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Effect of Local Search on the Performance of Genetic Algorithm

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Abstract—

Genetic Algorithms are biologically inspired optimization algorithms that has been used in a number of NP-hard optimization problems successfully like Travelling salesman, Knapsack problem etc. Performance of genetic algorithms largely depends on type of genetic operators - Selection, Crossover, Mutation and Replacement used in it. Replacement operator decides which individuals stay in a population and which are replaced by removing or replacing some offspring or parent individuals. Genetic algorithms mainly lead to the premature convergence that makes them incapable of finding global optimal solution. A hybrid algorithm is an extension of genetic algorithm that incorporates the local search techniques within genetic operations so as to prevent the premature convergence. In this paper author is analyzing the effect of hybridization of local search with replacement operators on the performance of genetic algorithm. Implementation is carried out using MATLAB code on test problem - Benchmark Dejong's Rastrigin Function (F4). The graphs clearly show that the hybrid algorithm is converging towards optima more quickly than the conventional algorithm.

Keywords— Genetic algorithm, hybridization, Genetic and local search algorithm, Dejong function,

I. INTRODUCTION

Genetic algorithm (ga) is a technique of parameter search depends on the procedure of natural genetics to find solution to optimization and search problem. It combines principle of the survival of fittest with a random structured information exchange among a population of artificial chromosomes [1]. During the optimization process a chromosome contains a group of numbers that completely specifies a candidate solution. The individuals with higher fitness values will survive and selected to produce a better generation while the lower fitness value will be eliminated. So, ga simulates survival of fittest among a population of artificial chromosome and it normally stop when the number of generation specified is met or there is no change in maximum fitness value.

II. HYBRID GENETIC ALGORITHM

Hybridization refers to the inclusion of problem-dependent knowledge in a general search algorithm. The performance of genetic algorithm depend on the mechanism for balancing two conflicting objectives, Exploitation (exploiting best solutions found so far) and Exploration(exploring the search space for promising solutions). The power of genetic algorithm comes from their ability to combine both exploitation and exploration in optimal way. Performing local search on the genetic algorithm population can maintain diversity and reduce the problem like genetic drift [1]. If one use some local optimization algorithm for making good balancing between global exploration and local exploitation then algorithm can easily produce solution with high accuracy. Genetic algorithm is very fast to locate the region where the global optimum lies, but it take long time to find exact local optima in a region. Therefore a combination of genetic algorithm and local search method are applied, that can speed up the search for finding global optima. A local search within a genetic algorithm can improve the search performance on condition that their roles co-operate to achieve the optimization goal. Hybrid optimization to capture the best of both Genetic algorithm and Local search schemes their need. [2] And their opportunity depends on the design details of hybrid genetic algorithm. Ant colony optimization model was used for continuous search space and local search method to improve the quality of solution produced by genetic algorithm to solve a real world heavily constrained Engineering design problem [3]. Before the algorithm begins the location of nest is to be determined. It should be point in the search space which seems promising for free local search exploitation. They suggest finding it by utilizing a niching GA or related strategy. Accurate result of genetic algorithm primarily depends on the initial population. Apply the Local search algorithm in simple genetic algorithm after initialization, crossover and mutation. Evolutionary local search algorithm is a simple genetic algorithm with local search method. Evolutionary local search algorithms become competitive with local search method on the test instances where the number of variables is higher than or equal to 100. Also Evolutionary local search algorithm find solutions with less number of accepted and evaluated flips on these test instances.

III. GENETIC AND LOCAL SEARCH:

Hybrid genetic algorithm is based on the complementary view of genetic algorithms and local search method. There are several ways in which a local search can be incorporated in genetic algorithm. The main purpose of incorporation is as follow:

