TESTING (PART B)

Chapter 8
Block b

Software Engineering

Computer Science School

DSIC – UPV

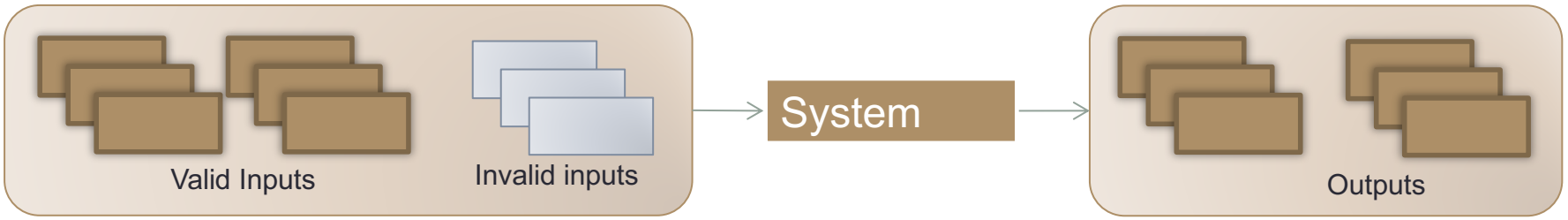
Black-box testing

- Black-box methods are focused on the functional requirements of software.

- Black box tests try to find errors of the following types:
  - Incorrect or non-existent functions.
  - Interface related errors.
  - Errors related to data structures or in external databases.
  - Performance related errors.
  - Initialization and termination errors.

Equivalence Partitioning

- **Input conditions** of the Software under test:
  format or *content restrictions* of the input data
  - Valid data
  - Invalid data
- **Equivalence classes**:
  - A test with a representative value of a class assumes that the obtained results (failure or success) will be the same for any other arbitrary member of the category



Equivalence Partitioning

- **Technique** for the **identification** of test cases:
  1. For each input condition of the software under test, we will identify its equivalence classes using **heuristics**.
  2. A unique number will be assigned to each identified equivalence class.
  3. Until all valid equivalence classes are covered by some test case. A test case covering as many as possible valid classes will be designed.
  4. Until all invalid equivalence classes have been covered. There will be a separate test case per invalid class to be covered.

  The previous process may also be applied to the output conditions of the software under test

Equivalence Partitioning

- **Identification Heuristics** of equivalence classes:
  a) If a **range of values** is specified for the input data, a valid class and two invalid classes will be created
  b) If a **finite value** is specified a valid class and two invalid classes will be created
  c) If a condition of type **«it must be»** or a **boolean** condition is specified (e.g. " the first character must be a character from the alphabet», a valid class «it is an alphabet character» and another invalid class «it is not an alphabet character» will be created
  d) if a **set of valid accepted values** and the program treats them in a different way, then a valid class for each value and another invalid class must be created
  e) If it is suspected that some concrete elements of a class are handled in a different way, the class must be partitioned into **reduced classes**

Exercise: Equivalent Partitioning

- Banking application. Input data (text file):
  - **Area code**: number with 3 digits not starting by 0 nor 1
  - **Operation Name**: 6 characters
  - **Valid Commands**: “check”, “deposit”, “bill payment”, “withdrawal”

Exercise: Equivalence Partitioning

Area Code:

- Boolean:
  - 1 valid class: it is a number
    - Range:
      - 1 valid class: 200 < area code < 999
      - 2 invalid classes: area code < 200; area code > 999
  - 1 invalid class: not a number

Operation Name:

- Finite Value:
  - 1 valid class: 6 characters
  - 2 invalid classes: >6 characters; < 6 characters

Valid commands:

- Set of values:
  - 4 valid classes: 4 valid commands
  - 1 invalid class: invalid command

