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Study Of White Box, Black Box And Grey Box Testing Techniques

Anjali Bhasin[1], Mr Manoj Kumar[2]
[1]Computer Science Engineering Department, [2]Associate Professor, CSE
SGT Institute of Engineering & Technology,
Gurgaon, India

***Abstract*- Software testing is a highly complex and time consuming activity- It is even difficult to say when testing is complete. Software testing is the process to uncover requirement, design and coding errors in the program. It is used to identify the correctness, completeness, security and quality of software products against a specification. The success rate of software system depends upon the following: requirements elicitation technique, modelling, analysis, verification, validation & testing.**

In literature, we have identified different types of Software Testing Techniques like, black box techniques, white box techniques, and grey box techniques; and choosing grey box testing is not an easy task according to need/criteria of the software projects. In our paper, we have described and compared the three most prevalent and commonly used software testing techniques and selection of grey box approach for detecting errors, which are the combination of: white box testing, black box testing.

Keywords*— *Black Box; Grey Box; White Box

I. INTRODUCTION

Software testing identifies defect, flows or errors in the software. In literature, we have identified various definitions of software testing. Few of them are given below: (i) testing is the process of demonstrating that errors are not present (ii) The purpose of testing is to show that a program performs its intended functions correctly. The three most important techniques that are used for finding errors are functional testing, structural testing and gray box testing. Functional testing is also referred to as black box testing in which contents of the black box are not known. Functionality of the black box is understood on the basis of the inputs and outputs in software. There are different methods which are used in black box testing methods like boundary value analysis, robustness testing, equivalence class partitioning, and decision table testing. White box testing or structural testing is the complementary approach of functional testing or black box testing. White box testing permits us to examine the internal structure of the program. In functional testing all specifications are checked against the implementation.

This type of testing includes path testing, data flow testing, and mutation testing. In white box testing there are various applications of graph theory which is used to identify the independent path in a program or software like decision to decision (DD) flow graph, Cyclomatic complexity etc.

Grey box testing is the testing of software application using effective combination of white box testing, black box testing, mutation, and regression testing [2]. This testing provides a method of testing software that will be both easy to implement and understand using commercial of the shelf (COTS) software [1]. In the Grey box testing, tester is usually has knowledge of limited access of code and based on this knowledge the test cases are designed; and the software application under test treat as a black box & tester test the application from outside. Grey box software testing methodology is a ten steps process for methods like boundary value analysis, robustness testing, equivalence class partitioning, and decision table testing. White box testing or structural testing is the complementary approach of functional testing or black box testing. White box testing permits us to examine the internal structure of the program. In functional testing all specifications are checked against the implementation. This type of testing includes path testing, data flow testing, and mutation testing. In white box testing there are various applications of graph theory which is used to identify the independent path in a program or software like decision to decision (DD) flow graph, Cyclomatic complexity etc. testing computer software. The methodology starts by identifying all the inputs and output requirements to computers systems. This information is captured in the software requirements documentation.

II. SOFTWARE TESTING TECHNIQUES

The three most important techniques that are used for finding errors are

A. White Box Testing Technique

It is the detailed investigation of internal logic and structure of the code. In white box testing it is necessary for a tester to have full knowledge of source code.

B. Black Box Testing Technique

It is a technique of testing without having any knowledge of the internal working of the application. It only examines the fundamental aspects of the system and has no or little relevance with the internal logical structure of the system.

C. Grey Box Testing

White box + Black box = Grey box, it is a technique to test the application with limited knowledge of the internal working of an application and also has the knowledge of fundamental aspects of the system.

