Volume 3, Issue 4, April 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Population Initialization Method by Memetic Algorithm

Rakesh Kumar* *DCSA, Kurukshetra University India.*
Sudhir Narula *DCSA, Kurukshetra University India.*
Rajesh Kumar *DCSA, Kurukshetra University India.*

Abstract— ***Genetic algorithm is search and optimization technique which can be used for number of NP hard problem such as Dejong's function, travelling salesman problem, Job scheduling problem. The performance of Genetic Algorithm can be improved by adding local search in any phase of Genetic algorithm. In this paper, initialization of population was carried by repeatedly calling hill climbing approach & performance improvement has been observed. The integration between genetic algorithms and local search has been discussed in the paper.***

Keywords— ***Chromosome, Genetic algorithm, local search, memetic algorithm.***

I. INTRODUCTION

Genetic Algorithms [1] are search algorithms based on the concepts of natural selection and natural evolution. Genetic Algorithm start with a set of solutions called initial population. Good initial population facililiates a GA's convergence to good solutions while poor initial population can hinder Genetic Algorithms (GA) convergence [2]. The random initialization is default method of population generation. Genetic algorithm uses an iterative process to create a population. The algorithm stops when the population converges towards the optimal solution.

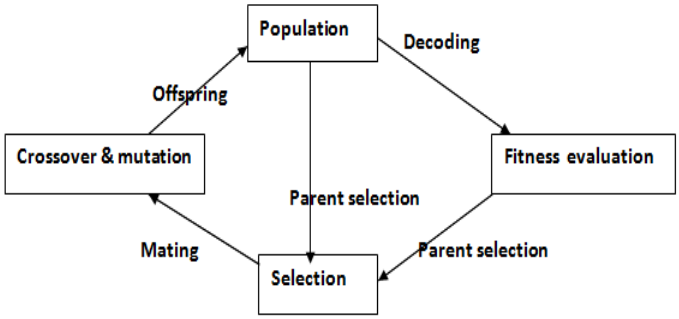

Figure 1 - GA Cycle

GA consists of following steps:-

1. Initialization: A population of chromosomes are generated randomly.
2. Selection: Individuals are selected according to their fitness. More fit individual has more chance to be selected.
3. Reproduction: On selected individuals crossover and mutation operators are applied.
4. Replacement: Individuals from old population are replaced by new ones.

Hybridization of genetic algorithm with local search is known as memetic algorithm [4]. Memetic algorithm (MA) is a type of evolutionary algorithm. MA is invented by Dawkins in 1976, inspired by memes, pieces of mental idea like stories, ideas and gossip, which reproduce (propagate) themselves through population of memes carriers [5]. In this paper hill climbing search was used to generate the initial population and then the performance was compared with Simple Genetic Algorithm (SGA). In the section II, related work in the domain was discussed followed by section III where the problem statement and methodology were discussed. In the section IV implementation was carried out and results were discussed.

II. Related work

Rahnamayan, Shahryar et. al. have introduced a new population method for accelerating evolutionary algorithm. This research proposes a new initialization approach which employs an opposition based learning [6] to generate initial population. By replacing random initialization with opposition based population initialization can accelerate convergence speed. Kallel, Leila & Schoenauer, Marc proposed an alternative random initialization [7] in genetic algorithm. This paper argues that such alternative criteria can be useful in general binary framework, to measure the uniformity and diversity of random initialization procedures. Sivaraj, R. et. al[8] proposed the boosting performance of genetic algorithm through selective initialization. The main success of Genetic Algorithm depends mainly upon the individuals chosen in the initial population and the size of population. If the poor individuals are selected in the initial population, it will result

in longer execution time and weaker optimal solutions. This paper discusses about a novel approach to improve the performance of Genetic Algorithm by using selective initialization which aims at supplying more fit individuals in the beginning phase itself. Louis, sushil J. & Johnson, Judy proposed a research paper on robustness of case-initialized genetic algorithms[9]. They investigate the robustness of case initialized genetic algorithm (CIGAR) system with respect to problem indexing. This approach borrows ideas from case –based reasoning (CBR) in which old problem and solution information, stores as cases in a case –base, help solve a new problem. Indexing is a major issue for case retrieval, especially in "poorly-understood" problems. The problem like Combinational circuit design, TSP and scheduling are solved by Louis and Johnson with improved performance. Ramsey, connie loggia & Grefenstette, john j. introduce a case based method [10] of initializing genetic algorithm that are used to guide search in changing environment .The cased based method incorporated in any time learning system.

