SCHOOL OF COMPUTER SCIENCE AND IT

School of Computer Science & IT

Department of BCA

SOFTWARE ENGINEERING (22BCA3C01)

MODULE 5: SOFTWARE TESTING

1. Discuss the importance of testing phase and Describe various testing strategies?

Testing is the process of exercising a program with the specific intent of finding errors prior to delivery to the end user.

Testing is intended to show that a program does what it is intended to do and to discover program defects before it is put into use.

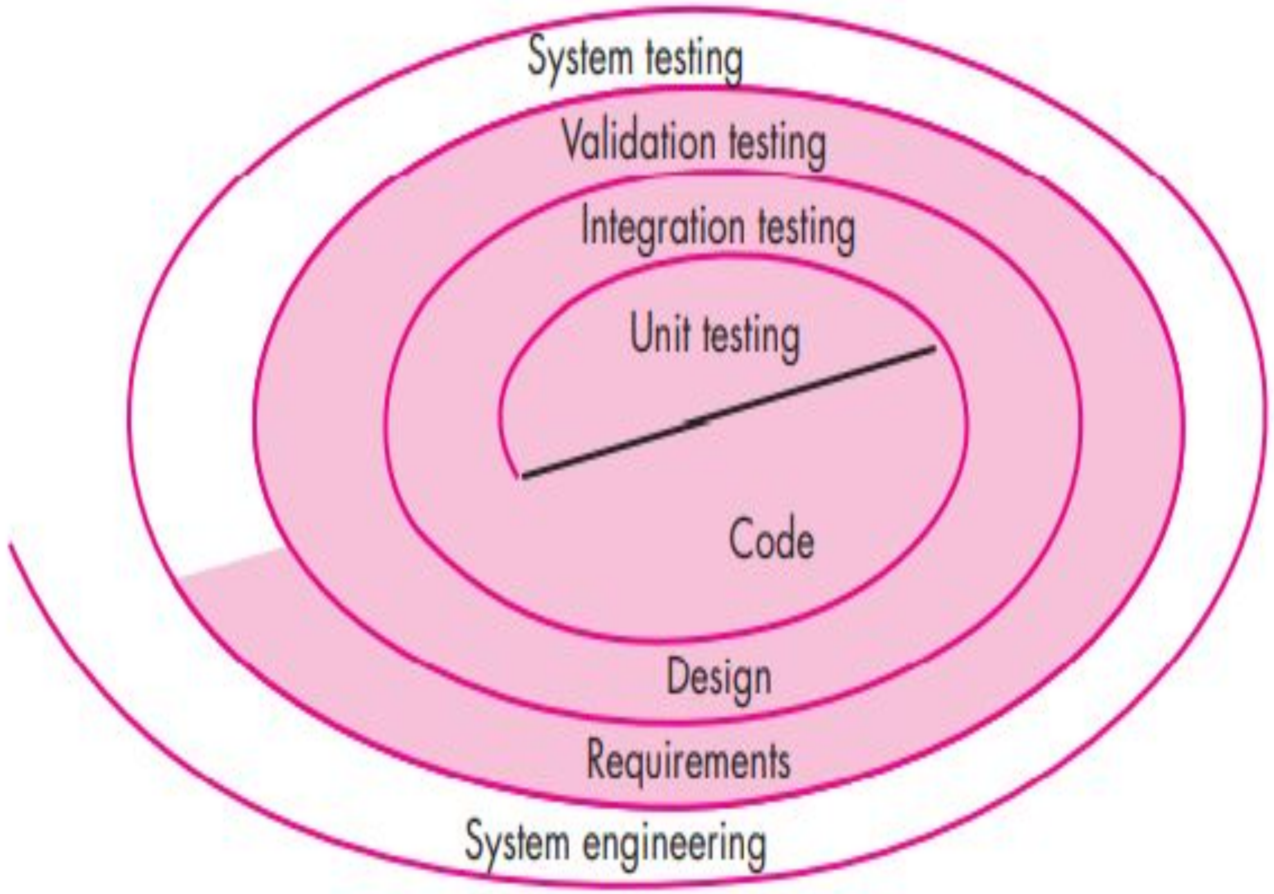
When you test software, you execute a program using artificial data (called test data).

You check the results of the test for errors, anomalies or information about the program's non-functional attributes.

Can reveal the presence of errors, NOT the absence of errors. That is why we do enough testing, but exhaustive testing may not be possible.

Testing is part of a more general verification and validation process.

Testing Strategy



We begin by ‘testing-in-the-small’ and move toward ‘testing-in-the-large’

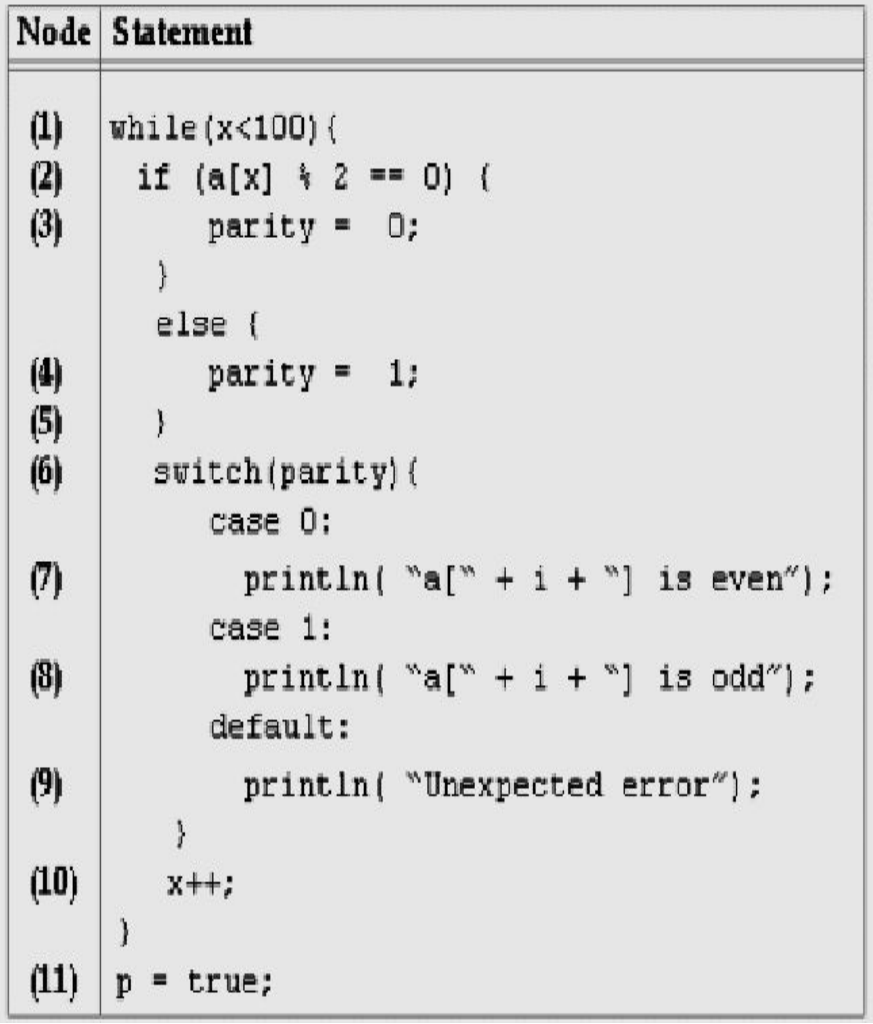
For conventional software

- The module (component) is our initial focus.
- Integration of modules follows.

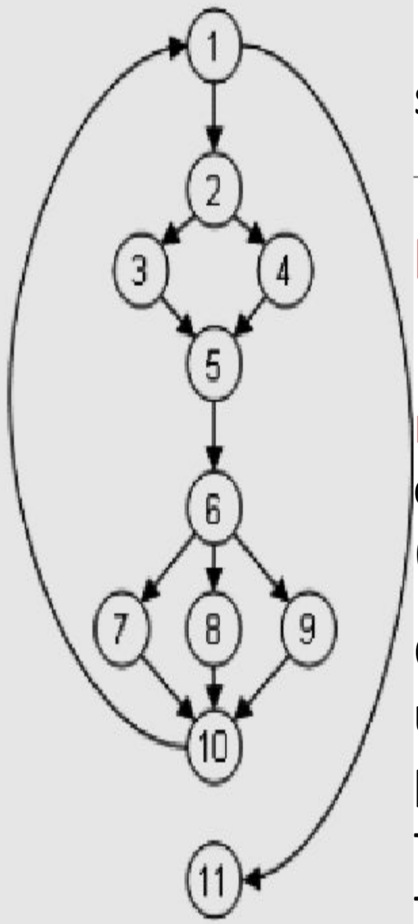
For OO software

- focus on class that encompasses attributes and operations and implies communication and collaboration
- Integrate classes one after another to form the whole system.

Unit Testing



Node	Statement
(1)	while(x<100){
(2)	if (a[x] % 2 == 0) {
(3)	parity = 0;
	}
	else {
(4)	parity = 1;
(5)	}
(6)	switch(parity){
	case 0:
(7)	println("a[" + i + "] is even");
	case 1:
(8)	println("a[" + i + "] is odd");
	default:
(9)	println("Unexpected error");
	}
(10)	x++;
	}
(11)	p = true;



Unit testing is the process of testing individual components in isolation.

It focuses testing on the function or software module of conventional software.

It concentrates on the internal processing logic and data structures.

Rule of Thumb: Concentrates on critical modules and those with **high cyclomatic complexity** when testing resources (manpower, time etc.) are limited.

Cyclomatic complexity is **a software metric used to indicate the complexity of a program**. It is a quantitative measure of the number of linearly independent paths through a program's source code.

The Cyclomatic complexity of the program can be defined using the formula – $V(G) = E - N + 2 = 14-11 +2= 5$

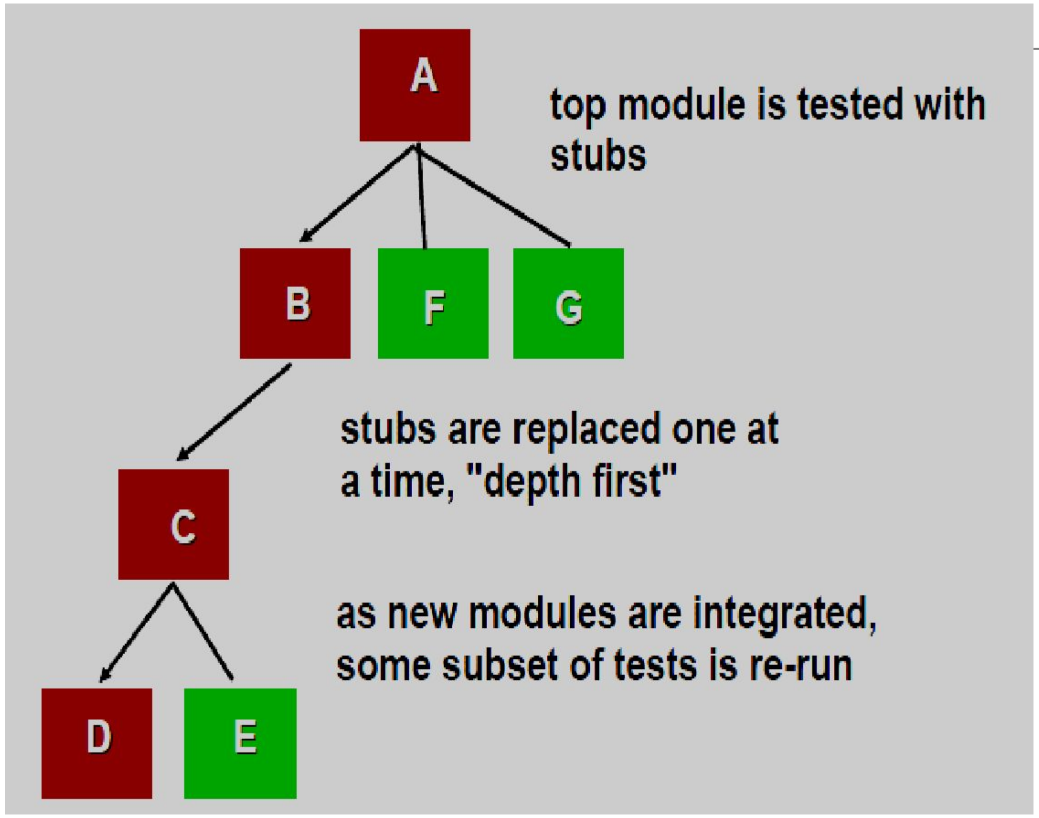
Integration Testing

Unit tested modules are combined one at a time to build a larger structure of the software system based on the prescribed design. Module integration is done incrementally.