I. *WHITE BOX TESTING TECHNIQUE*

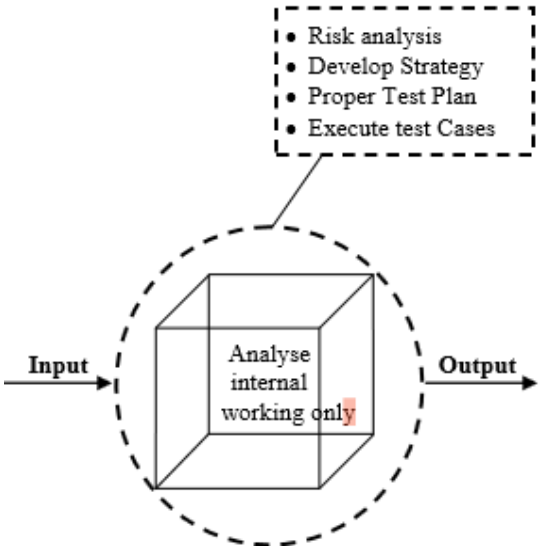

Figure 1. Represent white box testing

White box testing is a test case design method that uses the control structure of the procedural design to derive test cases. White box testing can uncover implementation errors such as poor key management by analysing internal workings and structure of a piece of software. White box testing is applicable at integration, unit and system levels of the software testing process. In white box testing the tester needs to have a look inside the source code and find out which unit of code is behaving inappropriately

Some of the advantages and disadvantages of white box testing technique are listed below: [3] [4]

Advantages

- It reveals error in hidden code by removing extra lines of code.
- Side effects are beneficial.
- Maximum coverage is attained during test scenario writing.

Disadvantages

- It is very expensive as it requires a skilled tester to perform it.
- Many paths will remain untested as it is very difficult to look into every nook and corner to find out hidden errors.
- Some of the codes omitted in the code could be missed out.

Some of the synonyms of white box testing are glass box testing, clear box testing, open box testing, transparent box testing, structural testing, logic driven testing and design based testing.

Some important types of white box testing techniques are briefly described below

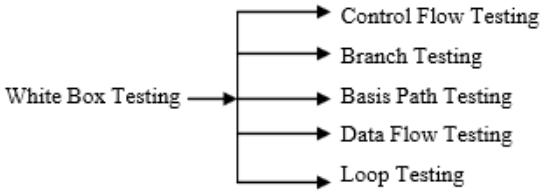

Figure 2. Represent different forms of white box testing techniques

A. Control Flow Testing

It is a structural testing strategy that uses the program control flow as a model control flow and favours more but simpler paths over fewer but complicated path.

B. Branch Testing

Branch testing has the objective to test every option (true or false) on every control statement which also includes compound decision.

C. *Basis Path Testing*

Basis path testing allows the test case designer to produce a logical complexity measure of procedural design and then uses this measure as an approach for outlining a basic set of execution paths.

D. *Data Flow Testing*

In this type of testing the control flow graph is annoted with the information about how the program variables are define and used.

E. *Loop Testing*
It exclusively focuses on the validity of loop construct

II. *BLACK BOX TESTING TECHNIQUE*

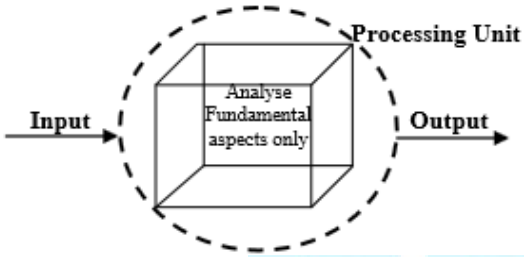

Figure 3. Represent black box testing

In this type of testing the control flow graph is annoted with the information about how the program variables are define and used.

Some of the advantages and disadvantages of black box testing technique are listed below:

Advantages
- Efficient for large code segment.
- Tester perception is very simple.
- Users perspective are clearly separated from developers perspective (programmer and tester are independent of each other).
- Quicker test case development.

Disadvantages
- Only a selected number of test scenarios are actually performed. As a result, there is only limited coverage.
- Without clear specification test cases are difficult to design.
- Inefficient testing.
- Some of the codes omitted in the code could be missed out.

Some of the synonyms of black box testing technique are opaque testing, functional testing, close box testing, and behavioural testing.

Some important types of black box testing techniques are briefly described below:

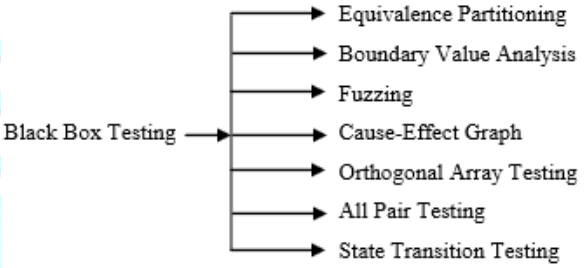

Figure 4. Represent different forms of black box testing techniques

A. Equivalence Partitioning
It can reduce the number of test cases, as it divides the input data of a software unit into partition of data from which test cases can be derived.

