A Comparative Study on Adaptive and Random Testing Technique

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Abstract: In the software development life cycle, the testing of software is considered to be an effective phase in force. Apparently, quality merit of the software can be improved by assessing it. Evidently random testing is one of the most old and basic techniques that are still considered to be the best and inevitable in practice. Random testing, although a prevalent technique, its efficacy is notified to be less while considering its capacity of defect detection. This has been proven to pertinently overcome by Adaptive Testing (AT), on the other hand the methodology of AT is comprised of intricate complexity and high computational cost as its main constituents. The other testing techniques like Adaptive Random Testing (ART), Random Partition Testing, Reduction Random Testing (RRT), etc., are also considered as the major procedures which are known to fetch remarkable influence towards the improvement of random testing. These techniques are effectual with reverence to the time required for the two substantial components specifically, the test case selection and code coverage. This paper offers a reviewed survey consisting of various methodologies in order to reduce the Computational Cost and Complexity, increase the Test Case Coverage, and improve the Fault Detection Capacity and to reduce the Time required to perform the above mentioned technique.


I. INTRODUCTION

In software testing practices, there are many types of techniques. They are Random testing, statistical testing, mutation testing, structural testing and others. Random testing selects the test data in a random manner, which means without any prejudice. The statistical testing calculate the probabilistic of the elements in the system and select test data according to the distribution as it is expected when the software in the actual use. The mutation testing selects the data based on the survived mutants in the program. The functional testing selects the data according to the function and the sub-function can be tested at least once. Lastly, the structural testing selects the test cases, according to structural specification with the aim of coverage the program with the statements, branch or path.

This study focuses on Random Testing (RT) and adaptive testing (AT). Different ways in RT produce and selects test cases across input domain in random approaches. In RT the generation and selection of test case are in one process and the selection of the test case is simply selecting test cases from an entire domain randomly and independently. [17]

Chen et al.,[2] mentioned that the RT is a poor method as it does not make use of any information to guide the generation of test cases although it is a commonly used testing technique for practitioners. It makes minimal use of the information from the specification or program code with does not tolerate about the overhead of the input domain division, thus the problem in RT was overcome by AT.

In ART basically, two disjoint sets of test cases are maintained, namely the executed set and the candidate set. Instead of randomly generating a test case at a time, a fixed number of test cases are randomly generated to form the candidate set. [13][14][16] The executed set keeps all the test cases that have been executed, but no failure revealed yet. An initial test case is picked at random. If it does not reveal any failure, an initial executed set is formed by this test case as the only element. From the candidate set, an element that is farthest away from the elements of the executed set is selected as the next test case, which is then put into the executed set if it does not reveal a failure. [15] The remaining elements of the candidate set are then discarded and a new candidate set is constructed. The above process is repeated, until a failure is revealed, or until the stopping condition is reached.

Many types of parameters like Computational overhead, Fault finding, and test case generation and coverage analyzed in ART. These notions are used for generating and select the test cases which are evenly spread over the input domain. All the methods in ART maintain the core of characteristic randomness and an even spread of test cases.
II. LITERATURE SURVEY

T.Y. Chen et al., [1] projected two algorithms on an adaptive random partitioning that offers more performance advantages than simple random testing, with considerably lower overhead than other ART algorithms. One is ART by random partitioning and the other is ART by bisection. The first algorithm exhibits failure measure 25-30% less than the random testing in block patterns, and 5% less for strip patterns. A negligible amount of failure measure for point patterns is found. The second algorithm is effective as 25% more than random testing in block patterns, 5-8% more effective when strip patterns are considered. Marginal effectiveness in case of point patterns is shown. The main disadvantage of this work is that the point pattern doesn’t exhibit any higher effectiveness.

