Lion Hunting Optimization Algorithm (LHOA): A nature inspired algorithm

Vinicius Pfeifer

Index Terms—Algorithm, LHOA, Lion hunting, Nature inspired, Optimization algorithm

1 Introduction

The need to solve complex optimization problems faster and faster has been inspiring researchers to develop algorithms with great performance to solve these kind of problems, some examples are data clustering [1], [2], image processing [3],[4], pattern recognition, neural networks tuning [5], etc. The common behavior of these problems is that the search space grows exponentially with the problem size.

During the past decades, a lot of algorithms has been developed using the inspiration of nature. Some examples of these algorithms are the Genetic algorithm [6], Ant Colony Optimization [7], Particle Swarm Optimization [8], Bacterial Foraging Algorithm [9] and many others. These algorithms are applied in different areas by researchers, but none of them provides the best solution for all problems, they provide a better solution for a particular problem compared with others.

In this paper, a nature inspired optimization algorithm based on lion's hunting behavior, called Lion Hunting Optimization Algorithm (LHOA) is proposed. In the literature, Wang [10] and Rajakumar [11] proposed two algorithms inspired on lions behavior. The Lion´s Algorithm [11] using mating, territorial defense and territorial takeover as main operators. The Lion pride optimizer [10] is based on fighting between individual and mating. Another proposed algorithm was Lion Optimization Algorithm (LOA) [12], in addition of mating and fighting exhibit, this algorithm is inspired by other behaviors prey capturing, territorial marking, migration and life style (nomad or resident). So, proposed algorithm is inspired by simulation of hunting, already proposed by LOA [12], but with some improvements which is different from the previous algorithms.

The main idea is propose a lightweight and less complex algorithm with better performance. In LOA [12], for example, the algorithm shows great results to find the global optimum, but with bad performance.

2 Nature Inspiration

Lions typically lives in groups called prides. Each pride includes about five females, their cubs and one or more adult males.

2.1 Hunting

Wild cats usually hunt alone, but lions hunt together with other members of their pride. Some female work together surrounding the prey and catch it with a fast attack.

During the hunt, the male lions and the other females stay in the pride waiting the hunters return with food.

These hunters has a standard way to encircle the prey, Stander [13] divided the lions into seven different roles, grouping these roles into left wing, center and right wing, shown in Figure 1.

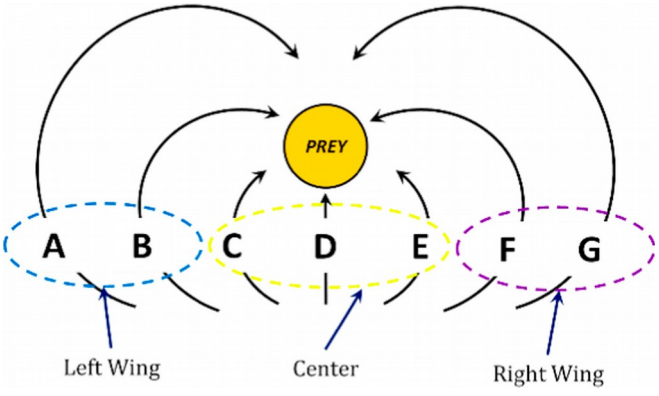


Figure 1 : Lion hunting behavior

The end state of the encircle will be explored in the proposed algorithm. In other words it will simulate the attack phase, after the encircle, when the prey is already surrounded by the hunters.

3 ALGORITHM

3.1 Initialization

The LHOA is based on lion hunting groups, so the first step of the algorithm is generate these groups randomly over the solution space. Like the other lion-based algorithms, LHOA represents every single solution as a "Lion". In a n-dimensional problem a Lion is represented as :

$$\text{Lion} = [\, x_1 , x_2 , x_3 , \dots , x_n \,] \qquad (1)$$

The fitness of a Lion is calculated by evaluating the function to be optimized, as follows:

$$\text{fitness} = f(\text{Lion}) = f(\, x_1 , x_2 , x_3 , \dots , x_n \,) \qquad (2)$$

In this first step, H_g hunting groups composed by h_n hunter lions. For each hunting group, a prey to be hunted is generated and positioned in the center of the lions in this group, simulating the end state of the encircle. Each lion holds its best visited position.

3.2 Hunting

This phase is where the optimization begins, for each hunting group, all lions are selected randomly one by one and attacks the prey.

In this attack phase, the hunter moves to the prey direction to a random position between the current position and the prey position. If the new position is better than the current best solution, then the best solution is updated. The formula to update the hunter position is :

$$h_{new} = (1 - u) \times h + u \times p$$

where h_{new} is the new position of the hunter, u is a uniform random number u between 0 and 1, h is the current position of the hunter and p is the position of the prey.

After all lions attacks, the prey position is updated to a new position adding a random number in each dimension. A schema of how this process works is shown in Figure 2.