While modules are integrated, tests are conducted to uncover errors associated with the integration.

- Three kinds
  - Top-down integration
  - Bottom-up integration
  - Sandwich integration

Top-down Integration


A
top module is tested with stubs
B
F
G
stubs are replaced one at a time, "depth first"
C
as new modules are integrated, some subset of tests is re-run
D
E

Modules are integrated by moving downward through the control hierarchy, beginning with the main module.

Subordinate modules are incorporated in either a depth-first or breadth-first fashion.

- DF: All modules on a major control path are integrated.
- BF: All modules directly subordinate at each level are integrated.

Advantages

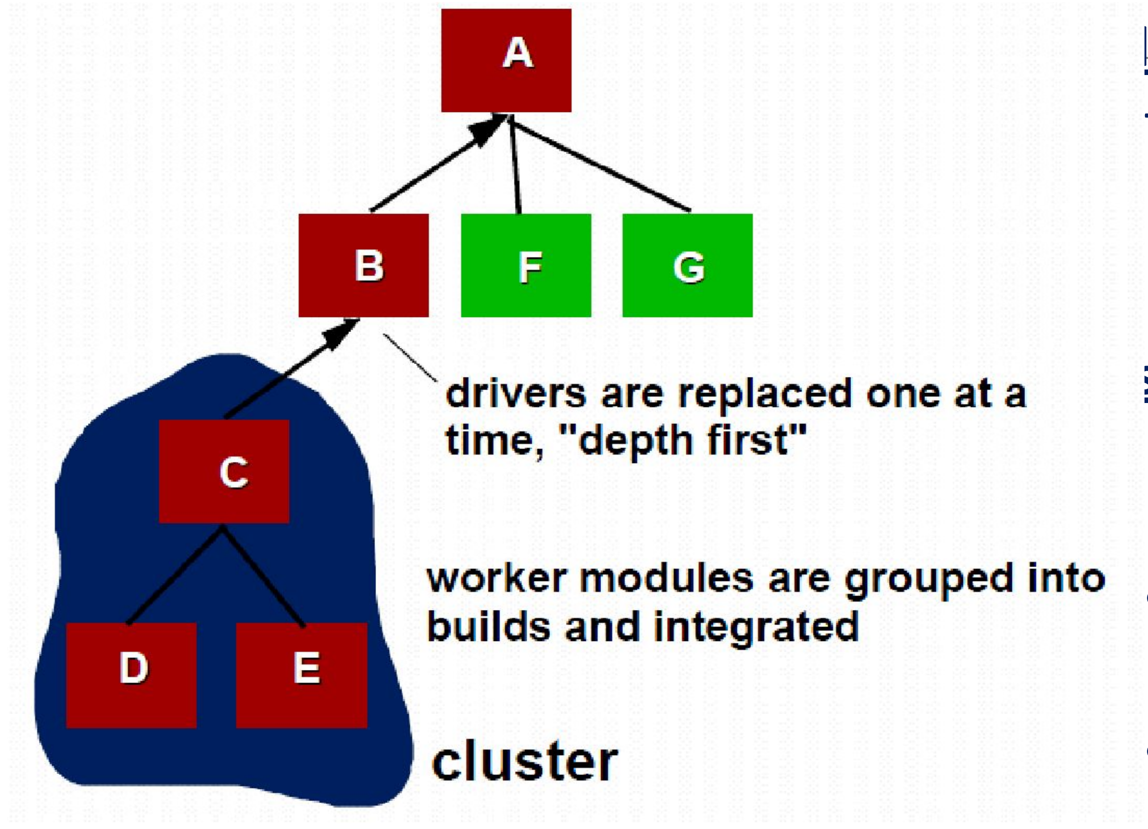
- This approach verifies major control or decision points early in the test process.

Disadvantages

- Stubs need to be created to substitute for modules that have not been built or tested yet; this code is later discarded.
- Because stubs are used to replace lower level modules, no significant data flow can occur until much later in the integration/testing process. This may require more testing when lower level modules are integrated.

Bottom-up Integration

Integration and testing starts with the most atomic modules in the control hierarchy.


A
B
F
G
C
D
E
drivers are replaced one at a time, "depth first"
worker modules are grouped into builds and integrated
cluster

vantages

This approach verifies low-level data processing early in the testing process.

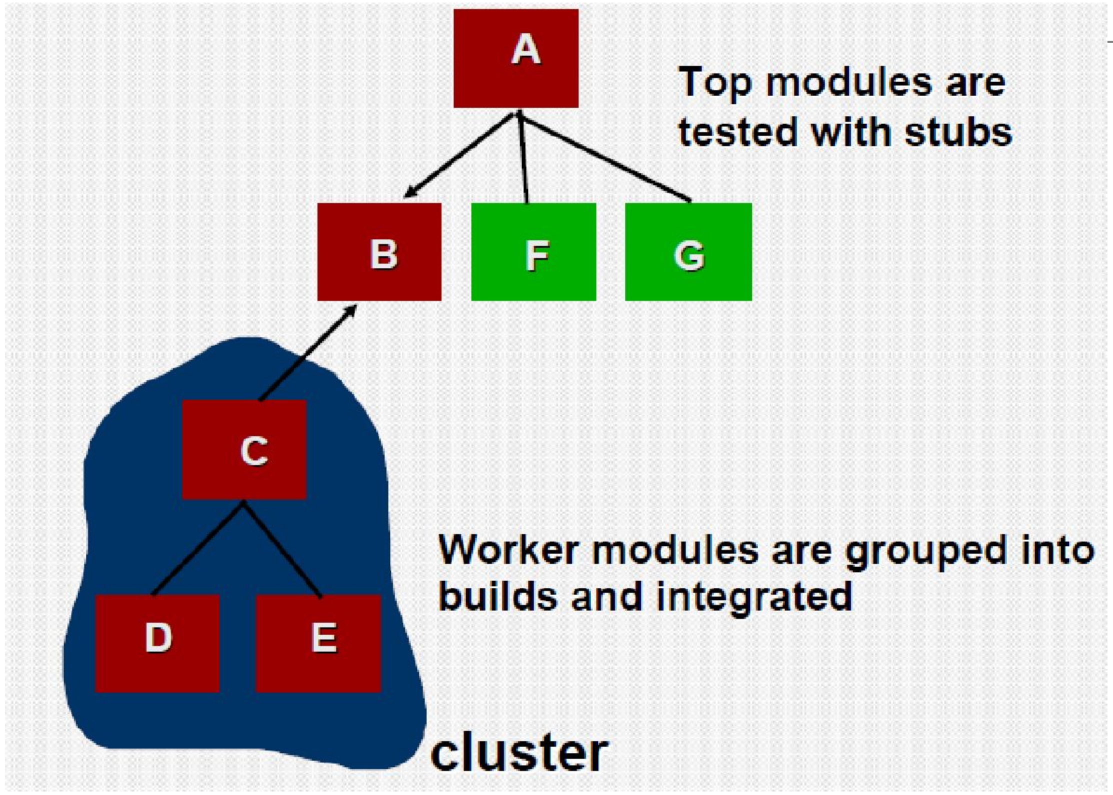
Need for stubs is eliminated.

sadvantages

Driver modules need to be built to test the lower-level modules; this code is later discarded or expanded into a full-featured version.

Drivers inherently do not contain the complete algorithms that will eventually use the services of the lower-level modules; consequently, testing may be incomplete or more testing may be needed later when the upper level modules are available.

Sandwich Integration


A
Top modules are tested with stubs
B
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G
C
Worker modules are grouped into builds and integrated
D
E
cluster

Consists of a combination of both top-down and bottom-up integration.

Occurs both at the highest level modules and also at the lowest level modules.

Proceeds using functional groups of modules, with each group completed before the next.

- High and low-level modules are grouped based on the control and data processing they provide for a specific program feature.
- Integration within the group progresses in alternating steps between the high and low level modules of the group.
- When integration for a certain functional group is complete, integration and testing moves onto the next group.

Advantage: Reaps the advantages of both types of integration while minimizing the need for drivers and stubs.

Disadvantage: Requires a disciplined approach so that integration doesn’t tend towards the “big bang” scenario.

Regression Testing

Each new addition or change to baselined software may cause problems with functions that previously worked flawlessly.

Regression testing re-executes a small subset of tests that have already been conducted.

- Ensures that changes have not propagated unintended side effects.
- Helps to ensure that changes do not introduce unintended behavior or additional errors.
- May be done manually or through the use of automated tools.

Regression test suite contains three different classes of test cases

- A representative sample of tests that will exercise all software functions.
- Additional tests that focus on software functions that are likely to be affected by the change.
- Tests that focus on the actual software components that have been changed.

Smoke Testing

- **Allows the software team to assess its project on a frequent basis. A common approach for creating "daily builds" for product software.**

Smoke testing steps:

- Software components that have been translated into code are integrated into a "build."
  - A build includes all data files, libraries, reusable modules, and engineered components that are required to implement one or more product functions.
- A series of tests is designed to expose errors that will keep the build from properly performing its function.
  - The intent should be to uncover "show stopper" errors that have the highest likelihood of throwing the software project behind schedule.
- The build is integrated with other builds and the entire product (in its current form) is smoke tested daily.
  - The integration approach may be top down or bottom up.

Benefits of Smoke Testing

Integration risk is minimized

- Daily testing uncovers incompatibilities and show-stoppers early in the testing process, thereby reducing schedule impact.

The quality of the end-product is improved

- Smoke testing is likely to uncover both functional errors and architectural and component-level design errors.

Error diagnosis and correction are simplified

- Smoke testing will probably uncover errors in the newest components that were integrated.

Progress is easier to assess

- As integration testing progresses, more software has been integrated and more has been demonstrated to work.
- Managers get a good indication that progress is being made.

2.Define Testing goals ?Define and differentiate verification and validation?

❑**Testing Goals**:

1. To discover faults or defects in the software where its behaviour is incorrect or not in conformance with its specification. This is Verification.
2. To demonstrate to the developer and the system customer that the software meets its requirements. This is called Validation.

Verification refers to the set of tasks that ensure that software correctly implements a specific function. The test cases are designed to expose defects.

