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ANALYSIS OF POPULATION BASED META HEURISTICS ALGORITHMS FOR OPTIMIZATION OF FUNCTIONS

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Abstract

Aim: The aim of the paper is to understand and utilize the meta heuristics algorithms for the optimization. These algorithms are tested against few standard functions.

Background: Meta heuristics are those group of algorithms which are used for getting domain independent solution in a mean time. These groups of algorithms are highly needed because of the growing applications along the length and breadth of the globe. Many real world problems are not linear, multi modal and with incomplete information. These applications create an urge in the research to find the better solutions through this type of algorithms rather than using the traditional solution strategy.

Methodology: In this study we have employed five population based meta heuristics namely Genetic Algorithm, Particle swarm Optimization, Artificial Bee Colony Optimization, Bat Algorithm and Ant Lion Optimization. These optimization algorithms are used to optimize the functions with single objective and many local minima. The functions experimented are Ackley function, Bukin Function, Cross in Tray function, Drop Wave function and Egg holder function. The optimization done here is to find the minimal value of these functions by using the above said algorithms.

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Contribution: This research is done to utilize the population based meta heuristics for optimization. This work gives the understanding of the working nature of the meta heuristics against the problem to be addressed. The stochastic nature is demonstrated. Local minima trapping are avoided by using these algorithms. It is clearly demonstrated by applying these algorithms to the functions having many local minima. The population management is done differently for different algorithms. This study provides an idea for choosing particular algorithm based on the problem over many Meta heuristics available.

1. Introduction

Optimization of functions is the key part in many of the problems in theory and in the real life. Function is of the changing value from point to point. The common applications of the optimization of function are of profit enhancement, loss minimization, designing of components, management problems.

In this paper we have considered the functions with single constraint and many local minima. The objective is to find the global minima. The point we have to consider is to not to be trapped in the local minima. In order to avoid the trapping into the local minima we have applied Meta heuristics algorithms instead of the traditional approaches.

2. Background Study

This paper involves the study of the Meta heuristics for the application of the optimization of the functions. When the problem space is large and complex, conventional methods suffer to solve the problem. In this case we can introduce Meta heuristics to solve these types of problems.

Meta heuristics are domain independent, simple and efficient to solve the problems compared to the traditional methods. Mathematical programming methods tend to fail as the size of the optimization problem increases [1].

3. Problem Statement

Single constraint functions with many local minima are considered as the problem to be solves. Classical solution strategies like mathematical programming, operational research solve the problem but lack in solution when the problem domain is complex and large. So there is a need to find the alternative strategy for the problems of this kind.

4. Proposed Methodology

The proposed methodology for the problem discussed above is to use Meat heuristics to optimize the functions considered.

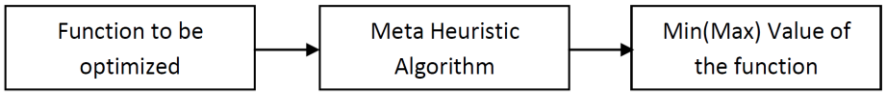

Figure 1. Workflow of the proposed methodology.

5. Experimental Setup

The experiment is carried out for the five test functions by applying five different Meta heuristics algorithms.

5.1. Test Functions used

The test functions used are described below.

5.1.1. Ackley Function

It is a non convex function used for testing. It is used by David Ackley [2] in his thesis. It is defined as

$$f(x) = -a \exp\left(-b\sqrt{\frac{1}{d}\sum_{i=1}^{d} x_i^2}\right) - \exp\left(\frac{1}{d}\sum_{i=1}^{d}\cos(cx_i)\right) + a + \exp(1).$$

5.1.2. Bukin Function N. 6

It is a continuous convex function. The sixth Bukin function has many local minima, all of which lie in a ridge [3]. It is defined as

$$f(x) = 100\sqrt{|\, x_2 - 0.01\, x_1^2 \,|} + 0.01|\, x_1 + 10 \,|.$$

5.1.3. Cross-in-Tray Function

It is a continuous non-convex function [4]. It is defined as

$$f(x) = -0.0001\left(|\, \sin(x_1)\sin(x_2)\exp\left(|\, 100 - \frac{x_1^2 + x_2^2}{\pi} \,|\right)|+1\right)^{0.1}.$$

5.1.4. Drop-Wave Function

It is a continuous non-convex function [5]. It is defined as

$$f(x) = -\frac{1 + \cos\left(12\sqrt{x_1^2 + x_2^2}\right)}{0.5\,(x_1^2 + x_2^2) + 2}.$$

5.1.5. Eggholder Function

It is a non convex function with large number of local minima [6]. It is defined as

$$f(x) = (x_2 + 47)\sin\left(\sqrt{|\, x_2 + \frac{x_1}{2} + 47\,|}\right) - x_1 \sin\left(\sqrt{|\, x_1 - (x_2 + 47)\,|}\right).$$

5.2. Population Based Meta Heuristics Algorithms

There are five Meta heuristics algorithms used for the experiment to find the local minima of the given functions. They are

- Artificial Bee Colony Optimization (ABC)
- Ant Lion Optimization (ALO)
- Bat Algorithm (BA)
- Genetic Algorithm (GA)
- Particle swarm Optimization (PSO)

6. Experimental Results

The following table gives the details of the consolidated results obtained by the experiments conducted, which is discussed above.

Table 1. Results obtained by application of Meta heuristics

Function/MH	ABC	ALO	BA	GA	PSO	Benchmark
Ackley	0.0065	0.00024	4.4408e-16	1.287549	2.6069e-5	0
Bukin	0.6166	0.04704	0.1	1.781361	0.1169401	0
Cross in Tray	–2.0626	–2.0626	–2.0621	–2.062199	–2.062612	–2.06261
Drop Wave	–0.9362	–1	–1	–0.9357529	–1	–1
Egg Holder	–62.432	–62.43271	62.43270	-62.38593	–62.43271	– 959.6407

7. Conclusion

Population based Meta heuristics are promising approach for the optimization of functions. It is proved from the results obtained. Mostly all the functions attained the minimum value for cross in tray function. It opens an avenue of hybridization since the various algorithms are giving near optimization for the functions. In the future work let us consider the hybridization of the Meta heuritstics.

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