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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 effectual 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.***

Key Words: Software Testing, Adaptive Testing, Random Testing, Partition Testing, Adaptive Random Testing, Reduction Random Testing, Computational Overhead, Complexity, Code / Test Case coverage and Time.

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 specified 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.

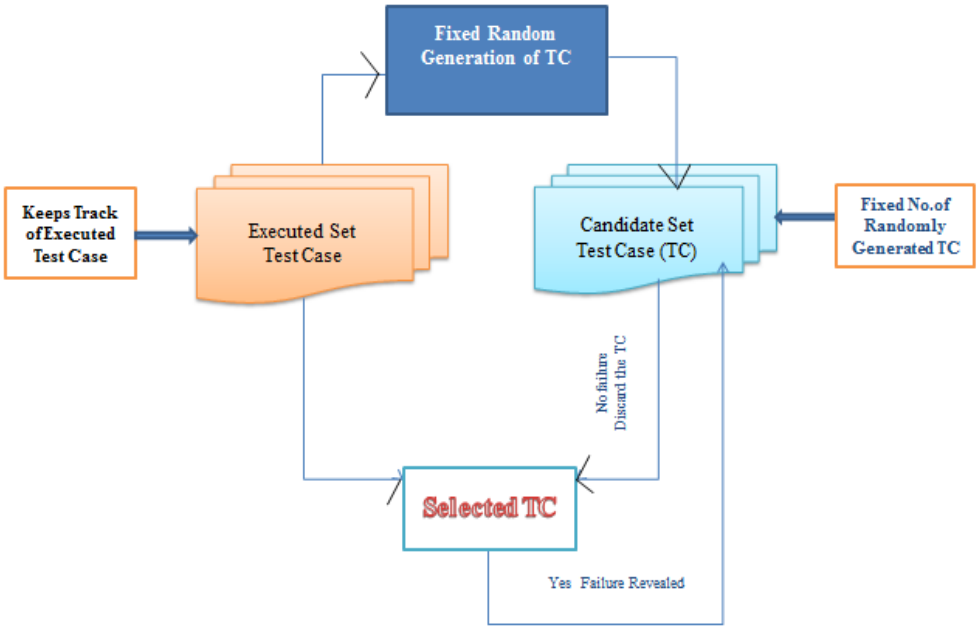

Fig 1. Basic Process of ART

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 I Comparisonof different Techniques used by RT, AT and ART

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

		Yueh Chen et al						
11.	**2011**	R. Huang, et al	Combinatorial Testing	Reduced	-	-	Improved	Reduced
12.	**2012**	Andrea Arcuri et al.,	Combinatorial interaction testing (CIT)	Increased	-	Increased	Improved	Increased
13.	**2013**	Ali Shahbazi et al	RT- RBCVT, ART-RBCVT and QRT-RBCVT	-	Done	Increased	Improved	Reduced
14.	**2013**	Cliff Chow et al	Divide and Conquer method in ART technique	Reduced	Done	Remains Same	Improved	Reduced
15.	**2014**	Junpeng Lv, Hai Hu et al.,	ARPT-1, ARPT-2	Reduced	Done	Increased	Improved	Reduced
16.	**2015**	BoJiang et al.,	Adaptive-Randomized Techniques (APFD)	Reduced	Done	Increased	Improved	Reduced

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

[1] T.Y. Chen et al, "Adaptive Random Testing Through Dynamic Partitioning", Proceedings of the Fourth International Conference on Quality Software (QSIC'04) IEEE, 0-7695-2207-6/04 .

[2] Chen *et al*, "Distributing Test Case more evenly in Adaptive Random Testing", The Journal of Systems and Software 81 (2008) 2146–2162.

[3] Feng Ye, Chang Liu, Hai Hu , "On the Computational Complexity of Parameter Estimation in Adaptive Testing Strategies", 15th IEEE Pacific Rim International Symposium on Dependable Computing, 2009.

[4] Andrew F. Tappenden, "A Novel Evolutionary Approach for Adaptive Random Testing", IEEE transactions on reliability, vol. 58, no. 4, December, 2009.

[5] Zhi Quan Zhou, Arnaldo Sinaga, Lei Zhao,"Improving Software Testing Cost-Effectiveness Through Dynamic Partitioning", Ninth International Conference on Quality Software, 2009.

[6] Liu, H, Xie, X, Yang, J, Lu, Y and Chen, T 2010, 'Adaptive random testing by exclusion through test profile', in Proceedings of the 10th International Conference on Quality Software, QSIC 2010, USA, 14-15 July 2010, pp. 147-156.

[7] T.Y. Chen, "Adaptive random Testing: the art of test case diversity", The Journal of Systems and Software 83 (2010) 60–66.

[8] Andrea Arcuri, Member, IEEE, and Lionel Briand, Fellow, IEEE, " Formal Analysis of the Probability of Interaction Fault Detection Using random testing", IEEE transactions on software engineering, VOL. 38, NO. X, 2012.

[9] Cliff Chow et al, "The ART of Divide and Conquer An Innovative Approach to Improving the Efficiency of Adaptive Random Testing " Symposium on Engineering Test Harness (TSETH '13), Proceedings of the 13th International Conference on Quality Software (QSIC '13), IEEE Computer Society, Los Alamitos, CA (2013).

[10] Ali Shahbazi , Andrew, " Centroidal Voronoi Tessellations— A New Approach to Random Testing", IEEE transactions on software engineering, vol. 39, no. 2, February 2013.

[11] Chen, T, Kuo, F, Liu, H and Wong, E 2013, 'Code coverage of adaptive random testing', IEEE Transactions on Reliability, vol. 62, no. 1, pp. 226-237.

[12] Bo Jianga, W.K. Chanb, "Input-based adaptive randomized test case prioritization: A local beam search approach ",The Journal of Systems and Software. http://dx.doi.org/10.1016/j.jss.2015.03.066.

[13] Zhang, X, Chen, T and Liu, H 2014, 'An application of adaptive random sequence in test case prioritization', in Marek Reformat (ed.) *Proceedings of the Twenty-Sixth International Conference on Software Engineering and Knowledge Engineering (SEKE 2014)*, Skokie, IL, United States, 1-3 July 2014, pp. 126-131.

[14] J. Mayer, "Adaptive Random Testing by Bisection with Restriction," in Formal Methods and Software Engineering, 3785th ed., vol. 3785, K.-K. Lau and R. Banach, Eds. Manchester, UK: Springer Berlin Heidelberg, 2005, pp. 251–263.

[15] T. Y. Chen, D. H. Huang, and Z. Q. Zhou, "Adaptive Random Testing Through Iterative Partitioning," in AdaEurope '06 Proceeding of the 11th Ada-Europe International conference on Reliable Software Technologies, 2006, pp. 155–166.

[16] K. P. Chan, T. Y. Chen, and D. Towey, "Restricted Random Testing," Proc. 7th Eur. Conf. Softw. Qual. (ECSQ 2002), vol. 2349, no. Lecture Notes in Computer Science, pp. 321–330, 2002.

[17] K. P. Chan, T. Y. Chen, and D. Towey, "Normalized Restricted Random Testing," Springer-Verlag Berlin Heidelb. 2003, vol. J.-P. Rose, pp. 368–381, 2003.

