A hybrid Approach of Genetic Algorithm and Particle Swarm Technique to Software Test Case Generation

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Abstract This paper presents A hybrid Genetic Particle swarm technique algorithm (HGPSTA) which is a technique that combines genetic algorithm (GA) and particle swarm optimization (PSO), which is used for Software Test Case Generation. Research Paper also presents the outcome of the research done in the area of software testing using the soft computing. Different soft computing approaches such as Particle Swarm Optimization (PSO) and Genetic Algorithm (GA), and hybrid of PSO and GA are used. These are used to compare and find the minimum software test cases for testing the software.

Keywords: Software Testing, Genetic Algorithms, Particle Swarm Optimization, Software test cases.

I. INTRODUCTION

Software Testing is one of the time consuming and costly phases in software development process. It takes lot of time and consumes 55% of the cost of a software development, It requires a lot of effort on developing software testing tools that can reduce time and cost of software development.

Generation of test cases depends on the skill of person and consumes a lot of effort. Therefore lots of chances which cause defects at the time of designing of test cases are enormous that leads to the insertion of bugs in the software system. Testing system is essential to make different good (suitable) test data from bad test (unsuitable) data, and so it should be proficient to detect good test data if they are generated. Testing is a means of making sure that the product meets the needs of the customer. Testing a software product is just a mechanism to compare the outputs on a given set of outputs and checking whether the output requirements are met. The software testing process also doesn't ensure that there is no error in the product but may that error is acceptable.[2,3] The application of artificial intelligence (AI) techniques is an emerging area of research in Software Engineering (SE) that focuses across two domains about the cross fertilization. Researchers have done some work in developing genetic algorithms (GA)-based test data generators. In this paper, we have tried to present the results of our research into the application of GA search approach and PSO, identifying those paths of software construct that are error prone.[4]

In comparison to genetic search, the particle swarm optimization is a relatively recent optimization technique of the swarm intelligence paradigm. We initialize the system with random particles. Each particle maintains its own current position, its present velocity and its personal best position on the basis of which we generate the test cases. Compared with GA, PSO has some attractive characteristics. PSO has a good memory which helps to retain good solutions by particles. but in GA, all the prior knowledge to problem changes once the population is changed. It has constructive cooperation between particles, particles in the swarm share information between them.

In this paper we develop an algorithm combining the power of GA, PSO, HGPSTA –Hybrid Genetic Particle Swarm Technique Algorithm with a new multi objective fitness function. This paper also tries demonstrating the effectiveness of our proposed approach in case of number of generations.

II. GENETIC ALGORITHM (GA) AND PARTICLE SWARM OPTIMIZATION (PSO)

2.1 Genetic Algorithm

GA can be classified into five categories:

(1) A representation of a guess called a chromosome.
(2) An initial pool of chromosomes
(3) A fitness function
(4) A selection function and
(5) A crossover operator and a mutation operator

The GAs uses three basic operators (reproduction, crossover, and mutation) to manipulate the genetic composition of a population. Reproduction is a process by which people rated the current generation are reproduced in the new generation.[5][6] The crossover operator produces two-off springs (new candidate solutions) by recombination of the information from both parents. The mutation is a random change value of some of the genes in an individual.

Flow Chart of Genetic Algorithm

This iterative process goes on till any one possible termination criteria is met or if a known solution level is achieved.

