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Machani SivaPrasad
CSE dept, JNTUA College of Engineering, Anantapur, Andhra Pradesh, India, msivaprasad88@gmail.com

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Recommended Citation
SivaPrasad, Machani (2012) "An Efficient Regression Testing By Computing Coverage Data For Software Evolution," International Journal of Computer Science and Informatics: Vol. 1 : Iss. 3 , Article 7. Available at: https://www.interscience.in/ijcsi/vol1/iss3/7

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An Efficient Regression Testing By Computing Coverage Data For Software Evolution

Machani SivaPrasad
M.Tech in CSE dept, JNTUA College of Engineering, Anantapur, Andhra Pradesh, India
E-mail: msivaprasad88@gmail.com

Abstract - Software systems evolve continuously during development and maintenance. After software is modified, regression testing is applied to software to ensure that it behaves as intended and modifications do not negatively impact its original functionality. It is time consuming to rerun test suite $T$ for program $Pi$ on modified program $Pi+1$. So there are many regression testing techniques that are there for doing regression testing. These are based on coverage data. So computing coverage data for $Pi+1$ without rerunning all test cases is the problem for doing regression testing of program $Pi+1$. This paper proposed a new approach that computes coverage data with selecting test cases $T'$ for the subsequent versions of the software. By computing coverage data for subsequent versions of software on without rerunning entire test suite $T$ we can improve overall time taken to retest the evolving software using Regression testing.

This paper focus on improving the performance of regression testing for software evolve continuously during maintenance, by implementing a new approach for regression testing by computing coverage data for evolving software using dataflow analysis and execution tracing.

Keywords: Software Engineering, Software testing, Regression testing, Coverage data.

I. INTRODUCTION

As software systems mature, maintenance activities are dominant. Reports estimate that regression testing consumes as much as 80 percent of the testing budget [1] and 50 percent of development effort in development life cycle spent on maintenance because evolving software by inducing changes [2][3]. Software System is continuously evolve because of adaptive, corrective and perfective. Thus the more effort is required to verify that changes induced affects it original functionality of the software. So regression testing is applied to the modified version of the software to ensure its original behavior.

One approach to regression testing saves the test suite $T$ used to test one version of the program $Pi$ and uses it to test the next (modified) version of the program $Pi+1$. As it is sometimes too expensive or time-consuming to rerun all of $T$ on $Pi+1$, researchers have developed techniques to improve the efficiency of the retesting. For example, regression test selection (RTS) techniques select a subset of $T$ as $T'$ and use it to test the program $Pi+1$ successfully. If the RTS technique is safe, then the test cases that it omits (i.e., $T - T'$) will give the same results on $Pi$ and $Pi+1$, and thus, do not need to be rerun on $Pi+1$. Studies have shown that RTS can be effective in reducing the time and cost of regression testing.

Many of these regression testing techniques use coverage data collected when testing $Pi$ using $T$ to assist the testing that should be performed on $Pi+1$. For example, several RTS techniques collect coverage data, such as which statements, branches, or methods are covered when $Pi$ is executed with $T$, for testing $Pi+1$. As subsequent versions of $Pi$ are created, coverage data of predecessor version are needed for regression testing tasks. In presentations of these regression testing techniques, especially to practitioners, there are usually questions about how the coverage data will be obtained for these subsequent versions, when only a subset of $T$ is used to test $Pi+1$. The coverage data on $Pi$ for those test cases in $T$ that are not run on $Pi+1$ (i.e., $T - T'$) cannot simply be copied for $Pi+1$ unless the development environment maintains a mapping between entities (such as statements, branches, and methods) in $Pi$ and entities in $Pi+1$. Because this mapping is not typically maintained, another approach for obtaining the coverage data for test cases in $T - T'$ is needed [10].

In this paper we developed new approach for regression testing by computing coverage data for selecting test case to achieve savings in testing time of continuously evolving software. Our approach involves several steps. First step is indentifying the program entities in the program for which to compute the coverage data in the program. Second step by applying execution tracing and dataflow analysis at dynamically computing coverage data for identified program entities in the step1. Third step apply first two steps on different versions of the software and compute coverage data to identifies changed entities in the two versions of the application and selected test cases to test changed program entities in the software application.
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2. RELATED WORK

In this section we consider a related work that illustrate the problem we are solving. In the fig 1 there three versions of the programs Pi, Pi+1, Pi+2 that evolves with changes to one another. Now test suit T in fig2 is used to test the program Pi and found that coverage data CDi in the form of matrix as shown in fig2.after doing some changes to the program Pi, it evolves to Pi+1 now we want to test program Pi+1 to ensures that previous functionality does not affect apply regression testing without rerunning all test cases by select some test case as T’ we need coverage data of program Pi that is available as CDi. so for doing regression testing for program Pi we have no problem. Now program pi+1 is evolves after adopting some changes as program Pi+2.Now we want to check the previous functionality of the program Pi+2 does not affect by doing regression testing So coverage data CDi+1 for the program Pi+1 is needed to perform regression test on program Pi+1.There two ways to compute the coveredataCDi+1forprogram Pi+1. One is rerun test suit T on program Pi+1 which is time consuming process for regression test. So Second our proposed method with running application with our frame work by some techniques in order to achieve greater savings in time of regression testing to continuously evolving software.

