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A Comprehensive Review of Soft Computing Techniques

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Abstract

Most of these techniques had shown potential in solving the real-world problems. The objective of this paper is to put together the popular optimization techniques for understanding and utilize them to excel the research work. It is not limited up to theoretical clearance of popular swarm's optimization techniques. But also helps the scholars to understand nonspecific implementation of these techniques. A comparative analysis of few techniques enriches the scope of understanding. The statistical information swears optimization techniques in real environment.

Keywords: PSO- Particle of swarm optimization, ACO- Ant colony optimization, SI- Swarm intelligence, GA- Genetic algorithm.

INTRODUCTION

In recent years, inside image processing the term swarm intelligence [3] approach has developed into novel artificial intelligence field. It is encouraged by swarm insect with the purpose to show collective intelligence on the swarm stage by very easy act together differently. Swarm intelligence [16] [25] is one of significant term in artificial intelligence with the purpose to learns the intelligence behavior of sets for example the conduct or action of natural structure of social insects such as bees, ants, termites also wasps. The fundamentals characteristics of swarm intelligence are self-organizing and division of labour. Self-organization having four important factors two are positive and negative feedback, which are important for amplification and stabilization. Third factor multiple interaction helps to share information among the group members and fluctuation is important for random nature. The labour division means execution of simple and necessary task at individual level.

Furthermore, used for solving the optimization problems the core algorithm is meta-heuristic and that is initiated by researches is Ant Colony Optimization.

REVIEW OF TECHNIQUES

I. Soft computing techniques: are found of wide applications which having emerging field that involves complementary elements of various techniques that are listed in below figure.

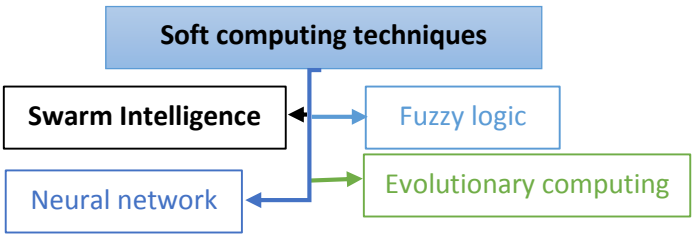

Figure 1: Soft computing techniques

Soft computing was first introduced in 1980. Soft computing is a process that is based upon principle components like machine learning, expert system, fuzzy logic, genetic algorithms and artificial neural network. The main goal of soft computing is to provide us a way to find solution of problems that are too difficult to answer. It is different from hard computing in many aspects as this technique is tolerant to uncertainty as oppose to discriminant results in hard computing. Soft computing is truth that is partial and approximation [18].

II. Fuzzy based technique: Fuzzy approach [17] is soft computing technique. For edge detection fuzzy logic defines different possibilities. In fuzzy logic one technique is describe a membership function representing the scale of every neighborhood. Fuzzy set can just performs true fuzzy logic if it is furthermore used to change membership values. This soft computing technique is fast but the performance is inadequate. For this method we use if-then rules. Fuzzy rule IF THEN shows edge recognition plus neighborhood of centre pixel of input image and Pixels are separated into fuzzy set. In this method homogeneity is evaluated to experiment the similarity of two regions through the segmentation process.

III. *Neural network approach:* This technique is different from artificial intelligence techniques in term of their ability of generalize and learning. This approach is made from a number of elements that are joined with variable weight[29]. It is generally used for pattern recognition. The Neural network is soft computing technique work in layers: the input layer, which provided to neuron is normalizing in [0-1] form. And also, the neuron's output values in [0-1] form. These three layers are fixed numbers of neurons, number of neuron depends on the size of image i.e. equal to image's size (I * J). All neurons have

one primary connection with weight equal to 1. All the neurons in all layers are interconnected with previous layer or neuron of one layer is linked with particular neuron of before layer with its command neighbor[14][16].

IV. Swarm intelligence techniques: In this section we will introduces various swarm intelligence-based techniques[21]. This section explains the concept of the respective technique and its steps wise logic useful to implement the technique. After discussing these all, we illustrate their comparative analysis with each other [13] [15]. This will help out in depth understanding the details of these techniques[24][29][35][38].

i. *Genetic Algorithm (GA):* Introduced in 1975 by John Holland based on natural selection and used for search optimization process. In natures structure only the strongest can adapt and survive and weaker are vanished from the system. This can be rule can be described as "survival of fittest". This method had proven to be robust by developing optimized solution for variety of complex as well as machine learning problems.

