소프트웨어공학 원리
(SEP521)

Software Testing - II

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SINCE 1971

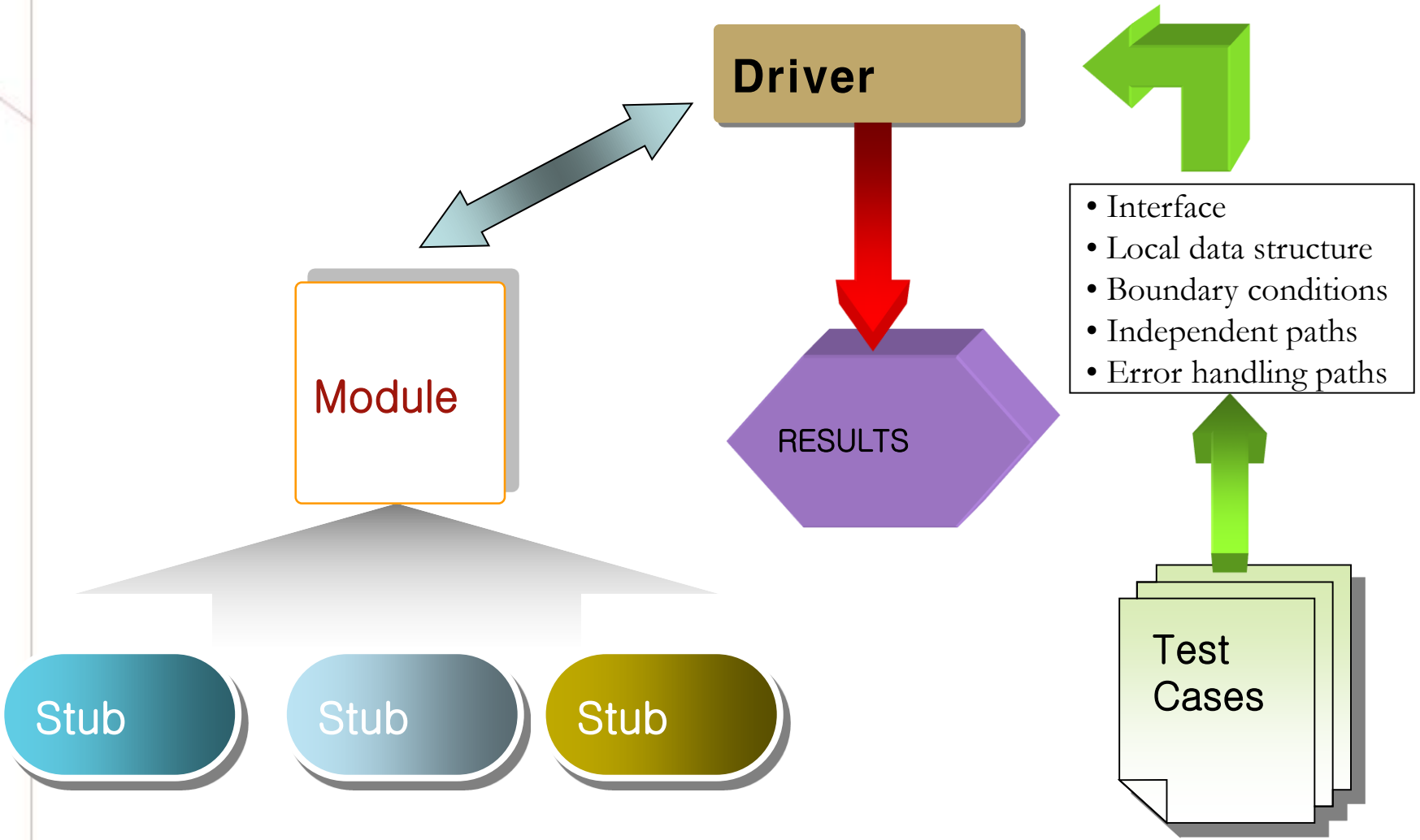
Unit (Component) Testing

- Focus on the smallest software design (module or component)
- Often corresponds to the notion of “compilation unit” from the prog. Language
- Responsibility: Developer
- Test internal processing logic and data structure within the boundary of a component
- Can be conducted in parallel for multiple components
- May be necessary to create stubs: “fake” code that replaces called modules
  - If not yet implemented, or not yet tested

What are tested in Unit Testing?

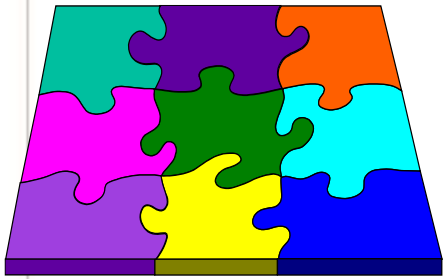
- Information flows for module interfaces
- Local data structures
- All independent paths (basis path) through control structure
- Boundary condition
- Error handling paths

Unit Test Environment



Integration Testing

- Exercise two or more combined units (or components)
- Main objectives:
  - Detect interface errors
  - Assure the functionalities when combined
- Responsibility: Developers or Testing Group



