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South FOR RESERACE	Original Research Paper	Computer Science
Priternational	WHITE-BOX TESTING TECHNIQUE FOR FINDING DEFECTS	
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ABSTRACT White box testing is involves multiple processes and designs that checks whether the source code works according the requirement. It provides the internal structure of a program and provides full visibility of		

code and logic of software product. It works mainly to improve Security, flow of input and output, and works to improve design, code and usability.

This paper will help software testers to understand white box testing for security, multiple methods to white box testing techniques and techniques and expected results.

KEYWORDS : Path Testing, Branch Testing, Control Flow Testing, Data Flow Testing, Loop Testing, White Box Testing Techniques etc.

1. INTRODUCTION

Software testing is used to verify and validate the quality of software by executing a program to find bugs ^[1]White Box Testing is a system analysis testing to identify the differences between system requirements with the developed or existing system ^[2]. White box Testing is used for testing that we are building the product right. It is based on the internal structure of the software product. First step is to documentation, source code and other artefacts associated with the development of the software. Second, tester must be aware of different tools and techniques for white box testing ^[3].

It involves several features such as:

- 1. Testers should have full knowledge of the internal structure of the software.
- 2. Internal structure can be easily tested.
- 3. Best suited for Algorithm testing
- 4. Mostly done by testers and developers.

1.1 White Box Testing is used types of Testing:

(a)Unit Testing-Unit testing is a software testing type by which source code, sets of one or more Program Modules together with associated control Data, Usage procedures, and operating procedures, are tested to determine whether they are fit for use [4].

(b)Integration Testing- Integration testing is the phase in software testing in which data flow between modules or features and tested as a group. It performs after unit testing and before system testing. Integration testing takes unit tested modules as an input, create scenario, test cases from integration test plan, and gives result as its output the integrated system ready for system testing [5].

(c)Regression Testing- selective retesting of a Component to verify that the modifications has not caused any unintended errors. A change in the feature is not affected to another feature so we test the change part & impact area. In white box testing techniques a developer can perform the Regression Testing.

1.2 Test Case

A test case verifies that expected result & actual Result. Purpose of using it is to uncover errors. White box testing tests cases are primarily created with the help of the design & source code.

Test cases are written based on the functional requirement and flow of application program. Grouping these test methods in white box testing. Test cases involve such as Test Case Id, Test Data, Expected Results, and Actual Results, test status Pass/Fail, and Comment and so on.

A software engineer can design test cases ^[6]that can:

- 1. Verify the internal data structure validity.
- 2. Exercise logical condition on both their true and false side.
- 3. Exercise independent path within a module.
- 4. Execute loops at their operational boundaries.

2. LITERATURE WORK

White box testing is software testing design technique which developer & tester can use to verify their code. Tester need to understand the white box Techniques that is available to make educated decisions about their use for the specific system. we are currently, and in future, will be testing. Planned with explicit input output groups. white box testing is a controlled Verification & Validation method.

White box testing is not cost effective but it increases the test effectiveness when performing the white box testing. More tests can be developed and executed by white box testing. Each testing techniques will guide testers to design test cases that will help developers to test plan specific decisions related to the systems advantages of White box testing technique.

3. WHITE BOX TESTING TECHNIQUES

3.1 Data Flow Testing: It is specifies how data revolves around the program and how the value is allocated to a variable. It not only explores program control flows but also shows how a variable is defined and used. It aims to execute the sub paths from points where each variable is defined to points where it is referenced. Most failures execute the incorrect definition such as:

- 1. Incorrect assignment/input statement.
- 2. Wrong path is taken, which perform to wrong definition.
- 3. Definition is missing. Data flow testing involves the following steps to correct them:
- Number the line
- List the variables
- List occurrences and assign a category to each variable.
- Identify du variable and their use.
- Define test cases depending upon the required coverage^{[7].}

3.2 Control Flow Testing: Control flow graphs that represent the control flow of programs are widely used in the analysis of software.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. Control flow testing performs to all software and it is effective

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for all software. Now, we will define various coverage methods:

(a)Statement Coverage: It is a measure of the percentage of statements that have been executed by test cases Less than 100% statement coverage means that not all lines of code have been executed we can achieve statement coverage by identifying cyclomatic number and executing this minimum set of test cases. An advantage of statement coverage is that it is greatly able to isolate the portion of program, which could not be executed.