Each candidate solution of a problem is represented by a data structure known as an individual. An individual has two parts: a chromosome and a fitness. The chromosome of an individual is made up of genes. The values that can be assigned to a gene of a chromosome are referred to as the alleles of that gene. A group of individuals collectively comprise what is known as a population. For most GAs, the size of the population remains constant for the duration of the search. Individuals selected from the current population, called parents, are selected based on their fitness and are allowed to create offspring [38]. Usually, individuals with above average fitness have an above average chance of being selected. After selection, reproductive operators such as crossover and mutation are applied to the parents. In crossover, parents contribute copies of their genes to create a chromosome for an offspring. This is analogous to the way offspring of living organisms are created as a genetic mixture of their parents. Mutation requires only one parent [1]. An offspring created by mutation usually resembles its parent with the exception of a few altered genes. After the children have been created, the candidate solutions that they represent are evaluated and each child receives a fitness. Before the children can be added to the population, some individuals in the current population must die and be removed to make room for the children. Usually, individuals are removed based on their fitness with below average individuals having an above average chance of being selected to die. This process of allowing individuals to procreate or die based on their relative fitness is called natural selection. Individuals that are better fit are allowed to live longer and procreate more often. An interesting aspect of GAs (and EC in general) is that the initial population of individuals need not be very good. In fact, each individual of an initial population usually represents a randomly generated candidate solution. By repeatedly applying selection and reproduction, GAs evolve satisfactory solutions quickly and efficiently[2].

Genetic algorithm can be characterized in terms of eight basic attributes: (1) the genetic representation of candidate solutions, (2) the population size, (3) the evaluation function, (4) the genetic operators, (5) the selection algorithm, (6) the generation gap, (7) the amount of elitism used, and (8) the number of duplicates allowed.

ii. *Particle swarm optimization:* is a population-based technique that is orginaly proposed by Dr. Eberhart & Dr. Kennedy in 1995. Inspired by social foraging behaviour of animals like flock of birds or fish schooling [8] [22].

In a large no. of iterations, all the variables group adjust their value closer to that one member who has the value that is closest to the target at any instance. Let's take a flock of birds that are circling over an area and where they can smell a hidden or solitary source of food. Bird is the oldest which is closest to the food chirps then all other birds move in his direction. If in any case, any other circling birds came near to the target food source than the first bird, it chirps louder than the first and the other birds swings toward him. This pattern continues until one of the bird reaches to the food source [9][10][23]. This is the simplest algorithm and it is very easy to implement.

Three global variables in the algorithm are:

- Value that is targeted
- Global best (gBest) value represents closest particle to the Target
- Stopping value indicates when to stop the algorithm if Target is not found in any case
- Each particle is composed of:
- Data that represent a solution which is possible
- A Velocity value with which particle move towards target
- A (pBest)personal best value represents the closest the particle has ever come to the Target

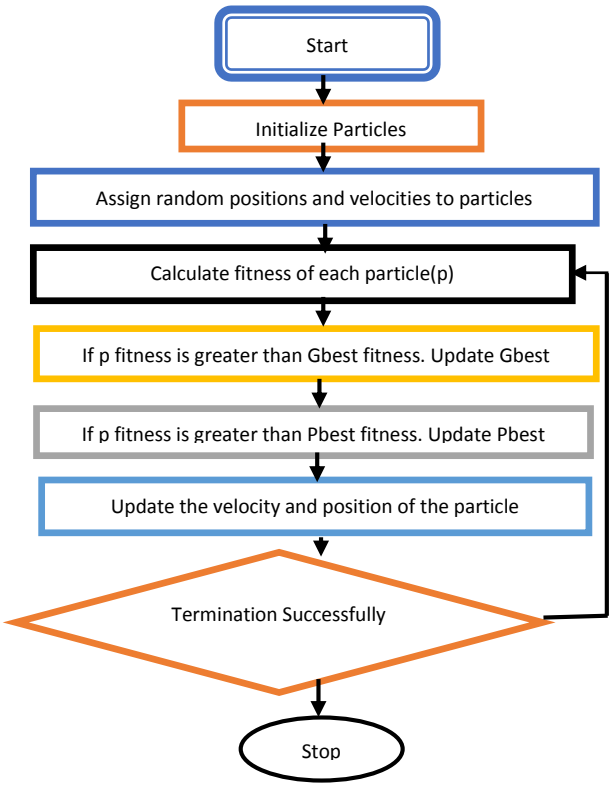

Figure 2: Particle swarm optimization flow

iii. *Ant Colony optimization technique:* It is inspired by social behaviour of ants. In this ant lays a pheromone on the path while walking to the source of food. Other ant's smell's this pheromone, its concentration is beneficial for other ants to choose their path. They follow the path in which pheromone has strong concentration [8][11][12][32].

