

## Comparative View of Genetic Algorithm and Pattern Search for Global Optimization

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**ABSTRACTS:** Optimization is the process of finding the conditions that give a maximum or minimum value of a function without violating the constraints. The objective functions used in engineering optimization are complex in nature and has many variables and constraints. Conventional optimization tools sometimes fail to give global optima point. Genetic algorithm, Pattern search, simulated annealing, Gradient Search etc. are very popular and useful methods to find global minima related to engineering problems. In this paper an attempt has been made to optimize an objective function related to engineering field having two variables subject to certain constraints. Two methods has been used i.e., Pattern search and simulated annealing and finally comparative view has been highlighted to reach the conclusion with the help of a case study.

**KEY WORDS:** comparative view, Genetic algorithm (GA), Optimization, Pattern search (PS),

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### I. INTRODUCTION

Genetic algorithm was first introduced in 1960 by I.Rechenberg. GA is the computerized search and optimization algorithm based on the mechanics of natural genetics. GA is different from most of the traditional algorithm. It is work with coding of variables and uses huge search space to find global minima. In traditional optimization methods, transition rules are used and they are deterministic in nature but GA uses randomized operators. Random operator improves the search space in an adaptive manner. Genetic algorithm consists of reproduction, crossover and mutation. GA uses initial single species chromosomes are encoded and each chromosome denotes a possible solution. These chromosomes are naturally selected for recombination through the crossover to improve offspring's which is produces in next generations. Mutation produces the child chromosomes for diversity. This process continues until the pre determined generation is reached. Finally the generation which contains highly fit chromosomes representing optimal solutions is reached.

The pattern search finds for the minimum along the direction  $S(i) = x(i) - x(i-n)$ , where  $x(i)$  is the point obtained at the end of  $n$  univariate steps and  $x(i-n)$  is the starting point before taking the  $n$  univariate steps and  $S(i)$  is the pattern direction. In the pattern search method, two points are created for pattern movement. A set of search direction is taken iteratively to work with pattern search. Starting from one point the next point can be found by walking along the search direction.

There are so many optimization techniques used in engineering applications, but still it is difficult to determine which type of technique is suitable for a particular problem considering global optima. An attempt has been made to clarify between above two techniques found appropriate, depending on the search space.

### II. ALGORITHMS OF PATTERN SEARCH

**Step1:** initialize  $x(0)$ , increment  $\Delta(i)$ , reduction factor  $\alpha > 1$  and termination criterion  $\epsilon$ .