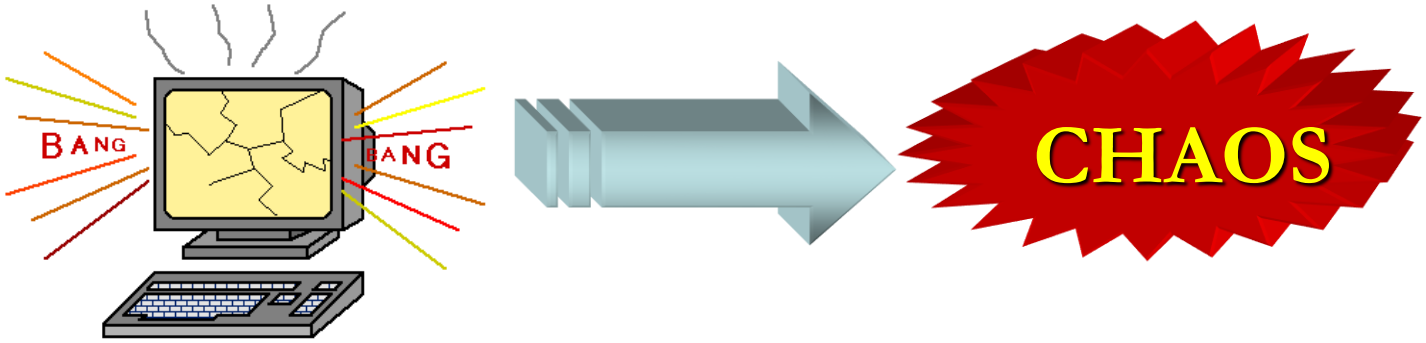
- Issues
  - Integration Strategy (How to Combine?)
  - Integration with thirty-party components
    - Compatibility, Correctness, etc

Integration Testing Strategies

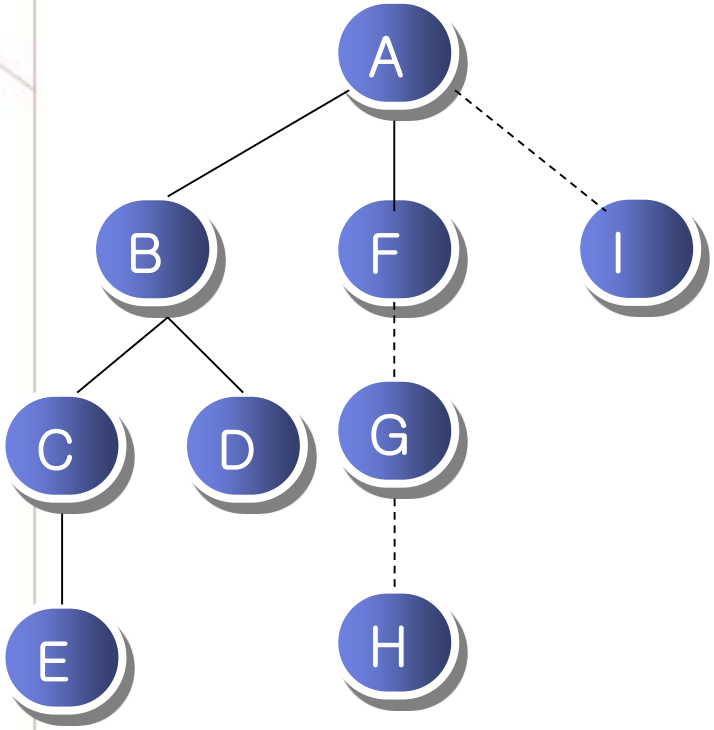
- Non- Incremental Integration
  - "Big Bang" approach
- Incremental Approaches
  - Top-down Integration
  - Bottom-up Integration
  - Sandwich Testing

"Big Bang" Approach

- All unit tested components are combined at once and tested as whole
- Disadvantages
  - Difficult to correct defects
    - Critical and peripheral modules not distinguished
  - When errors are corrected, new ones appear : endless loop
    - User does not see the product until very late in the development life cycle



