Chapter 4:

Test Design Techniques

- IV/01 Designing test cases
- IV/02 Categories of test design techniques
- IV/03 Black box techniques
- IV/04 White box techniques
- IV/05 Experience- based techniques
- IV/06 Choosing test techniques

IV – Test Design Technique

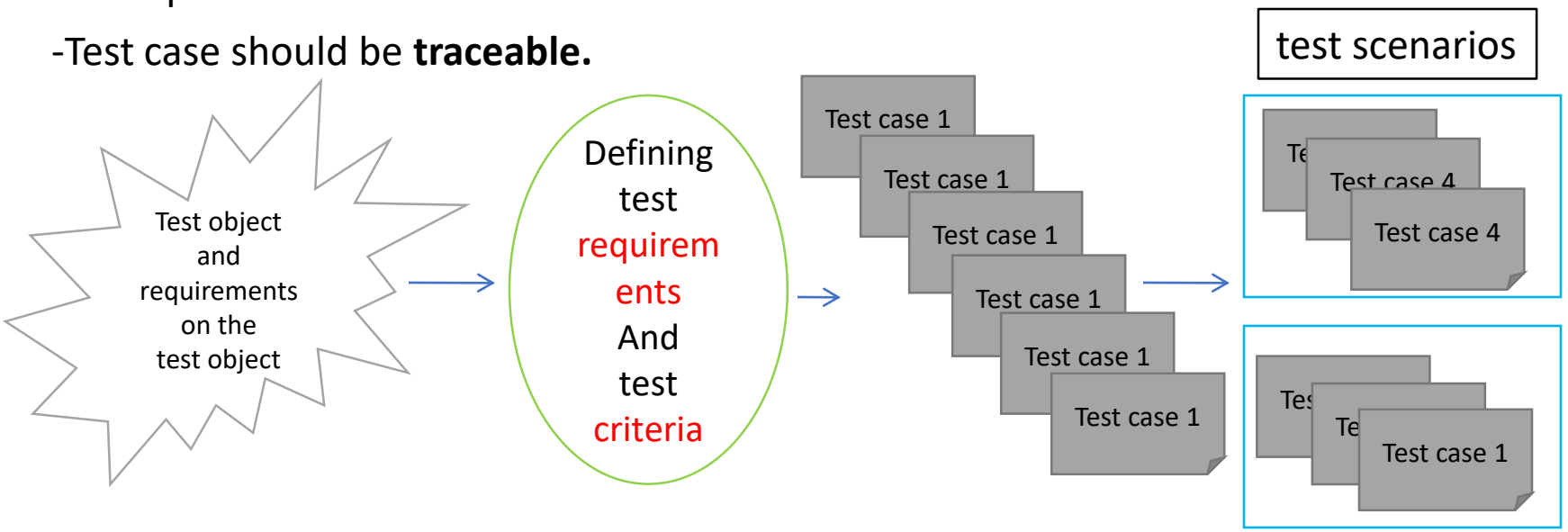
01 – Designing Test cases

Deriving test cases from requirements

Deriving test cases must be a **controlled** process.

-Test cases can be **created** in a **formal** way or in an **informal** way, depending on the project delimitations and on the maturity of the processes in use.

-Test case should be **traceable.**



Deriving Test Case from Requirement:

-Test Object:

The subject to be examined: a document or a piece of software in the software development process

