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TEST CASE GENERATION BASED ON ADAPTIVE RANDOM BORDER CENTROIDAL VORONOI TESSELLATION

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Abstract

Random testing is a black box testing approach where programs are tested by generating random, independent inputs and also tested by choosing an arbitrary subset of all possible input values. Random testing is low cost and straightforward but its effectiveness is not satisfactory and it doesn't cover the test cases properly. To increase the effectiveness of Random Testing, researchers have developed Adaptive Random Testing and Quasi-Random Testing methods which attempt to maximize the test case coverage of the input domain. Adaptive Random Border Centroidal Voronoi Tessellations (ARBCVT) utilizes Centroidal Voronoi Tessellations (CVT), enhances the existing state of the test case generation techniques. Besides, the voronoi regions are uniformly departed to cover maximum test points. A novel search algorithm has been included into ARBCVT by reducing the order of computational complexity of the new approach. The ARBCVT approach may results in production of maximum coverage of test cases when compared to the test cases covered by the existing approaches which are more cost-effective at a reduced computational complexity. It is recommended that the usage of ARBCVT approach leads to the enhancement of the existing strategies within a software testing.

Keywords—Software Testing, Random Testing, Centroidal Voronoi Tessellation

I. INTRODUCTION

Random testing is a black-box software testing technique where programs are tested by generating random, independent inputs. The outputs are compared against software specifications to verify that the test output is pass or fail. In Random Testing, the main disadvantage is that it won't cover the test cases properly. So ART is designed to cover the input space.

ART is designed to evenly distribute random test cases across the input domain in order to effectively detect failure regions with respect to the observation that faults often occur in failure regions or clusters in the input domain. As a consequence, ART methods increase the probability of fault detection within the input domain. Another approach is QRT which applies a quasi-random sequence to generate test cases. Quasi-random sequences take advantage of a group of mathematical algorithms producing low-discrepancy sequences. However, the use of quasi-random sequences in software testing suffers from the following limitations that Quasi-random algorithms are only valid for a finite number of dimensions and quasi-random algorithms can generate only a limited number of different sequences since they use a deterministic algorithm to produce the test cases.

In this research, we propose a new test case generation namely, Adaptive Random Border Centroidal Voronoi Tessellations (ARBCVT), which utilizes Centroidal Voronoi Tessellations (CVT). Many patterns seen in nature are closely approximated by a Centroidal Voronoi tessellation.

The ARBCVT approach enhances the existing state of the test case generation..To demonstrate the ARBCVT:

1. is able to produce a superiorly distributed set of test cases.
2. Still retains the random nature of RT.
3. Can be optimized to have linear execution characteristics across a wide set of situations.

In this, the ARBCVT can able to reduce the time consuming but comparing to previous method. In order to further reduce the time consuming density had been used. In an density, within a minimum distance the maximum points would cover. In that it will split the region in an uniform motion and it will cover what the test case is needed and produce the output. By means of this the time consuming will be reduced further.

II. RELATED WORKS

Random Testing is a black box testing where the inputs will be generated randomly. But in this it won't cover the test cases properly. In order to cover the effective test cases several techniques has been used.

Ciupa .I, Leitner .A, Oriol .M, and Meyer .B [13] proposed an Adaptive Random Testing. It is based on the intuition that for non-point types of failure patterns, an even set of test cases is more likely to detect failures using fewer test cases than ordinary random testing. But the assumption of selection with replacement has long been criticized by practitioners. In general test cases should not be repeated.

In order to overcome that Chen .T, Huang .D, and Zhou .Z [4] , suggested an Adaptive Random Testing Through Iterative Partioning. ART is different from random testing. In antirandom testing, only the first test case is selected randomly. The sequence of all test cases are deterministic, once the first test case is selected. Furthermore, the number of test cases in antirandom testing must be decided in the first place. The former is developed as an enhancement to RT with an aim of detecting the first failure quickly; whereas the latter involves dynamic selection of more than one testing strategy in one testing process, with an aim of minimizing the total cost of detecting and removing multiple defects. But in this also the failure-causing inputs are denser in some areas of the input domain.