**Step2:** set  $k = 0$ .

**Step3:** Base point is  $x(k)$ , if movement is successful then set  $x(k) = x$  and go to step5 else go to step 4.

**Step4:** is  $\|\Delta\| < \epsilon$ ? If yes terminate; else set  $\Delta(i) = \Delta(i)/\alpha$  and go to step2.

**Step5:** set  $k = k + 1$  and move  $x(k+1) = x(k) + [x(k) - x(k-1)]$

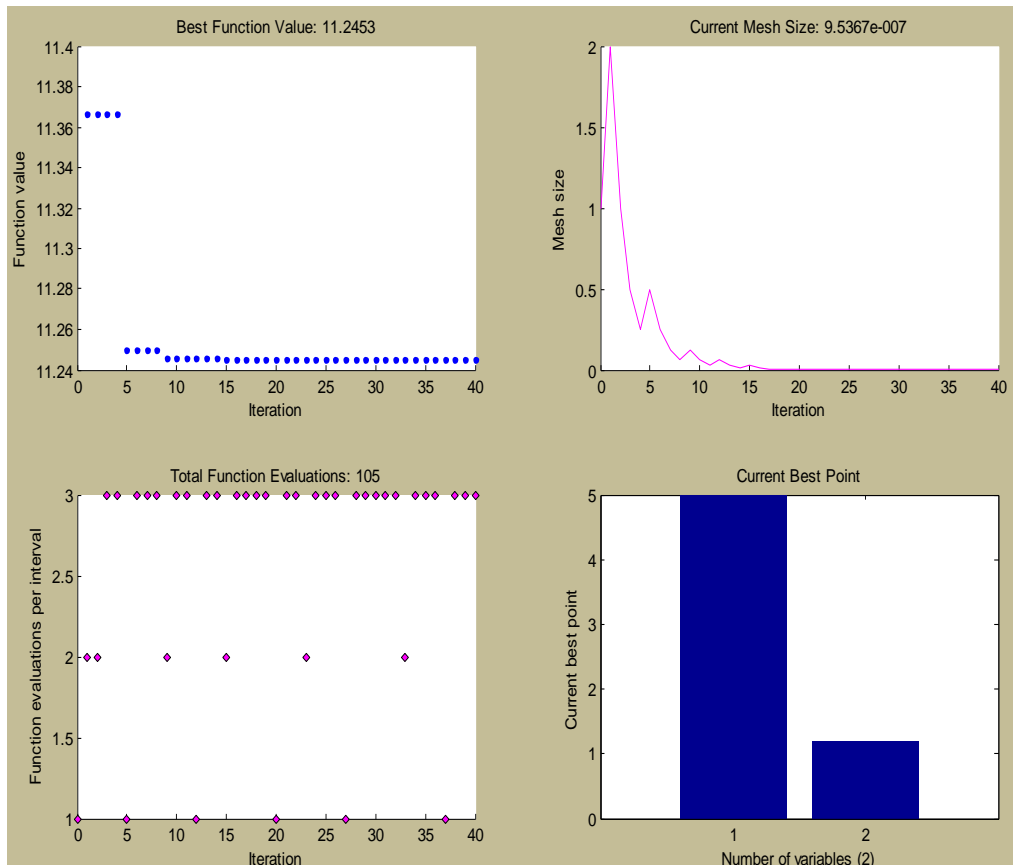
**Step6:** is  $f[x(k+1)] < f[x(k)]$ ? If yes go to step5; else go to step 4.

### III. OBJECTIVE FUNCTION

The objective function:  $F = \frac{x_1^2 x_2}{(x_1 + x_2)} + \frac{(x_1 + x_2)^2}{x_1 x_2}$  is taken for test case study in order to minimize the function by two methods viz. genetic algorithm and pattern search under the restrictions of  $5 \leq x_1 \leq 15$  and  $0 \leq x_2 \leq 9$ . Final conclusion has been made by comparing the results given below.

### IV. RESULTS

Genetic Algorithm (fig: 1)			Pattern search (fig: 2)	
Generation	Best f(x)	Mean f(x)	Iteration	f(x)
1	11.92	42.09	1-2	11.3667
2-5	11.61	35.21	3-4	11.3667
6-7	11.52	12.93	5-6	11.25
8-11	11.36	12.02	7-8	11.25
12	11.32	11.43	9-10	11.246
13-15	11.3	11.42	11	11.246
16	11.26	11.32	12	11.2458
17	11.25	11.29	13	11.2458
18	11.24	11.28	14	11.2458
19	11.244	11.27	15	11.2453
20	11.247	11.2475	16	11.2453