a. Capability Enhancement
b. Optimizing the Control Parameters

Capability Enhancement

Genetic algorithm can be combined with local search method in many different ways to optimize the overall search process. When genetic algorithm is combined with search algorithm which having local knowledge of problem and overall search ability will be enhanced. The enhancement can be in terms of Quality and efficiency. In the case of highly constrained problem performance can be improved through ensuring production of feasible solution. The efficiency of local search in reaching a local optimum integrates the efficiency of genetic algorithm in isolating the most promising basin of search space and incorporating local search into genetic algorithm can result in an efficient algorithm. In Genetic algorithm major concern is the design efficiency in terms of time needed to find a solution of desired quality. Population size is a most important in genetic algorithm. It determines the memory size and convergence speed in genetic algorithm and affects the speed of search in the case of parallel genetic algorithm. Efficient population sizing is critical for getting most out of a fixed budget of function evaluations. The gambler's ruin model, which was used to estimate the population size of genetic algorithms was shown [4]. This model was used to show that population size depend on two parameters, which can be affected by incorporating local search. The two parameters represent the standard deviation of population and the signal difference between the best and second best building block. If a local search method is incorporated in such away to reduce the standard deviation of the population and to increase the signal difference between the best and second best chromosome the resulting hybrid can be efficient with small population size. The combined effect of probability of local search and learning strategy on the population size requirements of a hybrid is shown [5].

Guarantee of feasible solution in highly constrained optimization problem is another factor. Crossover and mutation operator of GA generally produce illegal or infeasible solutions hence waste most of search time. This problem can be solved by incorporating problem-specific knowledge (local search). Problem specific knowledge can be used to prevent the genetic operators from producing infeasible solutions.

Optimizing the Control Parameters:

The setting of genetic algorithm control parameters is a key factor in the determination of the exploitation versus exploration trade-off. To monitor the behavior of genetic algorithm and adapt its control parameters to improve the search performance another techniques be used. The process of fuzzy logic to shows the knowledge in non specific way enables it used to reason on knowledge that is not clearly defined or completely understood. This ability makes fuzzy logic a suitable choice for adapting the control parameters of genetic algorithm.

IV. HYBRID DESIGN ISSUES:

A. Local Search and Learning
B. Balance between Local and Global Search

Local search and learning: Local Search methods use the local knowledge to improve a solution and give a chance of an individual to propagate into next generation. Due to the role of local search is same within the genetic search and the role of learning with the evolution process, the local search is viewed as a learning process. There are the two basic models to use the local knowledge in hybrid algorithm: Lamarckian evolution and Baldwin approach. Knowledge gained used by the global algorithm during local search is most important point of hybrid genetic algorithm [5].This information used by the Lamarckian or Baldwin approach. The Lamarckian approach is based on the inheritance mechanism and it inherits the acquired characteristic by learning process. The Lamarckian approach used the local search method as a genetic operator is called the refinement genetic operator. It modifies the genetic structure of an individual and enhances the fitness of an individual. In the Baldwin approach learning process do help the individual to adapt the environment and result to survive to gain the more chances to pass on the next generation [6]. In these approach effect of performing local search on the improve fitness value

Balance between Local and Global Search: According to hybrid theory, Solved an optimization problem of desired quality of solution in two ways [7]. Global search method guides the search to the basin of attraction from where the local search will lead to the desired solutions. In the genetic local hybrid the main role of GA is to explore the search space to find the regions where lies to the global optima [8]. However the main role of local search is to exploit the information gathered by genetic algorithm. So combine of genetic algorithm and local search to get the best of exploring capability of genetic algorithm and find the local optima.

V. HILL CLIMBING:

Hill climbing method use the exploration capabilities, parallelism and combining properties of GA and the local exploitation power of GA. Using the hill Climbing method as an accelerator mechanism genetic algorithm produce the better solutions. GA use the result of hill climbing Working with an initial guess corresponding to the individuals when evaluating the fitness of individuals, During reproduction and crossover, mutation for the production of the individuals of the next generation. New solution termination found by hill climbing genetic algorithm works on it. With hybrid methods genetic algorithms make their selection based fitness at the end of individual life and this process performed by the hill climbing method. Hill climbing method enhances the local exploitation properties of genetic algorithm by using the genetic operators. For replacement operator hill climbing help in finding the better individual. Dejong function solves using genetic algorithm with replace the all process. Results provide the larger improvement in the total performance. It works well if not the local optima in the search space. Hill climbing method provides the advantages to be easy to implement and good solutions very quickly [9].

VI. PROPOSED WORK:

In this proposed work we introduce the Hybrid genetic algorithm technique. Fig. shows the main phases of hybrid genetic algorithm and local search algorithm.