-Test Condition

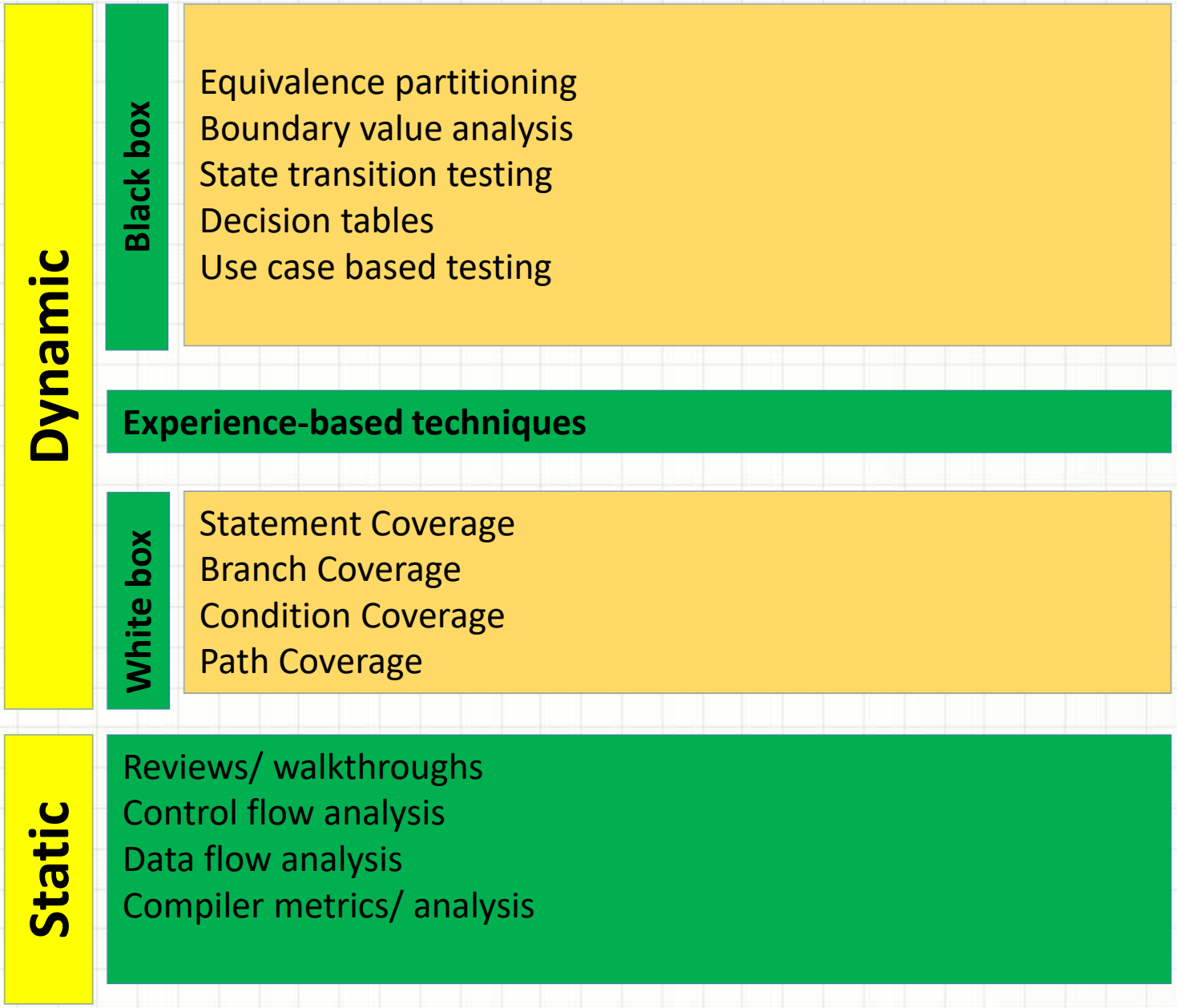
An item or an event: a function, a transaction, or an element in the system

-Test Criteria

The test object has to confirm the test criteria in order to pass the test

Test case description according to IEEE 829:

- **Distinct identification: Id or key** in order to link, for example, an error report to the test case where it appeared
- **Pre-Conditions:** situation previous to test execution or characteristics of the test object before conducting the test case
- **Input Values:** description of the input data on the test object
- **Expected Result:** output data that the test object is expected to produce
- **Post-Conditions:** Characteristics of the test object after test execution, description of its situation after the test
- **Dependencies**: order of execution of test cases, reason for dependencies
- **Requirements**: Characteristics of the test object that the test case will examine


Dynamic
Black box
Equivalence partitioning
Boundary value analysis
State transition testing
Decision tables
Use case based testing
Experience-based techniques
White box
Statement Coverage
Branch Coverage
Condition Coverage
Path Coverage
Static
Reviews/ walkthroughs
Control flow analysis
Data flow analysis
Compiler metrics/ analysis