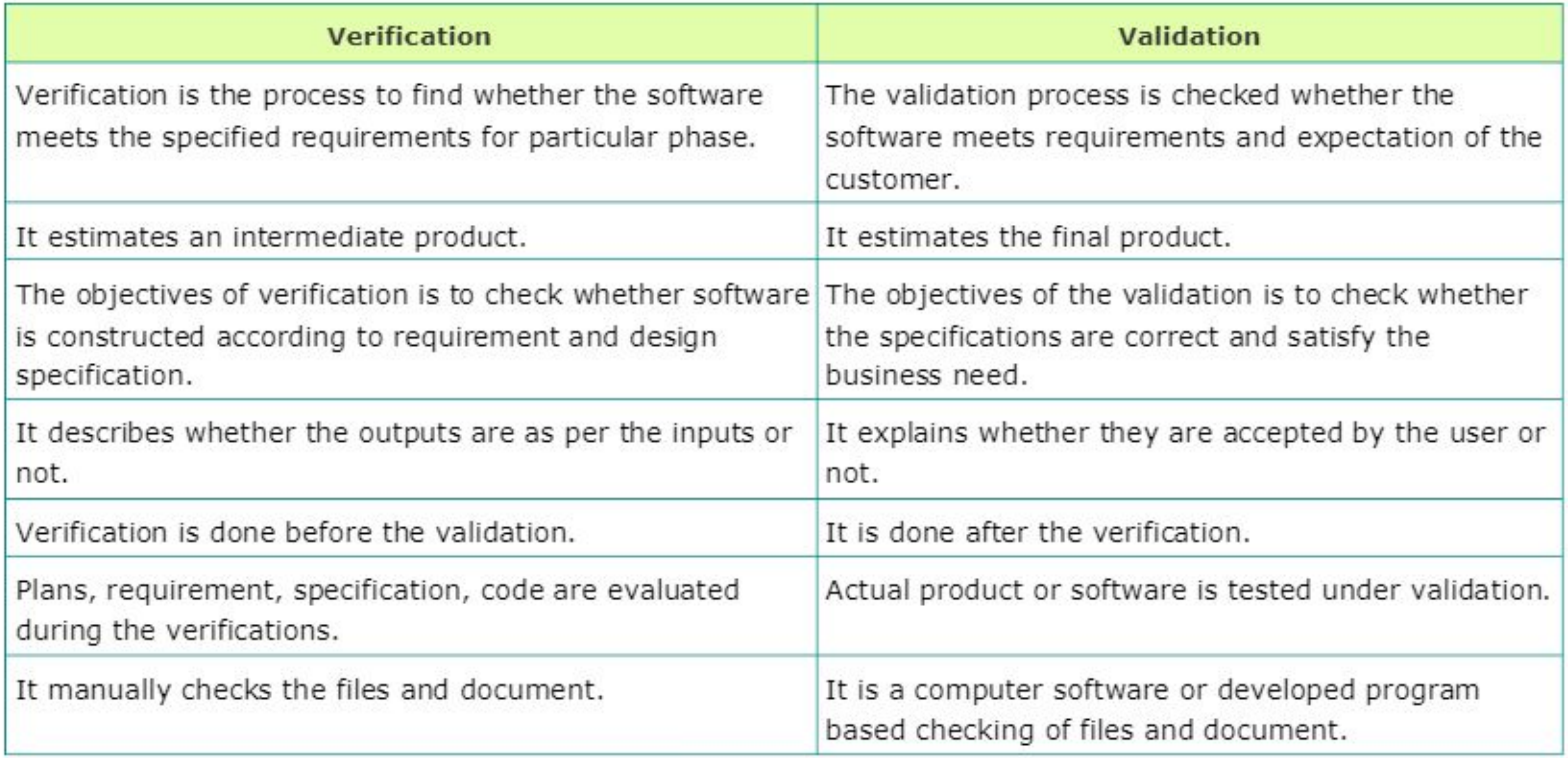
Validation refers to a different set of tasks that ensure that the software that has been built is traceable to customer requirements. You expect the system to perform correctly using a given set of test cases that reflect the system's expected use.

❑Barry Boehm, an pioneer in software engineering states this another way:

❖**Verification**: "Are we building the product right". i.e., The software should conform to its specification.

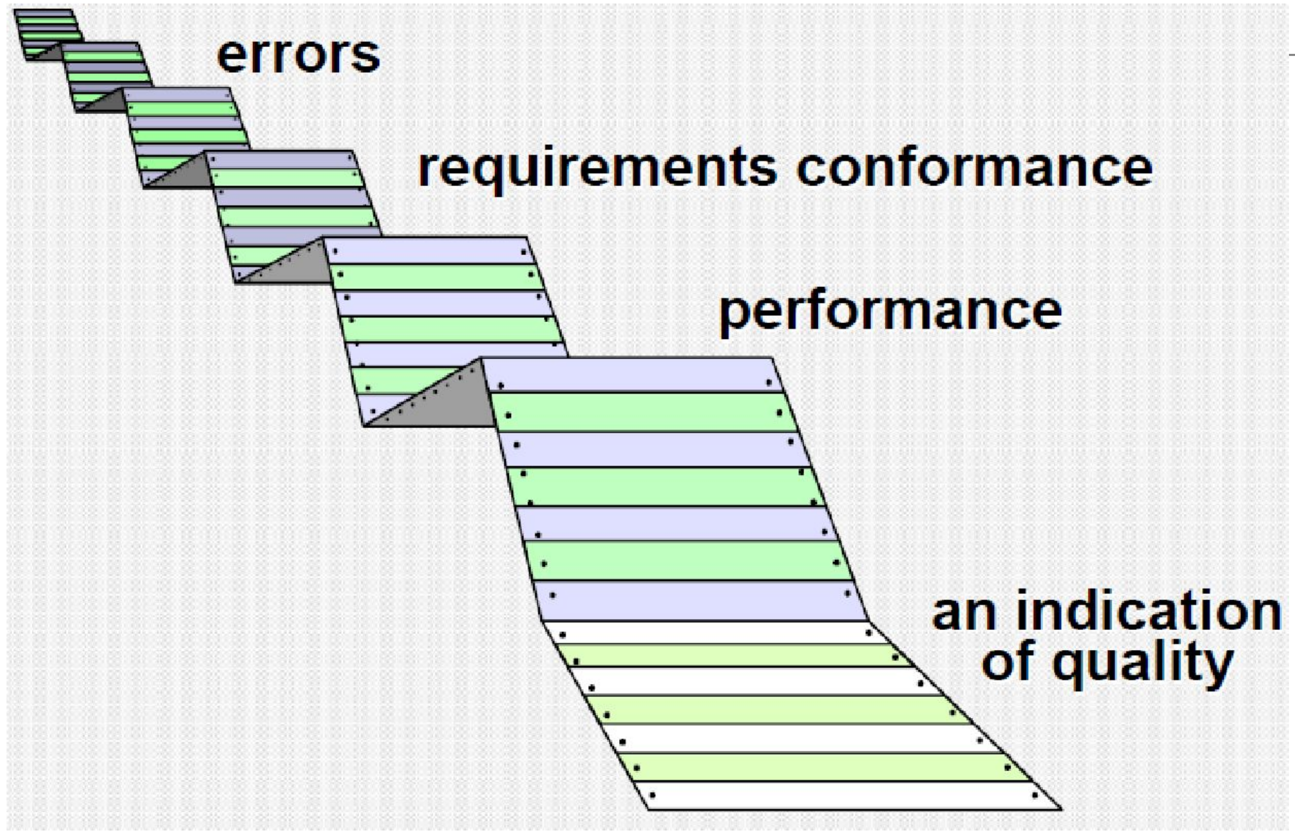
❖**Validation**: "Are we building the right product". i.e., The software should do what (specific functions) the user really requires.

Difference between Verification and Validation



Verification	Validation
Verification is the process to find whether the software meets the specified requirements for particular phase.	The validation process is checked whether the software meets requirements and expectation of the customer.
It estimates an intermediate product.	It estimates the final product.
The objectives of verification is to check whether software is constructed according to requirement and design specification.	The objectives of the validation is to check whether the specifications are correct and satisfy the business need.
It describes whether the outputs are as per the inputs or not.	It explains whether they are accepted by the user or not.
Verification is done before the validation.	It is done after the verification.
Plans, requirement, specification, code are evaluated during the verifications.	Actual product or software is tested under validation.
It manually checks the files and document.	It is a computer software or developed program based checking of files and document.

3.What Testing Shows?



Tests are executed to uncover errors in meeting customer requirements.

As errors are uncovered, they must be debugged to achieve requirements conformance.

Requirements conformance leads to overall software performance.

Improvement of software performance is an indication of quality software.

4.What is Strategic Approach for testing ?How testing differs from debugging?

To perform effective testing, you should conduct effective technical reviews (also called Inspections). ~~By doing this, many errors will be eliminated before testing commences.~~

Testing begins at the component level and works "outward" toward the integration of the entire computer based system.

Different testing techniques are appropriate for different software engineering approaches and at different points in time.

Testing is conducted by the developer of the software and (for large projects) an independent test group.

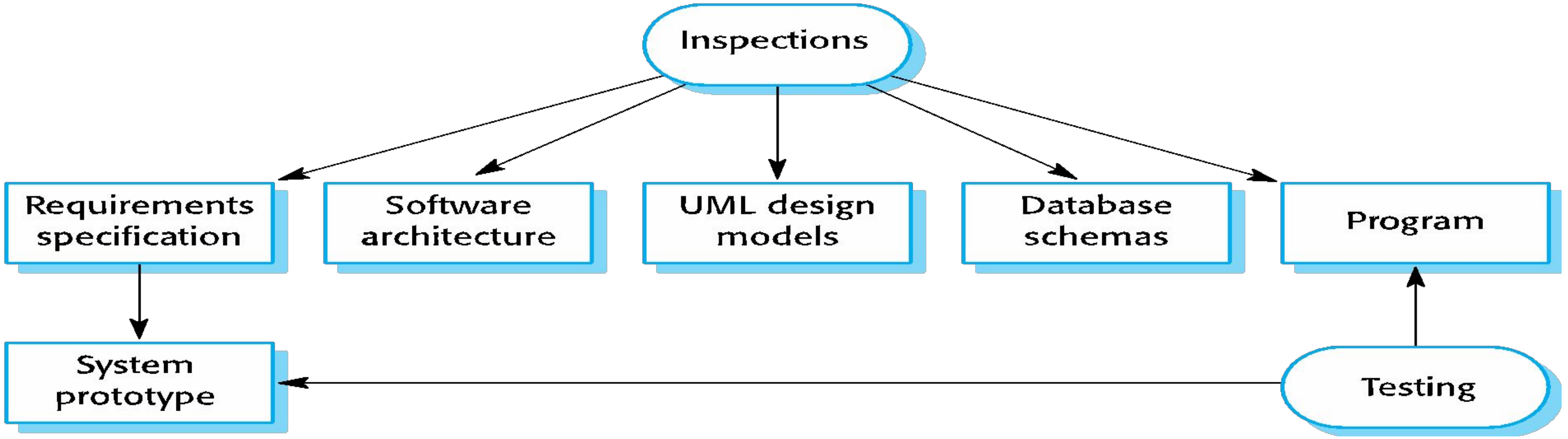
Testing and debugging are different activities; while testing finds errors, debugging removes errors. Debugging must be accommodated in any testing strategy.

5.Define inspections and how they differ from testing?

Software inspections concerned with analysis of the static system representation to discover problems (static verification)

Software testing concerned with exercising and observing product behaviour (dynamic verification)

The system is executed with test data and its operational behaviour is observed.