Exercise: Equivalence Partitioning

Input data	Valid classes	Invalid classes
Area code	(1) 200 <= code <= 999	(2) code < 200 (3) code > 999 (4) not a number
Operation name	(5) 6 characters	(6) < 6 characters (7) > 6 characters
Command	(8) “check” (9) “deposit” (10) “bill payment” (11) “withdrawal”	(12) invalid command

Exercise: Equivalence Partitioning Valid Test Cases

Code	Operation Name	Command	Covered classes
300	Nómina	“Deposit”	(1)^{C} (5)^{C} (9)^{C}
400	Viajes	“Check”	(1) (5) (8)^{C}
500	Coches	“Bill payment”	(1) (5) (10)^{C}
600	Comida	“Withdrawal”	(1) (5) (11)^{C}

Exercise: Equivalence partitioning Invalid Test cases

Code	Operation Name	Command	Covered Classes
180	Viajes	“Bill payment”	(2) C (5) (10)
1032	Nómina	“Deposit”	(3) C (5) (9)
XY	Compra	“Withdrawal”	(4) C (5) (11)
350	A	“Deposit”	(1) (6) C (9)
450	Regalos	“Check”	(1) (7) C (8)
550	Casita	&%4	(1) (5) (12) C

Analysis of Boundary values

- This technique selects as values for the test cases those that are boundary values (errors often occur at the boundaries).
- It complements the equivalent partitioning technique. Instead of selecting an arbitrary value from an equivalence class we choose a boundary value.
- Test cases may be derived for both input conditions and output conditions.

Analysis of Boundary values

- Heuristics:
  - If an input condition specifies a range of values limited by a and b, test cases must be defined using the a and b values and other values just below and above them.
  - If an input condition specifies a number of values, test cases must be define to consider the minimum and maximum values and also those just below and above them.

Analysis of Boundary Values

- Heuristics:
  - Apply the previous heuristics also to output conditions. Define test cases that produce values in the boundaries.
  - If we use data structures with boundaries (e.g., an array of 10 elements), a test case must be defined so that the data structure is tested at its boundaries.

Other types of tests

- Walkthroughs.
- Robustness testing
- Stress testing
- Performance testing
- Conformance testing
- Interoperability testing

Automatic Testing tools

- Static Analyzers. These systems allow the testing of those statements considered as weak within a program.
- Code auditing. Filters defined to verify that the code complies with different quality criteria (usually strongly dependent on the programming language).
- Test files generators. These tools automatically generate files with data that will serve as input for programs.
- Test Data Generators. These systems generate contrete input data to drive the program to a concrete behavior.
- Test controllers. Generate and feed the input data and simulate the behavior of other modules to restrict the scope of the test.

Automatic Testing tools

- Static Analyzers:
  - Data bugs: variables being used before they are initialized, variables defined but never used, variables not used between to assignment statements, violations of the size of an array, etc.
  - Control bugs: code fragments that are never reached.
  - Input/Output bugs: an output variable is returned without modifying its value.
  - Interface bugs: types or incorrect number of parameters, not using the result value of a function, never called functions.
  - Bugs related to pointers management.

Equivalence Partitioning: Exercise

A program takes as input a file with the following record format (fields):

- Num-employee is a field of positive integers less than 1000 and excluding 0.
- Name-employee is an alphanumeric field with 10 characters.
- Months-Work is a field indicating the number of months an employee is working; it is a positive integer less than 1000 and including 0.
- Manager is a field with just one character that may be «+» to indicate that an employee is a manager and «-» otherwise.

The program assigns a bonus to each employee and prints the list of assigned bonus following these rules:

- B1 for manager with at least 12 months of work experience
- B2 for non- managers with at least 12 months of experience
- B3 for manager with less than 12 months of experience
- B4 for non managers with less than 12 months of working experience

Obtain:

a) A table of numbered equivalence classes with the following columns: 1 Input Condition under consideration; 2 Valid Classes and 3 Invalid classes 4 Heuristic rule that is applied

b) The associated test cases