Black-box Technique:

The Tester looks the test object as a Black Box

-internal structure of the test object is irrelevant or unknown

-Testing of input/ output behavior

-Black box testing is also called functional testing or specification oriented testing

White-box Technique:

The Tester knows the internal structure of the program and code
-i.e. component hierarchy, control flow, data flow

Test case are selected on the basis of internal program Code/ program structure

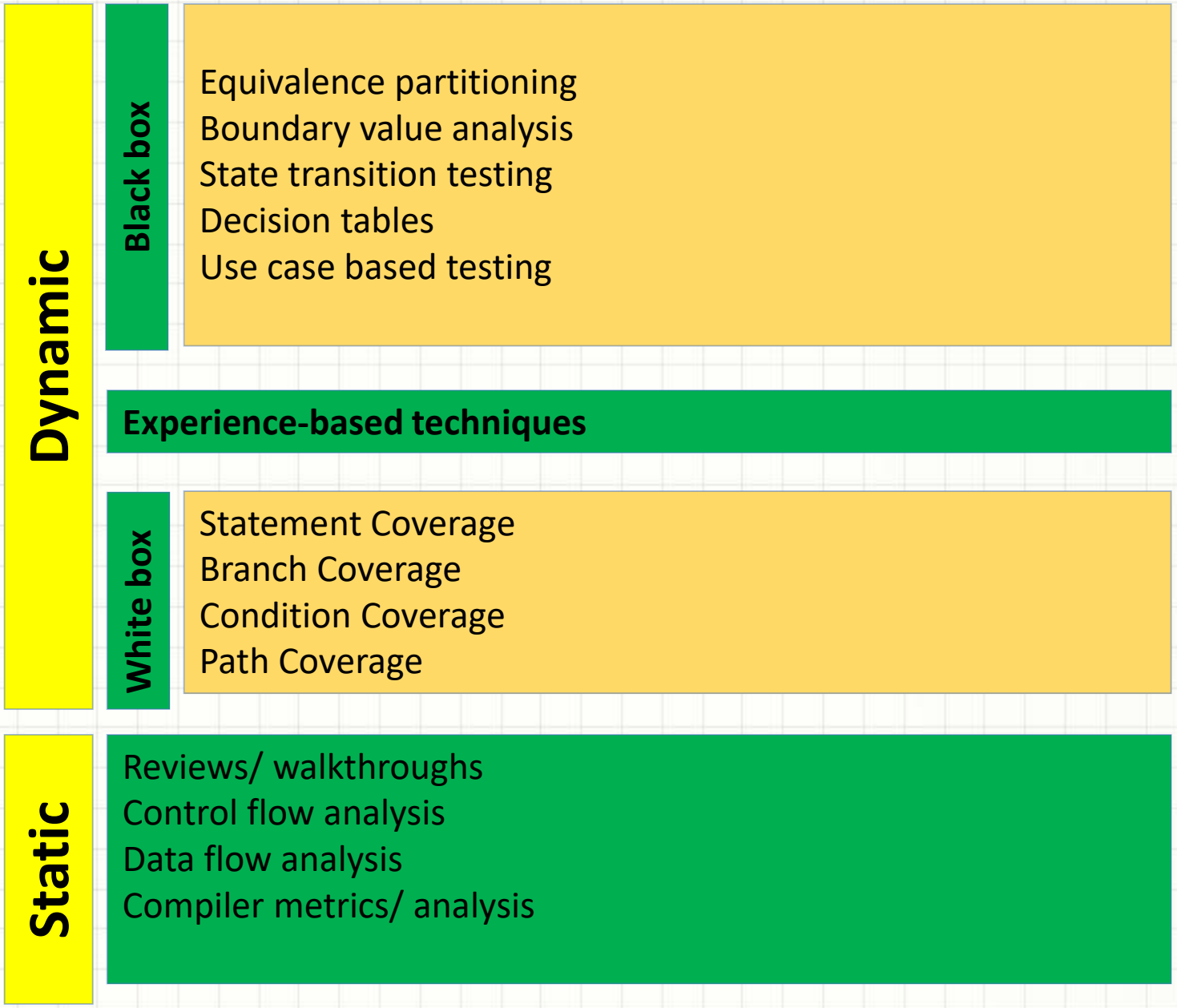
White box testing is also called structure based testing Or control flow based testing