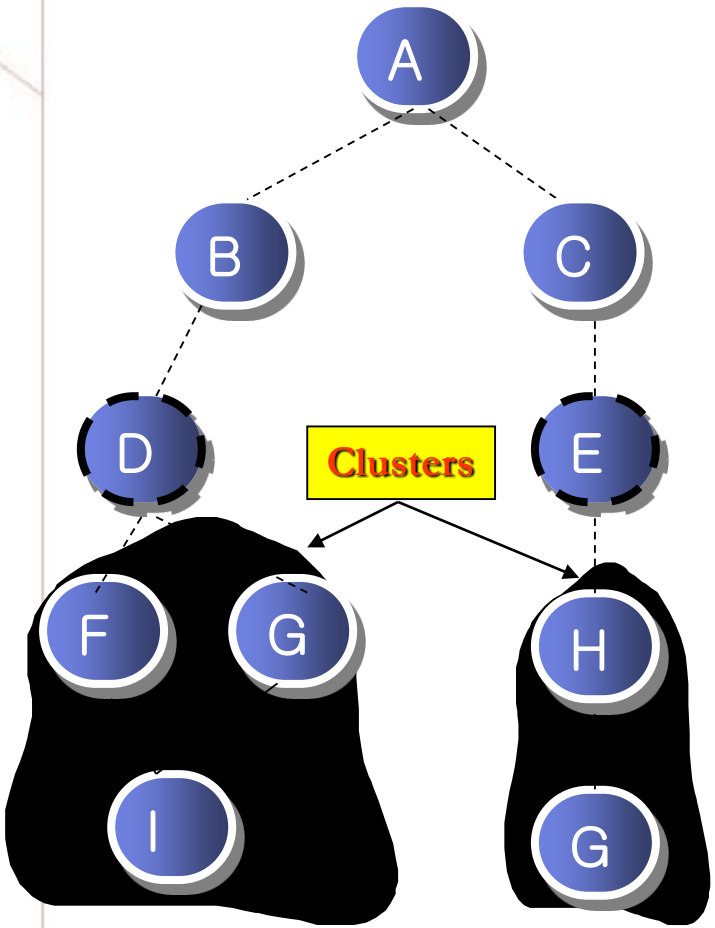
Top-down Integration



Depth-First Approach

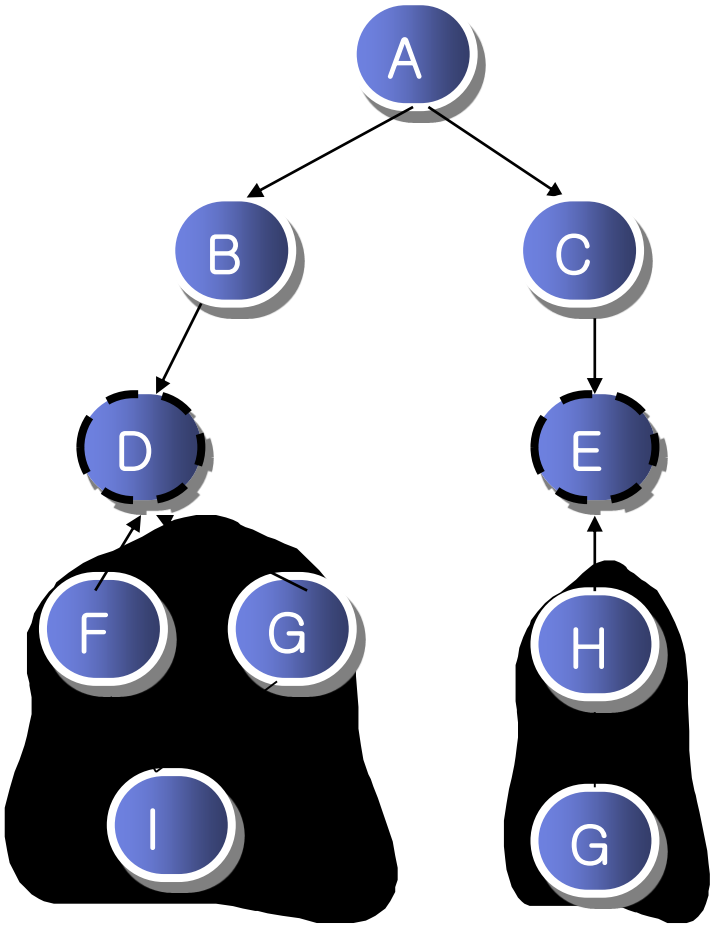
- An Incremental Approach to construction of the software architecture
- Integrated by moving downward through the control hierarchy
  - Depth-First or Breadth-First
- Begins with main control module (main program)

Bottom-up Integration



- Begins construction and testing with atomic modules
  - From components at the lowest levels in the program structure
- No need for stubs
- Drivers are replaced one at a time

Sandwich Integration



- Top level modules are tested with stubs
- Worker modules are integrated into clusters
- Advantages:
  - Significantly Reduced number of drivers
  - Simplified integration of clusters

Regression Testing

- Re-execution of some subset of tests to see if anything is broken by a change
  - Can be applied to unit, integration, and system testing
- Require automatic test suit to be practical
  - Impractical and inefficient to re-execute every test for every program function once a change has occurred
  - Prioritization of test cases (maximize defect detection rate)
- Regression testing is an integral part of the XP software development methodology

Smoke Testing

- Designed as a pacing mechanism for time-critical projects
  - Assess its project on a frequent basis
- Analogy to testing electrical circuits:
  - plug it in and see if it smokes.
- Main objective:
  - to detect “Show Stopper”
- Benefits:
  - Minimized integration risks
  - Improved quality of the end product
  - Simplified error diagnosis and correction
  - Easier progress to access

How to select a strategic option?

- Depends upon software characteristics and project schedule.
- Identify critical modules and test them as early as possible
  - Critical Module's characteristics:
    - Address several software requirements
    - Has a high level of control
    - Complex and error-prone
    - Has definite performance requirements
- Focus on critical module functions in regression tests

Validation Testing

- Intended to show that the software meets its requirements.
  - Focus on user-visible actions and user-recognizable output from the system
- A successful test is one that shows that a requirements has been properly implemented. (Conformity)
- A deviation or error uncovered at this stage can be rarely corrected prior to scheduled delivery
  - Necessary to negotiate with customer to establish a method for resolving deficiencies

