A Study with respect to Fuzzy Test Case Prioritization Technique for Regression Testing.

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Abstract

In present day systems, software is playing an important role in almost every aspect. These software intensive systems demand high quality software. Software testing is a process of verifying and validating that a software application or program meets the business and technical requirements. Among all the testing techniques Regression Testing is a very important process in the maintenance phase. The prioritization test case becomes more important because it is not feasible to run all the test cases after modification have been made in the software. The proposed work presents the application of fuzzy logic to develop a fuzzy expert system to select the test cases which retains the effectiveness and efficiency and also it is better than the normal expert system.

Keywords: Regression Testing, Test case Prioritization, fuzzy expert system.

Introduction

Maintenance is the important process during the life span of software. Software maintenance usually involves activities during which the software is modified for different reasons. Some of the reasons for which software may be modified are fixing faults, introducing a new functionality, improving the performance of some parts of the software through the introduction of new algorithms, etc. There is a probability of 50-80% of introducing faults to the modified software during software maintenance. For this reason regression testing is performed during software maintenance for the purpose of testing the modified software. Regression testing means re-execution of test cases after some modification have been made in the software, to ensure proper functioning of previous version's modules as well as the new ones. It gives assurance that newly added features do not cause any problem or side effects in the functioning of the system. This is generally performed in maintenance phase of software development cycle. There exists many regression testing methods which may be classified as specification-based or code-based. There are three types of regression testing techniques namely selection, prioritization and minimization. Selection deals with selecting the test cases that can be helpful in getting maximum number of errors if made to run, from all of the test cases. Its urpose is to identify the test cases that are relevant to some set of recent changes. Prioritization deals with prioritizing test cases to increase the rate of fault detection. Prioritization is used when the time for the testing is limited. The more important cases are tested so as to attain maximum coverage. Minimization deals with eliminating redundant test cases in order to reduce the number of test cases.Regression testing is a very labour intensive and may be responsible for approximately 50% of software maintenance's cost . In a systematic software development environment, all types of regression testing methods usually involve the usage of an original test suite which is used for the purpose of testing the original program before it has been modified. Sensible regression testing methods have to utilize existing test suite in some form. For example, a simple regression testing strategy would rerun existing testing suite, as it is, on the modified program while introducing new test cases to test new features. Although this method is simple, it is not practical for commercial software because existing test suite is usually very large and may take weeks to rerun on the new modified software. Therefore, regression test selection techniques, test suite minimization technique and test case prioritization techniques are proposed in the literature. Fuzzy Expert

System consists of fuzzification unit that converts crisp values into fuzzified input. It consists of inference engine that contains if then else rules and a defuzzification unit to convert the result in a readable form. Regression testing using fuzzification has been conceptualized by a few researchers as per the literature review. Fuzzy expert system is selected as the decisions made by it are better than the normal expert system [3]. The work improves the existing fuzzy logic based technique and removes the faults in it. The proposed system architecture has been designed and initial results are encouraging. Fuzzy expert system provides a better way of prioritizing the test cases.The rest of this paper is organized as follows. Literature Review is discussed in Section II. We present problems in existing system in Section III. The architecture and Proposed work is described in Section IV and the results and conclusions in Section V.

Literature review

Previous research in using fuzzy logic for the purpose of test case prioritization is scant. A fuzzy expert system is reported where this system is used for a telecommunication application. To build the required knowledge base for the expert system reported in this research, the researchers had to acquire knowledge from different sources such as customer profile, past test results, system failure rate, and the history of system architecture changes. Although this expert system has shown promising results with respect to the *specific* application it was designed for, it is necessary to acquire a new knowledge base for new applications.Prioritization of test cases can be done by gathering test execution information. Various techniques have been proposed to calculate cost and benefits of these techniques. Theoretical and practical issues are discussed for the design and construction of intelligent agents. Adaptive test management system has also been developed to increase efficiency Christoph Malz and Peter Gohner have presented an Adaptive Test Management System based on software agent which prioritizes the test cases on the basis of available information from test team and development teams about software system and test cases [2]. The architectural model is provided in XML format. For evaluation, the prototype uses data of a company of automobile industry to compare result of test cases when executed with ATMS and without using ATMS. Result found was, that without using ATMS, test cases were repeated after software changes and no fault was found.Fuzzy expert system based applications have been developed based on electronic commerce. Various fuzzymethodologies were considered to demonstrate the usefulness and to derive new ideas [8]. In the work carried out by Zhewei Xu, Kehan Gao and Taghi M Khoshgoftaar, a fuzzy expert system has been proposed in order to select the test cases when information of the source code is not available to testers [3]. A study has been done on the sample data from the GSM system test database. It has been demonstrated that the fuzzy expert system is suitable for solving inaccurate and subjective problem as encountered by system test case selection. The system has also been used to manage the complexity of mobile payment service. Structural and controlled study to test embedded software has also been studied in order to understand the fuzzy expert system.