A novel memetic algorithm was introduced by Pei Chann Chang, Chen-Hao Liu and Chin Ynan Fan for the flow shop scheduling problem by combining mutation based local search with traditional genetic algorithm.

A comparison among different approaches (different kind of evolutionary algorithms) to solve Vehicle routing problem was introduced by Humberto cesar Brando de Oliveria et al . This paper presents 4 different type of evolutionary algorithm (EA) for vehicle routing problem with time windows. Four variations of EA were implemented: genetic algorithm (GA), GA with genetic memory (GA M), MA and MA with genetic memory (MAM).

Devi, Swapna et al have introduced memetic algorithm (MA) and its application to function optimization and noise removal [IEEE, 2011]. In this paper GA due to its good exploration power is taken as main algorithm and chemotaxis mechanism of bacterial Foraging Optimization (BFO) is used local search. The proposed memetic algorithm show better performance than GA.

III. Proposed Work

The two significant issues in searching technique are exploration and exploitation. Exploitation means to use the already available knowledge to find out the better solution and Exploration means to investigate new and unknown area in search space**.** Genetic algorithm has high exploration power and Local search has high exploitation power. Memetic algorithm makes balance between exploration and exploitation. Local search can be applied in any phase of genetic algorithm. In this paper Work is done on initialization phase of genetic algorithm. Instead of randomly generating population used for selection, hill –climbing approach has been used for random initializing the population.

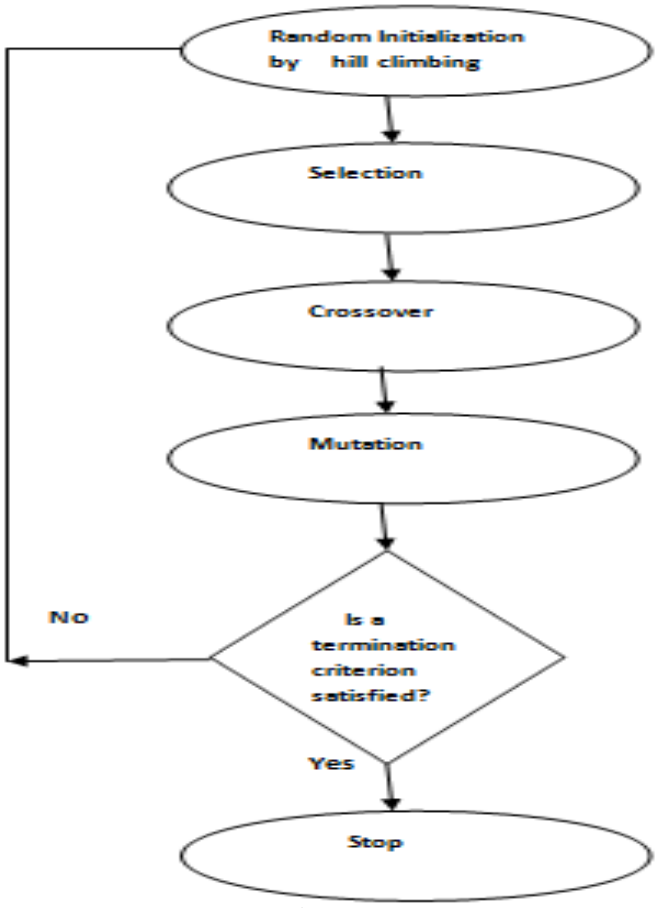

Fig2:-Flow chart for Memetic Algorithm

Hill-climbing starts with a randomly generated solution and continues to generate neighbours until a better solution is found. This new solution becomes the current solution and the algorithm begins producing its neighbours. If there are no improving solutions in the current neighbourhood, the method will stop. The current solution may or may not be a global optimum in this case. Hill Climbing Algorithm:-


```
While (termination condition is not satisfied) do
New solution ← neighbours (best solution);
If new solution is better than actual solution then
Best solution ← actual solution
End if
End while
```

IV. Implementation & observation

In this section of paper Matlab code has been developed for genetic algorithm as well as memetic algorithm. The test problem which is taken is dejong function which is one of the important NP hard problems often used as a benchmark for optimization. The code has been developed for dejong functions i.e. sphere model function, axis parallel hyper ellipsoid function. The code uses the same crossover operator and mutation operator. The code for both also uses the same crossover probability and mutation probability.

