

Comparative Analysis of Optimization Algorithms based on Hybrid Soft Computing Algorithm

Mr. Naveen Kumar Sahu¹ Prof. Rajesh Tiwari²

¹M.E. Student ²Associate Professor

¹Department of Computer Technology & Application ²Department of Computer Science & Engineering
^{1,2}SSTC, Bhilai, CG, India

Abstract— Optimization algorithms are the topic of research in recent years. Optimization is act method or methodology of constructing one issue (as a mode, system or decision) as totally excellent operate or effective as potential. It's conjointly act of rendering best the synchronic improvement of growth and profitableness. For Optimization in soft computing various algorithms (like PSO, GA, EA, DE, HPSO and HGA etc.) available on the market for solve and we don't know which algorithm is best for optimization for us. Throughout this paper we tend to mentioned regarding some optimization problem solution algorithms. And that we see regarding one thing of optimization issues and that we compare between some algorithms and verify that which algorithm is best for soft computing for optimization problem solution for us. The aim of this paper is to analyze and compare PSO, DE and PSODE algorithm in serial manner by matlab toolbox.

Key words: Optimization, Optimization Problem, PSO, GA, EA, DE, HPSO and HGA

I. INTRODUCTION

Evolutionary Algorithms: Evolutionary Algorithms (EA) use a population of potential solutions (points) of the search space. These solutions (initially arbitrarily way) generated) are evolved exploitation deferential specific operators which are galvanized from biology. Through cooperation and competition among the potential solutions, these techniques typically can notice optima quickly once applied to sophisticated improvement problems.[5]

A. Differential Evolution (DE):

According to DE operations, they're sent from one generation to successive generation by applying crossover and/or mutation operators. For doing each operator, crossover is sometimes applied initial, at that time it generates offspring by the mutation operation. DE is employed to calculate the population for each generation by $G = \text{zero}, 1, \dots, G_{\text{max}}$, however we are able to let it reckon and acquire the most effective worth between generations. So, it will scale back the interval to keep up higher performance.

B. Hybrid Evolutionary Algorithms:

Evolutionary computation has become an awfully vital draw back finding methodology among several researchers. The population-based collective learning method, self-adaptation, and robustness are variety of the key choices of organic process algorithms compared to alternative world improvement techniques. Even though biological process computation has been wide accepted for finding many vital sensible applications in engineering, business, commerce, etc., however in observe typically they deliver solely marginal performance. Inappropriate choice of assorted

parameters, illustration, etc. is usually goddamn. There is very little reason to expect that one will realize a uniformly best rule for resolution all optimization issues. This is often in accordance with the No gift theorem that explains that for any rule, any elevated performance over one category of issues is precisely got in performance over another category. Evolutionary algorithmic program behavior is set by the exploitation and exploration relationship unbroken throughout the run. Of these clearly illustrate the necessity for hybrid organic process approaches wherever the most tasks are to optimize the performance of the direct organic process approach. Recently, interbreeding of organic process algorithms is obtaining common owing to their capabilities in handling many planet issues involving quality, buzzing setting, inexactitude, uncertainty, and unclearness.[6][7]

C. Genetic Algorithm (GA):

A genetic algorithmic program is capable to mix totally different approach to make a hybrid to emphasize on the technique to supply best solutions. In the field of AI, a genetic rule (GA) may be a search heuristic that mimics the method of action. This heuristic is routinely used to generate useful solutions to improvement and search problems. The genetic formula is Search and improvement techniques that generate solutions to improvement issues mistreatment techniques galvanized by natural evolution. Improvement is that the central to any downside involving whether or not in engineering or political economy.[3] Genetic Algorithms square measure the heuristic search and improvement techniques that mimic the strategy of natural evolution. Thus genetic algorithms implement the advance strategies by simulating evolution of species through activity ("Select the foremost effective, Discard the Rest"). Genetic algorithms unit of measurement search and improvement tools, that employment otherwise compared to classical search methodology. Thanks to their broad relevance, simple use, and international perspective, GAs has been a lot of and a lot of applied to varied search and improvement problems inside the recent past.[4] GAs is processed search and improvement ways in which job very similar to the principles of natural evolution.