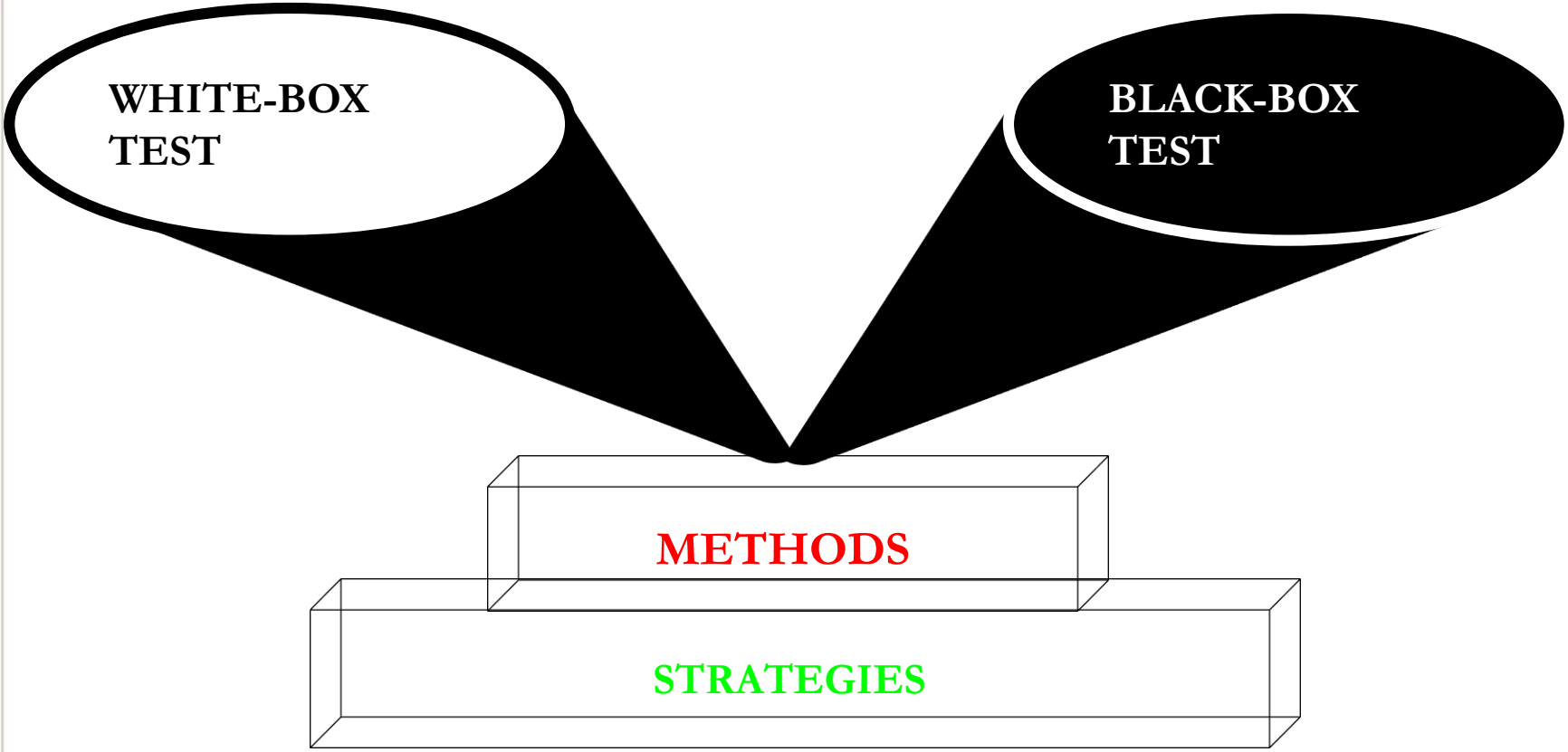
Alpha test vs. Beta test

- Alpha test
  - Conducted at developers' site by end-users
  - Under a controlled environment
  - is often employed for off-the-shelf software as a form of internal acceptance testing
- Beta test
  - Conducted at end-user sites
  - "live application" of the software in an non-controlled environment
  - available to the open public to increase the feedback field to a maximal number of future users

System Testing

- Test the system's compliance with its specified requirements as a whole.
  - After software is incorporated with other system elements (e.g.: Hardware, People, Information)
  - A series of different tests to fully exercise the computer-based system
- Types of system tests
  - Recovery Testing
  - Security Testing
  - Stress Testing
  - Performance Testing

Software Testing



Black-box test vs. White-box test

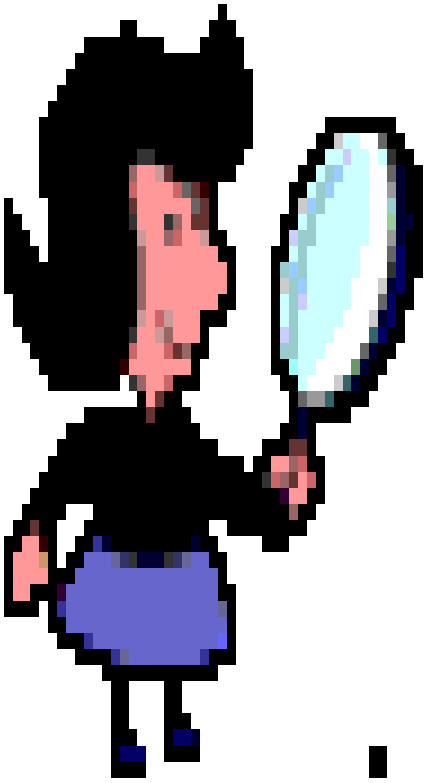
Black-box test

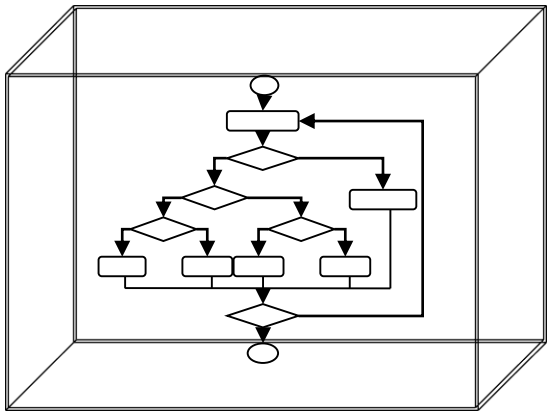
- *Functional or behavioral testing*
- Conducted at software interface
- Examines some fundamental aspect of a system
- Ignores internal logic of a software system

White-box test

- *Glass-box or structural testing*
- Uses knowledge of the internal structure of the software
- Examine procedural detail (logical paths and collaboration b/w components)

