Feasible Test Case Generation Using Search Based Technique

Jasmine Minj

Dept. of Comp. Sc. and Engg.,
Motilal National Institute of Technology, Allahabad

ABSTRACT

This paper presents automatic test case generation technique. Multi population genetic algorithm is used to generate test cases. Fitness function is based on the multiple condition decision coverage criteria. MATLAB Gatool is used for implementing the test case generation algorithm. It generates efficient and effective test cases. Test cases are optimized using multi population genetic algorithm. MCDC coverage is used as coverage criteria. Automatic test cases generation reduce the testing effort, time and cost.

General Terms:

Test Case Generation

Keywords:

Multi population genetic algorithm, Multiple condition decision coverage

1. INTRODUCTION

Software testing is one of the important phase in software development. It is one of the critical task as it lead to increase in cost, time and effort. To make testing easy there is a need to generate test cases to guide the testing process. Generating an optimized test cases lead to improve the software efficiency. Search based technique is used for test case generation as testing is an exhausting process and it is very difficult to handle, and generating test cases is NP hard problem [11].

The proposed method for automatic test case generation following a criteria of MCDC coverage guided by multi population genetic algorithm. Coverage criteria is used to measure the extent to which a given system satisfy its goal. Multiple condition decision coverage criteria is used which should satisfy as follows:

- (1) Every decision should execute all true as well as false criteria.
- (2) Every condition should execute all true as well false criteria.
- (3) Every condition in decision should be independently derive the output.

It is much more stricter than decision coverage. Using MCDC as coverage criteria we are able to evaluate software verification with a good metrics.

2. RELATED WORK

Hamilton Gross et al. [3] presented the evaluation of use of evolutionary testing technique in testing. Predicate coverage was used as coverage criteria. Java program taken as test data. Ali M. Alakeel [4] proposed the use of heuristic approach for test case generation based on assertion. Code based coverage criteria was used. Abdul Rauf et al. [1] presented an analysis of testing graphical user interface using genetic algorithm. Fitness function used as a evaluation parameter. Nodepad is taken as case study. Kewen Li et al. [2] proposed a method by combining genetic algorithm with particle swarm optimization to generate test cases efficiently. Diversity used as evaluation parameter and triangle program taken as case study.

Mark Harman et al. [5] presented three algorithm: Memory based, greedy based, CDG based approach to generate reduced and optimized test case which lead to reduced oracle cost. Yang Cao et al. [6] proposed genetic based automatic test case generation approach, fitness function on the basis of target path similarity with execution path. X. B. Tan et al. [7] proposed GA based annealing immune algorithm for generation of test data and presented the individual concentration adjustment and new mechanism for reproduction and triangle problem taken as case study. Yong Chen et al. [8] presented an evaluation of performance of branch distance based fitness function and modified hamming distance based fitness function. And showed that branch based fitness function works more efficiently than modified hamming distance fitness function. For evaluation triangle problem taken as case study.

Praveen Ranjan Srivastava et al. [9] proposed a method to generate test cases effectively using ant colony algorithm and GA. Based on constraints and test data evaluated the performance of both technique in software testing. Susan Khor et al. [10] presented a automatic test case generation approach using GA with formal techniques. Statement coverage and data flow coverage used as a coverage criteria. A Fibonacci series based algorithm was proposed for selection process in test case generation.

3. GENETIC ALGORITHM

General procedure of genetic algorithm:
begin
INITIALIZE the population;
EVALUATE each individual;
repeat

SELECT individuals;
APPLY CROSSOVER to the individual;
APPLY MUTATION to the resulting individual;
EVALUATE resulting individual;
SELECT individuals for the next generation
until STOPPING-CONDITION is reached
end

Initialization: Generated paths are represented in the form bit string and taken as initial chromosome for initial population.

Selection: Selection of individual is done on the basis of Fitness function based on Multiple condition decision coverage.

Crossover: It important part of GA. Crossover recombine bits of strings and produce the new result for next generation. We have used single point cross over. We have used crossover probability of 0.8. We generate random number according to the present chromosome, random number less then 0.8 are selected for crossover.