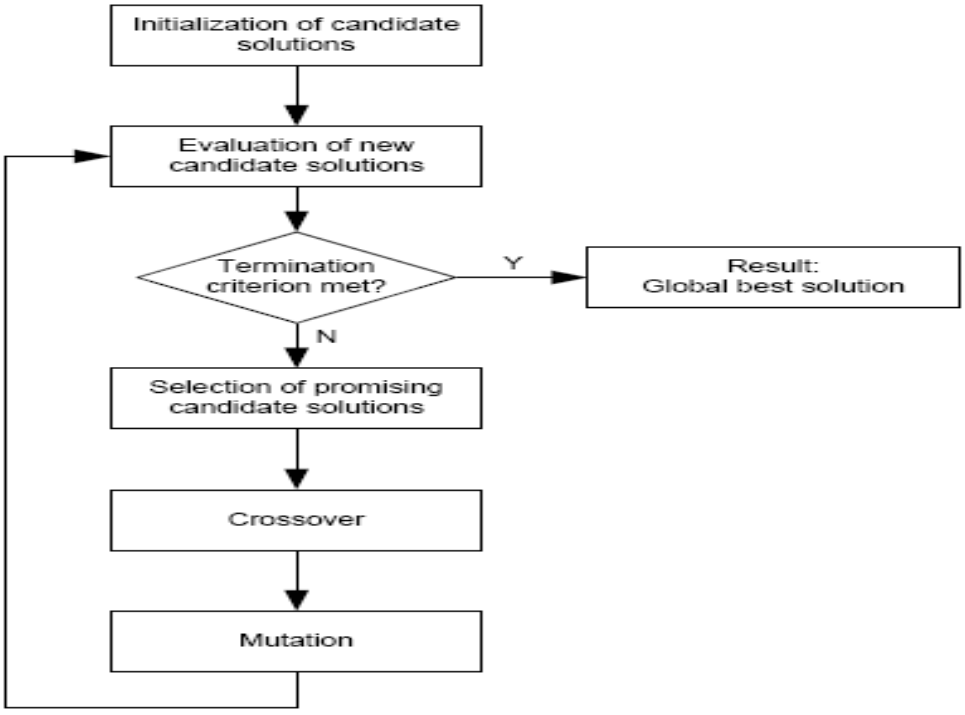

Figure 1. Genetic Algorithm Flow Chart

Pseudo code for GA is:

Initialize (population)

Evaluate (population)
While (stopping condition not satisfied) do
{
1. Selection (population)
2. Crossover (population)
3. Mutate (population)
4. Evaluate (population)
}

2.2 Particle swarm Optimization

In comparison to GA, PSO is a relatively recent optimization technique of the swarm intelligence paradigm. The particles are initialized to the system with a population of random solutions [7,8].

Flow Chart for Particle Swarm Optimization

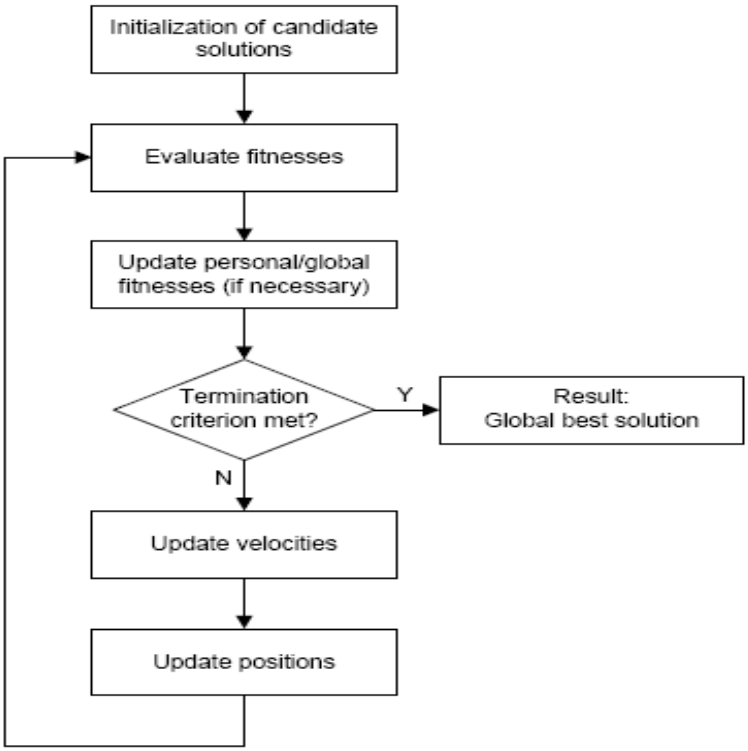

Figure 2: Particle Swarm Optimization algorithm Flow Chart

Pseudo Code for PSO

1:Procedure PSO
2: repeat
3: for i = 1 to number of individuals do
4: if G(~xi) > G(~pi) then . G () evaluates goodness
5: for d = 1 to dimensions do

