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A REVIEW OF SWARM INTELLIGENCE METAHEURISTICS

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Abstract: - In past decades, metaheuristics has been a trending topic in every field like operation research, science and engineering. But nature inspired metaheuristics from has been gaining popularity now a days due to their cooperative and collective of different species from the environment. Swarm inspired metaheuristics mimics the behavior of insects, birds, animals etc. These swarm intelligence metaheuristics solve very complex optimization problem in reasonable time with sub-optimal solution. These metaheuristics address different challenges which cannot be solved using traditional methods. The aim of the paper is to brief the basic concepts of different algorithms.

Keywords: Ant Colony Optimization, Metaheuristics, Particle Swarm Optimization

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I. INTRODUCTION

Real world is full of optimization problems in different fields like operation research, engineering etc. There are exact methods, heuristics to solve different problems in definite time but as problem size increased these methods are not able to handle it [1]. Metaheuristics are able to solve these problems which traditional methods are not able to solve. Metaheuristics provides a sub optimal solution in reasonable time. It is suitable to solve NP-hard problems in competitive computational time [2]. From metaheuristics, swarm intelligence metaheuristics gained prominence over different metaheuristics due to solving of complex problems. It was coined by Gerardo Beni and Jing Wang in 1989 [3].

Swarm intelligence metaheuristics took inspiration from those species which works in groups in search of food; basically it mimics their social behavior to solve the problem [4]. Ants, bird flocks, wasp, bat etc works collectively to search food [3]. Due to these interesting characteristics, researchers are working to develop new algorithms for solving challenging problems in different fields like machine learning, engineering etc. Hierarchy of swarm intelligence algorithm is shown in figure 1 below.
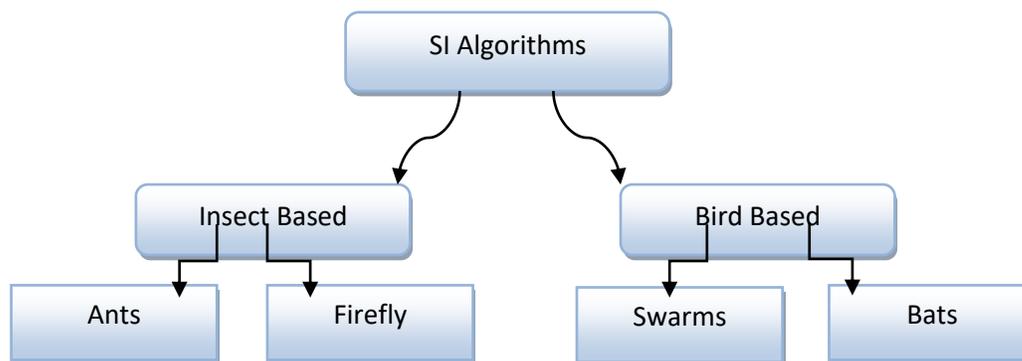

Figure1: Hierarchy of swarm intelligence algorithm

II. INSECT BASED ALGORITHMS

These algorithm mimics the behavior of insects like ants, firefly etc. but here in this paper ant colony optimization algorithm and firefly algorithm is discussed briefly.

A. Ant Colony Algorithm

Ant colony algorithm mimics the foraging behavior of real ants and this algorithm was coined by M.Dorigo in 1999. ACO is used to solve discrete optimization problem but later it was also used to solve continuous problems [6].

In an ant colony about 25 million ants live and it uses collective behavior of ants and their communication mechanism. Ants use indirect communication strategy known as stigmergy, according to this, ants left a chemical substance known as pheromone on ground during their trip. This pheromone guides other ants to the food source. Ants only follow those path which have high concentration of pheromone level but it is also get evaporated with time.

Pheromone evaporation act as an escape mechanism and prevent ants from choosing any random path. Pheromone amount depends upon the quality of the food source. If food source is high then pheromone quantity is high and vice-versa. If on a path ants find obstacle then ants choose any path around the obstacle and soon all the ants follow shorter path to the food source on the basis of pheromone quantity.

Variants of ant colony algorithm is many like elitist ant system, max-min ant system, rank based ant system, quantum ant colony optimization, cunning ant system, cooperative genetic ant system[7], [8].

ACO can be used for solving travelling salesman problem [9], scheduling problem [7], telecommunication network problem [10], quadratic assignment problem, vehicle routing [6].

B. Firefly Algorithm

Firefly algorithm was proposed by Xin-She Yang in 2008. This algorithm was inspired by flashing behavior of fireflies. This flash is used to attract other fireflies. Some assumption of this algorithm is any firefly can and will be attracted by any firefly. Brightness and attractiveness is directly proportional to each other i.e. brighter firefly will attract the less bright firefly. Firefly move randomly if there are no brighter fireflies present. [11], [12].

Variants of firefly are firefly for discrete problems, firefly algorithm to multi-objective optimization, hybridize firefly algorithm [13].

Firefly is applicable to different problems like travelling-salesman problems, graph coloring, Classifications and clustering, NP-hard scheduling problems etc. [13].

III. BIRD BASED ALGORITHMS

These algorithms imitates the behavior of birds like swarm, cuckoo, bat etc but here only particle swarm optimization and bat algorithm is discussed.

A. Particle Swarm Optimization

Particle swarm optimization algorithm was coined in 1995 by Kennedy and Eberhart. It is used to solve continuous optimization problems but some variants are also able to solve discrete problems [1].The amazing quality of bird swarm is that they never collide with each other because they keep track the status of seven birds neighbored to them. Each bird updates its velocity and position according to global best position and local best position. Everyone in the swarm try to achieve global best solution [2], [5].

Variants of particle swarm optimization are bare bones PSO (BBPSO), fuzzy PSO (FPSO), discrete PSO (DPSO), chaotic PSO (CPSO) etc [16].

PSO's application can be seen in many fields like engineering, image processing, scheduling, design optimization, science etc. [5].

B. Bat Algorithm

Bat algorithm was coined by Xin-She Yang in 2010. In environment there are 1000 species of bat but this algorithm was inspired by echolocation behavior of microbats. Ecolocation uses a type of sonar to find prey in the dark. Every artificial bat flies randomly with a certain velocity at a position with a varying loudness and wavelength. After finding its prey bat changes its wavelength and loudness. Random walk is used to intensify the local search and this search continues until stop criteria met [14] [15].

There are many variants of bat algorithm like fuzzy logic bat algorithm (FLBA), multi-objective bat algorithm (MOBA), k-means bat algorithm (KMBA), binary bat algorithm (BBA) etc.

Various applications of bat algorithm are continuous optimization problems, combinatorial optimization & scheduling problems, inverse problems, clustering and classification in data mining, image processing etc.[15].

IV. CONCLUSION

Swarm intelligence algorithms are very burning topic of this era and it solved numerous problems from different domains like supplier selection from industrial engineering, facility

layout problem, job scheduling, resource allocation etc. This paper presents a review of different swarm intelligence algorithms like ant colony, firefly algorithm, particle swarm optimization and bat algorithm. It also highlights their variants and applications in different domains. With the help of this paper one will be able to understand basic concepts of different swarm intelligence algorithms.

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