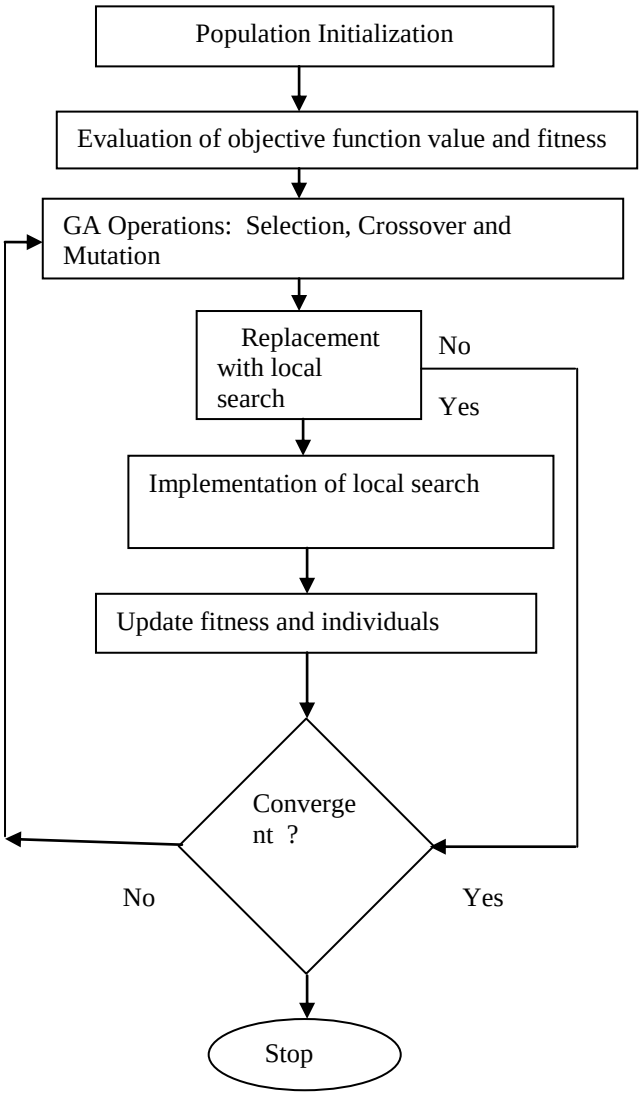

Fig.1 HGA Technique

The technical aspect combined a local search algorithm and a genetic algorithm is a HGA approach. The combining process Start from running GA with small iteration to be effective in computational time. By this process the capability of genetic algorithm to find the solution fast in exploring the area of solution is main consideration. The process of Hybrid genetic algorithm start from the initial population of parameter value and calculate the objective function value using an objective function by a genetic algorithm process.

Step-1:- Population initialization: Population initialization is the process of produce the initial population of N-pop chromosome here N-pop is the population size. To initiate the population heuristic method and random method can be used. Random method generate N-pop x N parameter values between 0&1and Heuristic method require some knowledge about the parameter set and chromosomes are generated randomly.

Step-2:- Evaluate Objective function: For objective function value is calculate associate with the chromosome the outputs are passed to the objective function, a fitness value is calculate and assigned to each chromosome based on its objective function value.

Step-3:- GA operation: one generation is formed by the process of selection, crossover and mutation in the execution of a genetic algorithm. New generation is produced after the one process is complete and best chromosome is carry by the next generation is no guarantee. If the conditions are satisfied then the genetic algorithm is terminated. Genetic algorithms terminate with an optimal solution if the objective function value is below and terminate without an optimal solution if the maximum number of prescribed generation has been reached.

Step-4:- Local search process: local search process is performed with replacement operation. It is required based on the objective function value after the genetic algorithm operations. Many options can be taken after the genetic algorithm operation. If genetic algorithm process is convergent then stop this process otherwise return to the GA operation. Local search is carryout if the local search is requires and update the fitness of individual. If the local search process is convergent then stop otherwise continue genetic operations. This process is continuous till the convergence is taken.

VII. IMPLEMENTATION & OBSERVATION

In this section of paper Matlab code has been developed for dejong function 4 like Rastrigin function. Rastrigin function is a non linear multimodal function. Due to large space and its large number of local minima is solves the difficult problem. Use this function we determine the effect on the performance of genetic algorithm. Plot the function with different population size and show the result by graphs and table.

