

Software Testing Using Genetic Algorithm

Soniya Malik

Computer Science And Engineering, Hindu college of Engineering, Sonapat (India)

ABSTRACT

Software testing is a phase of software development life cycle, which is used to discover the errors and to check whether the designed software fulfills the user requirement or not. Better testing leads to better software quality and reliability. There are various types of software testing which can be used to test a software. The main issue with the software testing is completeness. It is possible to test the software completely as it involves the exhaustive number of test cases to be put under test which in turn increases the total effort and cost of the software. Different techniques and methodologies have been proposed for taking care of these issues. Use of evolutionary algorithms for automatic test generation has been an area of interest. Genetic Algorithm is one such optimization technique. The aim of the research paper is to implement Genetic Algorithm for minimization of test cases and to reduce cost, time and effort in order to deliver the good quality software.

Keywords: *Crossover, Genetic Algorithm, Selection, Software Testing, Test Cases.*

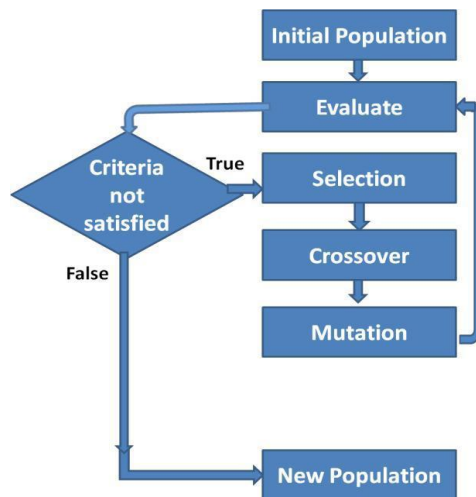
I. INTRODUCTION

Testing is process of discovering errors. The aim of testing is to eliminate the gap between actual output and expected output. There are various types of software testing techniques. Broadly, testing techniques include functional (black box) and structural (white box) testing. Functional testing is based on functional requirements whereas structural testing is done on code itself[1][2]. White box testing in which consider internal structure of the software. It is also known as clear box testing. In white box testing, path testing consider control flow and test each individual path of the control flow graph. and data flow testing, analyze decision to decision path graph. Data flow testing uses sequence of variable access to select path from a control graph. In Black box testing, the actual implementation of software is not analyzed.

Testing can be done either manually or automatically by using testing tools. It is found that automated software testing is better than manual testing. However, very few test data generation tools are commercially available today. Various techniques have been proposed for generating test data or test cases automatically. Recently, lot of work is being done for test cases generation using soft computing techniques like fuzzy logic, neural networks, GA, genetic programming and evolutionary computation providing keys to the problem areas of software testing. Genetic Algorithm generate optimal number of test cases to perform effective testing. Genetic Algorithm is used to perform various software testing techniques such as black box and white box testing. In this paper, various software testing techniques performed using Genetic Algorithm have been presented.

II. GENETIC ALGORITHM

Genetic Algorithm is an optimization technique. It is an evolutionary algorithm which generate solution to problem inspired by natural evolution, In this, randomly population are selected and that inherit to new population called offspring. Fitness of population is evaluated to generate offspring. After evaluation of fitness value ,perform mutation and crossover to generate offspring. This process perform in intration, until optimal solution is not found[3] [4][5].



flow diagram of genetic algorithm

2.1. It Consists Three Operation

2.1.1.Selection

Selection in which analyze chromosome or population by fitness function to generate offspring whether they are survive or not and reproduce in nature. There are various selection methods-

- 1.Random Selection
- 2.Roulette Wheel Selection
- 3.Tournament Selection

2.1.2.Crossover

It is technique to generate new chromosome, define pair of chromosome and swapping in sequence of bits and generate new population. For instance[3],

Parent 1: aAbBcC

Parent 2: 123456

Child: aAb45 (one possibility out of many)

2.1.3. Mutation

Mutaion is performed in bits and mutate every bit of chromosome every bit of chromosome to generate offspring. For instance,

Parent 1: aAbBcC

Parent 2: 123456

Child: aAbZ56 (changing 4 to Z).

III. USING GENETIC ALGORITHM IN SOFTWARE TESTING

Genetic Algorithm is basically developed in 1970's by Holland and his colleagues [6]. Genetic Algorithm is used to performed various testing techniques. Software testing is optimization problem to minimize number of test cases and minimize the time, cost and effort. And also increase the quality of the software. Genetic algorithm used with black box and white box testing to generate test cases[7].

3.1 White Box Testing Using Genetic Algorithms

White box testing check the internal behavior of the program. Tester deals with code, loop, condition statements. In some of the research work discuss the code coverage and data flow testing using Genetic Algorithm.

