Some Study on Bio-Inspired Optimization Algorithms

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Abstract: **Optimization is related to many areas including Engineering, Medical, and Computer Science. In optimization problems, we have a lot of feasible solutions and we choose best solutions among them which are more optimal. The algorithms which give optimal solutions are optimization algorithms. Nature is one of the important factor providing ideas to solve such optimization problems. The algorithms which are inspired by nature may be heuristic or Meta heuristic and they can be used to solve optimization problems. From last few years most of the researchers are focusing on such nature-inspired algorithms to solve the problems. With the invention in these areas and as we are getting the best results, it can be used for various applications and leads to increase the scope. This paper gives detail study on recent initiatives taken by different researchers to solve problems with the help of Bio-inspired algorithms.**

Keywords: - **Bio-Inspired Algorithm, Meta-heuristic, Optimization Problem, Optimization Algorithm.**

I. INTRODUCTION

In Computer Science most of the problems are not decision problems but they are optimization problems where we have to minimize or maximize the function value. Function allows the comparison of different choices to check which better solutions are. Based researchers on the nature of the variable optimization problems may be continuous or discrete. As the complexity of problems are increasing by taking efforts to find efficient and optimized method to solve problems. Nature is also providing effective solutions for solving optimization problems. In this paper we will study a systematic introduction to all major nature-inspired algorithms such as particle swarm optimization, ant and bee algorithms, simulated annealing, cuckoo search, firefly algorithm, genetic algorithm, etc .and also have a look towards some application . Figure 1. Shows different classification of bio-inspired algorithms.
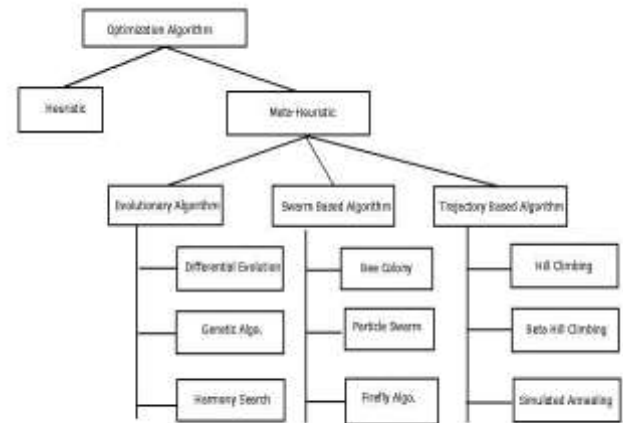
II. EVOLUTIONARY ALGORITHM

2.1 Differential Evolution: Global optimization is necessary as a part of science and engineering. Most of the problems have objective function nonlinear, noisy, multidimensional, and non-differential, these kinds of problems are difficult to solve. Differential evolution can be used to solve such problems. DE has emerged as fast and strong global search technique.

Fig.1 Classification of Optimization Algorithms

As compare to other clustering technique DE can be used effectively to cluster the data even without having prior knowledge about the data. DE optimizes the problem based on combination of different solutions which we have. Swagatam Das [1] purpose is to determine the optimal clusters for unlabeled data set. DE is keeps a simple structure, easy to use, and keep acceptable convergence properties and robustness. Most of the image processing applications aim to find the effective features so it can be used in high level task. DE is well known for its ability to efficiently and adaptively explore large search spaces and has two advantages: (1) DE has shown a faster convergence rate than other evolutionary algorithms on some problems, (2) it has very few parameters to adjust, which makes it particularly easy to implement [2]. Omran et al. also devised a non-automatic crisp clustering scheme based on DE and illustrated the application of the algorithm to image segmentation problems in [3].