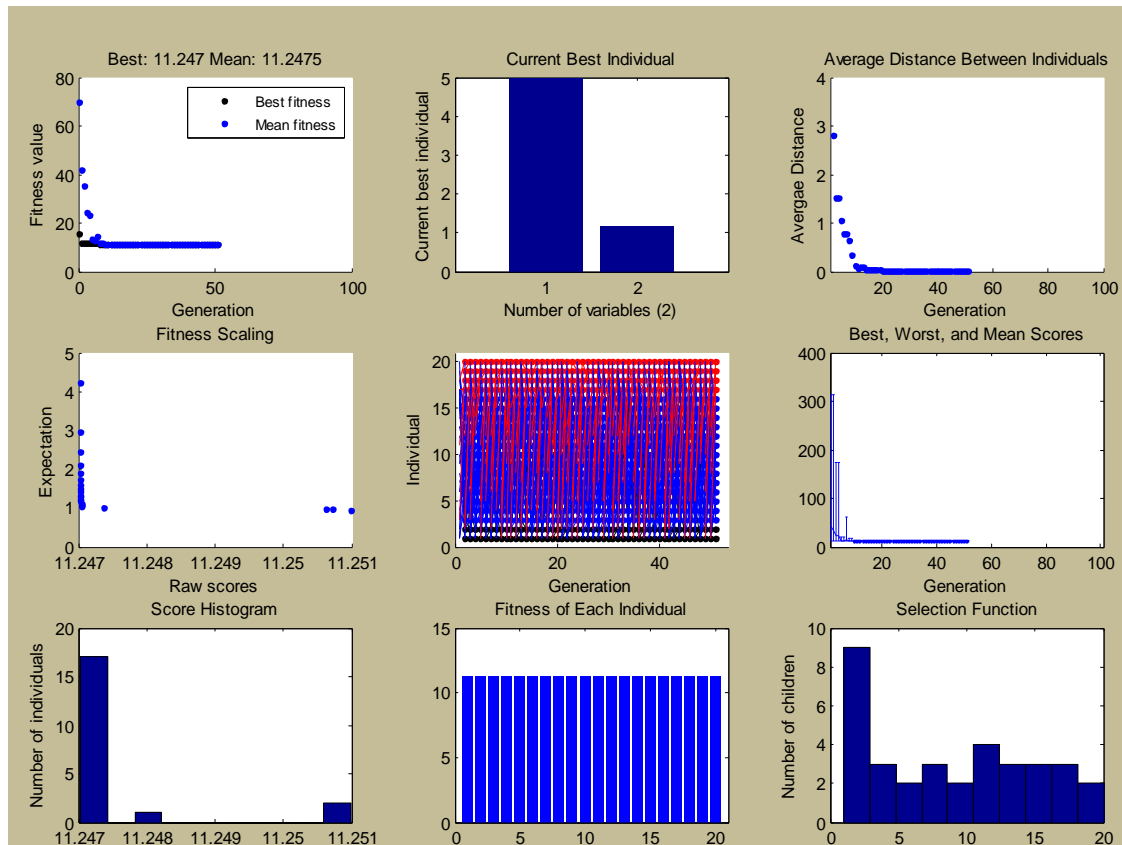


Figure 1&amp;2

## V. CONCLUSION

An objective function has been chosen having inequality constraints defining the search space. It has been optimized (minimized) by two methods viz. genetic algorithm and pattern search. The best value obtained by applying GA is 11.247 and by PS is 11.2453. Genetic Algorithm uses large search space and many generations for optimization whereas Pattern Search finds certain direction and comparatively less steps for solving the problem. GA is a tool to optimize where the search space is large especially in machine related complicated problems. PS finds the best performance for comparatively smaller search space and less computing time than GA. In this problem pattern Search gives the best value of 11.2453 with  $x_1=5$  and  $x_2=1.204$  depending on the nature and convergence (search space) of the problem. Finally it can be concluded that Pattern Search can be the better tool where optimization area is small.

## REFERENCES

- [1] Rao S.S., Engineering Optimization –Theory and Practice, Third Edition, New Age International (P) Ltd.,1996
- [2] Kambo N.S., Mathematical Programming Techniques , Revised Edition,1991,1984, Affiliated East-West Press Pvt. Ltd. New Delhi – 110 001, ISBN 81-85336-47-4.
- [3] Kalyanmoy Deb, Optimization for engineering design, PHI Pvt. Ltd. 1998.
- [4] David E.Goldberg, Genetic Algorithms in search, Optimization and Machine Learning, Pearson Education, South Asia, Sixth Impression,2011,ISBN 978-81-775-8829-3.
- [5] Bansal R K,Goel A,K,Sharma M.K - MATLAB and its application in engineering, First Impression, Pearson Education in South Asia, ISBN 978-81-317-1681-6, New Delhi – 110 001.
- [6] Rajasekaran S, Vijayalakshmi Pai G.A, Neural Network, Fuzzy Logic, Genetic Algorithms- Synthesis and Application, Fourth edition , ISBN 81-203-2186-3, PHI Pvt. Ltd, New Delhi – 110 001

## BIBLIOGRAPHY



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