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Model Based Test Case Prioritization for Cost Reduction using Genetic Algorithm

Neha Sharma
CSE/IT Dept,
ITM University

Ms Sujata
CSE/IT Dept.
ITM University

Abstract: Real time implementation of the software system requires being more versatile. In the maintenance phase, the modified system under regression testing must assure that the existing system remains defect free. Test case prioritization technique of regression testing includes code as well as model based methods of prioritizing the test cases. System model based test case prioritization can detect the severe faults early as compare to the code based test case prioritization. Model based prioritization techniques based on requirements in a cost effective manner has not been taken for study so far. Model based testing used to test the functionality of the software system based on requirement. An effective model based approach is defined for prioritizing test cases and to generate the effective test sequence. The test cases are rescheduled based on requirement analysis and user view analysis. With the use of weighted approach the overall cost is estimated to test the functionality of the model elements. Here, the genetic approach has been applied to generate efficient test path. The regression cost in terms of effort has been reduced under model based prioritization approach.

Keywords: regression testing; test case prioritization; model based test case prioritization; genetic algorithm

1. INTRODUCTION

Software testing is a process used to find out the correctness, completeness, and quality of developed system. Simply, it is an activity to check whether the actual results match the expected outcome and to ensure that the system is defect free. Software testing throughout maintenance phase is the most difficult task for software engineers. They depend on reusability of test suite in regression testing that incurs the cost which is a major concern. We can improve the testing efficiency by focusing the test cases which likely to contain most severe faults. In the maintenance phase of the software life cycle model, the updated system can increase lots of error in the existing system. Regression testing test case prioritization gives highly efficient result as compared to all other available techniques of regression testing. Test case prioritization technique can fulfill the major goal of testing [7]. Executing the most efficient test case earlier may have less risk of fetching the error in the modified system. There are number of approaches to perform regression testing [6]. In which genetic algorithm has been defined for finding the global optimal solution related to any problem concern [11] [14].

Test case prioritization regression method is categories into two: code based test case prioritization and model based test case prioritization. Code based technique focuses on testing the code of the system under the specified criteria such as statement coverage, branch coverage and functional coverage. Whereas the model based prioritization method concern about the functionality of the model elements [2].The model based regression testing may be used with the information of the solely code or without the knowledge of the code. There are some modeling language which focuses on the finite state of the model and the use case modeling language.

2. TEST CASE PRIORITIZATION PROBLEM

Test cases in the test suites are reschedule which will further prioritize using an algorithm. Before dealing with prioritization algorithms the problem associated with test case prioritization requires understanding which is defined as follows [6][7]:

Given: T is test suites, PT refers to a number of ways they are chosen, where f is a function whose value depends on permutation of these T to some real number.

Problem: We have to find T' such that T' ∈ PT For all T, (T '∈PT) where (T! = T') and f (T') >= f (T).

3. TEST CASE PRIORITIZATION METHOD

In terms of cost, time and efforts test case prioritization estimated as an efficient regression testing approach. It is used to reorder the test cases without having reducing or selecting any of the test cases from existing test suite. Test case prioritization further categories in two approaches [7]: General test case prioritization and Version based test case prioritization

To know general test case prioritization, consider a program P has test suite T with prioritized suite T' which is calculated without having familiar with modified program P'. It gives more successful prioritized suite than the original one. General testcase prioritization approach focuses on the

existing test suites without having any knowledge of updated version.

Within version specific test case prioritization, knowledge of modified program P' must require for prioritizing T test suite. It reschedules the available test cases with higher efficiency over the original order of the test cases. The version specific test case prioritization technique knows about the modified version of the system. Version specific prioritization may be more effective for modified program P' as compare to general test case prioritization, which is less effective in a successive release version [7].

Both the test case prioritization approach can work on the modified version of the system but in case of modified version test case prioritization it is necessary to have modification information. It uses the modified information for reordering the test cases. These approaches give more competent order of test suite for detecting the severe faults early.

3.1 Code based test case prioritization

The code based method focuses on the source code of the system to prioritize the test cases in a suite. While considering the code coverage criteria there are number of techniques such as statements, branches and functional coverage test case prioritization.