6: pid = xid . pid is the best state found so far
7: end for
8: end if
9: g = i . arbitrary
10: for j = indexes of neighbors do
11: if G(~pj) > G(~pg) then
12: g = j . g is the index of the best solution in the neighborhood
13: end if
14: end for
15: for d = 1 to number of dimensions do
16: vid(t) = f(xid(t − 1), vid(t − 1), pid, pgd) . update velocity
17: vid 2 (−Vmax,+Vmax)
18: xid(t) = f(vid(t), xid(t − 1)) . update position
19: end for
20: end for
21: until stopping criteria
22: end procedure

III. PROPOSED APPROACH

Hybrid Genetic Particle Swarm Technique algorithm (HGPSTA)

Generating test cases is time consuming and also an error-prone task. Evolutionary structural testing (EST) , is an automatic test case generation technique, to ease the testing process.[1] EST interprets the task of test case generation as an optimization problem and tries to solve it using a search technique, i.e. a genetic algorithm and particle swarm technique. [9]

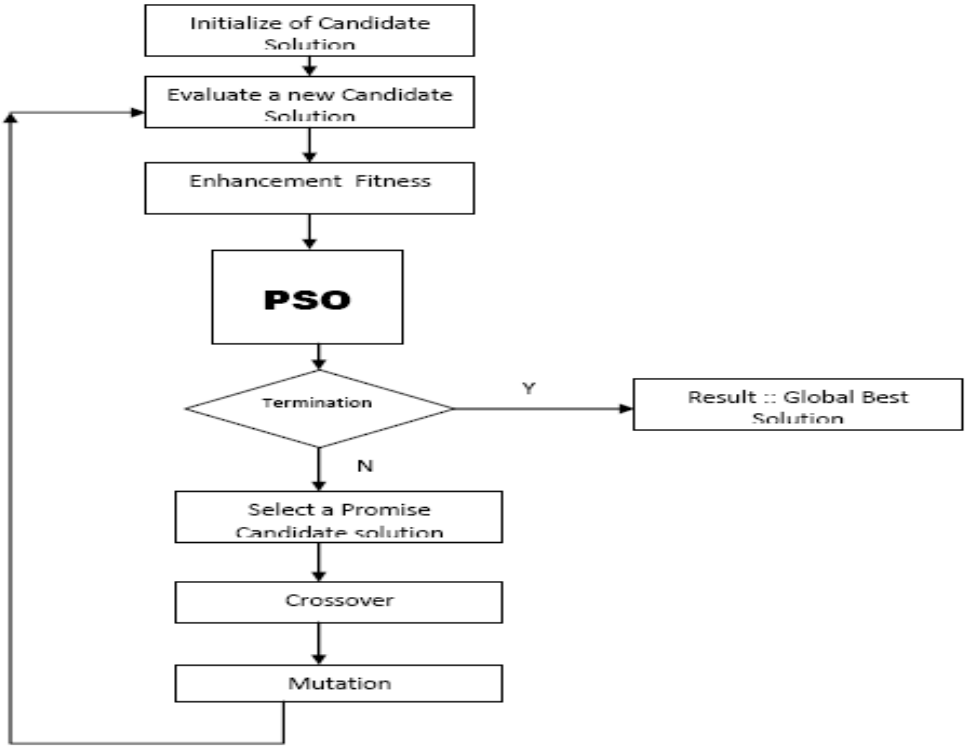

Figure 3. Hybrid Genetic Particle Swarm Technique algorithm Flow Graph

We combine the Pso and GA techniques to improve the efficiency of the testing process. Proposed hybrid approach is the combination of genetic and particle swarm algorithm to automatic test-data generation for searching test cases. The proposed hybrid system includes 3 main operators: enhancement, crossover, and mutation.

The proposed approach has three main operators: enhancement, crossover and mutations

Enhancement PSO is used to enhance individuals of the same generation. Once we calculate the fitness value of all individuals belonging to same population the most successful first half are marked. In place of reproducing the individuals to GA'S directly we use PSO to enhance individuals.
Crossover: To produce successful individuals among parents of the crossing operation are selected from the only people improved. To select parents for crossing operation, the selection scheme roulette wheel is used.