White-box Test





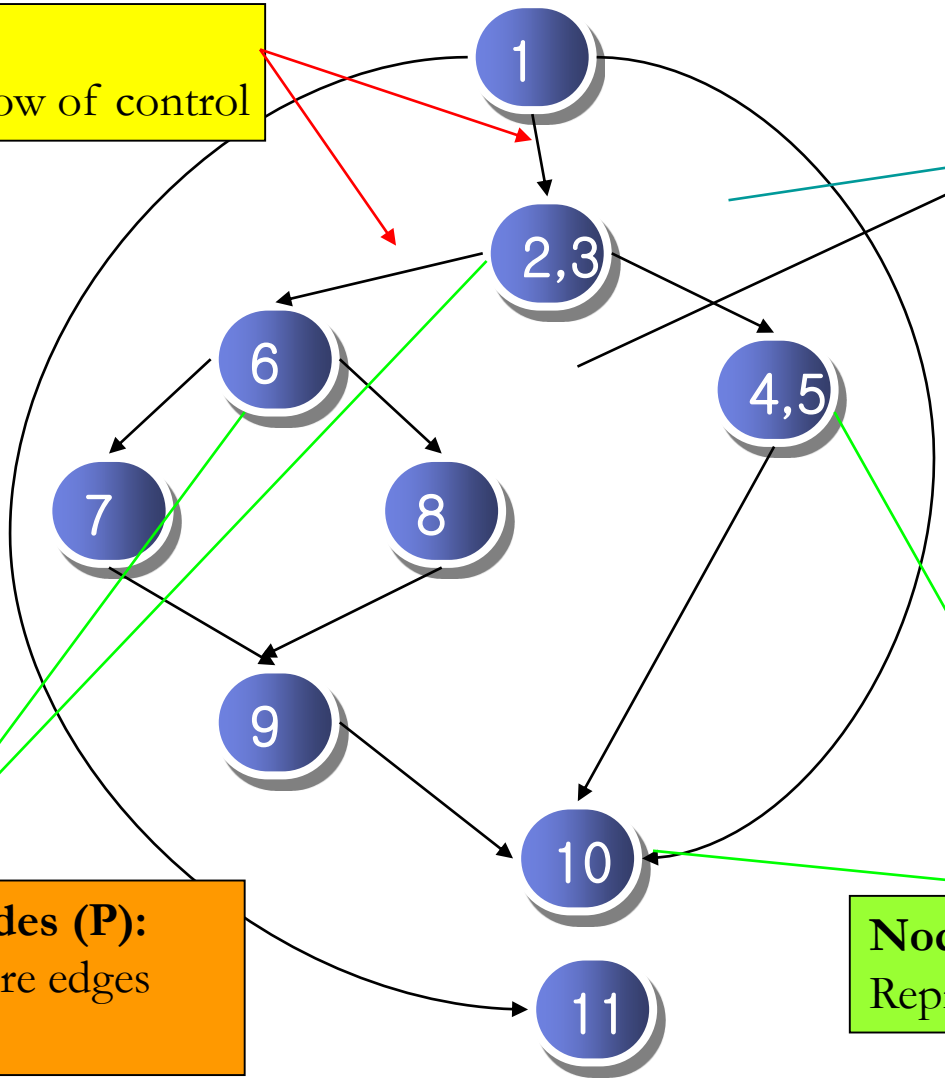
Basis Path Testing

- A white-box testing technique
- Enable to derive a logical complexity measure of a procedural design
- Provide a guideline defining a basis set of execution paths
- Guarantee to execute every statement in the program at once

Flow Graph

Edges (E):
Represent flow of control

Regions (R):
Represent areas bounded by edges and nodes (includes outside of graph)



Predicate Nodes (P):
Has two or more edges from it

Nodes (N):
Represent one or more statements

Independent Paths?

- Any path through the program that introduces at least one new set of processing statements or a new condition
- Test can be designed to force execution of these paths (a basis set)
- Guaranteed to execute every statement at least once

Steps to Derive Test Cases

1. Using the design or code as a foundation, draw a corresponding flow graph
2. Determine the cyclomatic complexity of the 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