D. Hybrid Genetic Algorithm (HGA):

Hybrid genetic algorithms have received important interest in recent years and area unit being more and more won't to solve real-world issues. A genetic formula is ready to include different techniques at intervals its framework to supply a hybrid that reaps the most effective from the mix. Hybrid genetic formula that uses another search methodology as an area search tool. These problems embrace varied approaches for using native search info and various mechanisms for achieving a balance between a world genetic formula and an area search methodology.[9]

E. Particle Swarm Optimization Algorithm (PSO):

Particle Swarm optimization (PSO) has shown its quick search speed in several sophisticated optimization and search issues. However, PSO typically simply falls into native optima as a result of the particles would quickly meet up with to the most effective particle. Particle Swarm optimization (PSO) is additionally a biologically affected technique search and optimization technique.[1]

Particle swarm optimization (PSO) has been growing speedily. PSO has been utilized by many applications of the many problems. The algorithmic rule of PSO emulates from behavior of animals societies that don't have any leader in their cluster or swarm, like bird flocking and fish schooling. Typically, a flock of animals that don't have any leaders will notice food by random, follow one amongst the members of the cluster that has the closest position with a food provide (potential solution). The flocks reach their best condition at a similar time through communication among members international organization agency have already got a stronger state of affairs. The method of PSO algorithmic rule notice an optimum values follows the work of academic degree animal society that has no leader. Particle swarm improvement consists of a swarm of particles, where particle represents a doable answer (better condition).[2]

F. Hybrid Particle Swarm Optimization algorithm (HPSO):

PSO likewise as unvaried improvement ways have blessings and downsides in terms of their optimization behavior. An advantage of reiterative improvement strategies is their sensible exploitation quality, that is, they accurately converge to an area optimum; but, they need no mechanism for a sturdy exploration of the search area. In distinction, PSO proven to possess sensible exploration performance however has issues with the exploitation during a promising space of the search area. Hybrid Particle Swarm optimization algorithmic rule (HPSO) that mixes PSO and iterative improvement methods. In HPSO, the PSO part guides the search towards promising regions of the search house and uses repetitious improvement strategies to take advantage of these regions. There square measure varied prospects of the way to add repetitious improvement strategies.[8]

II. PROBLEM STATEMENT

To achieve best optimization algorithms for soft computing we've several decisions (like PSO, GA, E, HPSO and HGA) however we have a tendency to can't know that algorithmic is best for our drawback. HPSO is extended version of PSO and HGA is extend version of GA. Thus hybrid algorithms could also be best for come through most or minimum price for optimization issues. (i.e. that algorithmic rules/ mathematics/ procedure offer best result for our experiment that algorithm builds good or effective as possible or increase the computing speed and potency of program for directions of computers.) every algorithms (like PSO, GA, E, HPSO and HGA) having advantages, square measure population primarily based heuristic search techniques which may be accustomed solve the improvement issues sculptural on the thought of organic process Approach each algorithms is in a position to

resolve improvement downside for soft computing with totally different speed potency for computers. Our main downside is a way to establish that algorithm is best for us for optimization from soft computing in offered algorithms with relevance save time and/or cash, Solve large problems and supply concurrency.

III. METHODOLOGY

A. Differential Evolution Algorithms (DE):

The DE algorithmic rule was introduced by Storn and value in 1995. It resembles the structure of associate degree Semitic deity, however differs from ancient EAs in its generation of latest candidate solutions by its use of a 'greedy' choice theme. The algorithm is quite smart and "DE can really be thought-about an exquisite initial choice", in keeping with Vesterstrom and Thomsen. Moreover, our has been utilised within the filter vogue problems that area unit delineates. In DE, the weighted distinction between the 2 population vectors is adscitious to a 3rd vector and optimized mistreatment choice, crossover and mutation operators as in GA. Fitness of each the parent and therefore the offspring is then calculated and therefore the offspring is chosen for ensuing generation providing it's a more robust fitness than the parent. The foremost recent improvement by Jeya kumar and Shan mugavelayutham planned to unravel free international optimization issues. They need chosen fourteen functions to implement and analyzed for thirty dimensions. The results recommend that the most effective playacting variants square measure quicker in connotation to the answer. The worst playacting variants were found to own less chance of convergence, and thus they were slow in convergence. So, DE mistreatment parallel programming has emerged.