B. Boundary Value Analysis
It focuses more on testing at boundaries, or where the extreme boundary values are chosen. It includes minimum, maximum, just inside/outside boundaries, error values and typical values.

C. Fuzzing
Fuzz testing is used for finding implementation bugs, using malformed/semi-malformed data injection in an automated or semi-automated session.

D. Cause-Effect Graph
It is a testing technique, in which testing begins by creating a graph and establishing the relation between the effect and its causes. Identity, negation, logic OR and logic

AND are the four basic symbols which expresses the interdependency between cause and effect.

F. Orthogonal Array Testing

OAT can be applied to problems in which the input domain is relatively small, but too large to accommodate exhaustive testing.

G. All Pair Testing

In all pair testing technique, test cases are designs to execute all possible discrete combinations of each pair of input parameters. Its main objective is to have a set of test cases that covers all the pairs.

H. State Transition Testing

This type of testing is useful for testing state machine and also for navigation of graphical user interface.

III. *GREY BOX TESTING TECHNIQUE*

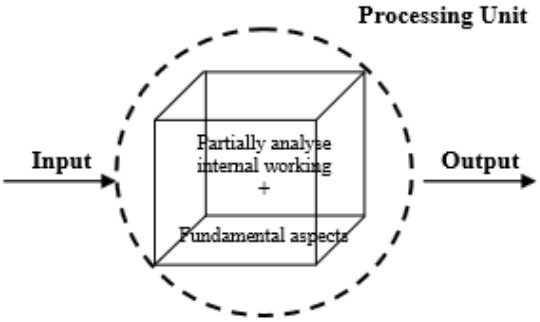

Figure 5. Represent grey box testing

Grey box testing technique will increase the testing coverage by allowing us to focus on all the layers of any complex system through the combination of all existing white box and black box testing.

In grey box testing the tester must have knowledge of internal data structures and algorithm, for the purpose of designing test cases. Examples of grey box testing technique are: [6]

- Architectural Model
- Unified Modeling language (UML)
- State Model (Finite State Machine)

In grey box testing the codes of two modules are studied (white box testing method) for the design of test cases and actual test are performed in the interfaces exposed (black box testing method).

Some of the advantages and disadvantages of grey box testing technique are listed below:

Advantages

- Grey box testing provides combined benefits of white box and black box testing techniques.
- In grey box testing, the tester relies on interface definition and functional specification rather than source code.
- In grey box testing, the tester can design excellent test scenarios.
- The test is done from the user's point of view rather than designer's point of view.
- Create an intelligent test authoring.
- Unbiased testing.

Disadvantages

- Test coverage is limited as the access to source code is not available.
- It is difficult to associate defect identification in distributed applications.
- Many program paths remain untested.
- If the software designer has already run a test case, the tests can be redundant.

The other name of grey box testing is translucent testing. Different forms of grey box testing techniques are briefly described below:

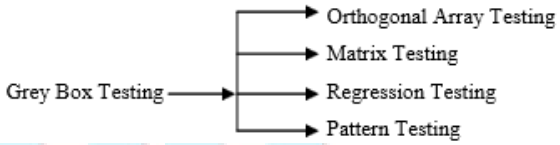

Figure 6. Represent different forms of grey box testing techniques

A. Orthogonal Array Testing

This type of testing use as subset of all possible combinations.

B. Matrix Testing

In matrix testing the status report of the project is stated.

C. Regression Testing

If new changes are made in software, regression testing implies running of test cases.

E. Pattern Testing

Pattern testing verifies the good application for its architecture and design.

IV. CONCLUSIONS

For most applications that now are under development, white and black box testing was defined long ago and does not cover all the possible scenarios that must be tested. By implementing gray box testing, we simply reduce the overall cost of system defects - and prevent more from passing the testing stage. Precisely, if the process is based on the effectiveness of the black-box testing, as a "non-biased" and "agnostic" method, then gray-box testing will work against that. But if the development process tries to accumulate the benefits of both black-box and gray-box (for example, some of the members of the testing team can use exclusively black-box testing, while others are also allowed to rely on white-box), then gray-box testing is also a good option. Grey-box testing is well suited for Web applications, Web services, functional or business domain testing, security assessment, GUI, distributed environments, etc.

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