Test cases | Input | Coverage Data
---|---|---
T1 | Total Score=71, midScore=81 | 1 1 1 1 0 0 0 0 1
T2 | Total Score=71, midScore=71 | 1 1 1 1 0 1 0 0 0
T3 | Total Score=64, midScore=82 | 1 1 0 0 0 1 1 0 0
T4 | Total Score=51, midScore=72 | 1 1 0 0 0 1 0 1 1

3. COMPUTING COVERAGE DATA

Our proposed system to compute coverage data for the software applications with out rerunning test suit using execution tracing and dataflow analysis . Studies
shown that by computing coverage data without rerunning entire test suite by selected test cases can provide significant savings in regression testing time. Thus, our proposed system can be an important part of an efficient regression testing process.

Proposed system involves 2 phases to compute the coverage data without rerunning entire test suite. First step is indentifying the program entities in the program for which to compute the coverage data in the program called as coverage criteria. Second step by applying execution tracing and dataflow analysis at dynamically computing coverage data for identified program entities in the step1.

A. Coverage Criteria

There are different coverage criterias basing upon program entities that considered while testing the program.some program entities considered in our approach are statement methods, classes, exceptions. Different coverage criteria is described below.

i Statement Coverage

This criteria reports whether each executable statement is encountered. Declarative statements that generate executable code are considered executable statements. Control-flow statements, such as if, for, and switch are covered if the expression controlling the flow is covered as well as all the contained statements. Implicit statements, such as an omitted return, are not subject to statement coverage.

ii Method Coverage

This criteria reports whether you invoked each function or procedure. It is useful during preliminary testing to assure at least some coverage in all areas of the software.

iii Call Coverage

This Criteria reports whether you executed each function call. The hypothesis is that bugs commonly occur in interfaces between modules.

iv Condition Coverage

Condition coverage reports the true or false outcome of each condition. A condition is an operand of a logical operator that does not contain logical operators. Condition coverage measures the conditions independently of each other.

B Execution tracing and Dataflow analysis

i Execution tracing

An execution trace of program P for some test suite T is the sequence of program entities is executed against T. for above example the execution traceis shown below

| Test cases | Execution trace |
|------------|-----------------|
| t1         | S1,S2,S3,S4,S9  |
| t2         | S1,S2,S3,S5,S9  |
| t3         | S1,S2,S6,S7,S9  |
| t4         | S1,S2,S6,S8,S9  |

Fig 3 Execution trace of program P1 on T

ii Dataflow Analysis

It is the process of collecting information about the way the variables are used, defined in the program. Analysis is done at basic block granularity. Dataflow analysis can be performed at both static and dynamic levels. But in our approach we use dynamic dataflow analysis to compute coverage data

i Static dataflow analysis

In static level Identify potential defects, to Analyze source code with out execution of code

ii Dynamic dataflow analysis

In dynamic level involves actual program execution. Identify paths to execute them. Paths are identified based on data flow diagrams. Dynamic dataflow analysis is carried by falling steps

1. Execute the program
2. Draw a data flow graph from a program.
3. Select one or more coverage criteria.
4. Identify paths in the data flow graph satisfying the coverage criteria.

4. EXPERIMENT DESIGN

To evaluate our technique, we develop an java framework called Dynamic Code Analyzer (DCA). Dynamic Code Analyzer that implements our techniques used it to conduct empirical studies to compute coverage and estimates time for computing coverage data for regression testing. For our experiment we used three versions GDownloader.

GDownloader is an downloading software developed in java that has six versions and 3,000-4,000 lines of code, depending on the version. Some of these versions have additional versions that can be obtained by enabling different numbers of faults: v1 has seven versions, v2 has seven versions, v3 has 10 versions, and v5 has nine
versions. Using these versions, we performed our studies on 3 versions of GDownloader. By testing GDownloader version 1, version 2, version 3, achieve, on average coverage of 67.76, 77.15, 88.15 percent the results shown in figure.

![Graph showing coverage results for version 1, version 2, version 3.]

Fig 5: Results of experiment for computing coverage data

After computing coverage data can compare the coverage data of 3 versions of software to identify the changed entities for doing regression testing, so that run testcases of that changed entities to regression test of the software. The results of our experiment shows that there will be significant savings in time of regression testing by computing coverage data. The results of time taken for doing regression are shown in fig6.

![Graph showing results for doing regression test.]

Fig 5: Results of experiment for doing regression test

5. CONCLUSION AND FUTURE WORK

In this paper we presented a new approach for doing regression testing by computing coverage data without incurring the expense of rerunning entire test cases. so we can achieve greater savings in time testing continuously evolving software by efficient regression test. The frame work developed for testing application consists all our technique to computing coverage data for different versions software using execution trace and dynamic dataflow analysis achieve greater savings in time of regression testing for continuously evolving software. In future work we extend obtain the dynamic slice by after tracing and dynamic analysis to achieve more performance in regression testing. Another scope for the extending this work is by considering the test case prioritizations along with selection for improve the quality of the testing.

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