In spite of the fairly smart algorithms for DE, some folks need to extend its performance exploitation parallel programming. it had been fictitious by Kozlov and Samsonov World Health Organization area unit developing the Combined improvement Technique (COT) for biological information fitting and playacting experiments within the context of 1 biological system. In this work, they introduced a replacement migration theme for the Parallel DE that's progressing to be used as an alternate for the Sturmarteilung at the primary stage of COT. For the result, the new migration theme for Parallel DE has shown that the speeds of convergence on the check drawback are magnified. But, there's a drag concerning the population as a result of it couldn't exceed 300. That's the rationale why Weber, Neri and Tirronen did their theme by change the Parallel DE for big Scale improvement. They declared that if they are doing able the spatial property of a drag they do not simply double its issue. The ensuing drawback issue would increase by over and over. The ensuing formula behaves in a very similar thanks to multi-start multiple searches and proven to be economical for extremely dimensional issues. Therefore, whereas spatiality grows, the projected formula appears to be plenty of capable to handle the fitness landscapes, and for the set of most multi-variant problems displays significantly higher performance. The DE has following steps:-

- 1) Step1. Initialize the population with Gen=1

- 2) Step2. Choose the population victimization the fitness function (f)
- 3) Step3. Manufacture offspring and choose their fitness
- 4) Step4. If fitness of offspring on top of fitness of folks
then
replaces the parents by offspring at intervals the new population
else
discard offspring in new population
- 5) Step5. If size of latest population < recent population
then
goto step6
else
goto step3
- 6) Step 6. if Gen > Max Gen
then
(stop the process)/exit
else
perform information= Gen + one
goto step3

B. Genetic Algorithms (GA):

The inspiration and motivation of genetic algorithms comes from observation the globe around our. And seeing a staggering diversity of life. lots of species, every with its own distinctive activity patterns and characteristics, abound. Yet, all of those plants and creatures have evolved, and continue evolving, over many years. Every species has developed physical choices and ancient habits that unit throughout a way optimum throughout a constantly shifting and impulsive atmosphere therefore on survive. Those weaker members of a species tend to decrease, exploit the stronger and fitter to mate, manufacture offspring and make certain the continuing survival of the species. Their lives unit set by the laws of natural process and Darwinian evolution. And it's upon these concepts that genetic algorithms unit based we have to understand to establish but each species has evolved throughout the ages to such an almost glorious standing. at intervals most cells at intervals the natural object (and in most different living organisms) are rounded (rodike) structures remarked as chromosomes. These chromosomes dictate varied hereditary aspects of the individual. Among the chromosomes are individual genes. A factor encodes a specific feature of the individual. As AN example, a person's eye color is ready by a particular issue. The particular value of the issue is termed Associate in nursing gene. This is a grossly oversimplified examine life science but will answer to suggests its correlation with genetic algorithms. A class-conscious image is made up, with alleles being encoded as genes, with sequences of genes being sure on in an exceedingly body, that makes up the DNA of a personal. Once two individuals mate, every of us pass their chromosomes onto their offspring. In humans, our agency have forty six paired chromosomes in total, every of us die twenty 3 chromosomes each to their child. Everybody passed to the child is associate uniting of two chromosomes from a parent. The two chromosomes shut and swap genetic material, and only one of the new body strands is passed to the child. That the body strands bear a crossover of genetic material those ends up in a singular new individual. As if this weren't enough, genetic material