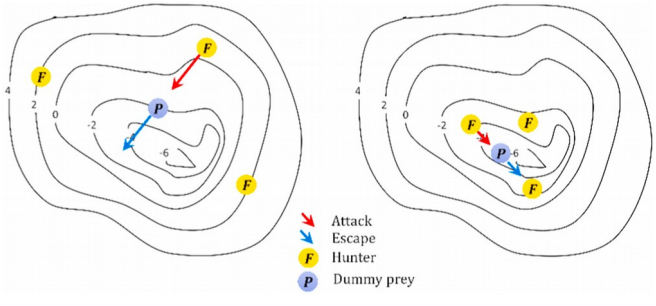


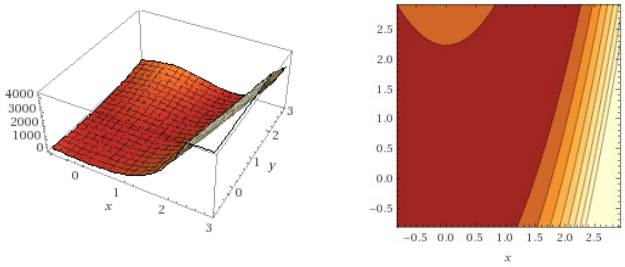
Figure 2 : Visualization of hunting process

This process is more simple than the proposed by LOA [12], for example. In LHOA, the Opposition-Based Learning to simulate the encircle of the prey and the movement of the hunters and prey are quite different.

4 RESULTS

The LHOA was compared with another algorithms to minimize the function :

$$(1 - x)^2 + 100\,(y - x^2)^2$$



The comparison was made between the algorithms LHOA, PSO and Genetic.

Parameters for the PSO were:

1. Particles = 3
2. v_{min} = -10 and v_{max} = 10
3. max iterations = 50
4. $AC_1 = AC_2 = 2.05$

Parameters for Genetic algorithm were:

1. Population size = 30
2. Crossover rate = 0.6
3. Mutation rate = 0.02
4. Max iterations = 1000

Parameters for LHOA were:

1. Hunting groups = 4
2. Hunters by group = 7
3. Max iterations = 50

The results obtained executing the algorithms with these parameters were :

Algorithm	Min	Max	Avg
Genetic	101	184936	62219,8
LHOA	0	14,16	1,13
PSO	0,4	106,22	17,58

5 PYTHON CODE

The following code is an example of the presented ideas in the paper for the tested function:

```
for i in range(0, _max_iterations):
    for hg in hunting_groups:
        for lion in hg.lions:
            u = random.uniform(0,1)
            new_x = (1 - u) * lion.current_position[0] + u * hg.prey.current_position[0]
            new_y = (1 - u) * lion.current_position[1] + u * hg.prey.current_position[1]
            new_fitness = f(new_x, new_y)
            if new_fitness < lion.fitness:
                lion.current_position[0] = new_x
                lion.current_position[1] = new_y
            if new_fitness < global_min:
                global_min = new_fitness
        u_prey = random.uniform(0,1)
        hg.prey.current_position[0] = hg.prey.current_position[0] + u_prey
        hg.prey.current_position[1] = hg.prey.current_position[1] + u_prey
```

6 CONCLUSION

Although the algorithm has been tested with only one function and only two other algorithms, the results obtained in the tests with great performance shown that the introduced algorithm is promising.

REFERENCES

[1] J. Senthilnath, S.N. Omkar, V. Mani, "Clustering using firefly algorithm: performance study", *Swarm Evolut. Comput., 1 (3) (2011), pp. 164-171*

[2] S.J. Nanda, G. Panda, "A survey on nature inspired metaheuristic algorithms for partitional clustering", *Swarm Evolut. Comput., 16 (0) (2014), pp. 1-18*

[3] G. Fornarelli, A. Giaquinto, "An unsupervised multi-swarm clustering technique for image segmentation," *Swarm Evolut. Comput., 11 (0) (2013), pp. 31-45*

[4] A. Draa, A. Bouaziz, "An artificial bee colony algorithm for image contrast enhancement", *Swarm Evolut. Comput., 16 (0) (2014), pp. 69-84*

[5] R. Malviya, D.K. Pratihar, "Tuning of neural networks using particle swarm optimization to model MIG welding process", *Swarm Evolut. Comput., 1 (4) (2011), pp. 223-235*

[6] J.H. Holland, "Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence", *U Michigan Press (1975)*

[7] M. Dorigo, "Optimization, learning and natural algorithms", *Ph.D. thesis, Politecnico di Milano, Italy (1992)*

[8] R.C., Eberhart and J. Kennedy, "A new optimizer using particle swarm theory", *Proceedings of the sixth International Symposium on Micro Machine and Human Science, New York, NY, 1995.*

[9] K.M. Passino, "Biomimicry of bacterial foraging for distributed optimization and control", *Control Syst. IEEE, 22 (3) (2002), pp. 52-67*

[10] B. Wang, X. Jin, B. Cheng, "Lion pride optimizer: an optimization algorithm inspired by lion pride behavior", *Sci. China Inf. Sci., 55 (10) (2012), pp. 2369-2389*

[11] B. Rajakumar, "The Lion's Algorithm: a new nature-inspired search algorithm", *Procedia Technol., 6 (2012), pp. 126-135*

[12] Maziar Yazdani and Fariborz Jolai, "Lion Optimization Algorithm (LOA): A nature-inspired metaheuristic algorithm" *School of Industrial Engineering, College of Engineering, University of Tehran, Tehran, Iran*

[13] P.E. Stander, "Cooperative hunting in lions: the role of the individual", *Behav. Ecol. Sociobiol., 29 (6) (1992), pp. 445-454*