Error Locating Driven Array*

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ABSTRACT

When the system under test(SUT) is suffered from interations faults such as option compliant, testers want to design. As . Efficenet test space is desired when . To handle this problem, the art of is to design a t-way covering array, which can cover all the t-way , just using small size of test cases. In this paper, however, we conjecture that the covering array is somewhat reduntant with respect to fault locating. The main reason for the reduntance the we find is the framework it takes is not efficent, traditional works will first generate a covering array to detect if any failing is triggered by any test case, and then pick these failing test case to further locating. In CT, most locating teachinques is just to generate addtional test cases to isolate the MFS. We find two shortcoming for this framework 1: if we had first identify some MFS, we do not need to generate any test case to conatin them, further, any combination contain this MFS will not need to be covered, 2: if we do not genrate, the extra test cases will support some coverage is that when we first already covered. So for this two points, in this paper, we propose a new framework to make the generating process and isolating process more tightly so that the isolating process and generating process will better utilize each other. We have done some emprical studies on several open-source software and found that our new frame work can significantly reduce the test cases.

Categories and Subject Descriptors

D.2.5 [**Software Engineering**]: Testing and debugging—*Debugging aids,testing tools*

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Reliability, Verification

Keywords

Software Testing, Combinatorial Testing, Covering Array, Failure-inducing combinations

1. INTRODUCTION

With the increasing complexity and size of modern software, many factors, such as input parameters and configuration options, can influence the behaviour of the SUT. The unexpected faults caused by the interaction among these factors can make testing such software a big challenge if the interaction space is too large. One remedy for this problem is combinatorial testing, which systematically sample the interaction space and select a relatively small set of test cases that cover all the valid iterations with the number of factors involved in the interaction no more than a prior fixed integer, i.e., the *strength* of the interaction.

Once failures are detected, it is desired to isolate the failure-inducing combinations in these failing test cases. This task is important in CT as it can facilitate the debugging efforts by reducing the code scope that needed to inspected.

2. MOTIVATING EXAMPLE

Combinatorial testing can effectively detect the failures caused by the interactions between various options or inputs of the SUT. Covering arrays, the test suite generated by this technique can cover each combination of the options at least once. We conjecture, however, although covering array can effectively, in practice, covering array was too much for detecting and locating the error in particular software.

As an motivating example, we looked through the following scenarios for detecting and locating the errors in the SUT.

Too much redundant fault test cases:

Too much redundant right test cases:

3. BACKGROUND

This section presents some definitions and propositions to give a formal model for the FCI problem.

3.1 Failure-inducing combinations in CT

Assume that the SUT is influenced by n parameters, and each parameter p_i has a_i discrete values from the finite set V_i, i.e., $a_i = |V_i|$ (i = 1,2,..n). Some of the definitions below are originally defined in .

Definition 1. A *test case* of the SUT is an array of n values, one for each parameter of the SUT, which is denoted as a n-tuple (v_1, v_2,...,v_n), where $v_1 \in V_1$, $v_2 \in V_2$ ... $v_n \in V_n$.

In practice, these parameters in the test case can represent many factors, such as input variables, run-time options, building options or various combination of them. We need to execute the SUT with these test cases to ensure the correctness of the behaviour of the software.

We consider the fact that the abnormally executing test cases as a *fault*. It can be a thrown exception, compilation error, assertion failure or constraint violation. When faults are triggered by some test cases, what is desired is to figure out the cause of these faults, and hence some subsets of this test case should be analysed.

Definition 2. For the SUT, the n-tuple (-,v_{n_1},...,v_{n_k},...)is called a k-value *combination* ($0 < k \leq n$) when some k parameters have fixed values and the others can take on their respective allowable values, represented as "-".

In effect a test case itself is a k-value *combination*, when k = n. Furthermore, if a test case contain a *combination*, i.e., every fixed value in the combination is in this test case, we say this test case *hits* the *combination*.

Definition 3. let c_l be a l-value combination, c_m be an m-value combination in SUT and $l < m$. If all the fixed parameter values in c_l are also in c_m, then c_m *subsumes* c_l. In this case we can also say that c_l is a *sub-combination* of c_m and c_m is a *parent-combination* of c_l, which can be denoted as $c_l \prec c_m$.

For example, in the motivation example section, the 2-value combination (-, 4, 4, -) is a sub-combination of the 3-value combination (-, 4, 4, 5), that is, (-,4,4,-) $\prec$ (-,4,4,5).

Definition 4. If all test cases contain a combination, say c, trigger a particular fault, say F, then we call this combination c the *faulty combination* for F. Additionally, if none sub-combination of c is the *faulty combination* for F, we then call the combination c the *minimal faulty combination* for F (It is also called Minimal failure-causing schema(MFS) in).

In fact, MFS and *minimal faulty combinations* are identical to the failure-inducing combinations we discussed previously. Figuring it out can eliminate all details that are irrelevant for causing the failure and hence facilitate the debugging efforts.

4. ALGORITHMS

4.1 Description

4.2 A case study

5. EMPIRICAL STUDIES

5.1 The existence of

5.1.1 Study setup

5.1.2 Result and discusssion

5.2 Performance of the traditional algorithms

5.2.1 Study setup

5.2.2 Result and discussion

5.3 Performance of our approach

5.3.1 Study setup

5.3.2 Result and discussion

5.4 Threats to validity

6. RELATED WORKS

7. CONCLUSIONS