Categories of test design methods:

Specification based methods:
(Black Box)

Structure based methods:
(White Box)

Experienced based methods:
(Black Box)


Dynamic
Black box
Equivalence partitioning
Boundary value analysis
State transition testing
Decision tables
Use case based testing
Experience-based techniques
White box
Statement Coverage
Branch Coverage
Condition Coverage
Path Coverage
Static
Reviews/ walkthroughs
Control flow analysis
Data flow analysis
Compiler metrics/ analysis

Equivalence class (EC) partitioning

Equivalence class (EC) partitioning

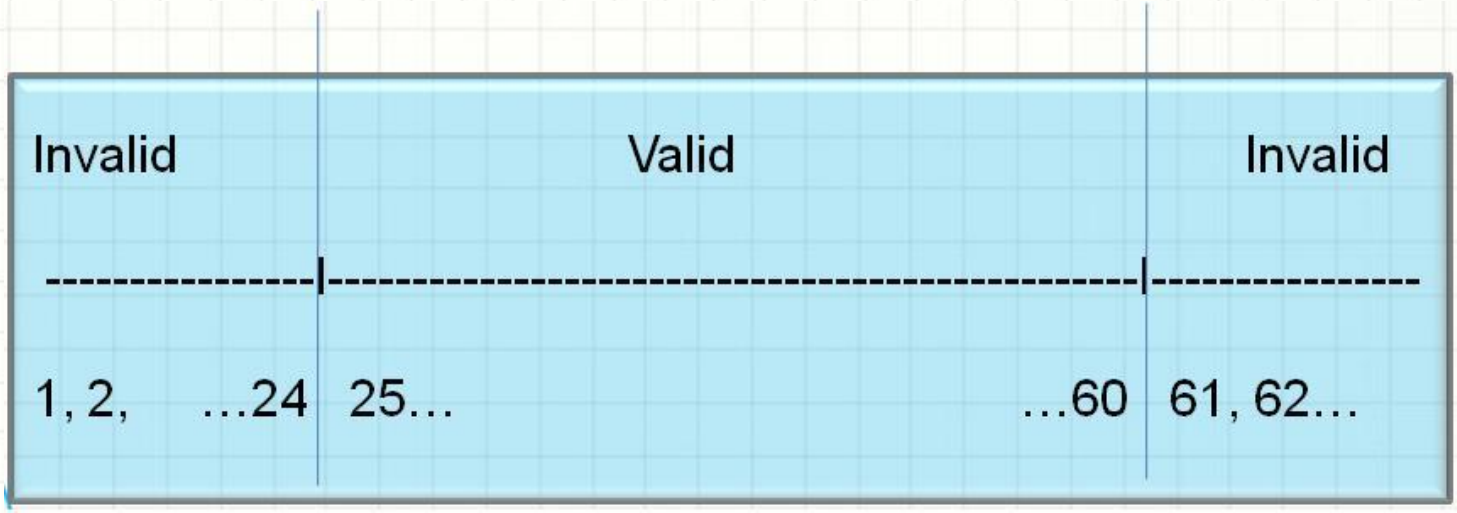
- The range of defined values is grouped into **equivalence classes**, for which the following **rules** apply:
    - All values, for which a **common behavior** of the program is **expected**, are grouped together in one equivalence class
    - Equivalence class may **not overlap** and may **not contain any gaps**
    - Equivalence class may contain a **range** of values (e.g. 0<x<10) or a **single** value (e.g. x="Yes")

-**invalid EC**

- **valid EC**:

