Implement adaptive random testing in TSTL

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1 Project Description

Software testing is one of the most important methods to assure the quality of software. There exist some testing approaches which generate test cases in order to detect system failures. In these methods, random testing is a basic and wide-adopted one which just randomly pick objects from a set of all possible inputs, generate test cases and executing the program with those test cases. However, random testing were called “least effective” method by some people for using little information about the system under test in test case generation. That is the reason of people put forward the idea of Adaptive Random Testing, which is a method based on observations about failure patterns to improve the effectiveness of random testing. ART is basically based on the theory of contiguous failure regions which shows that program faults are likely lead to contiguous failure regions of the program input domains (T.Y Chen 2010). Which means that if a test case does not reveal any failure, its neighbors would likely not found any failures either. So, it is obviously that a more even spread of test cases would have a better performance. However, in basic random testing, all input cases have the same possibility of being selected. A test case that is near to a previously executed non-failure-cause input may still be selected. Thus, ART take the advantage of this theory to improve the failure-detection effectiveness. It at first generate a set of test cases and execute them. Then they randomly generate a new set of ‘candidates’ from the domain and pick the one with the largest distance toward the previously executed cases. Generating new test cases in this way could make them become more evenly spread throughout the input domain. Earlier experiments confirmed that ART can use fewer test cases to detect failures that normal RT. So ART helps a lot in saving resources especially when test case execution is expensive. In the paper ‘Adaptive Random Testing: The ART of test case diversity’ the author clearly explained the idea of ART. Moreover, there are already some ART algorithms have been proposed based on this idea. Although both of them come from the same basic idea, they implement it in their unique way in distribute test cases. While evenly distributed test cases would increase the performance of testing, some degree of uneven preference also exist in some of the algorithms. In fact, some of those algorithms may not completely even distribute test cases. Thus, my implementation of ART algorithm partly based on the main idea of ART but also have some degree of uneven distribution.

2 basic idea of the project

Our main goal of this project is to improve the testing algorithm. Based on the paper about TSTL, we can find that the main role of TSTL is to automatically create test harness, which is a set of valid tests for the system under test. And our tester is to run these tests in a proper way and record all its results. Thus, our test generator would not target to any specific structures or systems. It should aim to all of those common issues. As it mentioned in the first part, this tester is based on the main idea of ART algorithm for testing test cases generated by TSTL. From the research papers about ART, we know that the most important idea of ART is to evenly distribute test cases throughout input domain. In other words, the system should avoid conjunction test cases picked. We know that in the paper “Adaptive Random Testing: The ART of test case diversity”, the author proposed his algorithm which fully evenly distribute

test cases throughout input domain by generate a set of candidate test cases to find the one with the largest distance to its closest executed test case. However, in my project I tried to not only improve the performance of RT but also not add too much additional computations. So my algorithm would not try to exactly even distribute test cases throughout input domain like the author did, it would try to avoid the conjunction cases by split input domain into several sub-domains and pick test cases from different sub-domains in testing sequence. Then we would use a list to save some (3 in current version) subdomains that we pick test cases from recently. When generating new test cases, we can pick new test case from those subdomains which are not in this list and then replace one of the subdomain in the list with the current subdomain.

3 Result and future works

From the tests already taken with the tester, it is fair to say that this algorithm have some effort on improving random testing algorithm on both code coverage ratio, which increased about 20 percent, and failure detect ratio. However, this tester is still a very rough implement of the idea of the idea of random testing. I think most of the default value of parameters might need to have some modify after have enough scope and various tests experiments taken. Moreover, it may not a really good idea to fix the number of subdomains and the size of “recently used subdomain” list. It is worth trying to using this tester with systems whose size is larger than the system we have used during this term to observe the performance of the tester.

On the other hand, it is also a very interesting idea that implementing feedback into testers. Although some very well developed ART algorithm can have a perfect evenly distribute of test cases throughout the input domain, it seems too generalize which never have any specific operations toward different test systems. But with feedback implement in the system which can collect the result of tests and directly modify the testing plan, the tester might, I think, take the advantage not only from even distributing test cases but also feedback system. Thus, implement feedback in ART algorithm could be an interesting idea which is worth trying.

4 relevant papers

[1] Tsong Yueh Chen, Fei-Ching Kuo, Robert. G. Merkel, S. P. NG Mirror adaptive random testing. 2004

[2] Tsong Yueh Chen, Fei-Ching Kuo, Robert. G. Merkel, T. H. Tse Adaptive Random Testing: The ART of test case diversity. 2010