These techniques use the information from the earlier execution. Some of the test case prioritization techniques are no prioritization, random prioritization, optimal prioritization, total statement coverage, additional statement coverage, simple branch coverage, additional branch coverage, total functional coverage and additional functional coverage. Additional coverage techniques outperformed the total coverage technique of prioritization [7]. These techniques can detect the severe fault earlier and they are also improving the reliability of the modified system. For measuring the efficiency of the techniques average faults per minute is calculated using APFD metric. There is some other method of test case prioritization that focuses on historical based information such as earlier test cost, fault severity information, number of test case requirement in the earlier testing, number of faults detected etc. [13]

3.2 Model based test case prioritization.

In model based test case prioritization software system testing has been performed. System model has been used for selecting and generating the test cases for the updated model. It focuses on the testing of a modified model. Model based approach is generally divided into two: first method is appropriate for the modified model and changes occur in the source code. Second method of model based test case prioritization doesn't deal with the changes in the modified model whereas its major concern is only to the change source code. In the second method, modified elements in the given model have been identified. And, based on that collecting information and execution information the test cases are prioritized for retesting the whole system[1][2]. After updating the system, the modified system must be tested to check the faults whether existing or not. It focuses on the requirement and the design of the complete system [3]. The model based testing can achieve the objectives of test case prioritization early in comparable to the code based test case prioritization. In this approach test cases are generated earlier so, the effectiveness of the test suite is known earlier. It can decrease the cost in terms of time and efforts and also improve the quality of the overall system [9]. The design phase of the software development needs more concentration. The model based approach focuses on the modeling of the system which has been used for state based system like an embedded system. It is used to get about the system behavior by considering some modeling languages such as specification description language (SDL), use case modeling language (UML), state charts, extended finites state machine, control flow structures and component integration graphs. EFSM (extended finite state machine) system model has been used to give the actual state and the transition between the states [1][3][4][11]. Whenever the action has been triggered the transition is shown using edges in the system model. It helps in developing the system design as well as in prioritizing the tests cases. The major goal of model based approach is to find the most severe fault during the implementation of the system. It is easy to test the model as test the actual system. The post processing of the test suite can be reducing if the prioritization of test cases has been done at the time of test case generation [8][12].

4. RELATED WORK

Requirement based modeling technique of test case prioritization can detect the severe faults earlier. It can fetch the faults in the earlier stage while gathering requirements[10]. When the cost related to each of the requirement has been known earlier in the testing approach then the cost of the complete system could be maintain in the next version of the software [11]. By testing the functional specification of the model, efficiency of a system can be improved. The requirements are weighted based on the factors for detecting the severe faults. The value given to the factor based on the people involved in the system development [5]. So it may possible that the resultant obtained differ based on the model which is considered. The historical based information such as the time taken by the test case; number of test cases run in the earlier testing, code coverage information, impact of the earlier testing etc can give highly efficient prioritization sequence of test sequence [14]. The model to be tested based on the state and the events corresponding to the each of the state of the system. The state can be known based on the event occur such as if state, when state; attribute state, system state and the output state[12].

Requirements which are of major concern for the tester, developer and the customer will be gathered first. The user view analysis has been performed so that the most important requirement tests earlier. After gathering requirements model using has been created using specification description language.

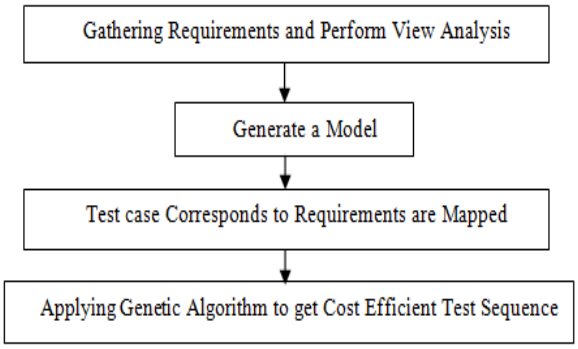

Figure 1. Procedure for Model Based TCP

The model created focuses on the state and transition between the several activities of mobile video communication system. By using genetic based approach test sequence has been generated. The work has been done in a user friendly environment so as to reduce the cost of the system.

5. EMPIRICAL STUDY

The model based test case prioritization method of regression testing firstly gathered the requirements based on the module. Requirement associated with the specific module will be mapped to the test cases [12]. Earlier testing of the requirement assures the higher efficient system at the end. Requirements are the basic building block of the system which has been assigned by the developer and the customer. If the requirements are tested then it will give higher assurance of customer satisfaction of the system. But it is very difficult while the requirements are changing or flexible. The cost is the major issue of concern in the regression testing. The test case prioritization approach of testing is highly efficient over the other approaches of regression testing.