Age limit = between 25 and 60

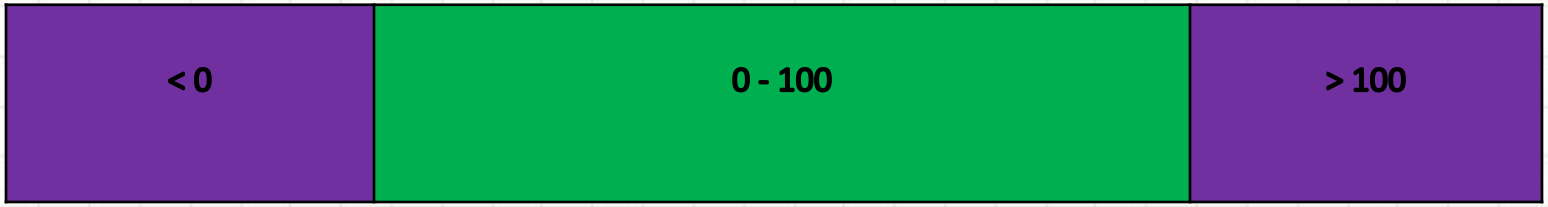
25<=Age=<60



Equivalence class partitioning – example

- Equivalence classes are chosen for valid and invalid inputs
  - if a value x is defined as **0≤ x ≤ 100**, then when we can initially identify three equivalence classes:
    1. **x<0** (invalid input values)
    2. **0 ≤ x≤100** (valid input)
    3. **x> 100**

- Further invalid EC can be defined, containing, but not limited to:
  non-numerical inputs,
  numbers to big or to small,
  non-supported format for numbers



Equivalence class partitioning – example

Problem:

A program expected a **percentage** value according to the following requirements:

- only integer values are allowed
- 0 is the valid lower boundary of the range
- 100 is the valid upper boundary of the range

Solution:

- **Valid** are all numbers from 0 to 100,
- **Invalid** are all negative numbers,
  all numbers greater than 100,
  all decimal numbers and
  all non numerical values (e.g. “fred”)

- one valid equivalence class: $0 \leq x \leq 100$
- 1st invalid equivalence class: $x < 0$
- 2nd invalid equivalence class: $0 > 100$
- 3rd invalid equivalence class: x = no integer
- 4th invalid equivalence class: x = not numeric (e.g. “abc”)

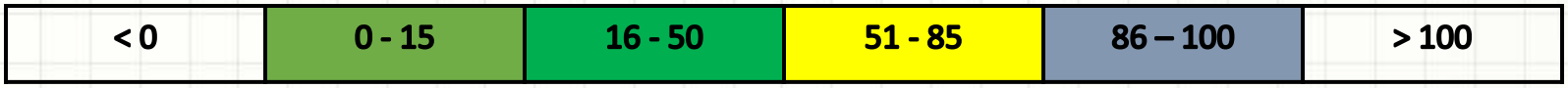
Equivalence class partitioning – example

Additional Requirement:

The percentage value will now be displayed in a bar chart.

The following additional requirements apply (both values included):

- values between 0 and 15 : Orange bar,
- values between 16 and 50: Green bar,
- values between 51 and 85: Yellow bar,
- values between 86 and 100: Blue bar,



Additional Solution for valid EC:

- Now there are four instead of one valid equivalence classes:
  - **1st valid equivalence class:** $0 \leq x \leq 15$
  - **2nd valid equivalence class:** $15 \leq x \leq 50$
  - **3rd valid equivalence class:** $51 \leq x \leq 85$
  - **4th valid equivalence class:** $86 \leq x \leq 100$

EC Partitioning – Picking Representatives

Variable	EC	Representative
Percentage Value (Valid)	EC 1: 0<= X <=15	+10
	EC 2: 16<= X <=50	+20
	EC 3: 51<= X <=85	+80
	EC 4: 85<= X <=100	+90
Percentage Value (Invalid)	EC 5: X<0	-10
	EC 6: X>100	+200
	EC 7: X not integer	1.5
	EC 8: X non number	fred

Equivalence class partitioning – example 2 /1

- Analyzing the specification

- A piece of code computes the **price** of a product, based on its **value**, a **discount** in % and **shipping costs** (6, 9, 12 EURO, depending on shipping mode)

