



# Examples Triangle Problem





# Triangle Problem

- Four possible outputs – NotA-Triangle, Scalene, Isosceles and Equilateral.

$R1 = \{ \langle a, b, c \rangle : \text{the triangle with sides } a, b \text{ and } c \text{ is equilateral} \}$

$R2 = \{ \langle a, b, c \rangle : \text{the triangle with sides } a, b \text{ and } c \text{ is isosceles} \}$

$R3 = \{ \langle a, b, c \rangle : \text{the triangle with sides } a, b \text{ and } c \text{ is isosceles} \}$

$R4 = \{ \langle a, b, c \rangle : \text{sides } a, b \text{ and } c \text{ do not form a triangle} \}$

Test Case	a	b	c	Expected Output
W N 1	5	5	5	Equilateral
W N 2	2	2	3	Isosceles
W N 3	3	4	5	Scalene
W N 4	4	1	2	Not a Triangle



# Triangle Problem

## ■ Weak robust Equivalence Class Test Cases

Test Case	a	b	c	Expected Output
WR1	-1	5	5	Value of a is not in the range of permitted values
WR2	5	-1	5	Value of b is not in the range of permitted values
WR3	5	5	-1	Value of c is not in the range of permitted values
WR4	201	5	5	Value of a is not in the range of permitted values
WR5	5	201	5	Value of b is not in the range of permitted values
WR6	5	5	201	Value of c is not in the range of permitted values



# Triangle Problem

- Here is one “corner” of the cube in 3-space of the additional strong robust equivalence class test cases.

Test Case	a	b	c	Expected Output
SR1	-1	5	5	Value of a is not in the range of permitted values
SR2	5	-1	5	Value of b is not in the range of permitted values
SR3	5	5	-1	Value of c is not in the range of permitted values
SR4	-1	-1	5	Values of a, b are not in the range of permitted values
SR5	5	-1	-1	Values of b, c are not in the range of permitted values
SR6	-1	5	-1	Values of a, c are not in the range of permitted values
SR7	-1	-1	-1	Values of a, b, c are not in the range of permitted values



# Triangle Problem

- $D1 = \{ \langle a, b, c \rangle : a = b = c \}$
- $D2 = \{ \langle a, b, c \rangle : a = b, a \neq c \}$
- $D3 = \{ \langle a, b, c \rangle : a = c, a \neq b \}$
- $D4 = \{ \langle a, b, c \rangle : b = c, a \neq b \}$
- $D5 = \{ \langle a, b, c \rangle : a \neq b, a \neq c, b \neq c \}$
  
- As separate question, constitute triangle?  $\langle 1, 4, 1 \rangle$
- $D6 = \{ \langle a, b, c \rangle : a \geq b + c \}$
- $D7 = \{ \langle a, b, c \rangle : b \geq a + c \}$
- $D8 = \{ \langle a, b, c \rangle : c \geq a + b \}$



# Examples

## Next Date Function Problem



# Next Date Function Problem

## ■ Valid Equivalence Classes

$M1 = \{ \text{month} : 1 \leq \text{month} \leq 12 \}$

$D1 = \{ \text{day} : 1 \leq \text{day} \leq 31 \}$

$Y1 = \{ \text{year} : 1812 \leq \text{year} \leq 2012 \}$

## ■ Invalid Equivalence Classes

$M2 = \{ \text{month} : \text{month} < 1 \}$

$M3 = \{ \text{month} : \text{month} > 12 \}$

$D2 = \{ \text{day} : \text{day} < 1 \}$

$D3 = \{ \text{day} : \text{day} > 31 \}$

$Y2 = \{ \text{year} : \text{year} < 1812 \}$

$Y3 = \{ \text{year} : \text{year} > 2012 \}$



# Next Date Function Problem

- Valid classes = Independent variables
- One weak and strong normal ECT.

Day	Month	Year	Expected Output
15	6	1912	16/6/1912





# Next Date Function Problem

## ■ Weak Robust Test Cases

Day	Month	Year	Expected Output
15	6	1912	16/6/1912
-1	6	1912	day not in range
32	6	1912	day not in range
15	-1	1912	month not in range
15	13	1912	month not in range
15	6	1811	year not in range
15	6	2013	year not in range



# Next Date Function Problem

## ■ Strong robust ECT

Test Case	Month	Day	Year	Expected Output
SR1	-1	15	1912	Value of month not in the range 1..12
SR2	6	-1	1912	Value of day not in the range 1..31
SR3	6	15	1811	Value of year not in the range 1812..2012
SR4	-1	-1	1912	Value of month not in the range 1..12 Value of day not in the range 1..31
SR5	6	-1	1811	Value of day not in the range 1..31 Value of year not in the range 1812..2012
SR6	-1	15	1811	Value of month not in the range 1..12 Value of year not in the range 1812..2012
SR7	-1	-1	1811	Value of month not in the range 1..12 Value of day not in the range 1..31 Value of year not in the range 1812..2012



# Next Date Function Problem

- Previous test cases were poor.
- Focus on Equivalence Relation.
- What must be done to an input date?
- We produce a new set of Equivalence Classes.



# Next Date Function Problem

- $M1 = \{ \text{month: month has 30 days} \}$
- $M2 = \{ \text{month: month has 31 days} \}$
- $M3 = \{ \text{month: month is February} \}$
- $D1 = \{ \text{day: } 1 \leq \text{day} \leq 28 \}$
- $D2 = \{ \text{day: day} = 29 \}$
- $D3 = \{ \text{day: day} = 30 \}$
- $D4 = \{ \text{day: day} = 31 \}$
- $Y1 = \{ \text{year: year} = 2000 \}$
- $Y2 = \{ \text{year: year is a leap year} \}$
- $Y3 = \{ \text{year: year is a common year} \}$
  
- Simplify the question of the last day of the month.



# Next Date Function Problem

- Weak normal ECT
- Mechanical selection & automatic test Generation

Day	Month	Year	Expected Output
14	6	2000	15/6/2000
29	7	1996	30/7/1996
30	2	2002	impossible date
31	6	2000	impossible input date



# Next Date Function Problem

## ■ Strong normal ECT

Day	Month	Year	Expected Output
14	6	2000	15/6/2000
14	6	1996	15/6/1996
14	6	2002	14/6/2002
29	6	2000	30/6/2000
29	6	1996	30/6/1996
29	6	2002	30/6/2002
30	6	2000	1/7/2000
30	6	1996	1/7/1996
...	...	...	...
30	2	2002	impossible date
31	2	2000	impossible date
31	2	1996	impossible date
31	6	2002	impossible date

3 month classes\*4 day classes\*3 year classes = 36 ECT.



# Next Date Function Problem

- Moving from weak to strong ECT.
- Independence resulting in the cross product.
- Adding two invalid classes for each variable = 150 robust equivalence class test cases!



# Summary

- Equivalence Class Testing improves on boundary value testing
- Equivalence Relation is key to producing useful test cases
- Equivalence Class Testing can be succeeded