Figure 2. Shows the states while video communication has been made via mobile. Each of the state has the transitions and there are about 57 test cases used to test the transition among all the state in a sample model. The TCP prioritize the test case without of selecting or minimizing of the test case from the test sequences. We have software system based on which the modules are define with its specific estimated time. We can define the estimated time based on which the tester, developer and user prioritize the test case. The prioritize value has been assign within a range of 1 to 5.

The test case having higher importance to the individual assign prioritize value (pv) as 5. User permission, identification, type of data communicated, location of video, session of video played, memory space, speed of uploading and downloading, server response while fetching a video has been tested. The user of the system has been explained in the below a state-transition diagram. The user of the system must authenticate with the server before uploading or search for any video.

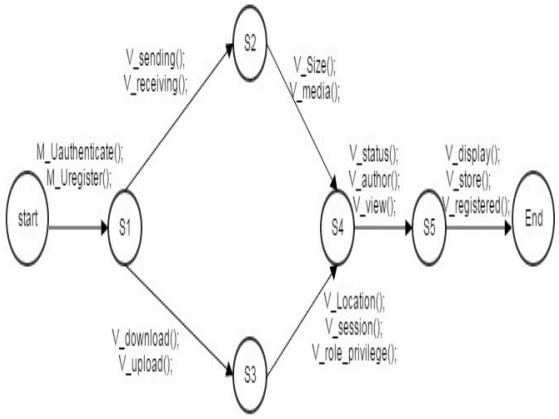

Figure 2. A Sample Model of Mobile Video Communication System

The developer's cost for the development point of view is initially higher. But as execution of test cases increase the cost is decreasing. For the tester, initial cost is less and it is increasing as the execution of test cases increases. Similarly, as per user perspective the test cost is decreasing. After implementing genetic algorithm using MATLAB with having mutation probability 0.8 and crossover probability 1.0 the test sequence has been generated. The cost for the developer, tester and customer has been defined in the figure 3, 4, 5.

The figure 5 shows that the actual cost of the test cases is high in earlier execution where the cost is reducing as on moving down in the bar. Hence it has been shown that the cost is improving.