3.1.1.Path Testing

Ranjan Srivastava and Tai-hoon Kim[5] worked on technique to test data generation using genetic algorithm. It uses a weighted CFG. Path testing covers every possible path in the program to discover the errors... If program have no of loops, then it contain infinite number of path. Here, large number of test cases needs to be covered every path. That is why ,covering of all possible path in testing can become a NP complete problem .Our algorithm works on control flow graph (CFG). CFG handles independent path for new set of statements or condition. During testing, every independent path must traverse at least once.

Keshavarz and Reza Javidan [8],worked on path testing using Genetic algorithm. In path testing, we deals with program to draw control flow graph. During testing we needs to consider following criteria to perform path testing as-

- 1.every independent path needs to be covered.
- 2.Testing time does not exceed the determined time.

The main motive is to perform path testing using genetic algorithm is software quality control.

Poonam Saini, Sanjay Tyagi[9],worked on test data generation in path testing using genetic algorithm. In software testing, generation of test cases or test data is more important aspect to perform effective testing. Manually. test data generation is time consuming process as compare to automated test date generation. Software Testing is optimization problem due to effort and time consuming process. Therefore, the optimization techniques Genetic Algorithm are used to generate suitable data, methods were covered every independent path in control flow graph.

3.1.2.Data Flow Testing

Moheb R. Girgis [10],worked on automated test data generation on data flow testing using genetic algorithm. Genetic algorithm accepts def-use paths of the program to be tested. Def-use path defines the number of input variables, and their definition and use of each input variable. Also, it analysis the population size, probability of crossover and mutation. Here ,find the number of test cases to def-use path to perform data flow testing. The algorithm have an integer vector to record the traverse to each def-use path. Initial value of integer vector is zero. It uses as a counter to count or check effectiveness of current population.

3.2 Black Box Testing Using Genetic Algorithms

Black box testing is which test the functionality of software and software full fill their specification and user requirement. In some research performed, functional testing and regression testing using Genetic Algorithm.

3.2.1.Functional Testing

Shay Eyal, and Abraham Kandel [11] ,worked on implementation of evolutionary techniques to improve the effectiveness of test cases. The “bad” test cases should be eliminated and “good” test cases are evaluated to perform testing. In functional testing ,we check the functionality of the software. in genetic algorithm, generate the random test cases with respect to population and initialize to numerical values. hen find the values of fitness function to test cases to discover the number of errors.”Good” population act as test cases while other are eliminated. this way consider prioritizes to set of test cases. Number of iteration performed to generate population or test cases by mutation. Consequently, functional testing using genetic algorithm expected to generate fault exposing test cases.

3.2.2 Regression Testing

Arvinder Kaur et al[12].,worked on regression testing using genetic algorithm. Regression testing retest the modified software. Here ,some test suite not possible to test altered software. That is why ,consider the problem of prioritization of test cases. Using genetic algorithm, obtain set of population or test cases based on fitness values. It consider the code coverage to perform testing.

Algorithm to prioritization of code coverage using Genetic algorithm:-

STEP 1. Generation of initial population

Generate ‘n’ number of chromosomes {c1, c2... cn}

STEP 2. Initialization of population

Set Test Suite= No. of chromosomes (n)

STEP 3. Fitness function criterion set

Set fitness function= total code coverage

STEP 4. Select suitable population on the basis of Fitness Function

SELECT (Best 2 chromosomes based on fitness function)

STEP 5. Genetic Operators Applied

Do for selected Chromosome(s)

While (all conditions are covered)

Do crossover

Do mutation

Remove Duplicacy

End While

End For

STEP 6. Optimization of solution checked.

If (solution!= feasible)

Goto STEP 5

Else END.

Using genetic algorithm, optimal solution is generated by random population and it changed to new population by crossover and mutation. Population can be generated on the basis of problem statement and code coverage[13].

Fitness function consider maximum detection of error within budget and less time. Fitness function is used to select the population to problem. After that perform crossover by swapping the values and mutation by changing bits to generate new population. If ,new population fitness value leads to more error detection. Iteration to generate new population is performed until, optimal solution is not found.

IV. CONCLUSION

In this paper, various software testing techniques have been discussed. In order to minimize the time, cost and effort required to test a software one needs to implement certain evolutionary algorithms in software testing. Genetic algorithm is one such evolutionary algorithm which can optimize the problem. It has been studied that genetic algorithm gives better results to increase quality of software by discovering errors. Our future work will involve applying GA for black box testing such as boundary value analysis and automated testing. We can also plan to perform mutation testing using Genetic algorithm.

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