2.2 Genetic Algorithm:

In computer science, a genetic algorithm (GA) inspired by the process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithm can be used to solve optimization problems it will create high quality solutions for search based problems. to perform the operations they are dependent on some of bio-inspired operators such as crossover , mutation and selection. In GA the search space is consisting of some parameters which are represented in the form of strings generally called chromosomes. Once we have collection of such strings they are called population. The degree of goodness is dependent on the association of strings with the fitness function the process of selection, crossover and mutation continues for a fixed number of generations or till a termination condition is satisfied. Ujjwal Maulik [4] describe A genetic algorithm-based clustering algorithm, called GA-clustering,. It has been used to search for the cluster centers which minimize the clustering metric. Image compression plays important role in case of multimedia applications. Mainly with the help of image compression we try to reduce the redundant and irrelevant data. M.Mary Shanthi Rani [5] use concept of genetic algorithm for image compression using based on vector quantization .the basic purpose to be served during implementation is to achieve high compression ratio without degradation of image. Digital watermarking is the process of embedding information into a digital signal Arun Kumar [6] uses the concept of GA for digital image watermarking. Image contain information in a very dense form. Shape, texture and color information have been the primitive data in content based image retrieval systems. Abhijit T. Somnathe et.al provide technique of image retrieval based on genetic algorithm [7].

2.3 Harmony Search:

The HS was initially proposed by Geem and applied to solve the optimization problem of water distribution networks in 2000. This algorithm gain popularity in different research fields such as mechanical engineering, control, signal processing, etc. when the musician try to compose the harmony he will use combination of different pitches to create it which indirectly consisting of optimizing process. Table 1.1 gives the Comparison of harmony improvisation and optimization [8].

Table 1 Comparison of harmony improvisation and optimization.

Comparison factors	Harmony improvisation	Optimization
Targets	Aesthetic standard	Objective function
Best states	Fantastic harmony	Global optimum

Components	Pitches of instruments	Values of variables
Process units	Process units	Each iteration

III. SWARM BASED ALGORITHMS

3.1 Bee Colony: The bees algorithm is population based search algorithm which was developed in 2005, Bee algorithm reflect the foraging behavior of honey bees. Image enhancement is important operation in image processing so that it is convenient to view the image by human being. In image improvement we can do lot of variation in image based on histogram equalization, adaptive histogram equalization. In this we can work on contrast parameter so as to optimize it. For that we can use Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Artificial Bee Colony (ABC) [11]. Contrast enhancement improves the visual quality of an image and also enhances image features for further processing. Contrast enhancement methods traditionally based on either spatial or Transform domain techniques. Elif Deniz Yelmenoglu et.al. [12] Worked on hybrid edge detection based on optimization algorithms. Edge detection has many applications such as in medical image processing, machine learning, and computer vision. They have used combined effect of Artificial Bee Colony and Firefly algorithms for the edge detection. Data clustering is also one the operation used in many areas such as medical image processing for brain tumor detection. In medical image analysis for computer-aided diagnosis and therapy, the primary operation has to be targeted is image segmentation. Medical image segmentation is a complex and challenging task due to the intrinsic nature of the images. Mihir A. Mishra et.al[13] have proposed the method for tumor localization and size identification based on fuzzy C-clustering and Artificial Bee colony algorithm.

3.2 Particle swarm: Particle swarm optimization was introduced by Kennedy and Eberhart (1995). Continuous and discrete optimization problems can be solved by using particle swarm which is population based algorithm. Particle Swarm Optimization belongs to the field of Swarm Intelligence. Particle Swarm Optimization is inspired by the social foraging behavior of some animals. Particle swarm optimization shows many similarities that to genetic algorithm. At initial stage system is initialized with many solutions and searches for optima by updating generations. PSO has no evolution operators like GA such as crossover and mutation.

In medical diagnosis registration or geometric alignment of two-dimensional or three-dimensional (3-D) image data is important. In optimization as the function of metrics with

respect to transformation parameters generally irregular and non-convex so local optimization generally fail that's why global optimizations are required. Mark P. Wachowiak [9] uses particle swarm optimization, is adapted for single-slice 3D to 3D biomedical image registration. A new hybrid particle swarm technique is proposed that incorporates initial user guidance. Multimodal registrations with initial orientations far from the ground truth were performed on three volumes from different modalities. Image Steganography is the process to hide the information in the target image in such a way that it will not get identified. In order to hide the details in more significant bit it is needed to optimize the image. Rafael Lima de Carvalho[10] uses the concept of PSO to optimize the image.