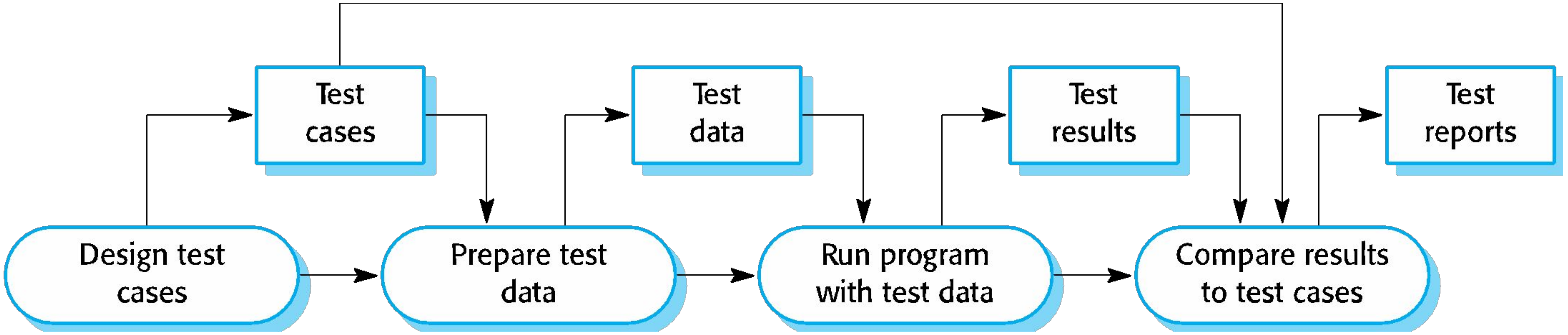


Software inspections

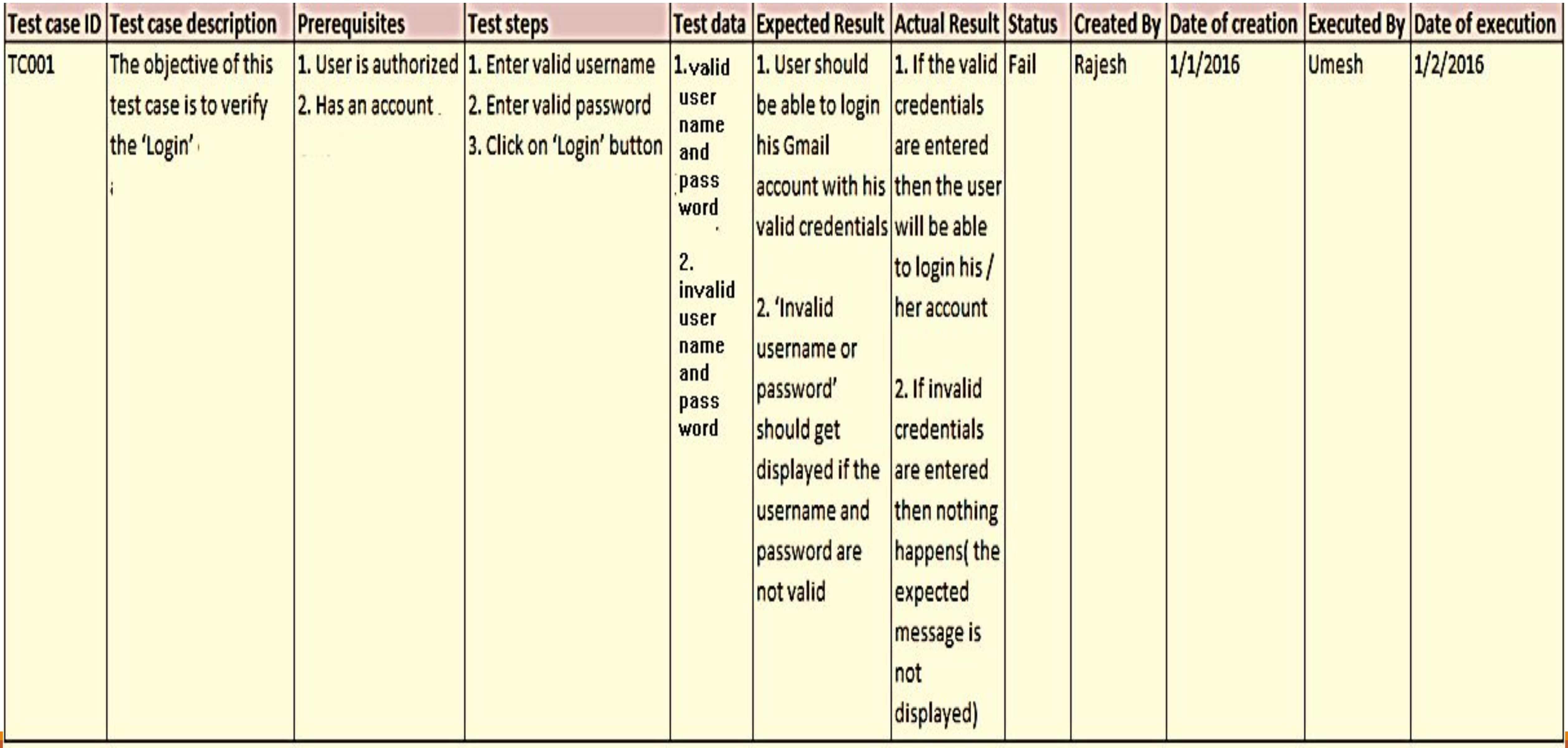
- These involve people examining the source representation with the aim of discovering anomalies and defects.
- Inspections do not require execution of a system so may be used before implementation.
- They may be applied to any representation of the system (requirements, designs, configuration data, test data, etc.).
- They have been shown to be an effective technique for discovering program errors.
- Inspections and testing are complementary and not opposing verification techniques.
- Inspections can check conformance with a specification but not conformance with the customer’s real requirements.
- Inspections cannot check non-functional characteristics such as performance, usability, etc.

6.Explain testing process(or Define Test case) with an example test case?

Test Case: **A test case is a specification of the inputs, execution conditions, testing procedure, and expected results that defines a single test to be executed to achieve a particular software testing objective.**

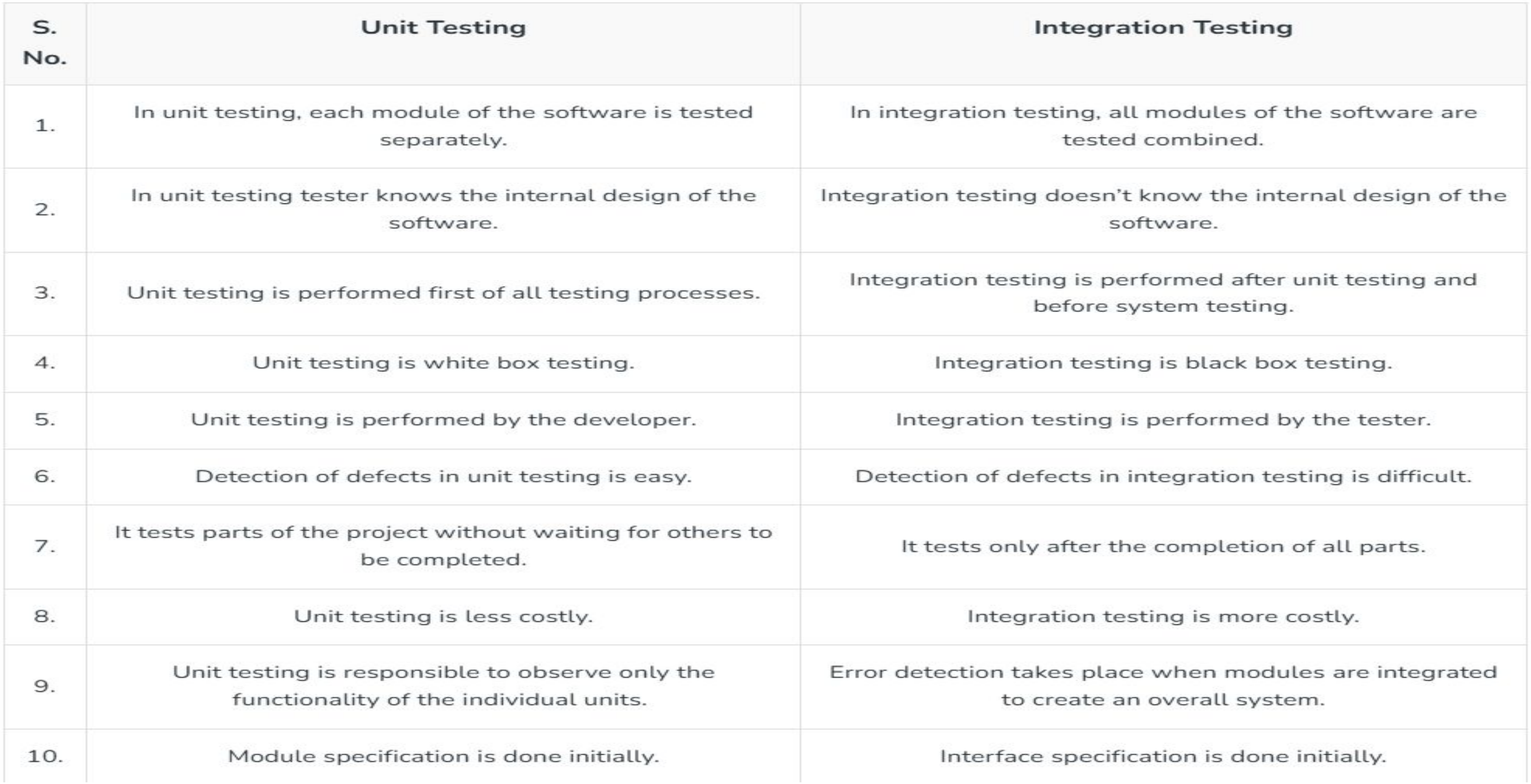


Sample Test Case



Test case ID	Test case description	Prerequisites	Test steps	Test data	Expected Result	Actual Result	Status	Created By	Date of creation	Executed By	Date of execution
TC001	The objective of this test case is to verify the 'Login'	1. User is authorized 2. Has an account	1. Enter valid username 2. Enter valid password 3. Click on 'Login' button	1.valid user name and pass word 2. invalid user name and pass word	1. User should be able to login his Gmail account with his valid credentials 2. 'Invalid username or password' should get displayed if the username and password are not valid	1. If the valid credentials are entered then the user will be able to login his / her account 2. If invalid credentials are entered then nothing happens(the expected message is not displayed)	Fail	Rajesh	1/1/2016	Umesh	1/2/2016

7.Distinguish Unit Testing and Integration Testing?



S. No.	Unit Testing	Integration Testing
1.	In unit testing, each module of the software is tested separately.	In integration testing, all modules of the software are tested combined.
2.	In unit testing tester knows the internal design of the software.	Integration testing doesn’t know the internal design of the software.
3.	Unit testing is performed first of all testing processes.	Integration testing is performed after unit testing and before system testing.
4.	Unit testing is white box testing.	Integration testing is black box testing.
5.	Unit testing is performed by the developer.	Integration testing is performed by the tester.
6.	Detection of defects in unit testing is easy.	Detection of defects in integration testing is difficult.
7.	It tests parts of the project without waiting for others to be completed.	It tests only after the completion of all parts.
8.	Unit testing is less costly.	Integration testing is more costly.
9.	Unit testing is responsible to observe only the functionality of the individual units.	Error detection takes place when modules are integrated to create an overall system.
10.	Module specification is done initially.	Interface specification is done initially.