The test functions which are used for this research are given below.

DeJong's function 1:-This is simplest test function in all DeJong's function. It is also known as sphere model. It is continuous, convex and unimodal.

Function definition:

$$F1(x) = \sum_{i=1}^{n} x_i^2 \quad -5.12 \le x_i \le 5.12$$

F1(x) = Sum(x(i)^2),

i=1: n, -5.12<=x(i)<=5.12.

Global Minimum: F1(x) = 0, x (i) =0, i=1to n.

Dejong function 2:- The axis parallel hyper-ellipsoid is similar to DeJong Function1.It is also known as the weighted sphere model. Again, it is continuous, convex and unimodal.

$$F2(x) = \sum_{i=1}^{n} i.x_i^2 \quad -5.12 \le x_i \le 5.12$$

F2(x)=Sum(i·x(i)^2), i=1: n, -5.12<=x(i)<=5.12.

Global minimum: F2(x) = 0; x(i)= 0, i=1:n

The optimization problem was run for 4 different cases of generation, 75 generation, 100 generation, 150 genration, and 200 generation. Average and minimum value are compared and graph are plotted to compare the result of MA with simple GA. Parameter used for implementation are as under:

a) Encoding: Real value encoding
b) Selection: roulette wheel selection
c) Crossover operator: Arithmetic crossover
d) Mutation operator: Uniform mutation
e) Replacement: generational update
f) Crossover probability: 0.7
g) Mutation probability: 0.01
h) Termination criteria: Max number of generation

Table-1

Algorithm		Dejong function1			
		75 generation	100 generation	150 generation	200 generation
GA	Min	5.65	4.4	5.385	2.763
	Avg	12.28	8.367	2.909	5.8
MA	Min	1.438	1.3	0.8043	1.38
	Avg	1.89	1.163	0.4978	0.58

Table-2

Algorithm		Dejong function2			
		75 generation	100 generation	150 generation	200 generation
GA	Min	3.064	1.613	0.8735	1.781
	Avg	10.99	18.04	44.19	40.35
MA	Min	0.7061	0.2521	0.6187	0.3361
	Avg	8.914	7.287	2.764	10.59

.

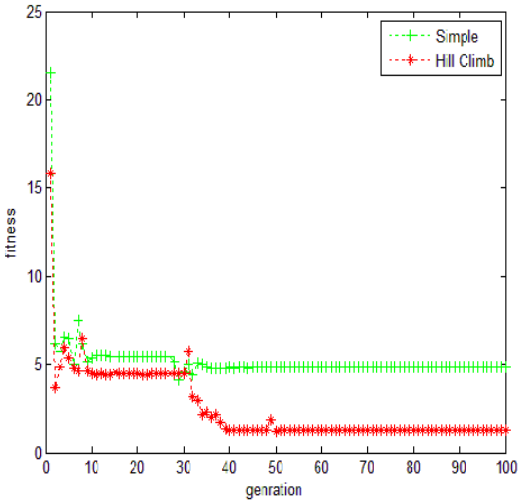

Figure 3- dejong function (Sphere) min graph

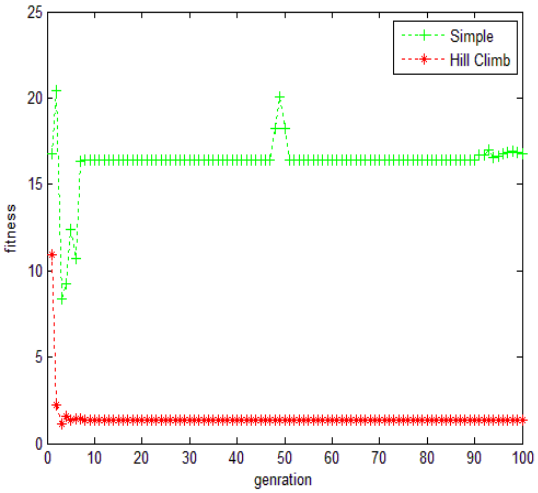

Figure 4- dejong function (sphere) average graph

Figure 3 and Figure 4 shows the minimum and average result of Genetic algorithm (GA) and Memetic Algorithm (MA) in Dejong1 sphere function with 100 generation. MA results in faster convergence as well as more optimum solution.