3.3 Firefly Algorithm: Firefly algorithm (FA) is one of the proposed intelligent algorithms inspired by the behavior of the flashing characteristics of fireflies. In FA, the fitness function for a given problem is associated with the light intensity. The search process of FA depends on the attraction among fireflies. Most fireflies produce short and rhythmic flashes to attract mating partners and potential prey. Hui Wang [14] proposed a new variant of Firefly algorithm as NSRaFA, which employs a random attraction model and three neighborhood search strategies. Firefly algorithm (FA) has shown an effective performance on many optimization problems. it may suffer from premature convergence when solving complex optimization problems. Yong Guo [15] applied the firefly algorithm for blind watermarking method in association with DWT QR transform domain. This is important because now a day's many operations involve transportation of digital images through the internet so the content security is one of the major tasks in this. As one of the popular and efficient method, the digital image watermarking, embed the watermark into the cover image.

IV. TRAJECTORY BASED ALGORITHM

4.1 Hill Climbing: Hill climbing is heuristic search used for mathematical optimization problems in the field of Artificial Intelligence. Hill climbing solves the problems where we need to maximize or minimize a given real function by choosing values from the given inputs. It is one of the optimization algorithms such as travelling salesman problem where we need to minimize the distance traveled by salesman. Takumi OHASHI et.al.[16] proposed a segmentation method that produces a set of visually coherent regions. Hill climbing technique is mainly used for solving computationally hard problems. It looks only at the current state and immediate future state. Hence, this technique is memory efficient as it does not maintain a search tree.

4.2. β-Hill Claiming : Recently, meta heuristic-based algorithms such as evolutionary algorithms and local search-based algorithms are successfully used β-hill climbing is a recent meta heuristic local search-based algorithm Omar Suleiman Arabeyyat et.al.[17] proposed the method for multiple reservoir scheduling based on β hill climbing. Here in β-hill climbing a stochastic operator β is used to control the balance between the exploration and exploitation during the search. Hill Climbing method is used as an optimization technique which is used to build a search trajectory in search space till it reaches local minima. As in hill climbing it involve uphill movements it stuck in local minima easily. Many extensions have been proposed by the researchers such as simulated annealing. In terms of search space navigation, β-hill climbing is able to jump from a search space region to another using β operator that can be thought as a source of exploration [18]

4.3 Simulated annealing: This is one of the probabilistic methods for approximating global optimum of a given function. It is often used when the search space is separate. Behind the name and concept annealing in metallurgy is the main inspiration. a technique involving heating and controlled cooling of a material to increase the size of its crystals and reduce their defects. Majdi M. Mafarja et.al. [19] Proposed the method for feature selection based on hybrid whale optimization algorithm with simulated annealing. for feature selection technique two hybridization models are used. In the first model, Simulated Annealing (SA) algorithm is embedded in Whale optimization algorithm, while it is used to improve the best solution found after each iteration of Whale optimization algorithm in the second model. The goal of using SA here is to enhance the exploitation by searching the most promising regions located by Whale optimization algorithm.

V. CONCLUSION

Many algorithms have been developed to solve and optimize the hard optimization problems but in the Revolution of algorithms nature inspired algorithms are having major impact. As the sources of inspiration for algorithm development is varied similarly there is more variation in terms of algorithms development strategies. The work presented the important features of these algorithms in terms of their input parameters, mechanism and applications. This will help to the research community to think over optimization problems from different angles and lead to have significant research in solving real world problems in this field. For the same reason researchers from different community such as computer science, biology, biomedical, artificial intelligence has to collaborated their work.

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