can bear mutations, succeeding from imperfect crossovers or various external stimuli. The mutation is rare; it'll cause a superb larger diversification of cistronr all the factor pool of the population. It ought to be noted however that AN excessive quantity of mutation is truly harmful and should destroy wise ordering, that the speed of mutation ought to be low therefore on stop severe degradation of the genetic pool. Genetic algorithms exploit the thought of the survival of the fittest Associate in Nursindg associate interbreeding population to make a completely unique and innovative search strategy. The primary step during a very GA is to hunt out an appropriate secret writing of the parameters of the fitness perform. Typically this can be often usually done using a population of strings, each representing a possible answer to the matter. Instead of victimization strings various schemes like trees and matrices may be accustomed cipher the parameters. Notice that an entire population of strings rather than one string is utilized. The genetic algorithmic rule then iteratively creates new populations from the recent by ranking the strings and interbreeding the fittest to make new strings, that unit (hopefully) nearer to the optimum resolution to the matter at hand. Thus in each generation, the GA creates a group of strings from the bits and things of the previous strings, generally adding random new data to remain the population from stagnating. The tip result's an enquiry strategy that is tailored for Brobdingnagian, complex, multimodal search areas. Genetic algorithms unit a spread of irregular search, during this suggests that inside that strings unit chosen and combined may be a framework. this is often a radically utterly completely different approach to the matter finding ways that used by plenty of ancient algorithms, that tend to be plenty of settled in nature, just like the gradient ways that accustomed notice minima in graph theory. The thought of survival of the fittest is of nice importance to genetic algorithms. Genetic algorithms use fitness operates thus on discover the fittest string that will be accustomed turn out new, and conceivably higher, populations of strings. The fitness operate takes a string and assigns a relative fitness worth to the string. The strategy by that it'll this and thus the character of the fitness worth does not matter. The sole issue that the fitness operate ought to do is to rank the strings in an exceedingly means by producing the fitness value. These values square measure then accustomed opt for the fittest strings. The conception of a fitness operate is, in fact, a particular instance of an extra general AI conception, the target operate the population could also be simply viewed as a gaggle of interacting creatures. As each generation of creatures comes and goes, the weaker ones tend to quiet whereas not producing youngsters, whereas the stronger mate, combining attributes of every folks, to provide new and perhaps distinctive youngsters to continue the cycle. Often, a mutation creeps into one among the creatures, diversifying the population even lots of. Bear in mind that in nature, a varied population at intervals a species tends to allow the species to adapt to its atmosphere with lots of ease. The same holds true for genetic algorithms.

The GA has following steps:-

- 1) Initialization: genetic rule area unit typically begin with Associate in Nursing initial population that's generated willy-nilly some analysis has been conducted victimization special technique to supply

the next quality initial population. Therefore Associate in Nursing approach is meant to relinquish the GA an honest begin and speed up the organic (process biological process) process.

- 2) Selection: It chooses the 2 parent body from a population in step with their fitness higher the fitness larger the prospect to be hand-picked.
- 3) Reproduction :- It choose the 2chromosomes in step with current choice procedure perform crossover on them and procure one or two youngsters, maybe apply mutation yet and install the result back to that population, the smallest amount match of population is destroyed.
- 4) Crossover: With a crossover chance crossover the parent to make new offspring (children).
- 5) Mutation:- After a crossover this operator is performed. Mutation can be a genetic operator accustomed maintains genetic diversity from one generation of a population of chromosomes to next.
- 6) Replacement: Use new generated population for an extra run of rule.

C. Hybrid Genetic Algorithm (HGA):

A Genetic Algorithm could be a population-based search and optimization methodology that mimics the method of natural evolution. The 2 main ideas of natural evolution, that are activity and genetic dynamics, galvanized the event of this methodology. The performance of genetic algorithms, like several world optimization algorithm, depends on the mechanism for leveling the 2 conflicting objectives that are exploiting the most effective solutions found to date and at a similar time exploring the search area for promising solutions. The facility of genetic algorithms comes from their ability to mix each exploration and exploitation in a best manner. However, though this best utilization could also be in theory true for a genetic rule, there are issues in apply. In apply, the population size is finite, that influences the sampling ability of a genetic algorithm and as a result affects its performance. Incorporating an area search methodology among a genetic algorithm will facilitate to beat most of the obstacles that arise as a result of finite population sizes. A finite population will cause a genetic formula to provide resolutions of caliber compared with the standard of solution which will be made exploitation native search strategies. Utilizing a neighborhood search methodology inside a genetic formula will improve the exploiting ability of the search formula while not limiting its exploring ability. If the correct balance between international exploration and native exploitation capabilities are often achieved, the formula will simply turn out solutions with high accuracy. Although genetic algorithms will chop-chop find the region during which the world optimum exists, they take a comparatively long term to find the precise native optimum within the region of convergence. A mix of a genetic formula and a neighborhood search methodology will speed up the search to find the precise international optimum. In such a hybrid, applying area unit a neighborhood search to the solutions that are guided by a genetic formula to the foremost promising region will accelerate convergence to the world optimum. The time required to achieve the world optimum are often additional reduced if native search strategies and

native data square measure wont to accelerate locating the foremost promising search region additionally to locating the world optimum beginning inside its basin of attraction.

