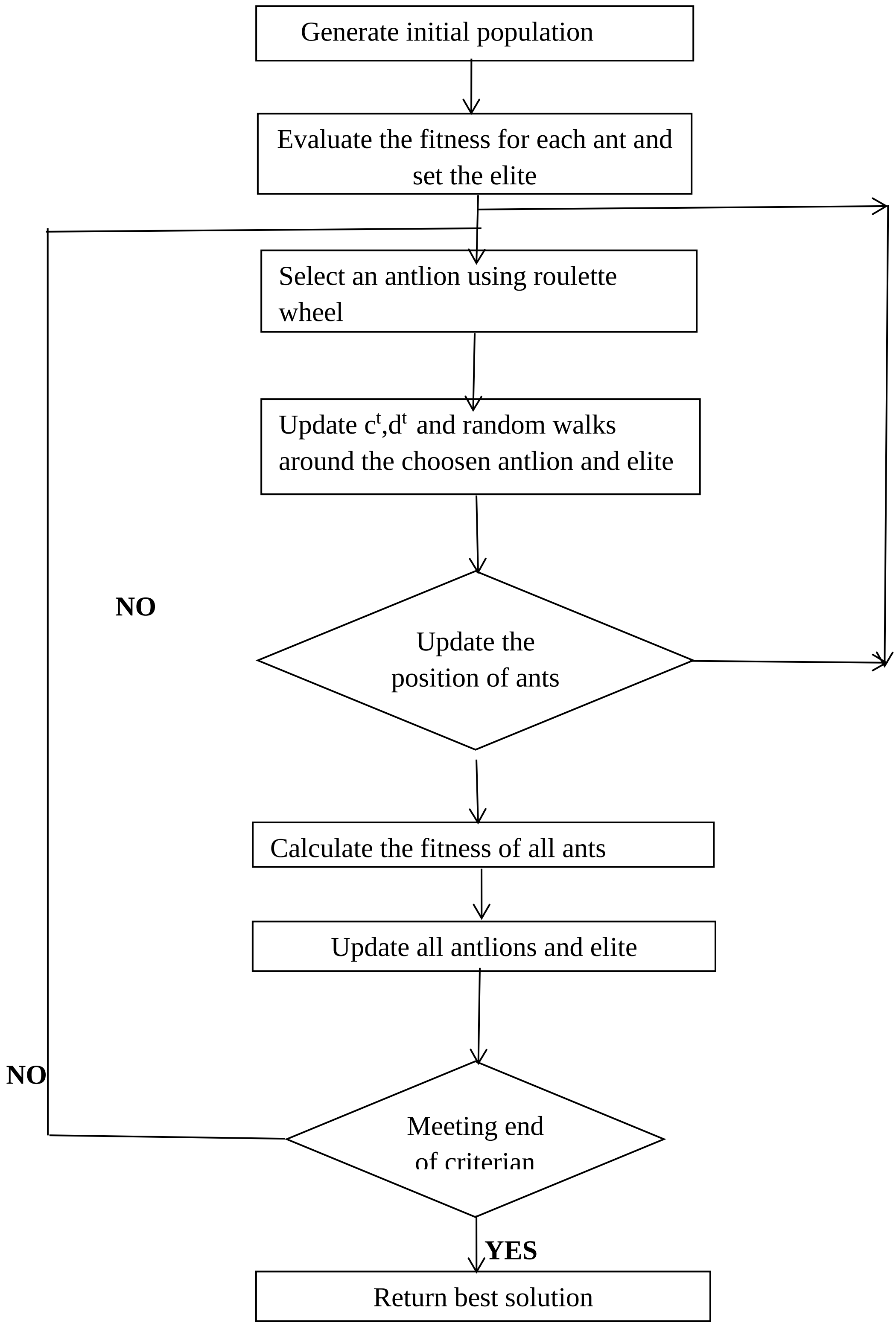
5.3.6 ELITISM

To obtain the best solution at each phase, this fittest one is saved and named as elite. The elite affects the steps of all ants random walks and therefore their destinations. This can be offered as:

$$Ant_j^t = \frac{R_A^t + R_E^t}{2} \qquad \text{——} \textbf{(14)}$$

Where R^t_A and $R_E{}^t$ are random walks of an ant the first is around the trap of chosen antlion and the second is around the trap of the elite respectively at t-th iteration

5.4 FLOWCHART OFANTLION OPTIMIZATION ALGORITHM



[16]

PROCEDURE:-

1. Initialize the first population of ants and antlion randomly.
2. Calculate the fitness of ants and antlions.
3. Find the best antlions and assume it as the elite(determine optimum).
4. While the end criterion is not satisfied is not satisfied for every event.
5. Select an antlion using Roulette wheel.
6. Update C and D using equation (12)
7. Create a random walk and normalize it using equation (8).
8. Update the position of ants using equation (14).
9. Calculate the fitness of all ants.
10. Replace an antlion with its corresponding ant it becomes fitter equation.
11. $Antlion_j^t = Ant_j^t \quad , if \;\; f(Ant_j^t) > f(Antlion_j^t)$
12. Update elite if an antlion becomes fitter than the clite end while.
13. Return elite.

5.5 MERITS OF ANTLION OPTIMIZATION

The ALO has three main advantages:-

1. It can find nearest possible optimal solution.
2. Its convergence rate is fast due to the employed random walk and roulette wheel selection mechanism.
3. It can handle non linear and multi modal problems.