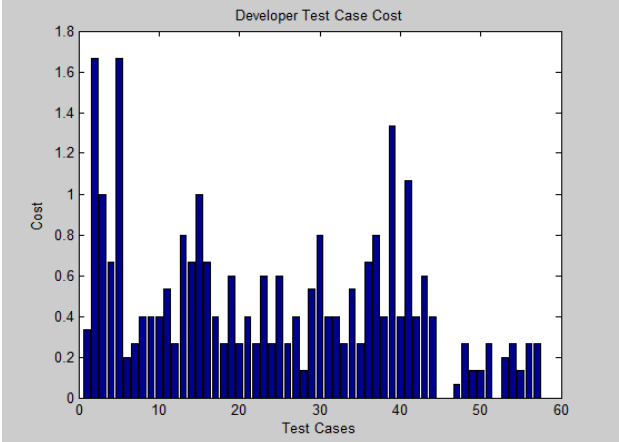

Figure 3. Developer Test Case Cost

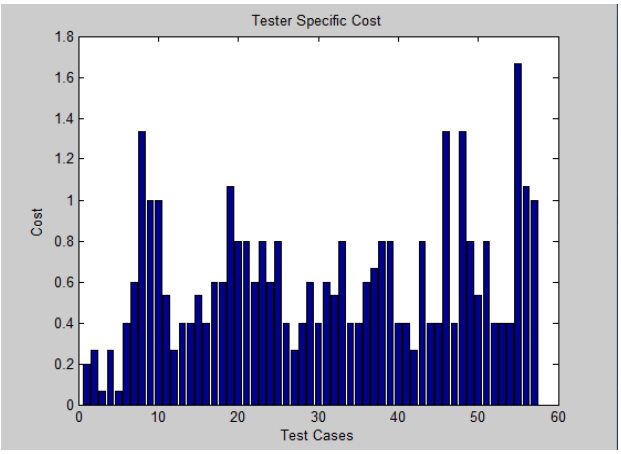

Figure 4. Tester Test Case Cost

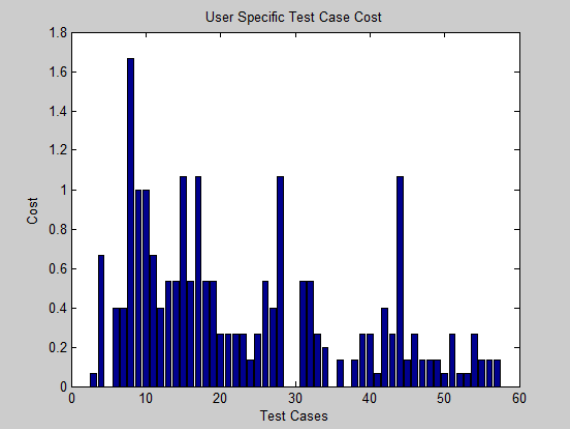

Figure 5. User Specific Test Case Cost

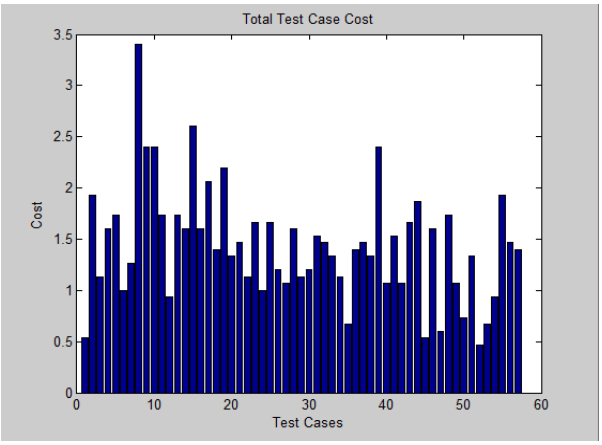

Figure 6. Total Test Case Cost

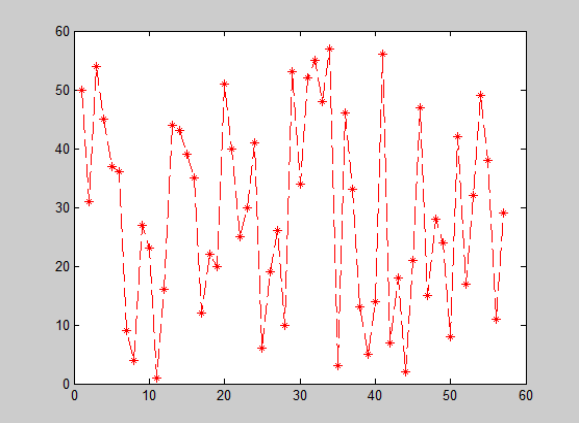

Figure 7. Sample of Test Case Pattern

The cost has been calculated based on the priority of the test cases assign by the developer, tester and the customer. The fitness function used is the summation of the cost of an individual member.

$$Devoloper = \frac{\sum_{i=1}^{N} Dev(i) * ViewDev(i)}{Maxvalue} \quad (1)$$

$$Customer = \frac{\sum_{i=1}^{N} Cust(i) * ViewCust(i)}{Maxvalue} \quad (2)$$

$$Tester = \frac{\sum_{i=1}^{N} Testr(i) * ViewTestr(i)}{Maxvalue} \quad (3)$$

$$fitness\ Cost = Developer + Customer + Tester \quad (4)$$

Where N is the total number of test cases and i is an individual test case

The overall cost is calculated by taking the summation of the all the above individual cost for the developer, customer and tester.

The cost obtained through from the equation 4. has been leveled using fuzzy logic. Fuzzy logic has defines for optimizing the cost and generate the best optimal sequence.

The figure 7 gives the path of execution of sample test cases which will gives lesser cost in terms of effort as compare to the random execution of test case. Here x-axis and y-axis gives the coordinate point of execution of the test case applying on the model. The result shows that the cost has been reduced while applying our genetic approach as compare to the random order of execution of test cases.

6. CONCLUSION AND FUTURE WORK

The Requirement model based test case prioritization can reduce the cost of the software. Considering the mobile video communication system, the authors has proposed the model based genetic algorithm for reducing the cost of the test case prioritization. The fitness function in genetic algorithm has been calculated by assigning prioritize value to each test case by the developer, tester and the user. The test case efficiency is based on the importance of the particular test case based on any of the module of the system. Genetic algorithm gives the best optimal set which is applicable throughout the system. With the use of our proposed approach the time of execution of the test case is reduce by generating the efficient prioritize test sequence. The most efficient test suite has been obtained by using fuzzy range. It provides the most versatile system so that if any changes found can easily be track and immediately changes has been checked for the failure. The algorithm defined use to reduce the cost based on efficiency of the test case for the particular module. The model based test case prioritization approach has not been used under hybrid approach of the regression testing. The hybrid approach focuses on the combination of either test cases selection and test case prioritization or test case reduction and test case prioritization techniques of regression testing. The fault detecting ability as well as the reliability of the system will be consider for covering more than one objective of regression testing.

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