Mutation:
The mutation is an operator such that the allele of a gene is randomly changed so that new genetic material may be introduced into the population.

IV. EXPERIMENT RESULTS

In the present work, Genetic Algorithm (GA), Particle Swarm Optimization (PSO) and A hybrid Genetic Particle swarm technique algorithm (HGPSTA) have been developed for fitness function which is based on dominance relation between two nodes. The fitness function based on the criteria of data flow coverage. The fitness function that is taken in this research is depending on the dominance relation between nodes of data flow graph. The main goal of research is to combine the power of two algorithms GA and PSO. It proves its power and effectiveness towards solving the testing problems. Initial population for GA, PSO and HGPSTA program is generated randomly. Experiments are conducted 10 times for averaging results. In each attempt, search functions are
Iterated for sufficient number of generations for each of ten runs. Experiments are conducted on seven programs they are

GTN – This is program for finding greatest of three numbers.
PRIME – this is the simplest program check whether a given number is Prime number or not.
RM – This program is loop based program which finds remainder of two integer numbers.
BS - This program is based on Bubble Sorting algorithm.
QE – This programs finds the roots of Quadratic Equation.
MM – this is array and loop based program that find minimum and maximum value from an array.
HCF – this program accepts two inputs and finds Highest Common Factor between these two integer numbers.

Results are analyzed by changing the size of populations with different mutation and crossover probability in GA and HGPSTA. In case of PSO and also the results are determined by changing the number of individuals. The results of the proposed HGPSTA are compared with GA and PSO. As shown in figures 4 HGPSTA performs better than GA and PSO in number of generation.

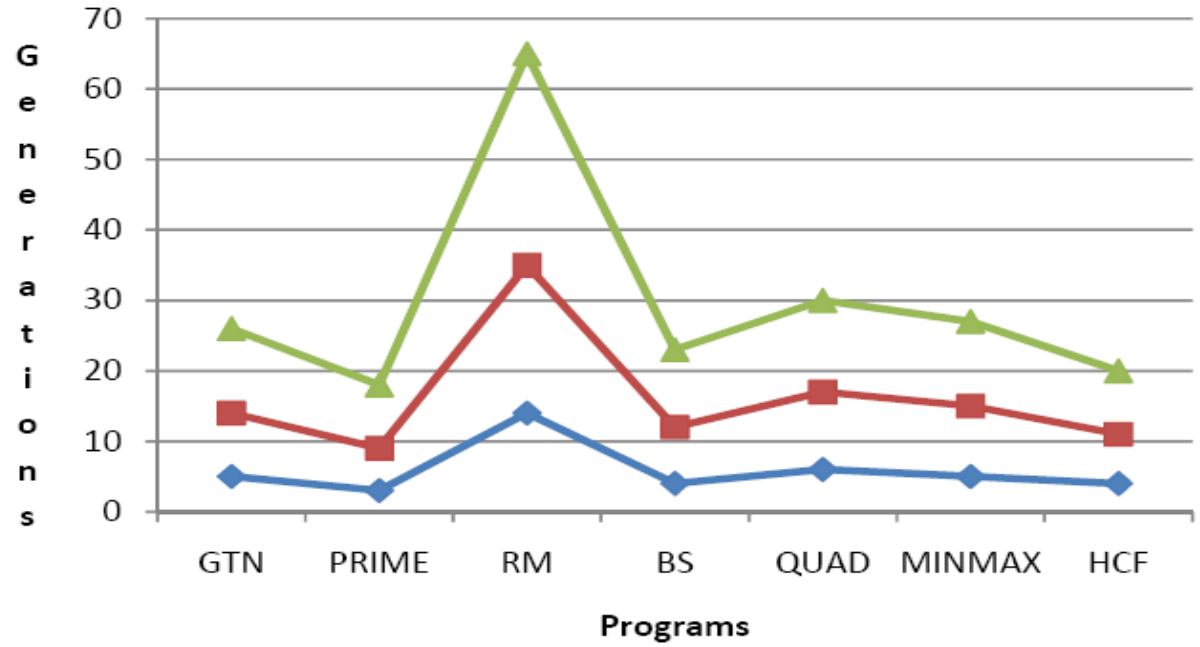

Figure 4. Comparisons of HGPSTA PSO and GA w. r. t. Number of Generations

From figure 5, it can be analy zed easily that number of test cases generated in case of HGPSTA is less than GA and PSO.

