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Smart Media
KOREAN INSTITUTE OF SMART MEDIA

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Optimized state machine for generating minimum Test cases

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Abstract. Actually, the formal description techniques (FDTs) describe the service definition and the protocol specifications for the layers of Open Systems Interconnection, which can express different two processes to find out whether it is strong equivalence or not. Therefore, we may remove the redundant state and transitions if there exists strong equivalence in even different processes. In this moment, there are many approaches how to optimize the state machine, but not enough to make optimized machine. With adapting this mechanism, we are going to suggest how to do maximum coverage with minimum test cases. This paper suggests a method about an efficient method of constructing test cases by removing duplications in the relationship of Strong Equivalence within sub LTS of Simplest LTS.

Keywords: Test case, Strong equivalence, Simplest LTS, Optimization

1 Introduction

In order to reduce errors included in the source code, testing method is very important. A primary purpose of testing is to detect software failures so that defects may be discovered and corrected. However, it is very hard to test in all source codes.
It will be ideal to use the minimum test cases and make the maximum of coverage with equivalence in view point of testing. It is why it can save time and reduces computer sources and as well, software quality can guarantee to easily detect errors in the codes of small-sized test cases [6,7].

Our previous studies[1] proved that Original LTS was transformed into Simplest LTS via Minimal LTS and these three LTS's have the relationship of Strong Equivalence. However, it is recognized that there exists the duplication even in the sub LTS of the optimized Simplest LTS. In the aspect of testing, there is no need to test the duplicated sub LTS which satisfies minimality, but is duplicated because more testing time and computer resources are necessary. If a test case is made, choosing just one among the duplicated ones, the relationship of equivalence will be established,

and the test coverage can remain the same however small it is. This paper suggests a method about an efficient method of constructing test cases by removing duplications in the relationship of Strong Equivalence within sub LTS of Simplest LTS.

2 Preliminaries

We can use a formal method concept for making the minimum testing case while keeping the equivalence relation from the original source code named as the process. It can represent semantics by the Labeled Transition System (LTS). The equivalence for processes is based on observations. The idea of the equivalence is that when an observer watches the behaviors of two processes from an environment, they are equal if the observer cannot distinguish these behaviors [4].

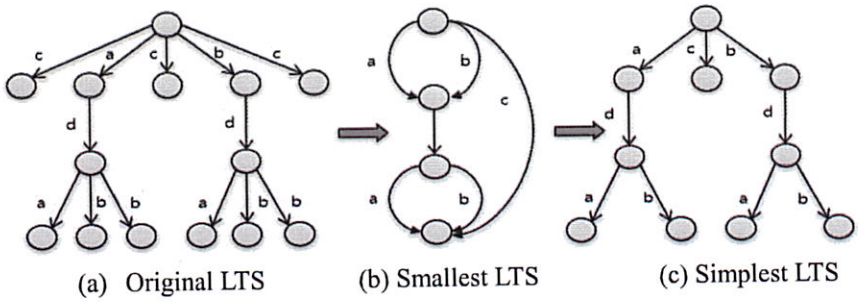
For processes P and Q, if there exists a strong bisimulation R such that $P, Q \in R$, then P and Q are strongly equivalent, written as $P \sim Q$. The strong equivalence does not consider internal actions which cannot be observed from the external environment.

In this paper, we deal only with observable actions because the strong equivalence is enough for our purpose. A process, which has an equivalence relation with any P but whose expression is different with P, generally exists infinitely.

We introduce a method[4] which can derive the process of only one form to be the smallest LTS among processes which have strong equivalence to P exclusive of a commutative law. $p(\rightarrow)^n P'$ means that there exist two types of processes as non-recursive LTS and recursive LTS.

In this paper, we just limited the scope to only non-recursive LTS. We already proposed an algorithm to transit from the smallest LTS to the simplest one [1]. The smallest LTS has the smallest number of states and nodes. But, an algorithm in this paper requires that LTS should be that any state which is transited from precedence state must have only one precedence state. Because a test method for a process is performed by each trace set.

Therefore, the smallest LTS must be changed as below. If a certain state has <n> number of transitions with its precedence state, we can divide such state into the same <n> number of subprocesses. This time, the relation of two LTS's between the smallest LTS and a changed LTS from the smallest LTS has Strong Equivalence. We named it a simplest LTS for the changed LTS from the smallest LTS. Fig.1, shows an example of simplest LTS via a smallest LTS from the original LTS.



(a) Original LTS (b) Smallest LTS (c) Simplest LTS

Fig. 1. Simplest LTS via smallest LTS from Original LTS

3 Generating minimum test cases

Even in Simplest process, there exists the same partial function whose behavior is the same based on strong equivalence. In (c) of Fig. 1, as Fig. 2 shown below, it is recognized that even L1 and R1 satisfy and optimize Simplest LTS, a duplicated sub LTS exists.

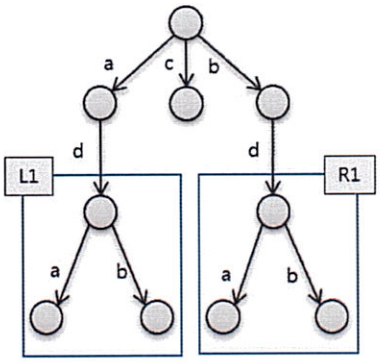


Fig. 2. Duplication among Sub Systems within Simplest LTS

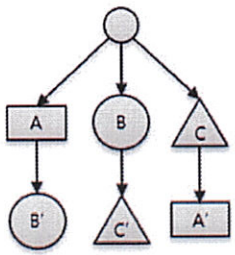


Fig. 3. A tree containing the same diagram of 3 types

Let's generalize the same method with Strong Equivalence and express it in a diagram. As shown in this diagram, the same type of two squares, circles, and triangles exist respectively, and it is enough to take only one among the duplicated ones in the aspect of constructing a test case.

As shown in Fig. 3, each diagram has the same method in the same diagram. Our aim is to reduce the test cases if there is assurance about test coverage. Suppose that they are the same for A and A', B and B' and C and C' respectively. A set is an unordered collection of objects. Two sets are equal if and only if they have the same elements. That is, if P and Q are sets, then P and Q are equal if and only if $\forall x \ (x \in P \leftrightarrow x \in Q)$.

In a view point of set, two squares, circles, and triangles are equivalent to a square, circle, and triangle. Therefore, these relations are established about $A \cup A' \sim A$, $B \cup B' \sim B$ and $C \cup C' \sim C$. If the process which has a minimum size while keeping the strong equivalence, it can save time and reduce computer sources, and as well, software quality can guarantee to easily detect errors in the codes of small-sized test cases. So, we just catch the only one to reduce the same behavior function.

4 Conclusion

Software testing is aimed to reduce a bug for evaluating the capability of a program. In a large scale system, making a high quality software is not easy even though test is performed at each software process step. Testing can never completely identify all the defects within the software source code. It is very difficult to test in all source codes.

So, we used our efficient method whose processes can keep the strong equivalence between the original software and the smallest one. Furthermore, this paper suggests a method about an efficient method of constructing test cases by removing duplications in the relationship of Strong Equivalence within sub LTS of Simplest LTS in a view point of Set.

This maximum test coverage method have the strong point that it can save time and reduce computer sources and as well, software quality can guarantee to easily detect errors in the code of small-sized test cases.

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