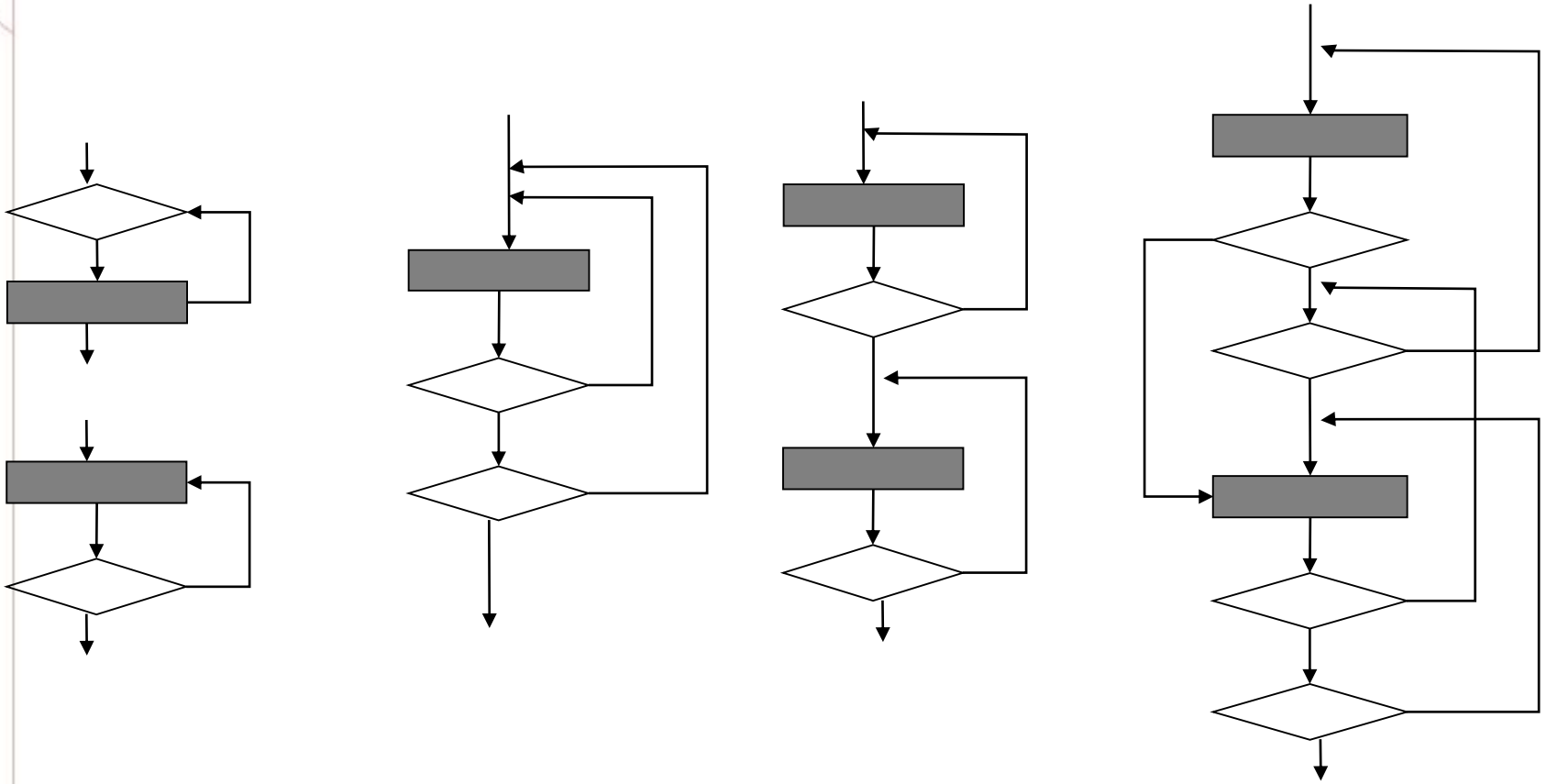
Other Control Structure

- Condition Testing:
  - Focus on exercising the logical condition
    - Simple and compound condition (s) : Boolean variables or relational expression

- Data Flow Testing:
  - Select test paths of a program according to the location s of definitions and uses of variables
  - Define-Use (DU) testing strategy
    - To require that every DU chain be covered at least once
    - No guarantee the coverage of all branches of a program

Loop Testing

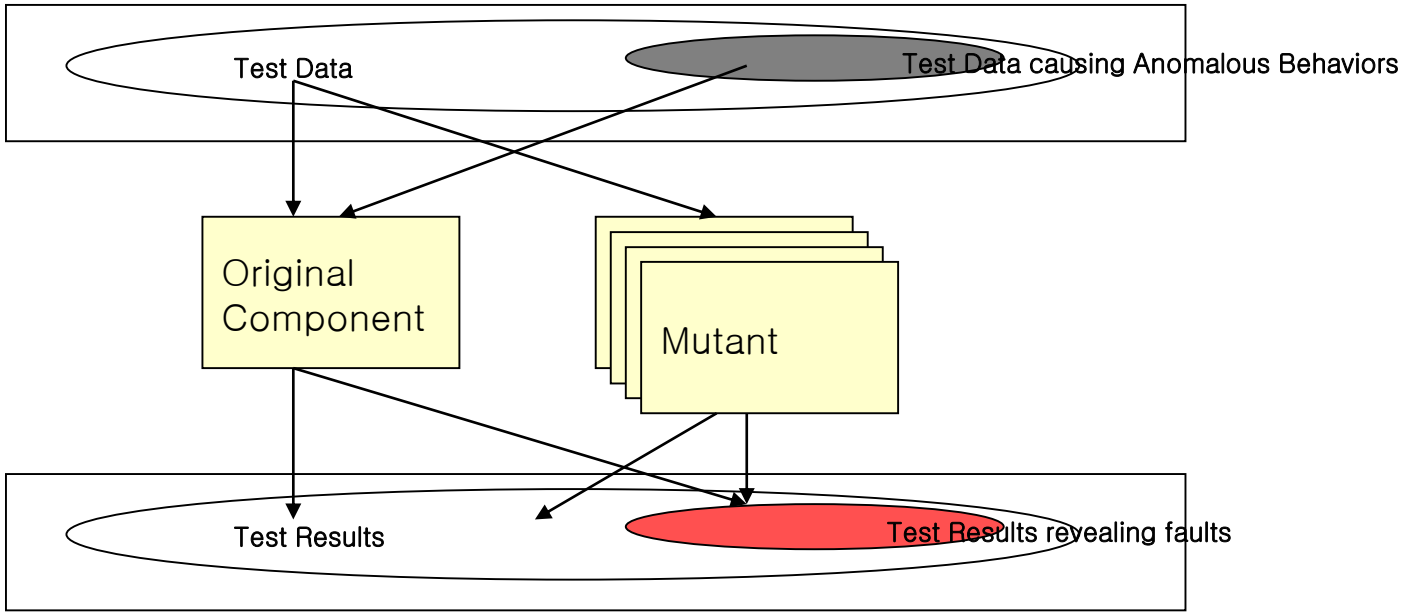
- Focus exclusively on the validity of loop conditions