8.Describe in detail 1.Alpha testing. 2.Beta testing. (Or)

Explain Types of user testing ?

User testing is divided into

Alpha testing

- Users of the software work with the development team to test the software at the developer's site.

Beta testing

- A release of the software is made available to users to allow them to experiment and to raise problems that they discover with the system developers.

Acceptance testing

Customers test a system to decide whether or not it is ready to be accepted from the system developers and deployed in the customer environment. Primarily for custom software systems.

Alpha and Beta Testing

Alpha testing

- Conducted at the developer's site (may be by end users)
- Software is used in a natural setting with developers watching intently
- Testing is conducted in a controlled environment

Beta testing

- Conducted at end-user sites
- Developer is generally not present
- It serves as a live application of the software in an environment that cannot be controlled by the developer
- The end-user records all problems that are encountered and reports these to the developers at regular intervals

After beta testing is complete, software engineers make software modifications and prepare for release of the software product to the entire customer base

ACCEPTANCE TESTING

Acceptance Testing is an important aspect of **Software Testing**, which guarantees that software aligns with user needs and business requirements. The major aim of this test is to evaluate the compliance of the system with the business requirements and assess whether it is acceptable for delivery or not.

Advantages of Acceptance Testing

1. This testing helps the project team to know the further requirements from the users directly as it involves the users for testing.
2. Automated test execution.
3. It brings confidence and satisfaction to the clients as they are directly involved in the testing process.
4. It is easier for the user to describe their requirement.

Disadvantages of Acceptance Testing

1. Users should have basic knowledge about the product or application.
2. Sometimes, users do not want to participate in the testing process.
3. The feedback for the testing takes a long time as it involves many users and the opinions may differ from one user to another user.
4. Development team is not participated in this testing process.

9.Describe Validation Testing?

Validation testing follows integration testing.

Focuses on user-visible actions and user-recognizable output from the system.

Demonstrates conformity with requirements.

Designed to ensure that

- All functional requirements are satisfied
- All behavioral characteristics are achieved
- All performance requirements are attained
- Documentation is correct
- Usability and other requirements are met (e.g., compatibility, error recovery, maintainability)

After each validation test.

- The function or performance characteristic conforms to specification and is accepted.
- A deviation from specification is uncovered and a deficiency list is created.

10.Distinguish between defects and errors?

In software development, **an error is a mistake in the code, while a defect is the result of that error.**

Error

A mistake made by a developer during coding. Errors can be caused by negligence, miscommunication, inexperience, or complexity.

Defect

A mismatch between the expected and actual result of software development. Defects can affect the quality and maintenance of the software system.

Here are some other terms related to errors and defects:

Bug: An error that is detected during the development environment during testing.

Failure: An error that is found by the end user.

11.Elaborate System Testing?

Definition of System Testing

System Testing is a high-level testing process that evaluates the complete and fully integrated software application. It aims to validate that the entire system meets the specified requirements and functions as intended in a real-world environment. This type of testing is performed after integration testing and before acceptance testing. System testing encompasses both functional and non-functional aspects, ensuring that the software is ready for deployment.

Categories of System Testing

System testing can be categorized into several types, each focusing on different aspects of the software. Here are the main categories explained in detail:

Recovery testing

- Tests for recovery from system faults.
- Forces the software to fail in a variety of ways and verifies that recovery is properly performed.
- Tests reinitialization, checkpointing mechanisms, data recovery, and restart for correctness.

Security testing

- Verifies that protection mechanisms built into a system will, in fact, protect it from improper access..

Stress testing

- Executes a system in a manner that demands resources in abnormal quantity, frequency, or volume.

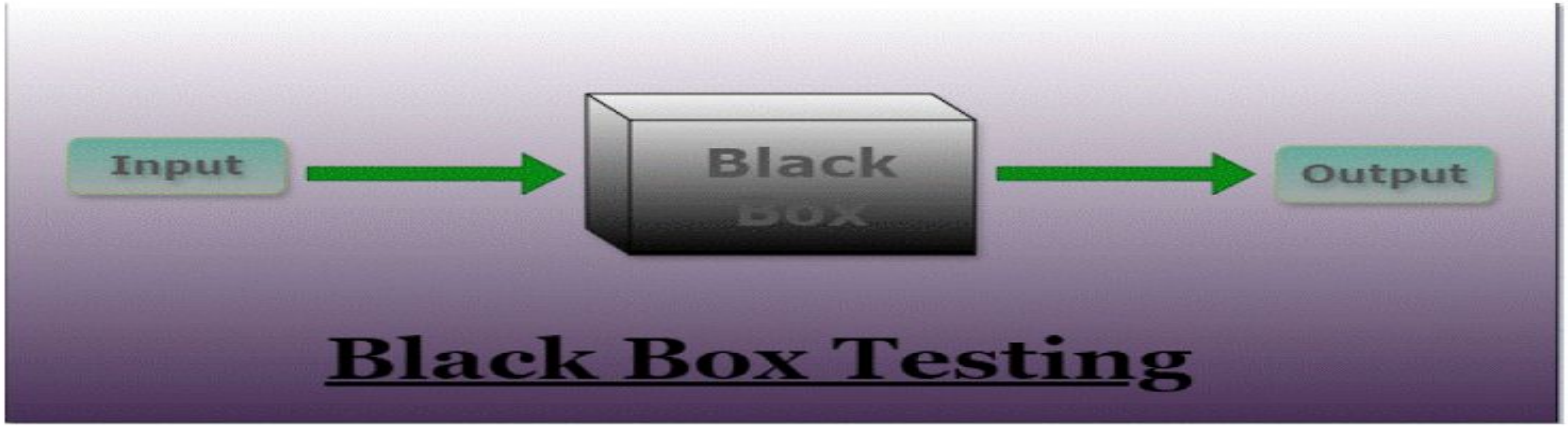
Performance testing

- Tests the run-time performance of software within the context of an integrated system
- Often coupled with stress testing and usually requires both hardware and software instrumentation.
- Can uncover situations that lead to degradation and possible system failure.

12.Discuss equivalence partitioning and boundary value analysis of black box testing?
Or (Explain various Black Box testing Techniques in detail?

Black box testing

Black box testing is a type of software testing in which the tester is not concerned with the software's internal knowledge or implementation details but rather focuses on validating the functionality based on the provided specifications or requirements.



Various Black box testing Techniques are

1.Equivalence Partitioning

Equivalence Partitioning or Equivalence Class Partitioning is type of black box testing technique which can be applied to all levels of software testing like unit, integration, system, etc.

In this technique, the input domain of a program is divided into equivalence data partitions (**also called equivalence class**) that can be used to derive test cases which reduces time required for testing because of small number of test cases are needed.

Test case design is based on an evaluation of equivalence classes for an input condition.

An equivalence class represents a set of valid or invalid states for input conditions.

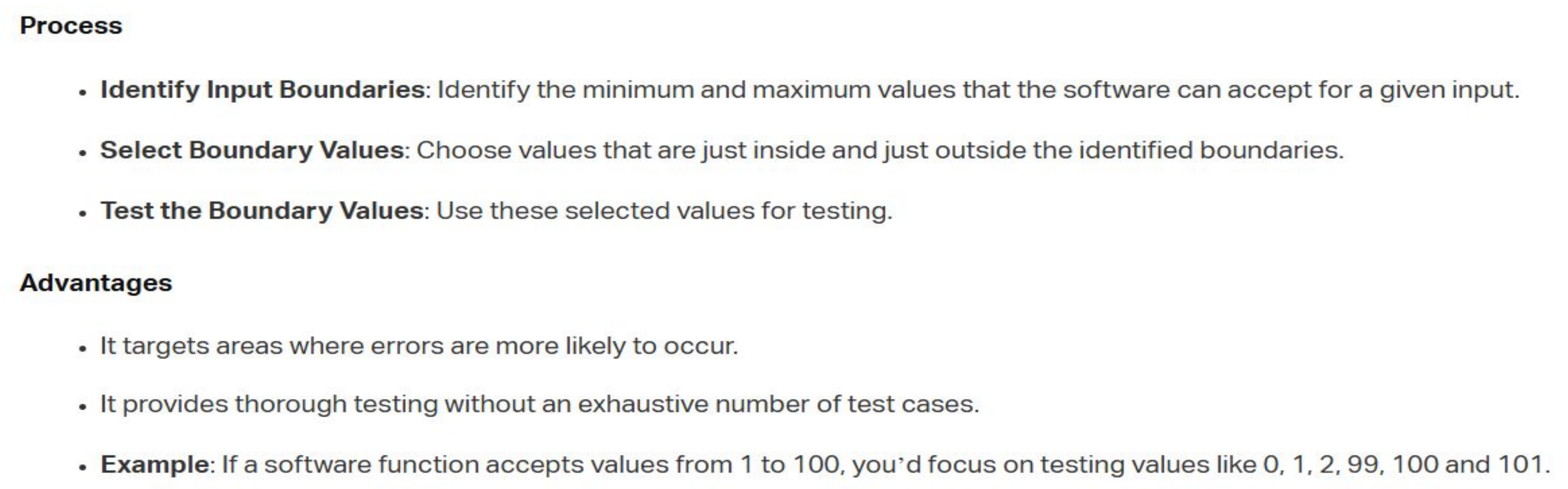
Boundary Value Analysis

It is another frequently used black-box testing technique.

A greater number of errors occur at the boundaries of the input domain rather than in the "center“.

Boundary value analysis is a test case design method that complements equivalence partitioning.

- It selects test cases at the edges of an input domain.



Process

- **Identify Input Boundaries**: Identify the minimum and maximum values that the software can accept for a given input.
- **Select Boundary Values**: Choose values that are just inside and just outside the identified boundaries.
- **Test the Boundary Values**: Use these selected values for testing.

Advantages

- It targets areas where errors are more likely to occur.
- It provides thorough testing without an exhaustive number of test cases.
- **Example**: If a software function accepts values from 1 to 100, you’d focus on testing values like 0, 1, 2, 99, 100 and 101.

13.Discuss the guidelines to be followed in defining equivalence classes?

1. If an input condition specifies a range bounded by values *a* and *b*, test cases should be designed with values *a* and *b* as well as values just above and just below *a* and *b*

- ~~Consider an example where a program under test accepts values only from 100 to 5000.~~
- The valid and invalid test cases are listed below.

Valid Test Cases

a) Enter the value 100 which is min value.

b) Enter the value 101 which is min+1 value.

c) Enter the value 4999 which is max-1 value.

d) Enter the value 5000 which is max value.

Invalid Test Cases

a) Enter the value 99 which is min-1 value.

b) Enter the value 5001 which is max+1 value

2. If an input condition specifies a number of values (i.e. a set), test case should be developed that exercise the minimum and maximum numbers. Values just above and just below the minimum and maximum are also tested

14.Discuss the Guidelines for Boundary Value Analysis?