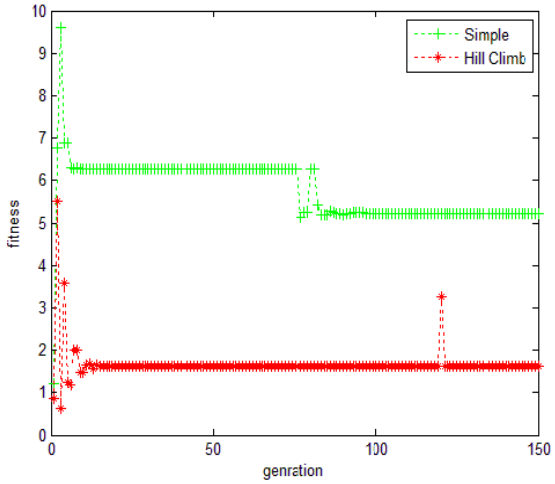

Figure 5- dejong function2 min graph

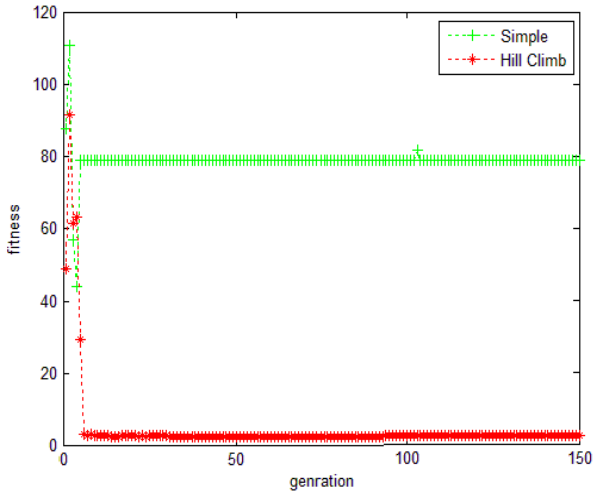

Figure 6- dejongfnction2 Average graph

Figure 5 and Figure 6 shows the minimum and average result of Genetic Algorithm (GA) and Memetic Algorithm (MA) in Dejong2 axis parallel hyper-ellipsoid function with 150 generation. MA results in faster convergence as well as more optimum solution.

V. Conclusion & future work

GA is good in exploring the search space but slow in convergence while local search techniques have been found good in exploiting the knowledge & resulting into fast convergence but sometime trapped into foot hills. But having a mix of these two, performance can be improved. It has been observed that hybridizing hill climbing into initialization step of genetic algorithm, performance improvement is there. It is further opine that other local search techniques may also be mixed in different steps of GA & can be tested on a number of different benchmark problems.

References

[1] D.E. Goldberg, Genetic algorithms in search, optimization, and machine learning. Addison Wesley Longman, Inc., ISBN 0-201-15767-5, 1989.

[2] Raymond R. Hill (1999), "A Monte Carlo Study of genetic algorithm initial population Generation method", In Proceeding of the 1999 Winter simulation Conference, on Genetic Algorithms, Lawrence Erlbaum Associates, pp 1-8

[3] Rakesh Kumar & Jyotishree "Novel Encoding Scheme in Genetic Algorithms for Better Fitness", published in "International Journal of Engineering and Advanced Technology (IJEAT)" ISSN: 2249 – 8958, Volume-1, Issue-6, August 2012.

[4] Swapna Devi, Devidas G. Jadhav ,Shyan S.Pattnaik, "Memetic algorithm and its application to function optimization and noise removal"

[5] S.Padmavathi, S.Mercy Shalinie and R.Abhilaash , "A Memetic Algorithm Based Task Scheduling considering Communication Cost on Cluster of Workstations" Int. J. Advance. Soft Comput. Appl., Vol. 2, No. 2, July 2010

ISSN 2074-8523;

[6] Shahryar Rahnamayan , Hamid R. Tizhoosh, Magdy M.A. Salama,"A Novel Population initialization method for accelerating evolutionary algorithms", an international journal computer and mathematics with application.

[7] Leila Kallel ,Marc Schoenauer ,"Alternative Random Intitialization in genetic algorithm"

[8] R. Sivaraj ,T.Ravichandran ,R.Devi Priya,"Boosting Performance of genetic algorithm through Selective intialization", European Journal of Scientific Research ISSN 1450-216x vol.68 No.1(2012), pp. 93-100.

[9] Sushil J.Louis,Judy Johnson, "Robustness of Case-Intialized Genetic algorithms".

[10] Connie loggia Ramsey ,John J. Grefenstee," Case based intialization of genetic algorithm".

