REVIEW ON CUKOO SEARCH ALGORITHM

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Abstract

Optimization techniques play key role in real world problems. In many situations where decisions are taken based on random search they are used. But choosing optimal Optimization algorithm is a major challenge to the user. This paper presents a review on Cuckoo Search Algorithm which can replace many traditionally used techniques. Cuckoo search uses Levi flight strategy based on EgglayingRadius in deriving the solution specific to problem. This can be used in many Engineering applications either electrical power distribution or random number generation in Computer applications. This can be categorized as one of the best optimization algorithm based on the review.

Keywords: Optimization, LeviFlights, EgglayingRadius, Cuckoo Search Algorithm

1. Introduction

Optimization is the process of finding the optimal solution among the particular problems. Among the optimization algorithms, there are two kinds of optimization algorithms they are heuristic and metaheuristic algortihms. The most efficient metaheuristic algorithm is cuckoo search algorithm which has been inspired from the nature and the behavior of leviflights. Cuckoo Search Algorithm has been discovered by Xin-She Yang and Suash Deb in 2009. Cuckoo Search Algorithm has been evolved by the brooding parasitic behavior[1,2].

2. Cuckoo Search Algorithm

Cuckoos are not only interesting because of the sound they make they are also amusing in their reproductive strategy. Cuckoo's such as auni and gyra lay their in eggs in their common nests and they may remove the eggs of other species in order to increase the probability of their own eggs. Sometimes some number of species lay their eggs in the nests of other host birds which may belong to other species. There are three kinds of brood paristism among the species. Intra specific brood parasitism, cooperative breeding, and nest takeover. some times host birds lays their eggs in the nests of their own species if they discover the eggs of other species birds then they may throw the eggs of other species birds or may sometimes destroy their own nest and move to other nest. Some cuckoo species such as Tapera is famous among the female parasitic behavior for laying their eggs in different colours and laying their eggs in host birds nest. The timing of egg laying of some species is surprising, parisitic cukoos choose the host species nest to lay their own eggs, sometimes the cuckoo eggs are hatched earlier when compared to the host species eggs. If once the cuckoo chick is hatched first then these chicks can also mimic to gain more access for the feeding from the host bird. The way in which the cuckoo breeding does can be applied to various optimization algorithms. Yang and Deb used the Levy Flights Technique instead of random walk to improve the implementation.

2.1. Levy Flights mechanism- Generally animal search for food in some random order from their location to any other location, this kind of searching from one location to other location can be defined as the random walk. The path in which the animal chooses to move from one place to next another place may depends upon the past location where the animal has moved earlier. Many Research activities convey that the flight behaviour of many animal and flies shows the feature of Levi Flights.

Levi Flight was nothing but a random walk where the number of steps covered is also taken a count according to Heavy-Tailed Probability Distribution. The steps length is also taken into account in this Proabability Distribution. The Distribution may tend to tend to stable if there are large number of steps.

