FIT5171 Tutorial 4 and 5
Blackbox Testing

Week 4, 2023

> Please do try the questions before coming to the tutorial. Your active participation is the most important!

1. In Lecture 4 we discussed Boundary Value Testing (BVT) and the (minimum) number of test cases for the "normal" (non-robust) version of BVT for n variables $(4n + 1)$. In this question, work out a formula for the number of test cases for each of the following cases and briefly explain why.

   (a) The robust BVT (with additional values $min-$ and $max+$ for each variable).

Solution: $6n + 1$, since we have 2 more test cases for each variable.

   (b) Weak normal equivalence class testing.

Solution: Let C_x denote the equivalence classes of valid values for variable x (C_x is a set of equivalence classes). Then the number of test cases is $max(\#C_{x_i})$, for x_i ranging over all variables. That is, the maximum number of equivalence classes for all variables.

   (c) Weak robust equivalence class testing.

Solution: We assume the same settings as in the previous question. Let I_{x_i} denote the equivalence classes of invalid values for variable x_i. Let n denote the number of variables.

the number of tests is $max(\#C_{x_i}) + \sum_{i=1}^{n}(\#I_{x_i})$, for x_i ranging over all variables.

Basically, we include also the total number of test cases in the invalid areas for each variable. Note that cardinality of I_{x_i} may not always be 2 since there may be gaps between valid equivalence classes.

2. In the last lecture we showed a triangle example to demonstrate test case generation for BVT (slide 11). In the example each of the three variables a, b and c is the length of a side from the range $[1, 200]$. Come up with test cases for weak normal equivalence class testing that cover the same expected outputs (isosceles, equilateral, scalene, not a triangle).

Solution: A simple/naïve solution would be to take those 4 expected outputs and use them directly to form equivalence classes:

$$R1 = \{(a, b, c) \mid \text{the triangle with sides } a,\ b \text{ and } c \text{ is isosceles}\}$$

$$R2 = \{(a, b, c) \mid \text{the triangle with sides } a,\ b \text{ and } c \text{ is equilateral}\}$$

$$R3 = \{(a, b, c) \mid \text{the triangle with sides } a,\ b \text{ and } c \text{ is scalene}\}$$

$$R4 = \{(a, b, c) \mid \text{sides } a,\ b \text{ and } c \text{ do not form a triangle}\}$$

Then we can take an arbitrary test case from each of these four cases:

Test case	a	b	c	**Expected output**
WN1	20	20	30	Isosceles
WN2	50	50	50	Equilateral
WN3	30	40	50	Scalene
WN4	30	40	100	Not a triangle

A more insightful solution requires the understanding of the domain. In this case, working out the relationship between the three sides a, b and c. If we take symmetry into consideration, we could come up with the following equivalence classes:

$$D1 = \{(a, b, c) \mid a = b = c\}$$

$$D2 = \{(a, b, c) \mid a = b \land a \neq c \land c < a + b\}$$

$$D3 = \{(a, b, c) \mid a \neq b \land a \neq c \land b \neq c \land a < b + c \land b < a + c \land c < a + b\}$$

$$D4 = \{(a, b, c) \mid a = b + c\}$$

$$D5 = \{(a, b, c) \mid a > b + c\}$$

Then base on these 5 classes we can work out the test cases more easily.

3. For the triangle problem above, come up with a decision table for testing.

Solution: The following is one such decision table. Note that for simplicity the value range $[1, 200]$ isn't considered below.

		Rules								
Conditions	c1: a,b,c form a triangle?	F	T	T	T	T	T	T	T	T
	c2: $a = b$?	-	T	T	T	T	F	F	F	F
	c3: $a = c$?	-	T	T	F	F	T	T	F	F
	c4: $b = c$?	-	T	F	T	F	T	F	T	F
Actions	a1: not a triangle	X								
	a2: scalene									X
	a3: isoscles					X		X	X	
	a4: equilateral		X							
	a5: impossible			X	X		X			

Note that if we want to be more specific about the conditions (for example, enumerating conditions when a, b and c do not form a triangle), we could come up with decision tables with more entries.

4. Under the tutorial resources, you will find a pdf document which includes the **NextDate method**, which, given a day, a month, and a year, returns the date of the following day.

   (a) Complete the decision table on slide 37 for NextDate by filling in the missing conditions and associated actions.

Solution:

The following table completes the decision table. Note: Rule 7 is already given in lecture slides.

		Rules							
		6	7	8	9	10	11	12	13
Conditions	c1: day in	D1-D4	D5	D1	D2	D2	D3	D3	D4, D5
	c2: month in	M3	M3	M4	M4	M4	M4	M4	M4
	c3: year in	-	-	-	Y1	Y2	Y1	Y2	-
Actions	a1: impossible							X	X
	a2: increment day	X		X	X				
	a3: reset day		X			X	X		
	a4: increment month					X	X		
	a5: reset month		X						
	a6: increment year		X						

   (b) How many test cases are needed to completely cover the entire decision table?

Solution:

13 test cases.

(c) For the NextDate method, assuming the year variable ranges over [1812, 2016], how many test cases are needed for strong, normal boundary value testing?

Solution:

Since BVT doesn't understand the semantics of variables, the boundary values for the variables are: day: 1 and 31, month: 1 and 12; and year: 1812 and 2016.

NOTE: the below answer (19) is for **weak, robust** boundary value testing! The test cases are given in the table below.

Test case	day	month	year	Expected output
1	0	6	1912	error
2	1	6	1912	2/6/1912
3	2	6	1912	3/6/1912
4	15	6	1912	16/6/1912
5	30	6	1912	1/7/1912
6	31	6	1912	error
7	32	6	1912	error
8	15	0	1912	error
9	15	1	1912	16/1/1912
10	15	2	1912	16/2/1912
11	15	11	1912	16/11/1912
12	15	12	1912	16/12/1912
13	15	13	1912	error
14	15	6	1811	error
15	15	6	1812	16/6/1812
16	15	6	1813	16/6/1813
17	15	6	2015	16/6/1815
18	15	6	2016	16/6/1816
19	15	6	2017	error

As can be seen, there are 19 test cases.

For **strong, normal** boundary value testing, each variable can take on (min, min+, nom, max-, max) values (normal), and all variables are free to take any of the above values (strong). Hence, the total number of test cases is 5^n for n variables. For our example, it is $5^3 = 125$ test cases.

(d) Compare and comment on the effort and effectiveness of BVT and decision table testing.

Solution:

Decision table testing requires significantly more effort in identifying test cases. However it is also more effective in that it covers more scenarios/corner cases than BVT in fewer test cases.