Tappenden .A and Miller .J [10] established a Novel Evolutionary Approach for an Adaptive Random Testing. However, the distinct difference is that anti-random testing does not contain random elements. Furthermore, not only is the anti-random testing method computationally expensive, but for any real-world testing scenario, it is simply intractable. Adaptive Random Testing increases the effectiveness of random testing by attempting to maximize the testing coverage of the input domain. But in this high cost been associated with the random generation of test cases.

Chen .T, Merkel .R , Wong .P, and Eddy .G [3] suggested Adaptive Random Testing through Dynamic Partitioning. The failures in programs are shaped according to the represented failure patterns, the new approach use of the available information about the location of previously executed test cases and tries to improve the performance by decreasing number of executed test cases required to reveal the first failure. In this the enlarged input domain approach is used for decreasing edge preference problem in ART with random partitioning by localization. Localization enhances evenly distribution of test cases in ART through dynamic partitioning, it increases the edge preference problem.

Chen .T .Y and Merkel .R [5] uses Quasi Random Testing. The use of quasi-random sequences within the testing community is a relatively recent contribution. The use of quasi-random sequences within the testing community is a relatively recent contribution .These investigations have demonstrated the increased effectiveness of quasi-random sequences over pseudorandom or conventional random testing.

The main benefit of quasi-random testing is the inexpensive computational cost associated with the generation of testing sequences .But in this only finite number of dimensions can be used for which these algorithms are valid, and the limited number of distinct sequences that can be generated.

Du. Q, Faber. V , and Gunzburger. M [12] suggested Centroidal Voronoi Tessellation. The use of Centroidal Voronoi Tessellation is that , it can able to form like an region by region. The centroids formula has been used to calculate the centroids.

By means of that centroid it can able to form an region. Since forming like an region by region can able to cover the test cases properly and effectively. The main benefit is that can able to cover all the test cases present around and can able to produce the effective output.

III. EXISTING WORK

The ART methods are developed based on the observation that clusters will be mapped within the same region. Each methods possesses strengths and weaknesses regarding efficient test case generation and computational complexity. In each of these techniques, the randomly generated subsequent test cases are based on each method's specific algorithm. In ART Halton sequence method is used to cover the test cases. The formula for Halton sequence method is

$$\Phi_b(n) = \sum_{j=0}^{k} n_j b^{-j-1}, \tag{1}$$

where nj is the jth digit of n in the base b, and k denotes the lowest integer that makes n j=0, for all j > k. It fills the space more uniformly than uncorrelated random points. It has been observed that, using these sequences as input test case generators, produce better results than RT but not that much effective.

In order to overcome this, the quasi random sequence is generated. The use of quasi-random sequences in software testing is that Quasi-random algorithms are only valid for a finite number of dimensions. Quasi-random algorithms can generate only a limited number of different sequences since they use a deterministic algorithm to produce the test cases. In order to overcome all this, Centroidal Voronoi Tessellation is used which is a special type of Voronoi tessellation.

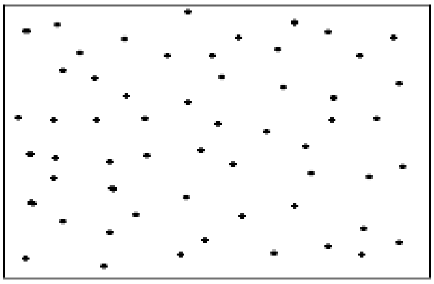

Fig 1: Adaptive Random Testing

A Voronoi tessellation generates test points in each Voronoi cell. It can be viewed as an optimal partition corresponding to an optimal distribution of generators.CVT has been applied within the wide array of applications. In CVT, it would calculate the centroids of the region where the points would be uniformly distributed.

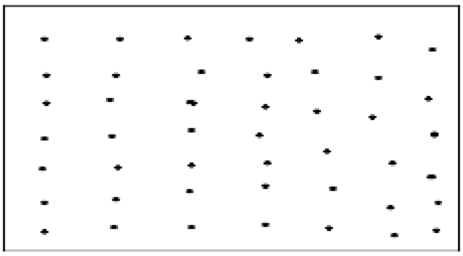

Fig 2: CVT Generated Points

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The CVT points are more "evenly distributed" than their generators comparing to the previous methods and also the CVT points are likely to detect a failure region more efficiently. Along with this ARBCVT has been included where it could cover all the points present in and around border of the system.