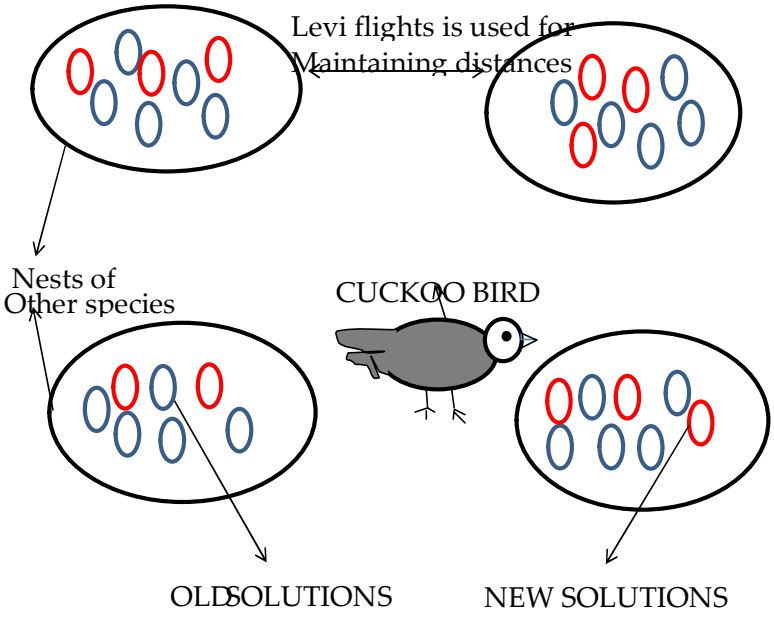

Fig1: Cuckoo Search Architecture

2.2. Execution Steps for Cuckoo Search Algorithm:

The every egg that is present in the nest represents a solution for a defined problem and the eggs that belong to cuckoo represents a newly occurred solution for the defined problem. Our goal is to implement better solutions by replacing the solution which are not so efficient when compared with the better solutions. When we use simplest case it have only single egg in each nest and it may become complicated when the number of eggs increases in the nest where the multiple eggs represent multiple solutions. The steps for the algorithm can be framed out based on three idealized rules.

1. Each and every cuckoo lays eggs at a time and places them in any of the nests which was aimlessly chosen.

2. The nests which are having high quality of eggs are only forwarded to future generations where here high quality of eggs represents high quality of solutions.

3. The available number of host nests is fixed and if the host bird discovers non-native egg with the probability pa ε[0,1] in the nest it might throw away the egg or else destroy the nest.

For simplicity if the assumption can be approximated by a fraction pa of n nests replaced by the new nests. For the problem maximization, the quality of a solution can be proportional to the objective function. Fitness can be defined by the fitness function in genetic algorithms. While generating new solutions x(t+1), for cuckoo if Levi Flight is performed. $X(t+1)= Xi(t)| + \alpha \oplus$ Levy where $\alpha > 0$ it is a step size which must be related to the problems of interest in some cases, we can also use $\alpha = 1$.The above equation is the theoretical equation for Random walk. Levi Flight provides a random walk while random step length can be drawn from Levy

Distribution. Levy $u = t^{-\lambda}$, $(1 < \lambda \leq 3)$ Which has infinite variance with infinite mean. New solutions can be generated by Levi walk method, this may result to speed up the local search. Cuckoo search is a population based algorithm and is similar to GA, PSO Algorithm. The Randomization in cuckoo search is heavily tailed so that any large step is possible. The number of Parameters to be adjusted in cuckoo search is probably less when compared with GA and PSO and so it is more genetic to obtain a wider class of optimization problems.

2.3. Originating of Cuckoo Habitat: In Cuckoo Search Optimization algorithm in order to solve the optimizations problem, it is mandatory that the values of problem variables should be formed as an array. In cuckoo optimization algorithm it is called "habitat". The array can be defined as habitat=[x1,x2,x3,……,xnvar] where 1 x n var is represented as current living position of the cuckoo. Each of the variable in the array is a floating point number in an array. The profit and cost can be determined as profit=fp(habitat)=fp(x1,x2,x3,…..,xnvar). In order to use cuckoo optimization algorithm in cost minimization problems, one can maximize the profit function as profit=cost(habitat)=fc(x1,x2,x3,…..xnvar). The habit of cuckoo that lays eggs with in the maximum distance from the habitat that is called egg laying radius. Each cuckoo has egg laying radius which is proportional to the number of eggs in the nest, current cuckoo eggs and the variable limits of varhi and varlow. The EgglayingRadius(ELR) can be defined as

$$ELR = \alpha \times \frac{(\text{number of current cuckoo eggs})}{(\text{total number of eggs})} \times (\text{varhi-varlow})$$

Where α is an integer which is needed to handle the maximum value of ELR.

