Data clustering and its Application to numerical function optimization algorithm

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Abstract: This paper present a novel technique of Artificial Intelligence (swarm), specifically teaching learning based optimization (TLBO), it is a nature inspired algorithm and based on two parameters i.e. Teacher phase and Learner Phase. These modes are the base for the teaching learning based optimization. Experimental results using various benchmarks mathematical function show that TLBO has improved performance than PSO and other optimization algorithm.

Keywords: Function, Optimization, Teaching and Learning Mode, clustering, TLB, Evolutionary algorithms; Swarm intelligence based algorithms, Unconstrained benchmark functions

I. INTRODUCTION

Clustering is process of grouping in this way that more similar items or groups known as cluster are keeping in a single unit (clusters). This is the key process of investigation in data mining and in statically data analysis technique it is very common and same it can be used in various fields i.e. pattern recognitions, computer graphics, data compression, machine learning and many more [1-3].

The common task can be solved with clustering but it is not only one techniques. This can be done with various algorithm techniques and notation to complete the work significantly or efficiently. In the figure 1 it is described the three different cluster for the different pattern as per there appearance on the basis of common features that is either shape or the color-coding [4-5].
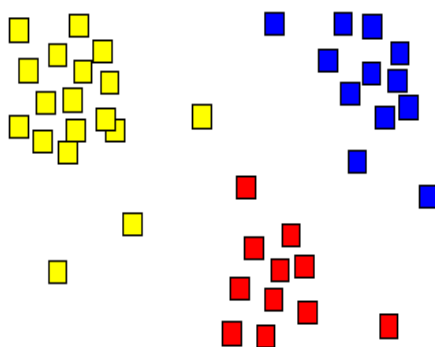

Figure 1.   Cluster analysis into three clusters

Groups of small distances with in the cluster members are included in common notations. Multi objective optimization glitches can be formulated with clustering. Clustering is an iterative process rather than automatic task. It is every time essential to revise data processing and various parameters until we achieved the desired results [6]. Further the clustering can be classified into two categories:-

- Soft Clustering
- Hard Clustering

In the field of computer science and engineering there are several optimization algorithms are present .further the problems can be classified into two categories that is uni-modal and muti-modal optimization. To minimization or intensification for the optimization function in these problems various method are used it is observed from the literature and these methods are used for solving various real life problems i.e. classification, scheduling and resource planning etc.

II. OPTIMIZATION AND RELATED WORK

In the recent years numerous optimization methods are developed to solve these kind of problems. Exact and approximation is the two categories in which these algorithms are divided. The population based heuristic algorithms have two significant clusters: evolutionary algorithms (EA) and swarm intelligence (SI) based algorithms. Further evolutionary algorithms and the swarm based algorithm are shown into the given figures that is Figure 2 and Figure 3.
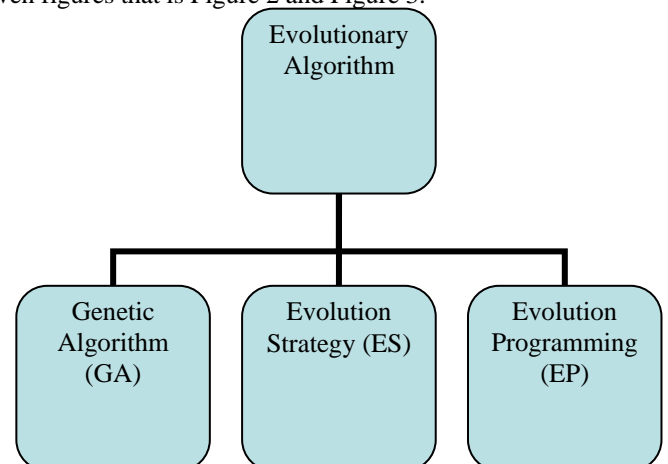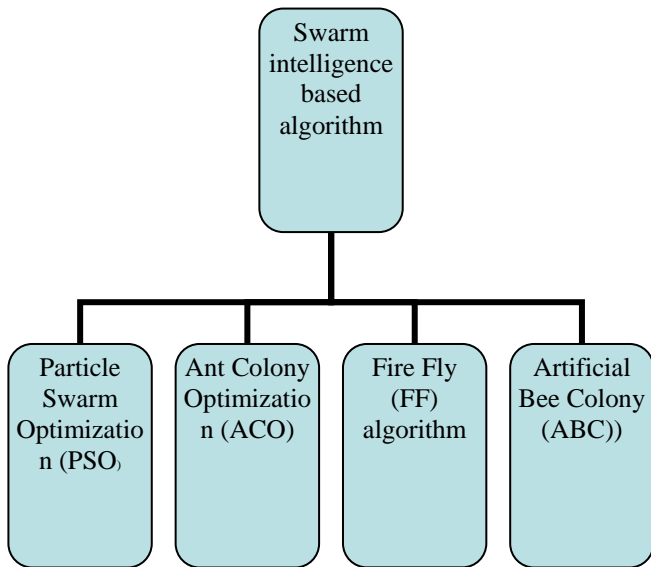