ARBCVT is not an independent method to generate input test cases. Other test case generation methods are also considered as input and increases software testing effectiveness by spreading the test cases more uniformly throughout the domain. Additionally, a novel search algorithm is proposed to enhance the computational complexity of the ARBCVT test case generation from a quadratic to linear runtime order. In addition to the even distribution of test cases over the input space, the degree of randomness within a set of test cases and between multiple sequences of test sets is an important aspect.

The randomness of the test case is critical in avoiding systematic poor performance in certain situations that is, where a non random sequence could significantly negatively correlate with a current set of defects. In regression testing, we can prevent the testing that are not efficient and if the test cases are not correlated with respect to each other which means a high degree of randomness.

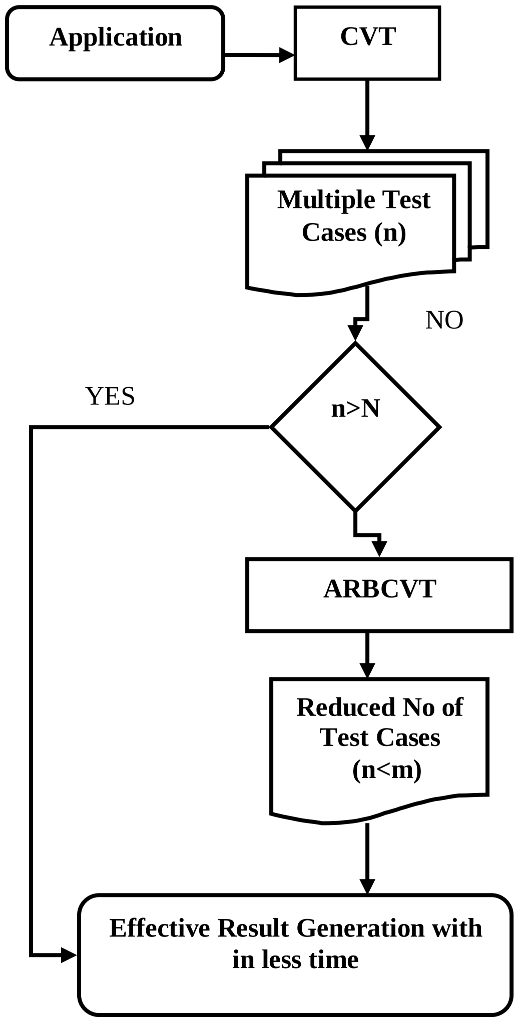
The ARBCVT approach used to generate more effective sequence of test cases with respect to software testing practice while retaining the degree of randomness possessed by RT and ARTs methods.

This approach may cover Test cases effectively and also reduce time consuming while comparing to previous methods. But, covering all the test cases which were not relevant to the output is quite difficult and more time consuming.

IV. Research Methodolohy

In CVT it can able to cover the test cases but in order to produce the output it takes certain amount of time. So in Adaptive Random Border Cenroidal Voronoi Tessellation it can able to reduce the test cases and also at the same time it can able to produce the output within an certain amount of time.

Fig 3: Architecture Diagram ARBCVT



At first the application will be generated. Then by means of Centroidal Voronoi Tessellation it would cover the test cases. Multiple test cases will be covered. If there is an less number of test cases only it can able to produce the output within an certain amount of time. But by means of CVT the large number of test cases only will be covered. That is the test cases will be exceeded behind the threshold level. So in order to reduce the test cases the Adaptive Random Border Centroidal Voroni Tesselllation is used. In this it will reduce the test cases up to the threshold level and can able to the effective output.

That is by means of CVT it would cover multiple test cases and produce the output but it would take large amount of time. In order to reduce the time consuming the ARBCVT method had been proposed. By means of this method the density would be calculated, that is within an minimum distance the maximum points would cover.

In this it can able to split the region in an uniform wise and cover the test cases. It would cover the test cases which is been relevant to the output . Automatically the test cases will be reduced and also the at the same time output will be produced within an particular amount of time.

In order to overcome the consequences of the existing system we compute the CVT along with ODT by proposing four methods such as Lloyd’s method, Lloyd-Newton method, Quasi-Newton method and Chen’s method. In CVT it will cover all the test cases that has been present around and finally only it would produce the output. It would take lot of time to produce the output since it covers all the test cases. To reduce the time consuming the CVT computes Lloyd’s method, Lloyd’s-Newton method and Quasi method. The ODT computes Chen’s method.