2.4. Cuckoos Manner of Egg Laying:

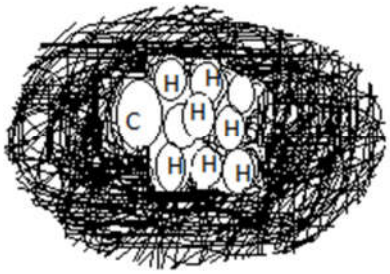

Fig 2: Egg Laying Feature of Cuckoo Search

Cuckoo lays eggs in the host bird's nest randomly among the host bird eggs within in the egg laying radius of the nest. In the Fig 2 C represents the cuckoo egg and H represents the host bird's eggs. Cuckoo eggs are different from the host birds eggs in colour or in shape. Cuckoo eggs are big sized when compared to host bird's eggs. So, after the egg laying procedure has been completed there is a probability of p% of all the eggs, with less profit values will be killed by the hosts bird's. These eggs are not carried forward to the future. Rest of the eggs which are present in the nest are fed by the host bird's. The interesting point here is that cuckoo eggs are the only eggs in the nest that has the chance to grow. when the cuckoo eggs are hatched by the host bird's then small cuckoo chicks come out from the eggs then the host bird thinks that they are not their own eggs and throws away all of the remaining eggs which are present in the nest which belongs to the host bird. If suppose the host chick's are hatched earlier than the cuckoo chicks then as the Cuckoo chicks are three times bigger than the host bird's chicks, they tries to eat

more food when compared to the host bird's chicks. After some days the host chicks die because of hunger as all of its food have been eaten by the cuckoo's chicks.

3. Applications

Cuckoo search has obtained better solutions than the existing solutions in Research. Some of the applications of cuckoo search are-

Lim Huai Tein[17] solved problems on Nurse Scheduling using cuckoo search method. Nurse scheduling method is playing key role many health care institutions around the world.

M. Dhivya et.al[18] achieved energy efficient Wireless Sensor Network and multimodel objective functions using Cuckoo based particle approach. In this paper network has been formulated by Cuckoo based particle approach. Cuckoo Search is applied for cluster head selection and formation of clusters among the sensors node. This developed algorithm reduces the complexity in chain formation and sustains longevity in sensor Network.

A. R. Yildiz [23] used Cuckoo Search algorithm to solve manufacturing Optimization problem. When the Results were compared to solve this manufacturing optimization problem among many algorithms such as genetic algorithm, colony algorithm, hybrid particle swarm algorithm, immune algorithm , Cuckoo search is performed effectively in the optimization of machining parameters of milling operation problem finding better solutions compared to other techniques. The Cuckoo Search is very robust for machining optimization problem.

Ahmed T. Sadiq Al-Obaidi[25] presents enhanced scatter search algorithm using Cuckoo Search algorithm. Testing is done on travelling salesman problem by original and improved scatter search. The scatter search is a strategy that is applied to some contionous optimization problems. The results shows that the improved scatter search algorithms produce better performance than the original scatter search algorithm.

Aziz Ouaarab et.al[20] said about an improved and discrete version of Cuckoo Search algorithm to solve famous travelling sales man problem. Symmetric Travelling Salesman problem solved by using improved cuckoo search algorithm. Cuckoos have mimic nature so that the complex problems can be easily solved by the algorithms with simplicity. They also want to develop more algorithms which are more intelligent and less complex than other algorithms.

A modified Cuckoo search by Walton et al. [34] has manifest to be very efficient for solving problems such as mesh generation. Vazquez[33] used cuckoo search to train spiking neural network models. Kumar and Chakravarthy[20] using cuckoo search they have achieved optimal design for reliable embedded systems.

A. Layeb [19] discovered a new algorithm named Quantum Inspired Cuckoo Search Algorithm, this depends on Quantum computing principles and Cuckoo search algorithm. This consists of defining an appropriate scheme representation in cuckoo search algorithm that allows applying successfully on combinational optimization problems. There are some issues to improve the algorithm one of it is integrate a local search method like tabu search and the second one is the better use of parallel machines because it was verified effectively that Quantum inspired algorithms can work better on parallel machines.

4. Conclusion

Cuckoo Search is being used as replacement of present used optimization algorithms. Through its advent in 2009, this has been used in numerous applications such as scheduling, routing, choosing random variables, trace weights in neural networks,

manufacturing, condition monitoring, health monitoring and so on. This can be compared with traditional optimization algorithm and is found to be best in the criteria.

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