Figure 2.   Evolutionary Algorithm

Figure 3. Swarm intelligence based algorithms

Figure 4. Flowchart for Teaching Learning Based Algorithm

Other than these two main categories of algorithm i.e. Evolutionary and swarm intelligence based algorithms, Some more algorithms that work on different nature inspired techniques are: Harmony Search (HS) algorithm, Gravitational Search Algorithm (GSA) League Championship Algorithm (LCA), Biogeography-Based Optimization (BBO), Water Cycle Algorithm (WCA), Flower Pollination Algorithm (FPA),CSS, MCSS,TLBO and Mine Blast Algorithm (MBA) [7-10], etc.

These both are the probabilistic algorithm and require common parameters like size and number of population or generations, along with these in various algorithms some other parameters are also required for example in Genetic algorithm it used mutation and crossover probability with selection operator ,artificial bee colony optimization algorithm uses watcher, working and scout bee with their specific limits, particle swarm optimization algorithm uses various weight i.e. inertia, social, and some cognitive parameter. Likewise, the some other algorithms that are EP, DE, SFL, ACO, AIA FPA, ES, BFO, etc. require the modification of individual algorithm or some of specific parameters [11-15]. The appropriate modification of the specific algorithm parameters is important factor which disturbs the routine some algorithms. The inappropriate modification of specific algorithm parameters can produce local optimal solution. Taking this fact in view Rao et al. in 2011 proposed a optimization algorithm i.e. is Teaching Learning based optimization also known as TLBO, that does not need any specific parameters. In this algorithm to perform some specific work it needs certain mutual monitoring parameters that are numbers of generations and population. The teaching learning based optimization algorithm is very popular kind of algorithm among in the new research area as well as in optimization researchers.
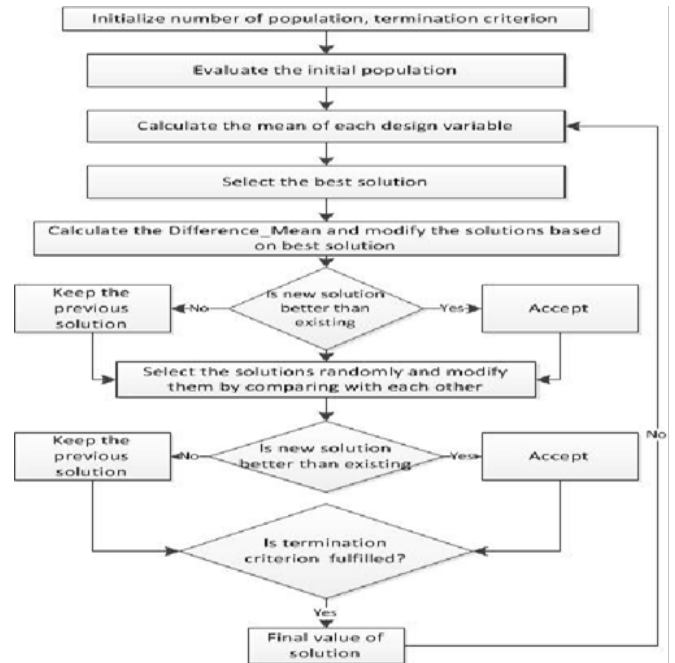
Figure 4 shows the complete flowchart for the above described optimization algorithm i.e. is the simple teaching learning based algorithm in this complete process for the optimization technique is described into the graphical representation for the further utilization purpose and flow of used information as the algorithm or the technique.