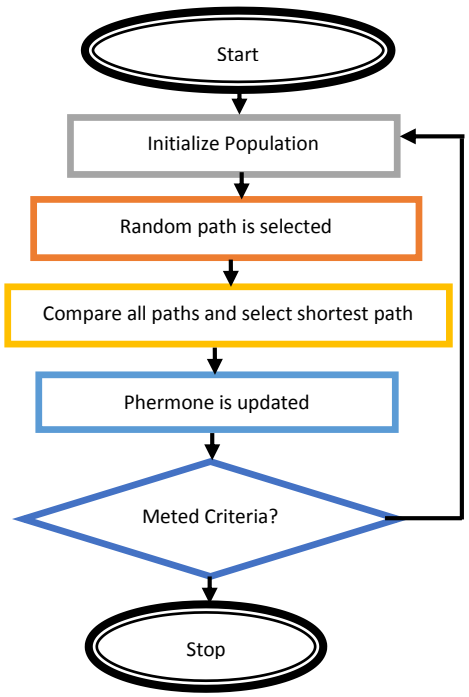

Figure 3: Ant Colony optimization flow diagram

iv. *Firefly technique:* It is a metaheuristic optimization technique that is inspired from the flashing behaviour of fireflies. Flash of fireflies behave as a signal to attract the other flies. Firefly with brightest flash attract other flies to mate, the less bright one is attracted by the more bright one [6-7][19][25-27][30-31][34].

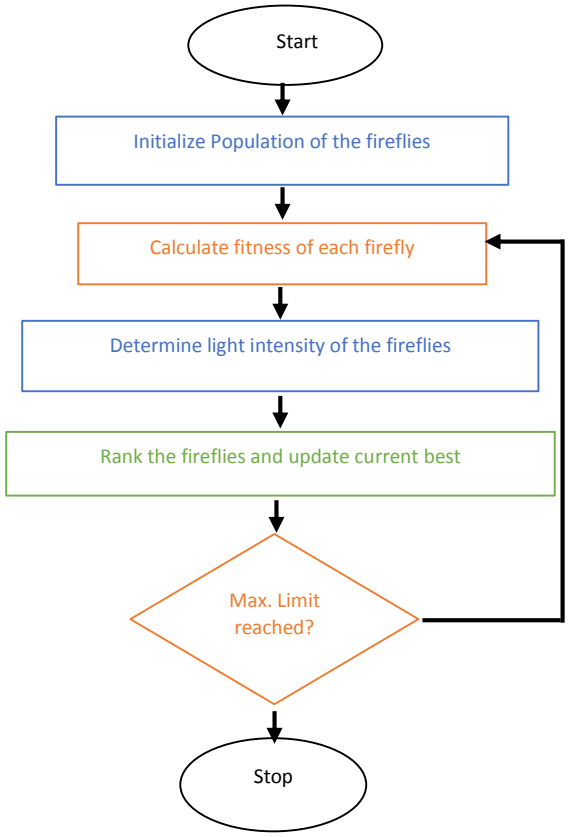

Figure 4: Flow diagram for Firefly algorithm

v. *Artificial Bee Colony (ABC):* proposed originally by Dervis Karaboga in 2005, further tested its performance in 2007 with other algorithms and its confirmed that this approach having better results [20][33]. inspired by the intelligent behaviour of real honey bees in finding food sources, known as nectar, and the sharing of information about that food source among other bees in the nest. This model having three base pillars and these are employed foraging bees, unemployed foraging bees, and food sources. The initial two factors that are employed and unemployed foraging bees helps in searching the third factor that is rich food sources near the hive. Unemployed bee's composed of scouts and onlooker bees [4]. Initially all food sources are discovered by scoot bees. When the food sources are exploited by employee bee are get converted to scout bees. The quality (fitness) corresponds to nectar amount of a food source [5][3].

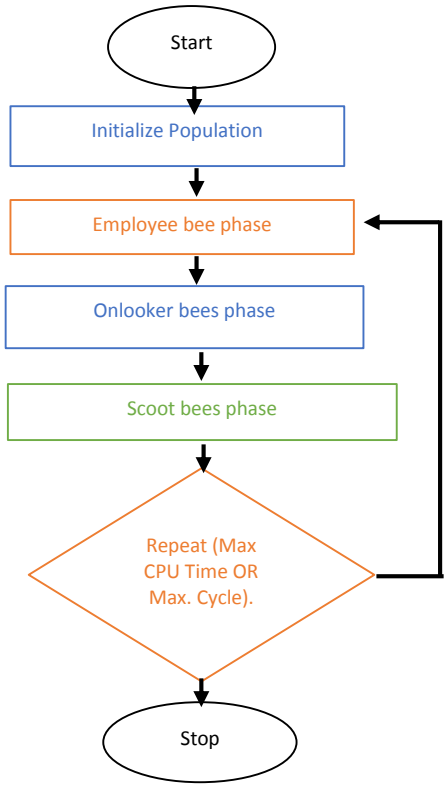

Figure 5: Artificial Bee colony flow diagram

PARAMETER FOR ANALYSIS

This paper represents the comprehensive analysis of different techniques of soft computing. Thus, for analysis purpose we had chosen parameters on the basis comparison is accomplished. These parameters are as described.