Example:

Parent1: 5 2 6 7 2 4

Parent2: 8 4 3 5 3 1

After applying single point crossover:

Child 1 : 5 2 3 5 3 1

Child 2 : 8 4 6 7 2 4

Mutation: Mutation gives the diversity to the population. We generate random number on the basis of current chromosome and mutation is applied if random number is less then the mutation probability of 0.2

4. PROPOSED APPROACH

Path based test case generation is used with search based technique for which it is converted into problem of optimization. It is the process of finding the best possible solution from the feasible solution. Multi population genetic algorithm is used as a search technique. It takes multiple populations. Randomly initialization of sub-population is done. Different Sub-population works separately with fitness function and have different search in search space. Then after some period of time they exchange their information and works again separately.

Method for test cases generation: Convert the program into Control flow graph. Generate all possible paths. Construct the fitness function based on MCDC coverage to evaluate the path feasibility. For example $X \wedge y$ where X, Y are the condition in predicate. The MCDC test cases for this will be Case1: when X is True and Y is True then result should be True. Case2: when X is True and Y is False then result should be False. Case3: when X is False and Y is True then result should be False.. Construct the instrumental version of the program. And set the **MATLAB Gatool** tool to set the specified parameters for multi population genetic algorithm and perform the execution until the stopping criteria is reached.

5. CASE STUDY

A bench mark problem triangle problem is taken as case study. A Triangle program used is given three input sides of the triangle and output will be a type of triangle according to the given input value. A triangle function is shown to check the triangle type. It is con-

verted into control flow graph shown in Fig. 1. Fitness function refer to the [12] branch distance function shown in Table 1 for predicates. The four path is shown here, out of which we find the most critical path and set the parameter in MATLAB Gatool for multi population genetic algorithm.

- (1) Path: d
- (2) Path: ae
- (3) Path: abf
- (4) Path: abc

Triangle Program:

```
function triangeltype = triangle(X, Y, Z)
if(X+Y>Z)&(Y+Z>X)&(Z+X>Y)&(X>0)&(Y>0)&(Z>0)
if(X~=Y)&(Y~=Z)&(Z~=X)
triangeltype='Scalene';
else
if(X==Y)&(Y==Z)|| (Y==Z)&(Z==X)|| (Z==X)&(X==Y)
triangeltype='Isosceles';
else
triangeltype='Equilateral';
end
end
else
type
triangeltype='Not-a-triangle';
end
```

Fig. 1. Control flow graph of triangle problem

Matlab Gatool settings for MGPA:

- (1) Binary string is taken as coding
- (2) Population size=2500
- (3) Number of sub-populations=5
- (4) Number of individuals in each sub-population=500
- (5) Fitness: Rank-based
- (6) Selection: Roulette wheel

Table 1.
Korel's_branch_distance

Relational and logical Predicate: C	Distance if different path is taken
$p1 = p2$	$\text{abs}(p1 - p2)$
$p1 \neq p2$	K
$p1 < p2$	$(p1 - p2) + k$
$p1 \leq p2$	$p1 - p2$
$p1 > p2$	$(p2 - p1) + k$
$p1 \geq p2$	$p2 - p1$
$X \wedge Y$	$\min(\text{Distance}(X) + \text{Distance}(Y))$
$X \vee Y$	$(\text{Distance}(X) + \text{Distance}(Y))$

- (7) Crossover: Single-point and probability= 0.8
- (8) Mutation probability=0.2
- (9) Migration rate=0.2
- (10) Maximum generation=500
- (11) Insertion rate=0.8
- (12) Generation gap=0.8
- (13) Migration period=20

6. RESULT AND ANALYSIS

Experiment is done in MATLAB using Gatool by taking triangle problem as case study. Multi population genetic algorithm with multiple condition decision coverage shown a better performance that Multi population genetic algorithm with decision coverage shown in Table. 2. Performance evaluation of other example is also shown the benefits of proposed approach.

7. CONCLUSION

Path oriented test case generation is guided by multi-population genetic to generate test cases efficiently. Fitness function is made by following MCDC coverage. Triangle problem is taken as case study. Using MCDC approach with MPGA gives the good result in generating test cases efficiently. It generates feasible and optimized test cases.

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Table 2.
Performance_Evaluation

Program	Type	NO.of branches	Generation	Coverage percentage	Average time in second
Triangle	MPGA with DC	8	85	100	295.4
Triangle	MPGA with MCDC	8	25	100	25.3
Quadratic	MPGA with DC	6	95	100	395.6
Quadratic	MPGA with MCDC	6	35	100	35.2