PHD ASSISTANCE Lab

UNDERSTANDING OF THE NATURE-INSPIRED-CUCKOO OPTIMIZATION ALGORITHM

Where and How it Apply in the Industrial Application?

PhD Research Lab
Industry ⇄ Research

INTRODUCTION

Every contemporary strong derived inversion imitates the finest characteristic of nature, particularly biological systems have developed over millions of years from natural selection. One of the most inspiring and a recent powerful evolutionary algorithm is Cuckoo Optimization Algorithm (COA). It is also nature-inspired metaheuristic algorithm, which is used for solving a continuous nonlinear optimisation problem. (Joshi, Kulkarni, Kakandikar, & Nandedkar, 2017). In 2009, Yang and Deb established Cuckoo Optimization which was influenced by nature and (Rajabioun, 2011) developed the new Cuckoo Optimization Algorithm in 2011. An optimisation is maximising or minimising the problem parameters and identifying the best and effective solution from it. Cuckoo Optimization Algorithm is developed based on the brood parasitism of some species like Ani and Guira cuckoos, along with random walks of Levy flights. Cuckoos are intriguing birds, not only for the lovely sounds but also for their aggressive strategy of reproduction (Joshi et al., 2017). COA is developed based on survival, immigration and nesting behaviour of cuckoo bird family (Ameryan, Akbarzadeh Totonchi, & Seyyed Mahdavi, 2014). COA is used in various applications in the fields of engineering components, design, modelling, optimisation and prediction behaviour, but mostly used in the area of engineering to solve optimization problems.

STRATEGY FOR CUCKOO BREEDING BEHAVIOR

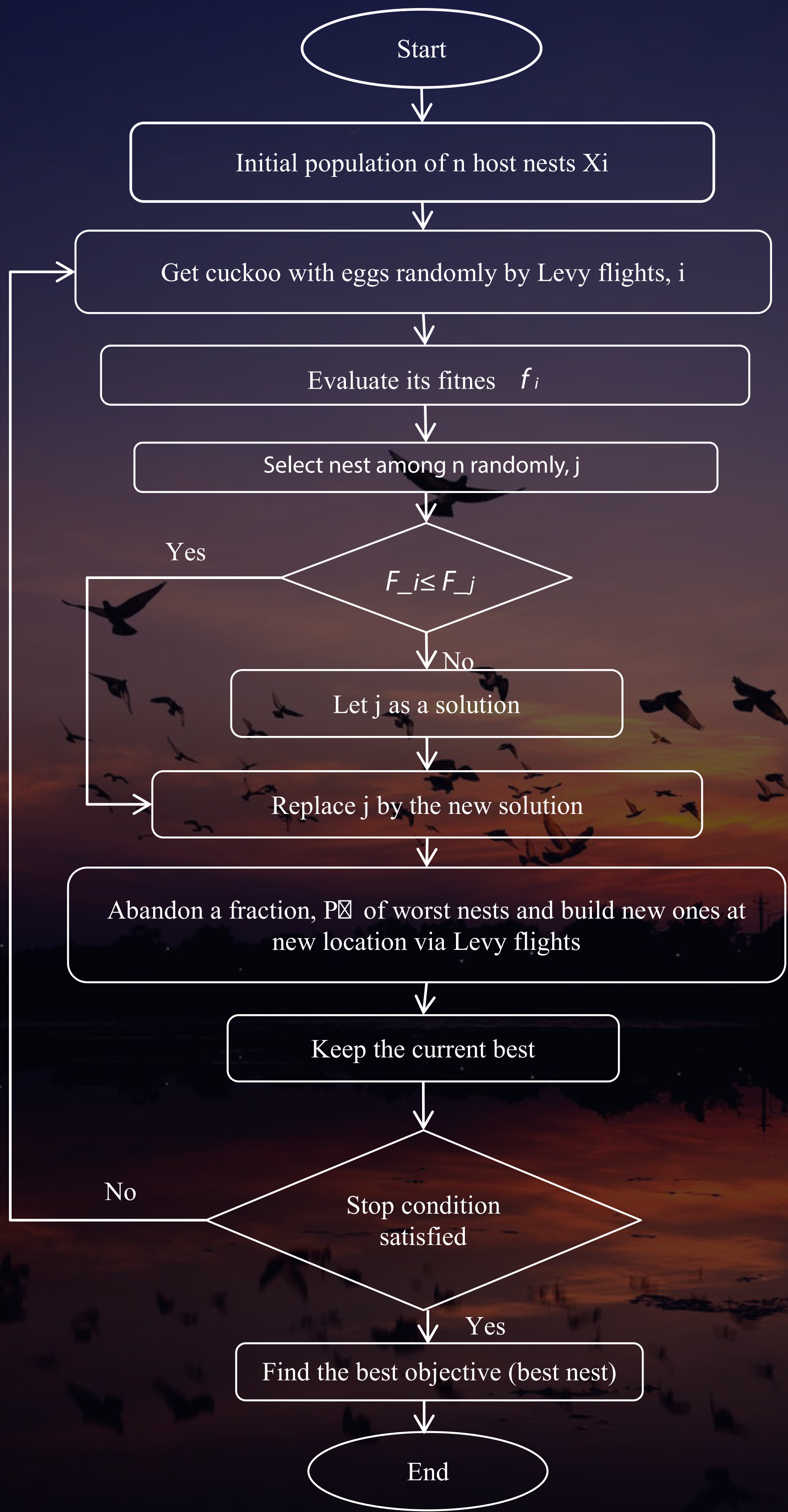
Cuckoos are interesting birds, not only because of the beautiful sounds but also because of their violent survival tactic. Cuckoos lay the eggs in the host bird nest and may remove other eggs to increase their hatching probability. By laying their eggs in host birds nest, quite a number of species(cuckoo) participate the obligatory brood parasitism. There are three fundamental kinds of parasitism in the brood they are nest takeover, intra-specific brood parasitism and cooperative breeding.The cuckoos are engaged in such a way that female parasite cuckoos will mimic the different patterns and colours of the host species' eggs. This decreases the probability of abandoning the eggs so that re-productivity increases. It is essential to note that there will be more conflicts between the birds and intruding cuckoos. Like, if host birds find the eggs of the cuckoo, then they will either throw them away or give up their nests and create fresh ones. Parasitic cuckoo always chooses fresh built nest of the host bird or just laid eggs nest of the host bird to place their eggs. The cuckoo eggs generally hatch a little earlier than host eggs. Once the chick of the first cuckoo is hatched, Chick's first immediate action is to push the host eggs out of the nest or deliberately propeller the eggs. As a result, cuckoo chick's gets more share of food from the host bird (Sorenson & Payne, 2005). In addition, a cuckoo chick will mimic the host chicks call to gain more feeding opportunities. Cuckoo's breeding behaviour can be implemented in different optimisation problems. Along with the Cuckoo's breeding behaviour, the mechanism of Lévy Flights mechanism is used to improve the COA effectiveness instead of just a random walk.