Test Case Prioritization*:* The main goal of the prioritization techniques is to increase the probability of detecting faults at an earlier stage of testing. Additionally, test case prioritization techniques objective is the utilization of previous test cases for the purpose of future testing. There may exists several goals of test cases prioritization such as: (1) to increase test suites fault detection rate; (2) to minimize the time required to satisfy a testing coverage criterion; (3) to enhance tester's confidence in the reliability of the

software in a shorter time period; (4) to be able to detect risky faults as early as possible; (5) to increase the chances of detecting faults related to software modification during regression testing.

Fuzzy Logic Background

In our daily life we use words and terms which are vague or fuzzy such as:

"The FAN is *slow*" or
"The weather is *hot*" or
"RAMA is *tall*."

Fuzzy Logic concepts, e.g., [25-27], give us the ability to quantify and reason with words which have ambiguous meanings such the words (*slow*, *hot*, *tall*) mentioned above. In fuzzy sets [25], an object may belong partially to a set as opposed to classical or "crisp" sets in which an object may belong to a set or not. For example, in a universe of heights (in feet) for adult people defined as

μ= {5, 5.5, 6, 6.5, 7, 7.5, 8},

a fuzzy subset TALL can be defined as follows:

TALL = [0/5, .125/5.5, .5/6, .875/6.5, 1/7, 1/7.5, 1/8].

In this example, the degree of membership for the members of the universe, μ, with respect to the set TALL may be interpreted as that the value "6" belongs to the set TALL 60% percent of the time while the value 8 belongs to the set TALL all the time.

Problems in existing system

The previous work studied states that the high value of local priority indicates probability of finding faults but no formula has been stated to calculate the local priority. The Software Module agent gives the information about the change. Test Case agent answers the question how probable is the probability of finding faults with the test case and calculate its global priority that depend on local priority but both the techniques have not been theoretically justified. In the above work, test importance is an indication of need of high test intensity for software module and value of test importance lies between 1to 10.The proposed technique aims at removing the limitations observed and provide the better result.

Proposed work

The proposed architecture of Fuzzy Regression Expert System (FRES) consists of three components knowledge base, inference engine and user interface. Knowledge base contains all the rules. Inference engine takes the decision by checking which rules are satisfied by facts, prioritize the rules that are satisfied and execute the highest priority rules. The rules are to be prioritized based on premise discussed in the section. Inference engine processes the rules that are extracted and whose patterns are satisfied by facts in contention. The user interface presents the user available facts and other information as input.

A. Knowledge Base

Knowledge base consists of objects that can be rules, classes and instances or goals and tasks. It consists of domain knowledge that is useful for the inference engine. It consist natural language rules in form of if then else. Rules depict the knowledge to be used by the expert

system. For example, the rule test case suite which has higher priority based on calculating the local priority and hence it would have higher priority

B. Inference Engine

Expert system searches for rules in knowledge base at first. Inference engine then relate different pieces of knowledge against relevant data. Example, as per the previous work, if coupling becomes high then local priority in software module becomes more. More is a fuzzy adjective and hence the value is calculated using fuzzy system.

C. User Interface

The user interface allows user to enter rules. It also presents explanation to conclusions and the data acquisition facility.

D. Software Module

As per the previous work, a software module is a basic unit of a program which accomplishes a particular task. A program is the combination of different software modules.

E. Software Module Importance Evaluator

Software Module Importance Evaluator evaluates the probability of finding the faults in a module by the requisite rules.

F. Test Case Evaluator

A test case consists of inputs and outputs. Set of test cases is called as test case suite. A module can have many test cases. The Test Case Evaluator component evaluates different test cases and indicates the importance of the test cases.