1. If an input condition specifies a range bounded by values *a* and *b*, test cases should be designed with values *a* and *b* as well as values just above and just below *a* and *b*

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❑ **Invalid Test Cases**

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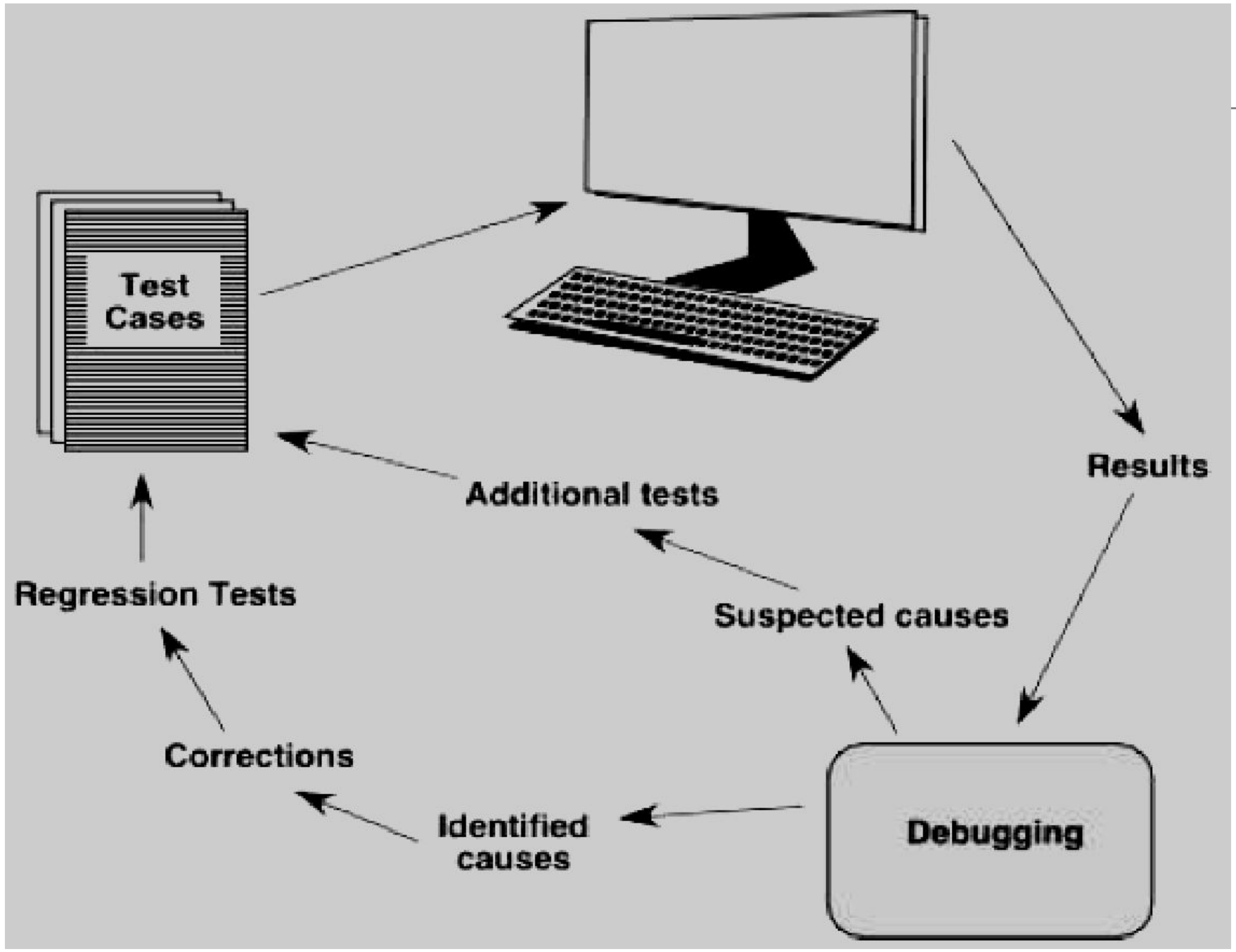
15.Elaborate the Debugging process?



Debugging occurs as a consequence of successful testing.

It is still very much an art rather than a science

Good debugging ability may be an innate human trait.

Large variances in debugging ability exist.

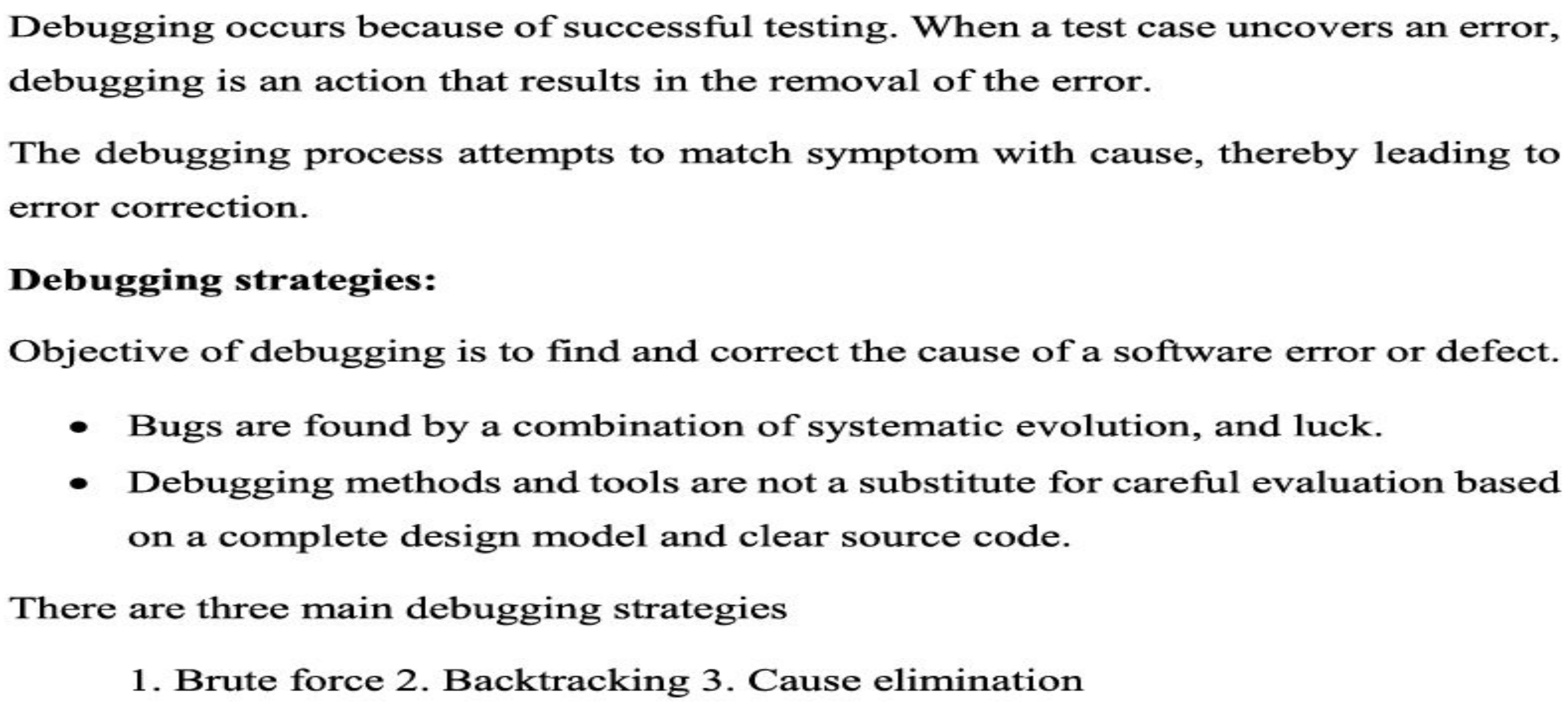
The debugging process begins with the execution of a test case.

Results are assessed and the difference between expected and actual performance is encountered.

This difference is a symptom of an underlying cause that lies hidden.

The debugging process attempts to match symptom with cause, thereby leading to error correction.

16.Describe the Debugging Approaches used in Testing?



Debugging occurs because of successful testing. When a test case uncovers an error, debugging is an action that results in the removal of the error.

The debugging process attempts to match symptom with cause, thereby leading to error correction.

Debugging strategies:

Objective of debugging is to find and correct the cause of a software error or defect.

- Bugs are found by a combination of systematic evolution, and luck.
- Debugging methods and tools are not a substitute for careful evaluation based on a complete design model and clear source code.

There are three main debugging strategies

1. Brute force 2. Backtracking 3. Cause elimination

Strategy #1: Brute Force

- This is conceptually the simplest of the methods, and often the least successful.
- This involves the developer manually searching through stack-traces, memory-dumps, log files, and so on, for traces of the error.
- Extra output statements, in addition to break points, are often added to the code in order to examine what the software is doing at every step.

Strategy #2: Backtracking

- An effective method for locating errors in small programs is to backtrack the incorrect results through the logic of the program until you find the point where the logic went wrong.
- In other words, start at the point where the program gives the incorrect result—such as where incorrect data were printed, program produces observable error. The developer than backtracks through the execution path, looking for the cause.
- Can be used successfully in small programs.
- In large programs, the number of potential backward paths may become unmanageably large.

Strategy #3: Cause Elimination

- In this method, the developer develops hypotheses as to why the bug has occurred.
- The code ~~can either be directly examined for the bug, or data to test the hypothesis can~~ be constructed.
- Data related to the error occurrence are organized to isolate potential causes
- A cause hypothesis is devised, and the aforementioned data are used to prove or disprove the hypothesis.
- A list of all possible causes is developed, and tests are conducted to eliminate each cause.
- If initial tests indicate that a particular cause hypothesis shows promise, data are refined in an attempt to isolate the bug.

17.Describe Basis Path Testing with an example?

This is a White-box testing technique proposed by Tom McCabe.

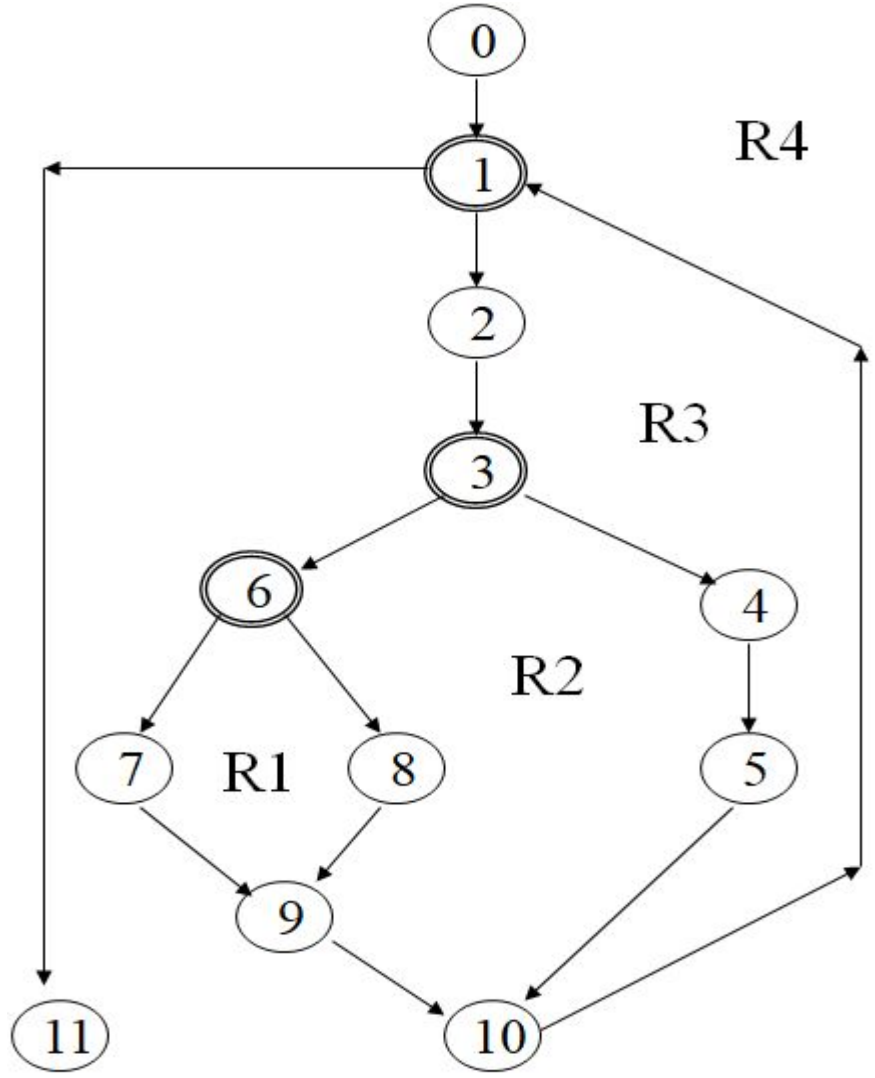
It ~~enables the test case designer to derive a logical complexity measure of a~~ procedural design.