III. ENRICHED TLBO (E-TLBO) ALGORITHM

In the simple Teaching Learning Based Optimization algorithm, the outcomes of the learner phase is enriched by interacting with the other leaners or a unique teacher, however, in the simple TLBO algorithm, during the class timing the students or learners can learn by discussion with each other in the class room or classmates and some of them can try himself/herself to learn by self-motivation, and simultaneously either students are learning something from the teacher or not. [16] In this kind of environment, a teacher need to put more labours to enhance the performance of the students .during the phase of optimization process, it is leisurelier merging rate of the optimization technique, by keeping this in view, to enriched the investigation and manipulation abilities, a few modifications have been identified to the simple teaching based learning algorithm so in this given proposed algorithm we tried to introduced a novel and hybrid kind of teaching based learning optimization algorithm to enhance the performance of simple TLBO and the name is suggested for this kind of algorithm is Enriched teaching based learning algorithm (E-TLBO) [17-20].
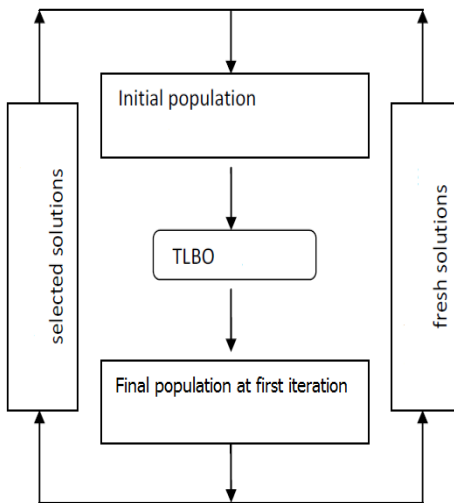
Figure 5.   Proposed Enriched Teaching Learning based Algorithm (E-TLBO)

The figure 5 shows the proposed algorithm for the enriched teaching learning based algorithm in this we used the initial population as a input to the given algorithm and then this is given to the teaching learning based algorithm and after that the final population for the first iteration is taken into consideration and it is given to the fresh solution or again taken as a selected solution for the given problem or the environment [21-25].

IV.   EXPERIMENT ON BEANCHMARK FUNCTION

In this part of paper the performance of enriched teaching learning based optimization algorithm is calculated by different search space on benchmark functions and further the results are compared with various nature evolutionary or swarm based algorithm that are also discussed into the above paper and the results are in this manner.

Table I.   Benchmark Function

S.NO	Function Definition	Parameter
Function _01	Sphere	[-200, 200]
Function _02	Rosenbrock	[-40,40]
Function _03	Rastrigin	[-4.2, 4.2]

The table 1 shows the various benchmarks function that are to be used to perform and find out the performance of the above stated algorithm that is enriched teaching learning based algorithm for various nature inspired algorithm or optimization techniques.

Table II.   Performance of E-TLBO on various benchmark functions

	Strategies for Teaching learning based Algorithm			
Function Name	E-TLBO_01	E-TLBO_02	E-TLBO_03	E-TLBO_04
Sphere	5.10E-13	4.50E-10	4.20E-09	4.10E-01
Rosenbrock	6.93E-20	6.90E-15	9.03E-10	8.83E-20
Rastrigin	20.236	22.426	26.123	28.948

The table 2 demonstrate the results of the given proposed algorithm that is enriched teaching learning based optimization technique on the numerical function or on the standard mathematical function and there various clusters .

Table III.   Comparison table of results with other techniques

Dataset	Algorithm							
	Used parameter							
		HS	GSA	LCA	BBO	WCA	TLBO	E-TLBO
Cluster_01	Best	90.10	90.09	90.10	90.01	89.10	89.40	89.10
	Average	100.11	100.20	100.31	101.11	99.20	99.10	98.90
Cluster_01	Best	90.11	90.01	89.11	89.41	90.05	90.11	89.90
	Average	100.12	100.02	100.60	102.12	100.60	99.12	99.10

Table 3 shows the comparisons results of the given or hybrid optimization method with the various other evolutionary or swarm based optimization algorithm that are described into the literature for example Harmony Search (HS) algorithm, Gravitational Search Algorithm (GSA) League Championship Algorithm (LCA), Biogeography-Based Optimization (BBO), Water Cycle Algorithm (WCA), Flower Pollination Algorithm (FPA), CSS, MCSS, TLBO and Mine Blast Algorithm (MBA) etc:

V.   CONCLUSION

It was identified that the related to some other evolutionary methods, E-TLBO (enriched teaching based learning optimization) performance and results are better, it has been found better results are found on mathematical function as well as on others hand to simple teaching learning based optimization technique. This can be achieved by the various modification that can done into the enriched teaching learning based algorithm (E-TLBO), and further this proposed optimization method can be used in various engineering fields to find out the strength and fitness.

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