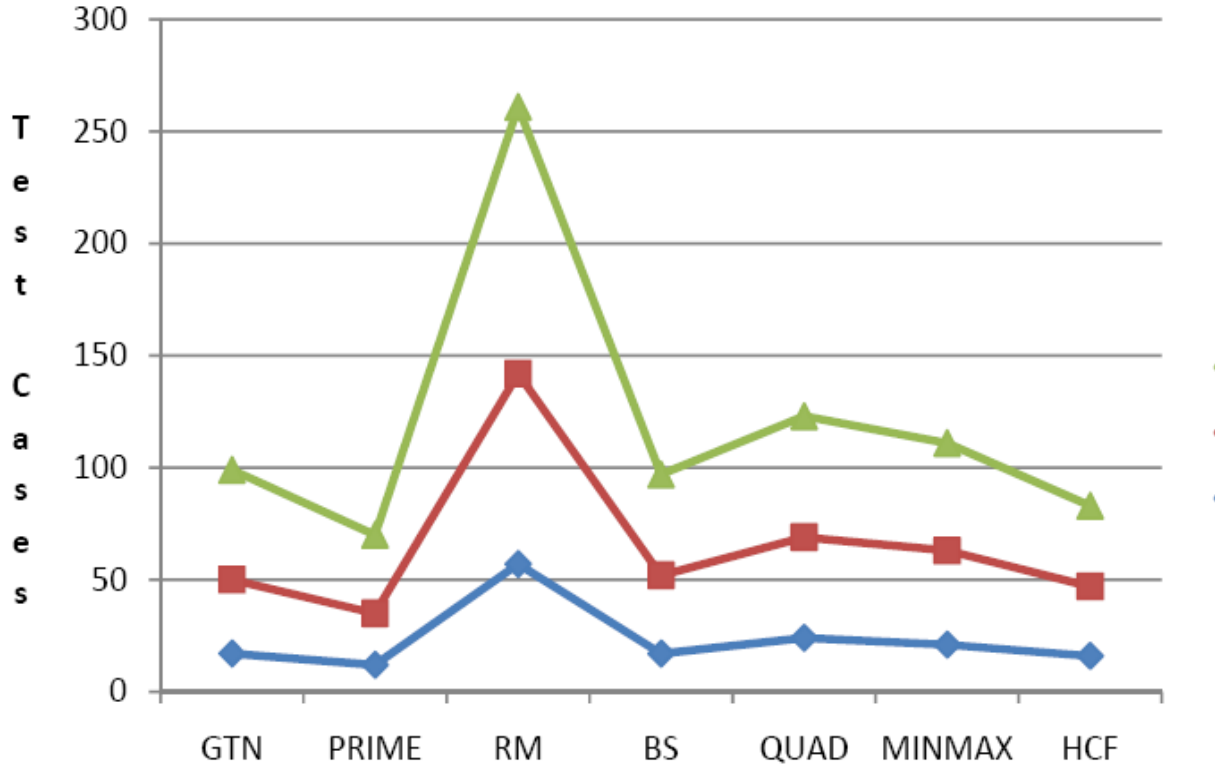

Figure 5. Comparisons of HGPSTA PSO and GA w. r. t. Number of Test Cases.

V. CONCLUSION AND FUTURE WORK

In this paper we have proposed an algorithm for generating test cases using combining the power of GA and PSO, HGPSTA – Hybrid of Genetic Particle Swarm Combined Algorithm. Experiments show the effectiveness of the proposed HGPSTA compared to the PSO and GA techniques. The results of our new approach, HGPSTA is better than GA and PSO. HGPSTA achieves 100 percent coverage in less number of iterations.

Future work is to analyze the test case generation using hybrid PSO and ACO (Ant colony optimization) and compare its fectiveness with our HGPSTA.

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