It uses this measure as a guide for defining a basis set of execution paths.

Test cases derived to exercise the basis set are guaranteed to execute every statement in the program at least one time during testing.

A Flow Graph is constructed to show the basis paths.

Flow Graph Notation



A circle in a graph represents a node, which stands for a sequence of one or more procedural statements.

A node containing a simple conditional expression is referred to as a predicate node.

- Each compound condition in a conditional expression containing one or more Boolean operators (e.g., and, or) is represented by a separate predicate node.
- A predicate node has two edges leading out from it (True and False)

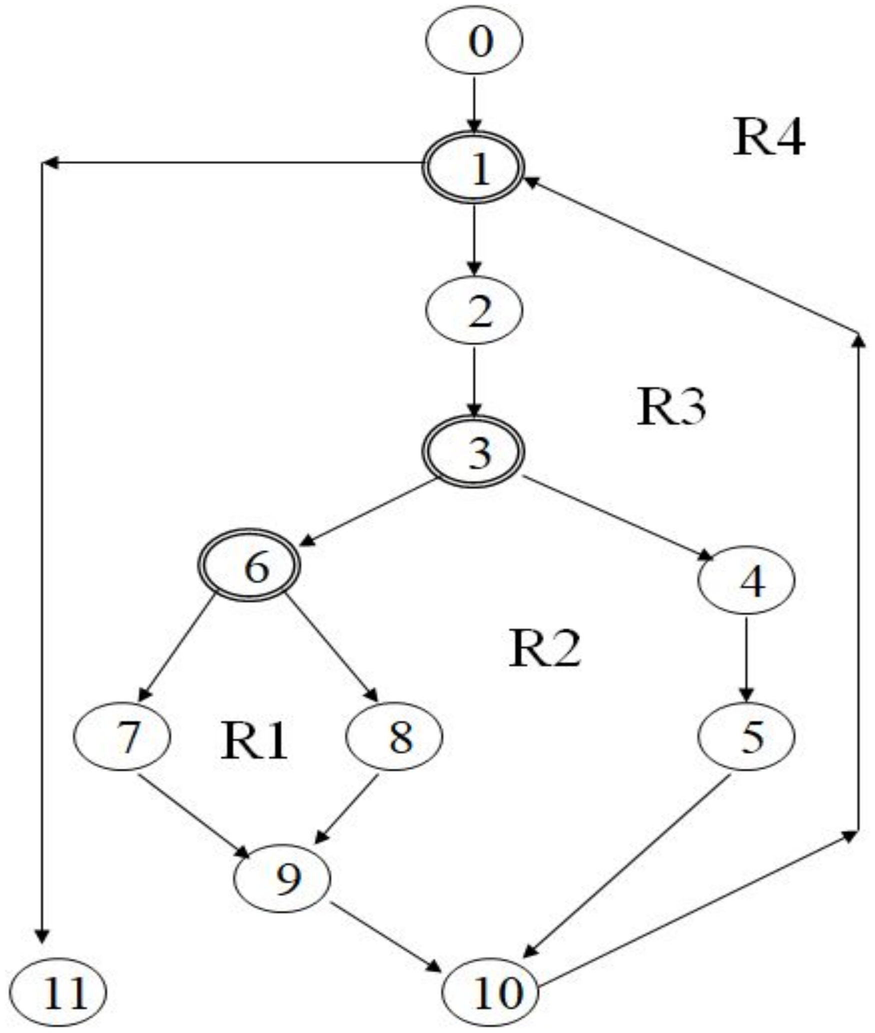
An edge, or a link, is a an arrow representing flow of control in a specific direction

- An edge must start and terminate at a node.
- An edge does not intersect or cross over another edge.

Areas bounded by a set of edges and nodes are called regions.

When counting regions, include the area outside the graph as a region too.

Basis Paths / Independent Paths



Defined as a path through the program from the start node until the end node that introduces at least one new set of processing statements or a new condition (i.e., new nodes).

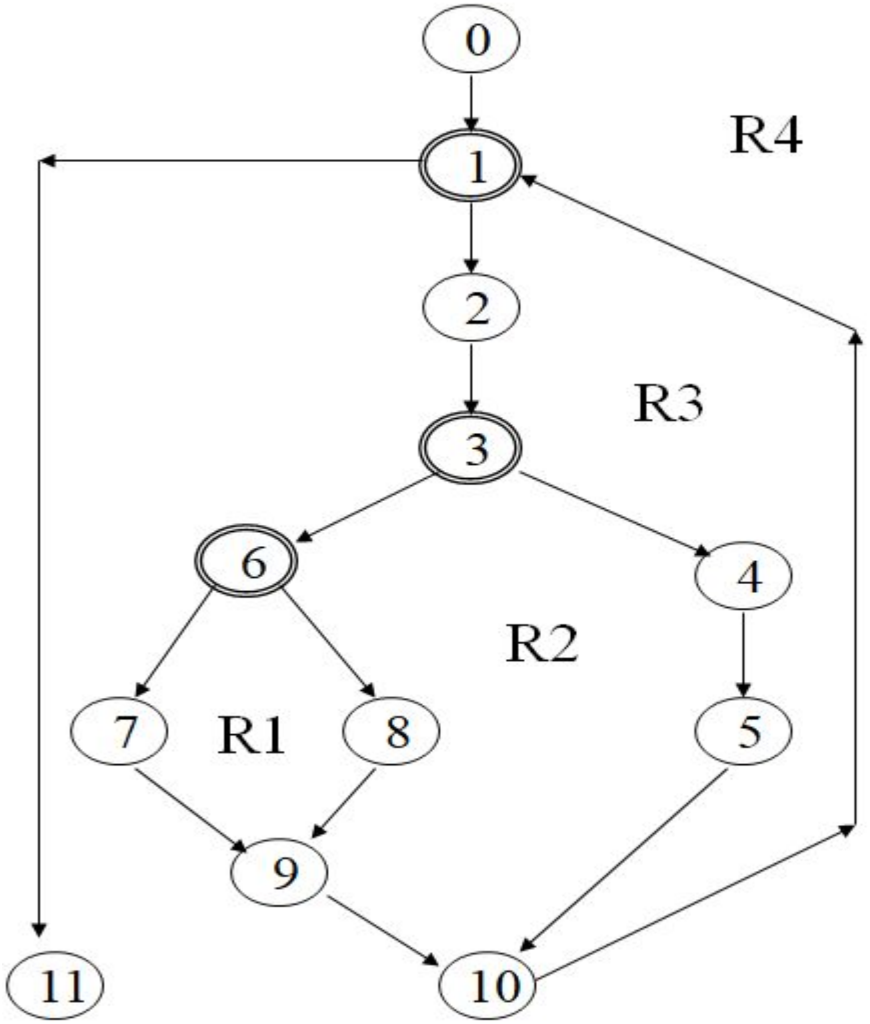
Must move along at least one edge that has not been traversed before by a previous path

Basis set for flow graph

- Path 1: 0-1-11
- Path 2: 0-1-2-3-4-5-10-1-11
- Path 3: 0-1-2-3-6-8-9-10-1-11
- Path 4: 0-1-2-3-6-7-9-10-1-11

The number of paths in the basis set is determined by the cyclomatic complexity

18.Describe cyclomatic complexity with an example?



Provides a quantitative measure of the logical complexity of a program.

Defines the number of independent paths in the basis set.

Provides an upper bound for the number of tests that must be conducted to ensure all statements have been executed at least once.

Can be computed three ways

The number of regions , **V(G) = E – N + 2**,

- where E is the number of edges and N is the number of nodes in graph G.
- V(G) = P + 1, where P is the number of predicate nodes in the flow graph G.

Results in the following equations for the example flow graph

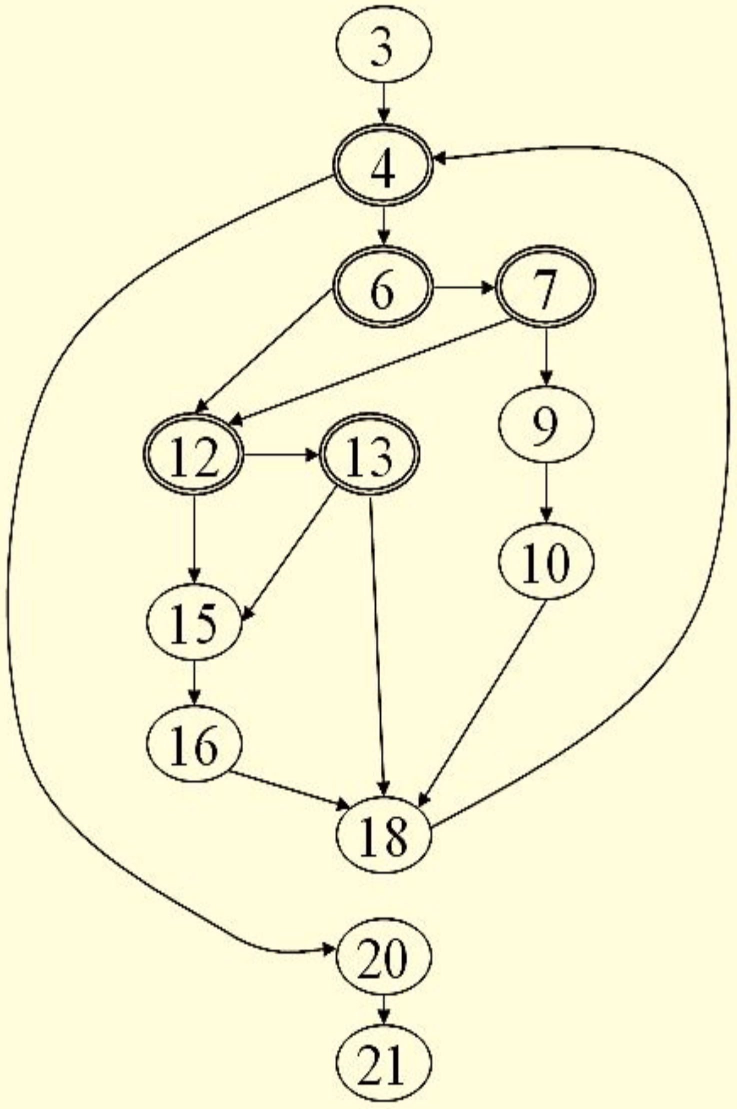
- Number of regions = 4
- V(G) = 14 edges – 12 nodes + 2 = 4
- V(G) = 3 predicate nodes + 1 = 4

Deriving the Basis Set and Test Cases

```
1   int functionZ(int y)
2   {
3   int x = 0;

4   while (x <= (y * y))
5       {
6       if ((x % 11 == 0) &&
7          (x % y == 0))
8           {
9           printf("%d", x);
10          x++;
11          } // End if
12      else if ((x % 7 == 0) ||
13               (x % y == 1))
14          {
15          printf("%d", y);
16          x = x + 2;
17          } // End else
18      printf("\n");
19      } // End while

20  printf("End of list\n");
21  return 0;
22  } // End functionZ
```



1) Using the code, draw a corresponding flow graph.