Variable	Equivalence class	Status	Representatives
Values of goods	EC_{11}: x >= 0	Valid	1000.00
	EC_{12}: x < 0	invalid	-1000.00
	EC_{13}: x non-numerical value	Invalid	Fred
Discount	EC_{21}: 0% ≤ x ≤ 100%	valid	10%
	EC_{22}: x < 0%	Invalid	-10%
	EC_{23}: > 100	Invalid	200%
	EC_{24}: x non numeric value	Invalid	Fred
Shipping costs	EC_{31}: x = 6	valid	6
	EC_{32}: x = 9	valid	9
	EC_{33}: x =12	valid	12
	EC_{34}: x ≠ {6, 9, 12}	Invalid	4
	EC_{35}: x non numeric value	invalid	Fred

Assumptions:

-Value of goods is given as a **positive number with 2 decimal places**

- Discount is a percentage Value without Decimal places **Between 0% and 100%**

- Shipping costs can only be **6, 9 or 12**

Equivalence class partitioning – example 2 /2

- Test cases for valid EC:

- Valid equivalence classes provide the following combinations or test cases: T01, T02 and T03

Variable	Equivalence class	Status	Representatives	T01	T02	T03
Values of goods	EC_{11}: x >= 0	valid	1000,00	*	*	*
	EC_{12}: x < 0	invalid	-1000,00			
	EC_{13}: x non-numerical value	Invalid	Fred			
Discount	EC_{21}: 0% ≤ x ≤ 100%	valid	10%	*	*	*
	EC_{22}: x < 0%	Invalid	-10%			
	EC_{23}: > 100	Invalid	200%			
	EC_{24}: x non numeric value	Invalid	Fred			
Shipping costs	EC_{31}: x = 6	valid	6	*		
	EC_{32}: x = 9	valid	9		*	
	EC_{33}: x =12	valid	12			*
	EC_{34}: x ≠ {6, 9, 12}	Invalid	4			
	EC_{35}: x non numeric value	invalid	Fred			

Equivalence class partitioning – example 2 /3

- Test cases for valid EC:

- The following test cases were created using the invalid EC, each in combination with valid ECs of other elements:

Variable	Equivalence class	Status	Representatives	T04	T05	T06	T07	T08	T09	T010
Values of goods	EC_{11}: x >= 0	valid	1000,00			*	*	*	*	*
	EC_{12}: x < 0	invalid	-1000,00	*						
	EC_{13}: x non-numerical value	Invalid	Fred		*					
Discount	EC_{21}: 0% ≤ x ≤ 100%	valid	10%	*	*				*	*
	EC_{22}: x < 0%	Invalid	-10%			*				
	EC_{23}: > 100	Invalid	200%				*			
	EC_{24}: x non numeric value	Invalid	Fred					*		
Shipping costs	EC_{31}: x = 6	valid	6	*	*	*	*	*		
	EC_{32}: x = 9	valid	9							
	EC_{33}: x =12	valid	12							
	EC_{34}: x ≠ {6, 9, 12}	Invalid	4						*	
	EC_{35}: x non numeric value	invalid	Fred							*

Equivalence class partitioning – example 2 /4

- All test cases:

- 10 test cases are derived: 3 positive (valid values) and 7 negative (invalid values) test cases:

Variable	Status	Representatives	T01	T02	T03	T04	T05	T06	T07	T08	T09	T010
Values of goods	valid	1000,00	*	*	*			*	*	*	*	*
	invalid	-1000,00				*						
	Invalid	Fred					*					
Discount	valid	10%	*	*	*	*	*				*	*
	Invalid	-10%						*				
	Invalid	200%							*			
	Invalid	Fred								*		
Shipping costs	valid	6	*			*	*	*	*	*		
	valid	9		*								
	valid	12			*							
	Invalid	4									*	
	invalid	Fred										*

Equivalence class partitioning – coverage

Equivalence class coverage can be used as exit criteria to end testing activities

$$\text{EC Coverage} = \frac{\text{Number of EC tested}}{\text{Number of EC defined}} * 100\%$$

Thank you all