Lévy Flights mechanism

Birds in nature, search for food randomly or quasi-randomly. A foraging path for a bird is a random walk, as the next move is based on both the current location and the probability of moving to the next location. The probability of selected directions modelled mathematically. Different studies have proven that several birds, insects and animals - flight behaviour indicates the features of Lévy flights. A Lévy flight is a random walk, using heavy-tailed probability distribution, the step-lengths are calculated. Lévy flights are a series of linear flights preceded by a sudden switch of 90 degrees. Using levy flight a random new nest is chosen, where it is the key element to improve CSA performance. The following levy-based formula is used to obtain a fresh random nest.

$$x_l^{(t+1)} = x_i^{(t)} + v \oplus Lévy(\lambda)$$

Where $v > 0$ is the step size, which should be related to the scales of the problems of interest. In most cases, we can use $v = 1$.



The Cuckoo Optimisation Algorithm Flowchart

COA IMPLEMENTATION FLOW

The goal of COA is to find new and efficiently solutions (cuckoos) and replace not-so-good solutions are to from the nest. Each egg in a nest is a solution, and a cuckoo egg is a new occurred solution. That is, each nest will have one cuckoo egg. In real-time, we can extend the algorithm to more complex ways, by placing multiple eggs in each nest, which means a set of solutions can be obtained from COA. The COA is depend on the following three idealized rules:

1. At a time a cuckoo lays only one egg, and place it in the randomly selected nest.
2. The high quality finest nests with eggs (solutions) will be transported to the next generations.
3. The host nest availability is fixed, the host will detect an alien egg with probability pa ε[0,1] . Now, the host bird will throw away the egg or leave the nest and build a new nest in a new location.

SUMMARY

The Cuckoo Optimization Algorithm (COA) is one of the nature-inspired algorithms widely used in various engineering areas to solve continuous non-linear optimisation problems. It is a very efficient way to solve global optimisation because it can preserve an equilibrium between local and worldwide random walks using the switching parameter. Where the survival effort of Cuckoos is not just for the cuckoo society, it is for society as a whole, and all will have the same value of profit. When we analyse the cuckoo algorithm for benchmarking features and real-world problems, the algorithm can manage difficult issues with optimisation. The areas of engineering in which COA used are pattern recognition, job scheduling, software testing, networking, power system, data fusion in wireless sensor networks(WSN), data mining, drilling optimization problem, vehicle routing problem, train neural network, industrial applications, theft detection context for power distribution systems, spam detection, power system analysis and face recognition. Advancement and improvement in all engineering fields, particularly in industrial applications and neural networks, can take place in the future.

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