D. Particle Swarm optimization (PSO):

Particle swarm optimizer (PSO), that was first of all introduced by Kenedy and Eberhart in 1995, emulates the flocking behavior of birds to resolve improvement issues. In PSO, every potential answer is taken into account as a particle. All particles have their own fitness values and velocities. These particles fly through the Dimensional downside area by learning from the historical data of all the particles. A possible answer is painted by a particle that adjusts its position and speed in step with equation (1) and (2):

$$(1) v_{id}^{(t+1)} = wv_{id}^{(t)} + c_1r_1(p_{id}^t - x_{id}^t) + c_2r_2(p_{gd}^t - x_{id}^t)$$

$$(2) x_{id}^{(t+1)} = x_{id}^{(t)} + v_{id}^{(t+1)}$$

Where t is that the time index, i is that the particle index, and d is that the dimension index. pi is that the individual best position. pg is that the notable international best position. c1 and c2 are the acceleration rates of the psychological feature and social elements, severally. r1 and r2 are random values totally different for every particle I similarly as for every dimension d. The position every of every particle is additionally updated in each iteration by adding the speed vector to the position vector. One downside found within the normal PSO is that it may simply fall under native optima in several optimization issues. One reason for PSO to converge to native optima is that particles in PSO will quickly converge to the most effective position once the most effective position has no amendment. Once all particles become similar, there's somewhat hope to search out a much better position to switch the most effective position found to date.

Each particle maintains its position, composed of the candidate resolution and its evaluated fitness, and its rate. to boot, it remembers the simplest fitness worth it's achieved to date throughout the operation of the rule, mentioned because the individual best fitness, and therefore the candidate resolution that achieved this fitness, mentioned because the individual best position or individual best candidate resolution. Finally, the PSO rule maintains the simplest fitness worth achieved among all particles within the swarm, known as the worldwide best fitness, and therefore the candidate resolution that achieved this fitness, known as international/the worldwide/the world best position or global best candidate resolution.

The PSO formula consists of simply 3 steps, that area unit recurrent till some stopping condition is met:

- 1) Evaluate the fitness of every particle
- 2) Update individual and world best fitness and positions
- 3) Update velocity and position of every particle

The first 2 steps square measure fairly trivial. Fitness analysis is conducted by provision the candidate answer to the target operate. Individual and world best fitness and positions square measure updated by comparison the fresh evaluated fitness against the previous individual and world best fitness, and commutation the simplest fitness and positions as necessary.

PSO learns from a state of affairs and uses it to resolve improvement problems by victimization

displacement calculations. In PSO, each single answer may be a "bird" among the search house. We've a bent to call it "particle". All the particles have fitness values, that unit of measurement evaluated by the fitness perform to be optimized, and have velocities that direct the flying of the particles. Particle Swarm improvement (PSO) is a cost-effective and powerful population-based random search technique for determination world improvement problems that has been wide applied in many scientific and engineering fields. It's supported the social behavior figure of speech. It's usually thought to be another tool to genetic algorithms (GAs) and various biological process algorithms (EAs). Because of its hardness, efficiency and ease PSO is turning into widespread day by day. But rather like completely different population based meta-heuristics PSO suffers from two difficulties: (i) falling into native optima for large downside instances of some heavy problems, (ii) long execution times for time intense objective functions. Parallel computing is accustomed overcome these difficulties.