A. Lloyd’s method

Lloyd’s algorithm uses Voronoi diagrams rather simply determining the nearest centre to each of a finite set of points as the *k*-means algorithm does. At each iteration the Lloyd’s method moves each test point of the voronoi region towards the centroid of the region. In this the density will be calculated according to the centroids. The density is that within the minimum distance the maximum points would occur.

B. Lloyd’s-Newton Method

The Newton’s approach speeds up the fixed point Lloyd’s iteration. So that, we can deal with this problem by coupling the two algorithms into one hybrid scheme. It’s been possible, but nevertheless to couple these fast converging schemes with some global minimization methods to achieve the optimal performance. And also in this the density will be controlled. Since there would be more number of points to reduce the coverage the density would be controlled.

C. Quasi-Newton Method

Quasi-Newton methods are based on Newton's method to find the stationary point of a function, in which the gradient is 0. It assumes that the function can be locally approximated as a quadratic in the region around the optimum, where the first and second derivatives are used to find the stationary point. In higher dimensions, it uses the gradient and the Hessian matrix of second derivatives of the function to be minimized. By means of this the order of the test cases will be reduced while comparing to the previous one. But in this also it takes certain amount of time to produce the output.

Chen’s Method

It is similar to the Lloyd’s method and is also iterative. It forms Delaunay triangulation and move through each testing point. It assures a monotonic decrease in objective function. At each iteration the Delaunay triangulation is updated. In this the mean will be calculated and according to that the test cases will be obtained. By means of this it can able to cover the relevant test cases and can able to produce the effective output.

Now the combination of the four methods by computing the CVT and ODT techniques the resultant test cases will be obtained. The main benefit of this method is that these test cases cover most of the test points at a reduced set of time.

For an better understand of my project let’s take an scenario of employee details. At first need to find an employee who had been under senior aged people. For that by means of an Lyold’s method it can able to find but it would cover all the test cases and then only it would produce the output. For that it takes large amount of time .

In order to reduce the time if the test cases had been splitted then it can able to produce the output within an certain amount of time. For that the Chen's method had been used. In this it can able to split the region in an uniform wise. That is it would split the employee according to the age categories of youth, middle and senior aged people .So if it needs to find an employee present in an senior aged means it would cover only the people present in an senior aged and can able to produce the output. By means of this the test cases had been reduced and also at the same time it can able to produce the output within an certain amount of time.

V. PERFORMANCE ANALYSIS

By means of using all these types of methods, ARBCVT is the best one. In ARBCVT only the test cases has been reduced and also at the same time the time consuming has been reduced.

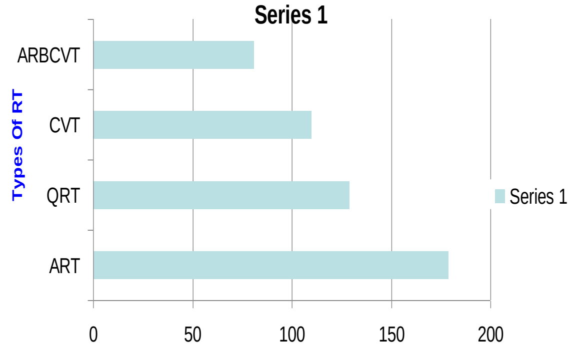


Fig 4: Performance Analysis

By means of splitting the region in an uniform one can able to reduce the test cases and the time consuming has also been reduced. It would cover only the test cases that have been present relevant to the output.

VI. CONCLUSION AND FUTURE WORK

ARBCVT method has been proposed to the domain of software testing with the aim of increasing the effectiveness of test case generation approaches. The ARBCVT method cannot be considered as an independent approach since it requires an initial set of input test cases. This method is developed as an add-on to the previous ART and QRT methods, enhancing the testing effectiveness by more evenly distributing test cases across the input space. In addition, the applied probabilistic approach for ARBCVT generation allows different sets of output to be produced from the same set of inputs, which makes ARBCVT an appropriate method for software testing application. In this it would cover all the test cases which were irrelevant to the system. It would produce the output but it would take large amount of time. In order to reduce the time the computation of CVT and ODT is performed. In this the regions will be splitted in an uniform motion. So in this it would cover the particular test cases which were relevant to the system. By means of this, the test cases has been reduced and the time consuming also will be reduced.

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