G. Local Priority Evaluator

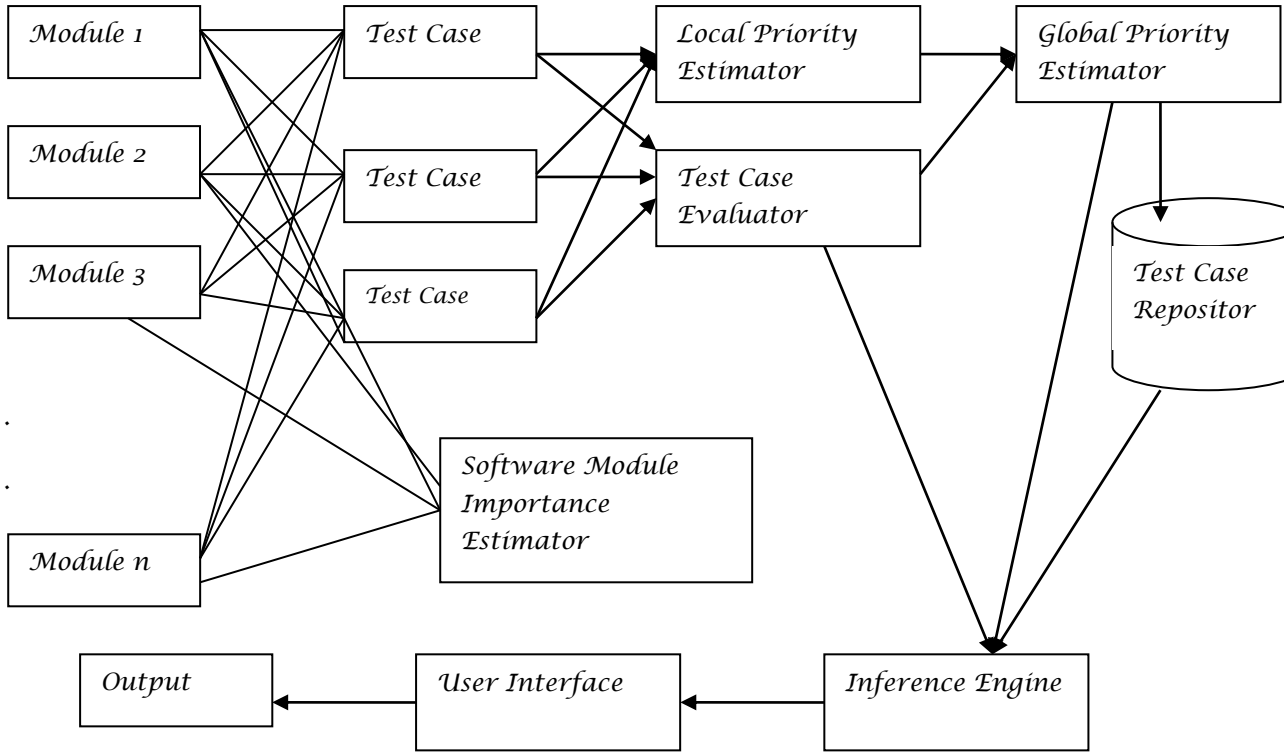
Local priority is the probability of a test case to find faults in a software module that is related to the test case.To determine the local priority, the software agent (TCagent) uses information from SM-agents and available databases. The local priority component calculates the local priority of module.

H. Global Priority Evaluator

Global priority is the priority of a test case with respect to all other test cases. The software agents (SM agents) uses test importance of a software module and local priority of test cases to determine global priority.

I. Inference Generator

Inference Generator is a reasoning generator that is based on some information that derives to a conclusion or new information i.e., from the given rules and facts, it derives new rules.Diagrammatic representation of the proposed Fuzzy Expert System architecture as follows:



Architecture of Fuzzy Expert System

A software program consist of various software modules here represented by module1, module2… module n. A test case evaluator (TC evaluator) considers various software modules and their related test cases. It takes different test cases as inputs and determines test importance of the test cases. These test cases are provided to local priority estimator by different test case evaluators. Local priority estimator takes the results of test case evaluator and obtains local priority by using coupling and cohesion among different software modules. Local priority is being obtained by calculating the weighted sum of the entire incoming andoutgoing link from the module. Global priority is then calculated by TC-agent as the weighted average value of the local priorities. All the test cases generated are stored in the repository called test case repository. Software module importance estimator interacts with different software modules to tell the importance of different software modules. Inference engine then using the global priority estimator, test case repository and software module importance estimator generates test importance. It is conveyed to user via user interface.

Conclusions

In this paper, we developed a fuzzy expert system on the basis of rule base fuzzy logic to overcome the problems in regression testing. Regression testing is the most important task in retesting of the whole system. Once a change is made it is not possible to retest all the test cases of the test suite as it consumes lot of time and is not a feasible solution. Therefore, prioritization of the test cases present in test suite becomes important. The regression testing using fuzzy expert system used here provides a new approach to prioritization of test cases.

It has been found that fuzzy expert system provides better results than the other decision making systems. The work proposed is being implemented and analyzed. The results obtained so far are encouraging. The proposed work is to be tested using commercial software of 10000 lines of code. The software consists of around 250 modules and 500test cases.

References

- *Christoph Malz, Peter Göhner, "Agent-Based Test Case Prioritization," icstw, pp.149-152, 2011 IEEE Fourth InternationalConference on Software Testing, Verification and Validation Workshops, 2011.*
- *Z. Xu, K. Gao, and T.M. Khoshgoftaar, "Application of fuzzy expert system in test case selection for system regression test", ;in Proc. IRI, 2005, pp.120-125.*
- *Malz, C., Jazdi, N., Gohner, P., "Prioritization of Test Cases Using Software Agents and Fuzzy Logic", Software Testing, Verification and Validation (ICST), 2012 IEEE Fifth International*
- *Conference on, On page(s): 483 – 486.*
- *Alakeel A., "Regression Testing Method for Programs with Assertions," American Journal of Scientific Research, no. 11, pp. 111-122, 2010.*
- *G. Rothermel, R. H. Untch, C.Chu, M. J. Harrold, "Prioritizing test cases for regression testing", IEEE Transactions on Software Engineering, 27, 2001.*