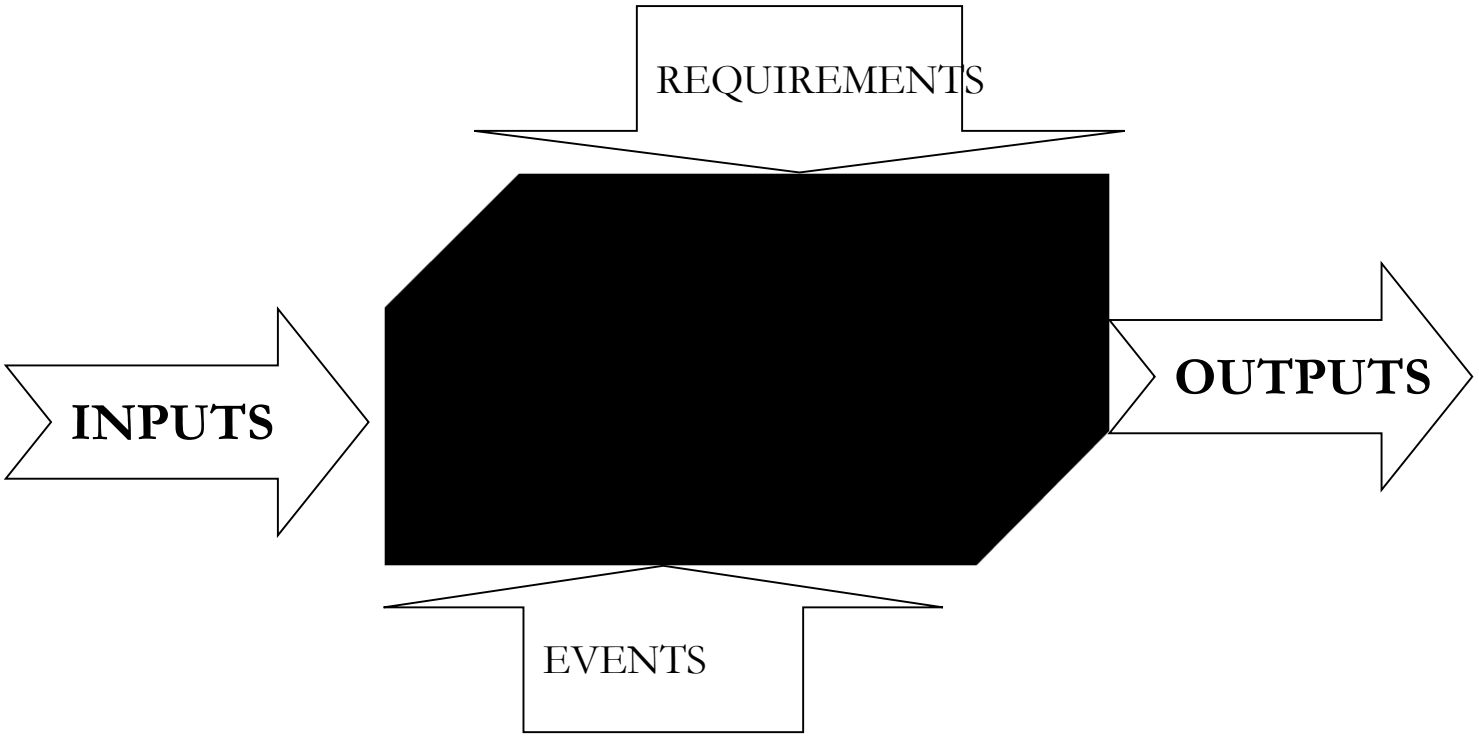
Simple Loop Nested Loop Concatenated Loop Unstructured Loop

Mutation Testing (Fault Injection)

- Test run with mutants which are similar components modified from the original components
  - If the test data reveals the fault in the mutant, kill the mutant
  - If not, the tests can not distinguish the original from the mutant
    - Develop additional test data to reveal the fault and kill the mutant



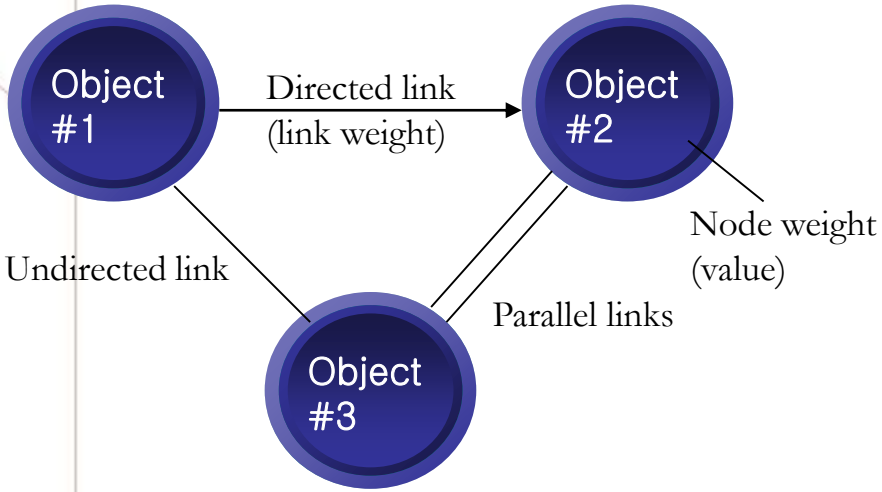
Black-box Testing

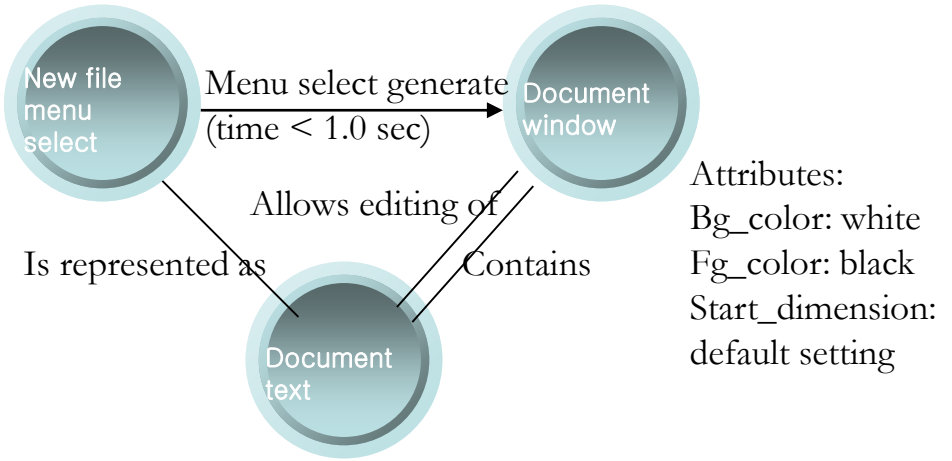


How to Design Black-box tests?