Parameters used for implementation are :

1. Random initialization
2. Value encoding
3. Population size
4. Arithmetic crossover
5. Uniform mutation
6. Crossover probability
7. Mutation probability
8. Generation at gap of 50 starting from 5o to 500.

Function definition

F4 (X) =

$$10 \cdot n + \sum_{i=1}^{N} \left(x_i^2 - 10 \cdot \cos(2 \cdot \pi \cdot x_i) \right) \qquad -5.12 \le x_i \le 5.12$$

F4(x) =10.n+sum(x(i)^2-10.cos(2.pi.x(i))), i=1:n; -5.12≤x(i)≤ 5.12

Global minimum:

F4(x)=0, x(i)=0, i=1 to n.

Graphs are plotted between minimum fitness and number of generation

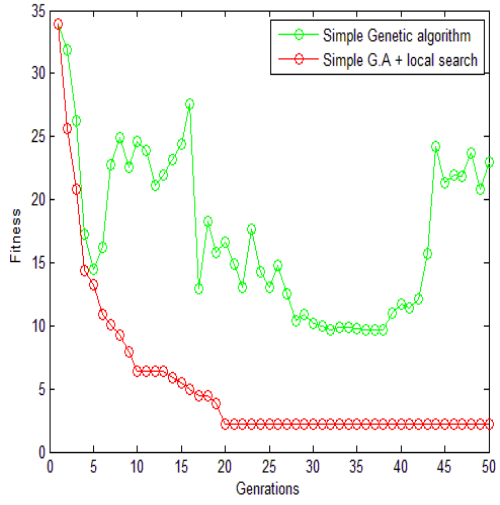

Fig.2 dejong function 4 (50 generation)

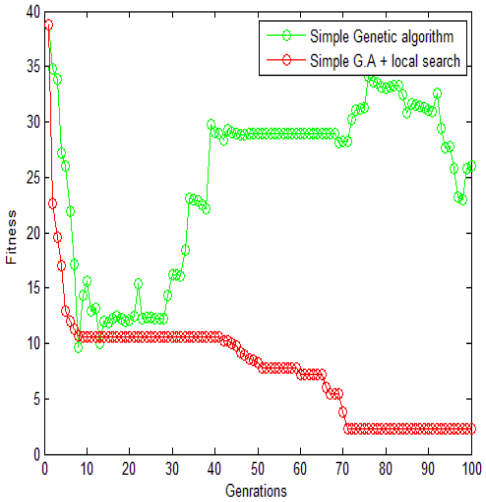

Fig.3 Dejong function 4 (100 generation)

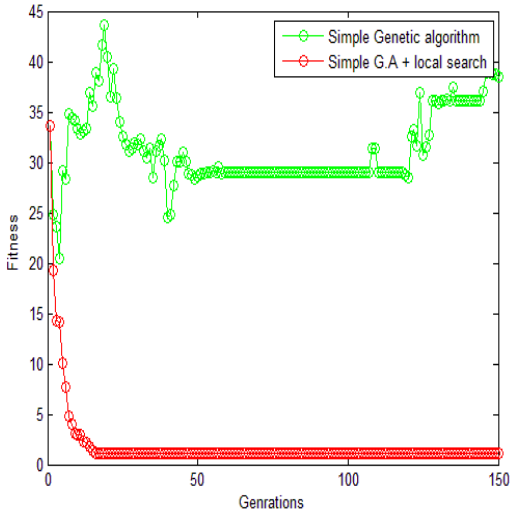

Fig.4 Dejong function 4 (150 generation)

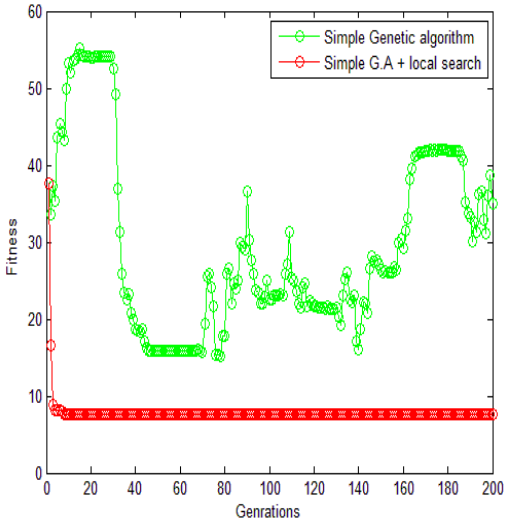

Fig.5 dejong fun. 4(200 generation)