I. Intent: describes the targeted objective of the technique. Its purpose is not to explain the detail the parameter but just the nub of it.

II. Where to apply: purpose of this parameter is to define the application area of technique.

III. Convergence: when the objective gets achieved. Different entities are coming together toward the achievement of purposed goal.

IV. Methodology: is a systematical mode through which the goal is get realized. In other words, the set of steps if followed in defined manner will able to achieve the target.

V. Inspiration: intention to do something new. Finding the solution of problem with newness.

VI. Approach: effort input to deal with the given problem.

COMPARATIVE ANALYSIS

This section of paper represents the comparison of different algorithms discussed above in brief. This approach will help to analyze all the aspects of different algorithm. In this section we also describe the few areas on which these techniques can be applied.

Table 1: Comparative study of algorithm*s*

Algorithm→	**Genetic algorithm**	**PSO**	**ACO**	**ABC**	**Firefly**
Intent	The genetic algorithm (GA) [16] transforms a population (set) of individual objects, each with an associated fitness value, into a new generation of the population using the Darwinian principle of reproduction and survival of the fittest and analogs of naturally occurring genetic operations such as crossover (sexual recombination) and mutation.	They don't have genetic operators like crossover and mutation as it is present in genetic algorithm(GA), with the internal velocity particle update themselves and in this memory is also present which is beneficial for an algorithm.	The ACO is more applicable for problems that requires crisps results. As compare to GA it retains memory of entire colony rather than previous generation only. In this convergance is guranteed but, time to convergence is not guaranteed.	It has -strong robustness -fast convergence rate -high flexibility -fewer control parameters -used for solving multidimensional and multimodal optimization problems.	Key feature of this alg. is its fast convergence rate, act as general, global problems Solver as well as local search heuristic. In this there is no use of velocities therefore we don't have to face any problem as associated in PSO.
Where to apply	• Hardware evolution • Invention of biometric • Robotics • Design automation • Investment decisions	• Fuzzy control system • ANN • Function optimization	• Biomedical and bioinformatics • Image processing • Telecommunication network • Data mining • System identification	• Image analysis • Data clustering • On road traffic congestion • Train neural network • Routing in OFC network	• Ob scheduling • For training • Image compression • Feature selection • Multimodal design
Convergence	Mutation dependent	fast	Not guaranteed	Faster	Faster
Methodology	• Initialize the population • Set fitness function • Generate new population ✓ Selection ✓ Crossover	• Initialize each particle • Calculate fitness function for each particle.	• Set parameter and initialize pheromone trials. Construct Solution i. solution construction	• Initialize the population of the solution and select the feasible solution for the problem. It is the best	Three idealized rules: • One fly moves toward other regardless of their sex

Algorithm→	Genetic algorithm	PSO	ACO	ABC	Firefly
	✓ Mutation • Compare with criteria function • Stopping criteria	• Compare the fitness value with another calculated fitness value. The best value set as p Best. • Choose the particle with best fitness value to provide g best • Calculate particle velocity • Update particle position.	starts with an empty partial solution. • Local Search • Improving the solutions • Constructed by the ants. • Update pheromone concentration. • Terminating criteria.	initial solution. For each Bee ✓ make a forward pass (Allows all bees from the hive and evaluate all possible moves. Choose one move using greedy selection process.) ✓ make a backward pass (All bees are back to hive and evaluate the partial objective function value for each bee. Each bee decides randomly whether to continue its own exploration and become a recruiter or to become a follower. For each follower, choose a new solution from recruiters by the greedy method) • Evaluate all the feasible solution and find best one. • Stopping condition. • Provide the best solution for the problem.	• Attractiveness is proportional to brightness, which decreases if distance b/w two increases. Thus less brighter moves toward brighter. If no one brighter then move random. • Brightness obtained by landscape of objective function.
Inspiration	Evolution	Swarm behavior	Behavior of ant	Behavior of honey bee	flashing behaviour of fireflies
Approach	Global search heuristic method both 2/3 dimension approach	Population based stochastic optimization both 2/3 dimension approach	Meta heuristic algorithm only Two-dimension approach	Population based three dimension approach	Metaheuristic

CONCLUSION

This manuscript is a review of published algorithms applied soft computing techniques. In second section describe these theoretically. And then we try to make the comparive analysis on few parameters. Section fourth describe the analysis in crisp from without omitting the important information.

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