- Questions to be answered for designing tests
  - How is functional validity tested?
  - How is system behavior and performance tested?
  - What classes of input will make good test cases?
  - Is the system particularly sensitive to certain input values?
  - How are the boundaries of a data class isolated?
  - What data rates and data volume can the system tolerate?
  - What effect will specific combinations of data have on system operation?

Graph-Based Testing Method





- First Step in Black-box testing
  - Understand the objects modeled in software and relationships among these objects
- Verify all objects have the expected relationship to one another
  - Design test cases by traversing the graph and covering all the relationships to uncover errors

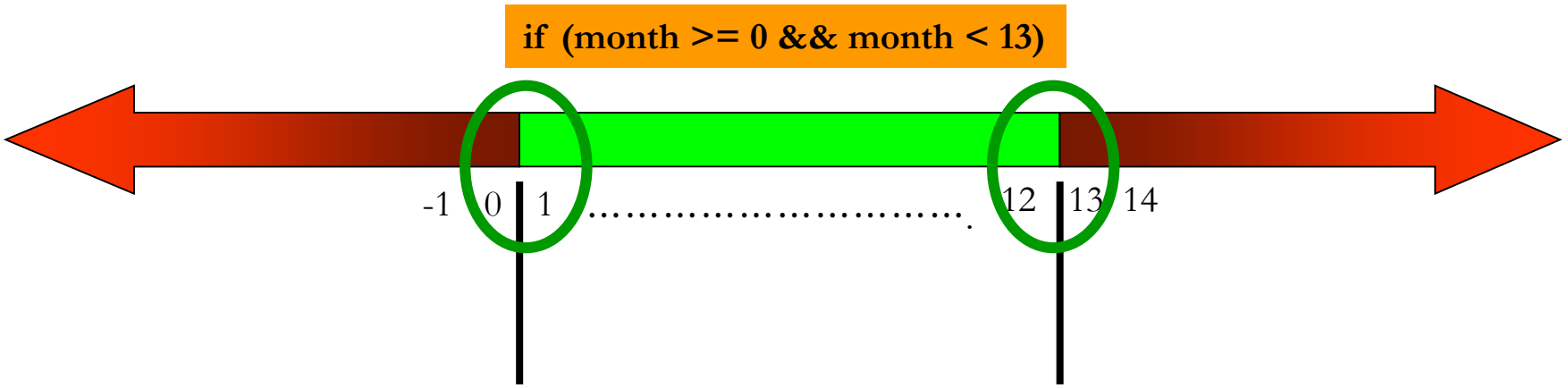
Equivalence Partitioning

- Divides the input domain of a program into classes of data
- Based on an evaluation of equivalent classes for an input condition.
  - An equivalent class: a set of valid or invalid states for input conditions
- Each of these classes is an equivalence partition where the program behaves in an equivalent way for each class member

- A guideline (not a rule) to define equivalence classes
  - If an input condition specifies a range, define one valid and two invalid equivalence classes
  - If an input condition is Boolean, define one valid and one invalid equivalence classes
  - If an input condition requires specific value, define one valid and two invalid equivalence classes
  - If an input condition specifies a member of set, define one valid and one invalid equivalence classes

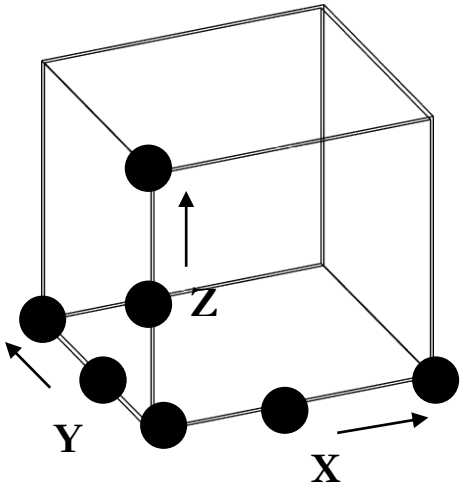
Boundary Value Analysis

- Focus on selecting a set of test cases that exercise bounding values
  - Select test cases at the edges of the class
- Complementary to Equivalence Partitioning
- Derive test cases from output domain as well

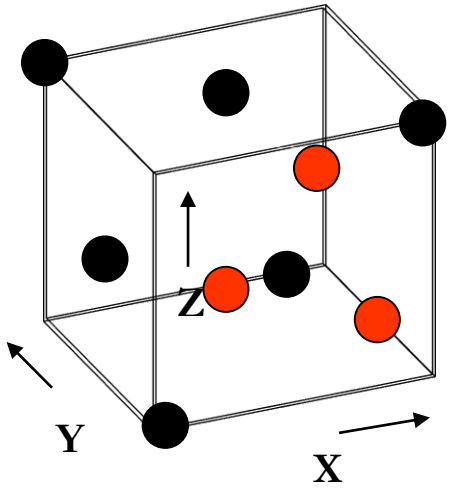


Orthogonal Array Testing

- Can be used when the number of input parameters and their values are clearly bounded
- Support more complete test coverage



One input items at a time



L9 orthogonal array

Q & A