Tsong Yueh Chen et al., [2] proposed some ART algorithms by offsetting the edge preference, and offer a new family of ART algorithms. A series of simulations are conducted and it proved that these new algorithms not only select test cases more effectively, but also have better failure detection capabilities. This work investigated the edge preferences of FSCS-ART and RRT, and a new family of algorithms, namely ART with Partitioning by Edge and Centre (ECP-ART) was offered. There exists one particular ART algorithm, namely ART by bisection (ART-B) that does not have any preference in the test case selection. The main disadvantage is that FSCS-ART and RRT only outperform ART-B when the failure rate is small.

Feng Ye et al., [3] investigate the computational complexity of the parameter estimation process in two adaptive testing strategies which adopt different parameter estimation methods, namely the genetic algorithm (GA) method and the recursive least square estimation (RLSE) method. This work had presented an analysis of the computational complexity and actual testing performance of two adaptive testing strategies: AT-GA and AT-RLSE. The main disadvantage is that GA consumes more time in decision making.

Andrew F. Tappenden et al., [4] projected a novel evolutionary algorithm like eAR and FSCS to increase the effectiveness of random testing by attempting to maximize the testing coverage of the input domain. The main disadvantage in the work of eAR is less effective and care should be taken in the selection of a proper fitness function, and possibly functions tailored for specific fault-patterns and input domains.

Zhiquan Zhou et al., [5] proposed a dynamic partitioning strategy that selects test cases using online feedback information. The partitioning is carried out online rather than off-line, then the partitioning is not based on program code instead, it is simply based on the fail or passes information about previously executed test cases. The cost- effectiveness of the strategies such as PRT, RRT, DPFM, and DPIS are investigated with three programs, namely SPACE, SED, and GREP. The main disadvantage in DPFM, and DPIS technique are it does not incorporate other forms of feedback.

Huai Liu et al., [6] projected a technique to implement adaptive random testing by omitting the selection of test cases from the exclusion region (Restricted Random Testing) and test cases is simply selected based on a well-designed test profile. This method has a low computation overhead and it includes all possible program inputs that can detect failures. The RRT method not only spreads test cases more evenly, but also brings higher failure-detection effectiveness than random testing. The main disadvantage of this method is that it exhibits an uneven distribution of test case if the input dimension of input domain is high. It also performs well in a single test profile only.

Tsong Yueh Chen et al., [7] present a synthesis of results related to adaptive random testing. ART is regarded as an effective alternative to random testing, this work also discusses the results of various issues such as adaptive Random sequences, and failure based testing and test case diversity. Many issues about ART are discussed, among that PS strategy and ART goes similar to having a single test case to be selected from each testing strategy. Hence ART has a disadvantage of selecting at least one test case under each testing strategy using probability. It should also improve the relationship between software tester and the strategies.
Andrea Arcuri et al., [8] present various theorems that describe the probability of random testing to detect the interaction faults and the results are compared with the combinational testing that has a smaller test suite with all possible test features. The main disadvantage in random testing is that, it becomes very inefficient if the features have constraints as in industrial systems.

Cliff Chow et al., [9] presented a technique called Divide and Conquer method in ART technique. The results are compared with two most commonly used ART algorithms, namely fixed size candidate set and restricted random testing. The disadvantages of the Divide and Conquer method, it becomes slightly poor in case of block and stripe patterns and also poorer for smaller threshold values.

Ali Shahbazi et al., [10] proposed a Random Border Centroidal Voronoi Tessellations (RBCVT) technique that is not an independent method; it gets the inputs as test cases that are generated from other methods. It is compared with ART and Quasi-Random Testing (QRT) techniques and random testing (RT). The RBCVT uses the test cases from other techniques, thus referred as RT- RBCVT, ART- RBCVT and QRT- RBCVT. The RBCVT work works more efficiently than RT, ART and QRT. But still it has computational cost and time increased.

Tsong Yueh Chen, et al., [11] evaluates and compares the performance of Adaptive random testing and random testing based on code coverage. Higher code coverage not only brings a higher failure-detection capability, but also improves the effectiveness of software reliability estimation. For comparison FSCS ART is taken. This study has a disadvantage as it does not compare ART with larger scale.