(b)Branch Coverage: A stronger logic coverage criterion is known as branch coverage. It is measures of the percentage of the decision point of the program have been evaluated as both true and false in test cases. By 100% branch coverage mean that every control flow graph is traversed.

(c)Condition Coverage: A criterion which is stronger than decision coverage is condition coverage. It is a measure of percentage of Boolean sub-expressions of the program that have been evaluated as both true and false outcome in test cases^{[8].}

3.3 Path Testing

Path coverage tests every paths of the program. This is a comprehensive technique which ensures that all the paths of the program are traversed at least once. Path Coverage is more powerful as comparison to Branch coverage. This technique is more useful for testing the complex programs.

Taking up each and every individual path through which the flow of code taken place $^{\mbox{\tiny [N]}}$



Fig.1

(a)Flow Graph Notation: Notation used for representing control flow is Control flow graph.

A control flow graph is a directed graph that includes of node and control flow. Node is labelled by a circle whereas control flow represented by an arc with an arrow on a flow graph:

- 1. The symbol arrows called as edges that represent the flow of control
- Circles are defined by nodes, which describes one or more actions
- 3. Area bounded by edges and nodes are called regions
- A predicate node is a node containing a condition Procedural.



Fig.2

(b). Cyclomatic Complexity: It is software metric which provides logical complexity of a program by measuring the number of paths through a method.

Every method has a minimum cyclomatic complexity of 1, since there is at least 1 path by a method which defines getter

method has CCN = 1.

Cyclomatic complexity number (CCN) can be calculated as CCN = E-N+P, Where E represents the number of edges on the graph, N the number of nodes on the graph, and P the number of connected Components.

Drawbacks

- 1. It does not compute the data involvement of a program.
- 2. It must be used with care as it gives misleading figures of simple comparisons and decision structures¹⁰⁰⁽¹¹⁾.

©. Deriving Test cases:

- Procedure for deriving test cases:
- 1. Flow graph derived with the help of design or code.
- 2. Regulate cyclomatic complexity of the resultant flow graph.
- 3. Determine set of linearly independent paths
- 4. Construct test cases that will execute each path.

3.4 Loop Testing: It is focuses exclusively on validity of loop construct.

- a) Loops testing reveal loops initialization problems.
- b) By going through the loop once, the uninitialized variables in the loop can be determined.
- c) Testing can also fix loop repetition issues.
- d) Loops can also reveal capacity bottlenecks.

Single Loop Strategy

• Zero, One, Two, n-1, n, n+1 & typical number of iterations.

Nested Loop Strategy

- Single loop strategy
- Select minimum values for outer loop(s).
- Treat inner loop as a single loop.

Concatenated Loops

- Treat as single, if independent.
- Treat as nested, if dependent.

4. ADVANTAGES OF WHITEBOX TESTING

White box testing has multiple advantages for making secure software:

- It removes extra lines of code that can bring in hidden defects.
- Optimizes the code.
- As the internal code it is easy to find out which type of data can help in testing application efficiently.
- Bugs are identified in hidden code.
- Testing can be done at an earlier stage which covers most possible paths to test.
- Start the White Box Testing without wait the GUI.
- As covering all possible paths of code so this is a thorough testing.
- It is allows you to help in the code optimization.
- White box testing gives clear, engineering-based, rules for when to stop testing.

5. CONCLUSION

White box testing which is a controlled V & V technique. We have reviewed various White Box testing techniques such as Data Flow Testing, Control Flow, Basis Path Testing, and Loop Testing with test cases. Each testing techniques will allow testers to design test cases that will help developers to properly plan specific decisions related to the systems. This paper will help developers:

- 1. Study internal data structure and how value is allocated to a variable.
- 2. To make logical decisions based.
- 3. Tests every independent path of the code.
- 4. Execute loops at the boundaries.

White box testing guarantee that all independent paths within a module has been covered at least once and exercise internal data structure to ensure their validity. Hence, we conclude that white box is more efficient and reliable as it covers maximum error in the modules and provides an effective software product to customer as technology.

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