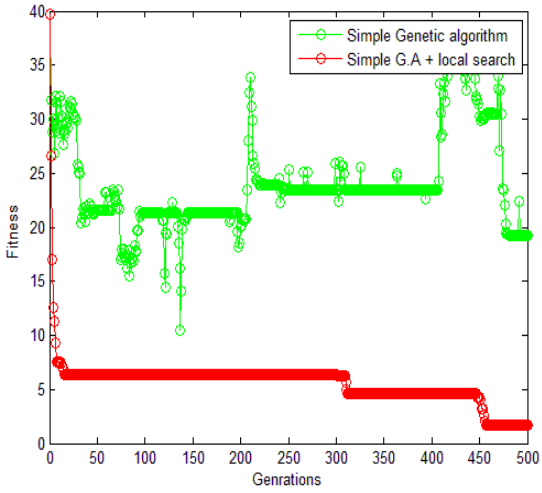

Fig.6 Dejong function 4(500 generation)

Figures show the minimum result of rastigin function

Algorithm	50 generation	100 generation	150 generation	200 generation	500 generation
GA	9.714	9.647	20.48	15.28	10.48
HYBRID GA	2.245	2.259	1.163	7.609	1.72

Table 1.

VIII. CONCLUSION

Genetic algorithm refers to a technique of parameter search based on the procedure of natural genetic to find solution to optimization and search problem. In this paper we implement the dejong function 4 (rastrigin function) and determine the performance of genetic algorithm by the effect of local search scheme. Local search is performed with the replacement operation. Results show by graphs and table. Graphs are plotted between number of generation and minimum fitness. The performance of genetic algorithm depends on the mechanism for balancing two objective exploration and exploitation. Genetic algorithm is combined with local search algorithm which having local knowledge of problem and overall search ability to be enhance. The enhancement can be in terms of efficiency and quality. In this paper we discuss Lamarckian and Baldwin approach these approach use the local search in hybrid technique and improve the fitness value of individual.

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REFERENCES

[1] Holland J., 1975, " Adaptation in Natural and artificial Systems", the university of Michigan.

[2] Martinez-Estudillo A., Hervas-Martinez C., Martinez-Estudillo F., and Garca-Pedrajas N., 2004, " Hybrid method based on clustering for evolutionary algorithms with local search", IEEE Transactions on systems, Man and Cybernetics.

[3] Bilchev G. and Parmee I. C., 1995, " The ant colony metaphor for searching continuous design spaces", in AISB Workshop on Evolutionary Computing, vol.993, Lecture Notes In Computer Science, T. C. Fogarty, Ed. Sheffield, UK: Springer Verlag, pp. 25-39.

[4] Harik G., Cantu-Paz E., Goldberg D.E., and Miller B.I., 1999, " The gambler's ruin problem, genetic algorithms, and the sizing of populations", Evolutionary Computation, vol.7, pp-231-253.

[5] Elmihoub T., Hopgood A., Nolle L., and Battersby A., 2004, " Performance of hybrid genetic algorithms incorporating local search", in 18th European Simulation Multiconference(ESM2004), G. Horton, Ed. Magdeburg, Germany, pp.154-160.

[6] Natalio Krasnogor and Jim Smith, 2005, " A Tutorial for Competent Memetic Algorithm: Model , Taxonomy and Design issues", ISSN: 1089-778X. IEEE

[7] Goldberg D.E. and Voessner S., 1999, " Optimizing global-local search hybrids", in the genetic and Evolutionary Computation Conference (GECCO 1999). Orlando, USA: Morgan Kaufmann, pp.222-228

[8] J. Digalakis and K. Margaritis, 2004, "Performance Comparison of Memetic Algorithms", Appl. Math. Computing 158.

[9] S.N. Sivanandam and S.N.Deepa, 2008 " Introduction to genetic algorithm" , 1st edition, Springer-Verlag Berlin Heidelberg.