E. HYBRID PSO (HPSO):

Hybrid Particle Swarm improvement PSO conjointly as repetitive improvement methods have edges and disadvantages in terms of their improvement behavior. a bonus of unvaried improvement ways in which is their wise exploitation quality, that is, they accurately converge to a neighborhood optimum; however, they have no mechanism for a robust exploration of the search house. In distinction, PSO established to have good exploration performance, but has problems with the exploitation in Associate in Nursing extremely promising area of the search house. We tend to propose a Hybrid Particle Swarm improvement algorithm (HPSO) that mixes PSO and iterative improvement ways in which. : In HPSO, the PSO guides the search towards promising regions of the search area and uses repetitive improvement ways in which within which to need advantage of these regions. There are varied prospects of the thanks to add iterative improvement methods.

The HPSO has following steps:-

- Step1. Random data format of particles.
- Stwp2. whereas termination
- Step3. Initialize the velocity
- Step4. Decision the fitness
- Step5. Obtained gbest, pbest
- Step6. Update the velocity
- Step7. Update the particle
- Step8. Applying crossover with gbest and pbest of every particle.
- Step9. Check for the criteria if criteria obtained then exit else goto step2.

IV. EXPERIMENTAL RESULTS

This section focuses on the comparison between the PSO, DE & PSODE algorithms.

A. Population size=10, Dimension=10, Iteration=500

Bench mark	PSO		DE		PSODE	
	Mean	STD	Mean	S T	Mean	STD

				D		
Sphere	10.0189	0	11.0208	0	10.0189	0
Rastrigin	302.935	0	332.228	0	302.935	0
Griewank	724.387	0	796.829	0	724.387	0
Ackley	19.566	0.0192118	21.5608	0	19.1512	0.0302671
Rosenbrock	8.21709e+08	0	9.0388e+08	0	8.21709E+08	0
Penalized	460.522	0	506.574	0	460.522	0
Penalized16	11223.5	0	12345.8	0	177753.9	905.476

B. Population size=20, Dimension=10, Iteration=1000

Bench mark	PSO		DE		PSODE	
	Mean	STD	Mean	STD	Mean	S T D
Sphere	2.29004	5.12069	22	4.25575e+97	3.2591	0
Rastrigin	263.9	0	342.729	76086.1	275.909	0
Griewank	901	0	991.1	10.0709	901	0
Ackley	19.8951	0.0461198	991.1	0.243053	19.851	0
Rosenbrock	8.43309e+08	0	9.2764e+08	6.69193e+11	8.43309e+08	0
Penalized	463.64	0	0	1.53031e+10	467.417	0
Penalized16	11426.3	59.0916	0	2.8785e+09	10343.3	0

C. Population size=30, Dimension=10, Iteration=1500

Benc hmar k	PSO		DE		PSODE	
	Mean	STD	Mean	STD	Mean	STD
Spher e	2.04507	4.57293	2.24958	7.20522e+149	2.0468	4.5686
Rastrigin	311.572	0.0865147	342.729	19644.1	311.572	0.0865147
Griewank	901	0	991.1	2.98769	901	0
Ackle y	20	0	22	0.143168	21	0
Rosen brock	8.43309e+08	0	9.2764e+08	8.56173e+09	8.43309e+08	0
Penali zed	463.25	0	509.575	4.0683e+09	463.25	0
Penali zed16	15111.2	2278.15	1662.3	1.12459e+09	15111.2	2278.15

D. Population size=20, Dimension=10, Iteration=1500

Benchmark	PSO		DE		PSODE	
	Mean	STD	Mean	STD	Mean	STD
Sphere	2.29004	5.12069	2.51905	1.74495e+138	2.12234	4.36589
Rastrigin	311.572	0.0865147	342.729	38708	311.572	0.0865147
Griewank	901	0	991.1	9.2025	901	0
Ackley	19.9994	0	21.9994	0.0851105	19.5684	0
Rosenbrock	8.43309E+08	0	9.2764E+08	8.64735E+10	8.43309E+08	0
Penalized	463.25	0	509.575	1.8799E+10	463.25	0
Penalized16	15111.2	2278.15	16622.3	2.58837E+09	15111.2	2278.15

V. CONCLUSION

In this study paper we have described some Optimization algorithms for Optimization problems. And the use of algorithms when required and what are the necessary conditions for solutions. How to day by day optimization algorithms modified described in this paper.

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