Bo Jiang et al., [12] proposed a novel technique of input-based local-beam-search adaptive-randomized techniques. They make adaptive tree-based randomized search with a randomized candidate test set strategy to even out the search space explorations among the branches of the explosion trees. The local-beam-search, adaptive-randomized technique achieve either higher APFD values than or the same mean APFD values as the existing code-coverage-based greedy or search-based prioritization techniques, including Genetic, Greedy and ART. The main disadvantage of the local-beam-search, adaptive-randomized techniques is that it does not outperform ART.

### III. COMPARATIVE STUDY

A comparison of different techniques used by RT, AT and ART are compared for the following parameters, Computational Overhead, Test case generation, Code / Test Case Coverage, and Fault detection are stated in the table 1.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Year</th>
<th>Authors</th>
<th>Technique</th>
<th>Computational Overhead</th>
<th>Test Case Generation</th>
<th>Code / Test Case Coverage</th>
<th>Fault Detection</th>
<th>Time Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2002</td>
<td>K P Chan et al</td>
<td>Reduction Random Testing (RRT)</td>
<td>Reduced</td>
<td>-</td>
<td>-</td>
<td>Improved</td>
<td>Reduced</td>
</tr>
<tr>
<td>2.</td>
<td>2003</td>
<td>K P Chan et al</td>
<td>Ordinary Restricted Random Testing (ORRT)</td>
<td>Reduced</td>
<td>Done</td>
<td>Increased</td>
<td>Improved</td>
<td>-</td>
</tr>
<tr>
<td>3.</td>
<td>2004</td>
<td>T.Y. Chen et al</td>
<td>ART by random partitioning and the other is ART by bisection</td>
<td>Reduced</td>
<td>-</td>
<td>Increased</td>
<td>Improved</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>2005</td>
<td>J. Mayer</td>
<td>Bisection with Restriction.</td>
<td>Reduced</td>
<td>-</td>
<td>Not improved</td>
<td>Improved</td>
<td>Reduced</td>
</tr>
<tr>
<td>5.</td>
<td>2006</td>
<td>T. Y. Chen et al</td>
<td>Iterative Partition</td>
<td>Reduced</td>
<td>Done</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>2008</td>
<td>Tsong Yueh Chen et al</td>
<td>FSCS-ART and RRT</td>
<td>Reduced</td>
<td>-</td>
<td>-</td>
<td>Improved</td>
<td>Increased</td>
</tr>
<tr>
<td>7.</td>
<td>2009</td>
<td>Feng Ye et al</td>
<td>GA With RLSE method</td>
<td>Increased</td>
<td>Done</td>
<td>Increased</td>
<td>Improved</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>2009</td>
<td>Andrew F. Tappende n et al</td>
<td>Evolutionary algorithm like eAR and FSCS</td>
<td>Reduced</td>
<td>Done</td>
<td>-</td>
<td>Improved</td>
<td>Reduced</td>
</tr>
<tr>
<td>9.</td>
<td>2009</td>
<td>Zhiquan Zhou et al</td>
<td>A Dynamic partitioning strategy</td>
<td>Reduced</td>
<td>Done</td>
<td>-</td>
<td>Not improved</td>
<td>Reduced</td>
</tr>
<tr>
<td>10.</td>
<td>2010</td>
<td>Tsong</td>
<td>ART</td>
<td>Reduced</td>
<td>Done</td>
<td>-</td>
<td>-</td>
<td>Reduced</td>
</tr>
</tbody>
</table>
IV. CONCLUSION

This survey explores and prospect various RT techniques that are effective with respect to the time required for the two considerable components specifically, the test case selection and code coverage. Implementation of any type of ART family technique requires consideration of certain parameters mentioned above. The techniques that are to be painstaking are associated with the purely random process. On applying ART it contributes towards the improvement of techniques and that is made possible via the combination of two or more techniques.

REFERENCES