2) Determine the cyclomatic complexity of the resultant flow graph.

3) Determine a basis set of linearly independent paths.

4) Prepare test cases that will force execution of each path in the basis set.

V(G) = 17 edges – 13 nodes + 2 = 6

Basis Set:

- Path 1: 3-4-20-21
- Path 2: 3-4-6-12-15-16-18-4-20-21
- Path 3: 3-4-6-12-13-15-16-18-4-20-21
- Path 4: 3-4-6-12-13-18-4-20-21
- Path 5: 3-4-6-7-12-13-18-4-20-21
- Path 6: 3-4-6-7-9-10-18-4-20-21

19.Classify software Testing Techniques? Or Explain whitebox and Black box testing techniques?

White-box testing

- Knowing the internal workings of a product, test that all internal operations are performed according to specifications and all internal components have been exercised.
- Involves tests that concentrate on close examination of procedural detail.
- Logical paths through the software are tested
- Test cases exercise specific sets of conditions and/or loops.

Black-box testing

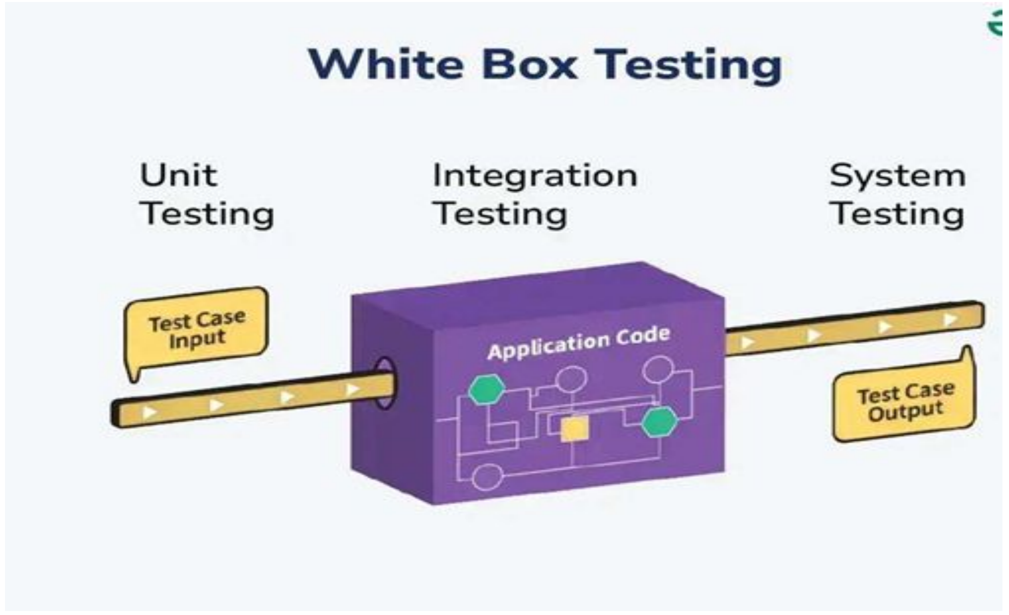
- Knowing the specified function that a product has been designed to perform, test to see if that function is fully operational and error free.
- Includes tests that are conducted at the software interface.
- Not concerned with internal logical structure of the software .

White-box Testing

White-box testing sometime referred to as **Glass-box testing** is an approach used to test the internal logic / procedure of the module.

Using the approach, a software engineer achieves the following:

- Guarantee that all independent paths within a module have been exercised at least once.
- Exercise all logical decisions on their true and false sides.
- Execute all loops (simple and nested) at their boundaries and within their operational bounds.
- Exercise internal data structures to ensure their validity.



Black-box Testing

- Here, the tester has no knowledge of the internal logic of the program/ software.

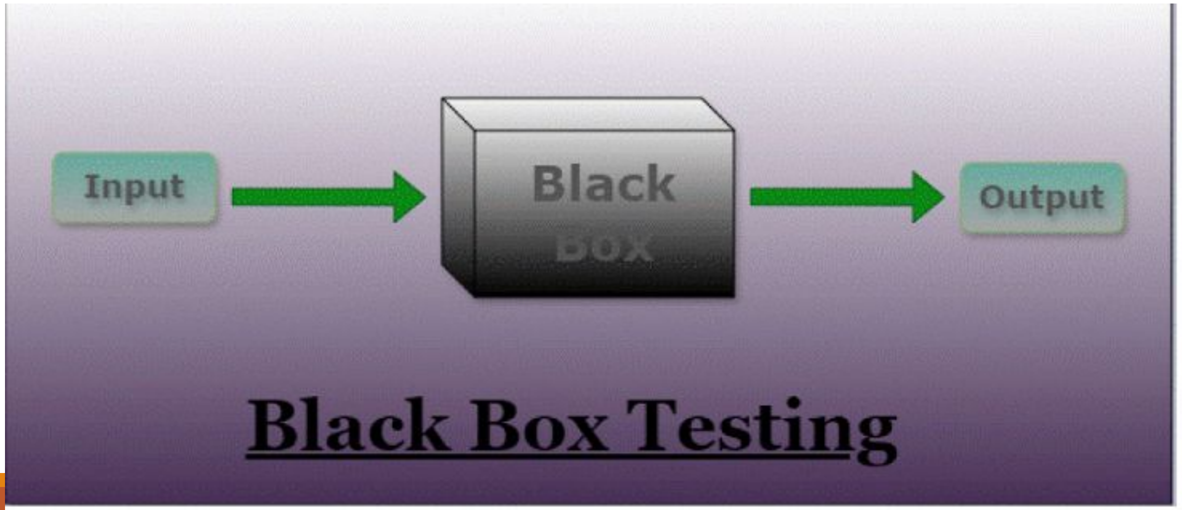
It complements white-box testing by uncovering different types of errors.

Used after white box testing has been performed.

Focuses on the functional requirements and the information domain of the software.

The test cases uncover the following errors:

- Incorrect or missing functions.
- Interface errors.
- Errors in data structures or external data base access.
- Behavior or performance errors.
- Initialization and termination errors.



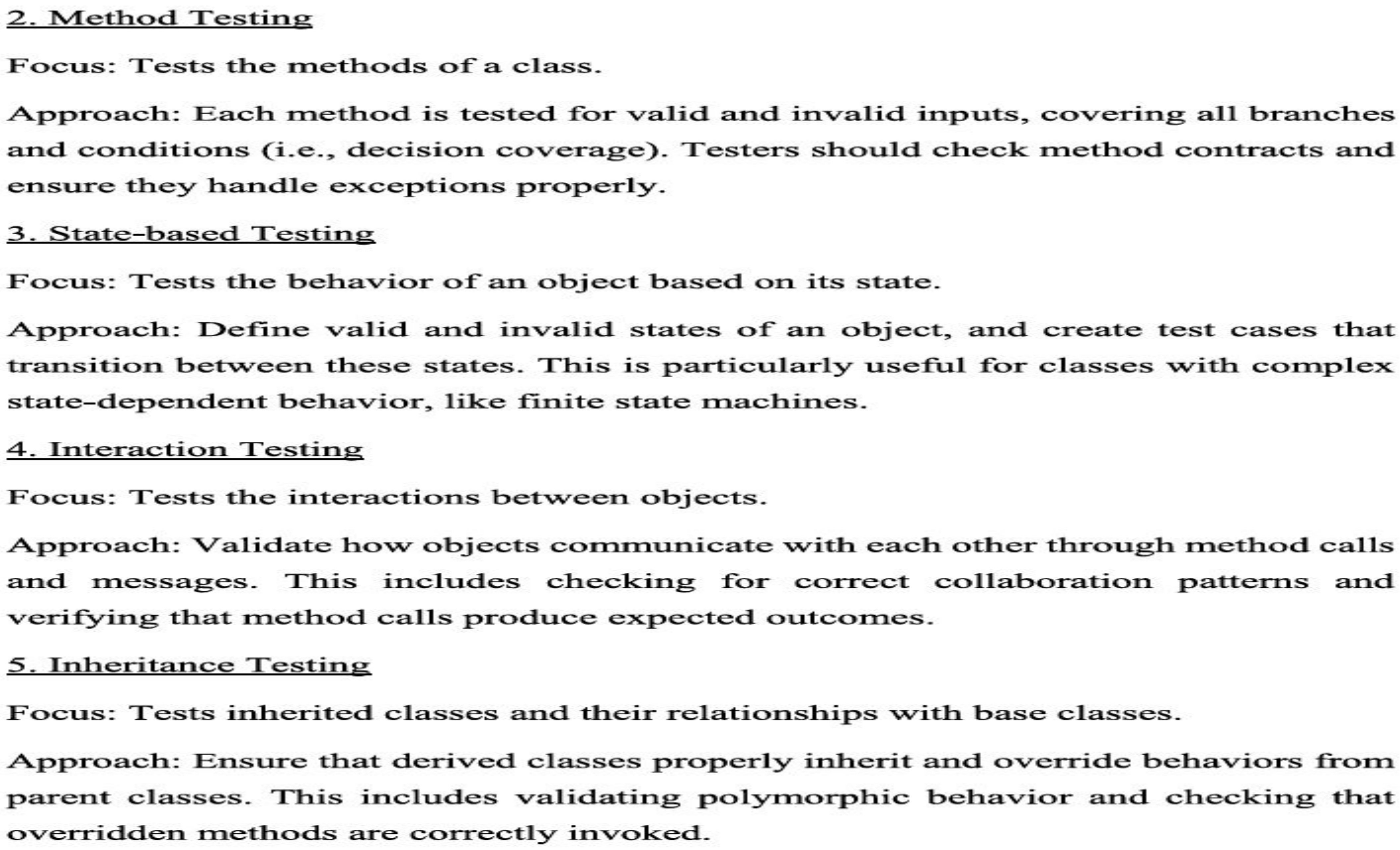
4. What are the test strategies for Object oriented software? (8m)

Testing object-oriented software requires specific strategies that account for the unique features and behaviors of object-oriented programming (OOP) paradigms, such as encapsulation, inheritance, and polymorphism. Here are some.:

1. Class Testing

Focus: Tests the individual classes in isolation.

Approach: Verify that each class behaves as expected, including its methods, properties, and interactions with other classes. Ensure that constructors and destructors work correctly, and validate encapsulated data.



2. Method Testing

Focus: Tests the methods of a class.

Approach: Each method is tested for valid and invalid inputs, covering all branches and conditions (i.e., decision coverage). Testers should check method contracts and ensure they handle exceptions properly.

3. State-based Testing

Focus: Tests the behavior of an object based on its state.

Approach: Define valid and invalid states of an object, and create test cases that transition between these states. This is particularly useful for classes with complex state-dependent behavior, like finite state machines.

4. Interaction Testing

Focus: Tests the interactions between objects.

Approach: Validate how objects communicate with each other through method calls and messages. This includes checking for correct collaboration patterns and verifying that method calls produce expected outcomes.

5. Inheritance Testing

Focus: Tests inherited classes and their relationships with base classes.

Approach: Ensure that derived classes properly inherit and override behaviors from parent classes. This includes validating polymorphic behavior and checking that overridden methods are correctly invoked.