Intro to Software Testing Chapter 8.1.2

Logic Coverage

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SWE 437

Adapted from slides by Paul Ammann & Jeff Offutt

Combinatorial Coverage

This is simple, neat, clean, and comprehensive …

But can be **expensive**

— Impractical for predicates with more than 3 or 4 clauses

The literature has lots of suggestions — some confusing

The general idea is simple:

Test each clause independently from the other clauses

Getting the details right is hard

What exactly does "independently" mean ?

The book presents this idea as **"*making clauses active*"** …

Active Clauses (8.1.2)

Clause coverage has a **weakness** : The values do not always make a difference

Consider the CC tests for P = (a & (b | c))**:**

- *Test 1: (true & (true | true))*
- *Test 2: (false & (false | false))*

Clauses b and c are ignored!

To really test the results of a clause, the clause should be the **determining factor** in the value of the predicate

Active Clauses

Clause c_i **determines** the value of its predicate when the other clauses have certain values

If c_i is changed, the value of the predicate changes

c_i is called the *major clause*

Other clauses are *minor clauses*

This is called *making the clause active*

Determining Predicates

$P = A \lor B$
if **B = *true***, p is always true.
so if **B = *false***, *A* determines p.
if **A = *false***, *B* determines p.

$P = A \land B$
if **B = *false***, p is always false.
so if **B = *true***, *A* determines p.
if **A = *true***, *B* determines p.

- **Goal** : Find tests for each clause when the clause determines the value of the predicate

- This is formalized in a **family of criteria** that have subtle, but very important, differences

In-Class Exercise

Making clauses active

P = (a & (b | c))

Write truth values for **b and c** that make clause **a** active
For example: Pa : b=?? or c=??
Write truth values for **a and c** that make clause **b** active
Write truth values for **a and b** that make clause **c** active

In-Class Exercise

Making clauses active

P = (a & (b | c))

Pa : (b=true or c=true
    compactly: (b or c)
Pb : (a and !c)
Pc : (a and !b)

Write truth values for **b and c** that make clause **a** active
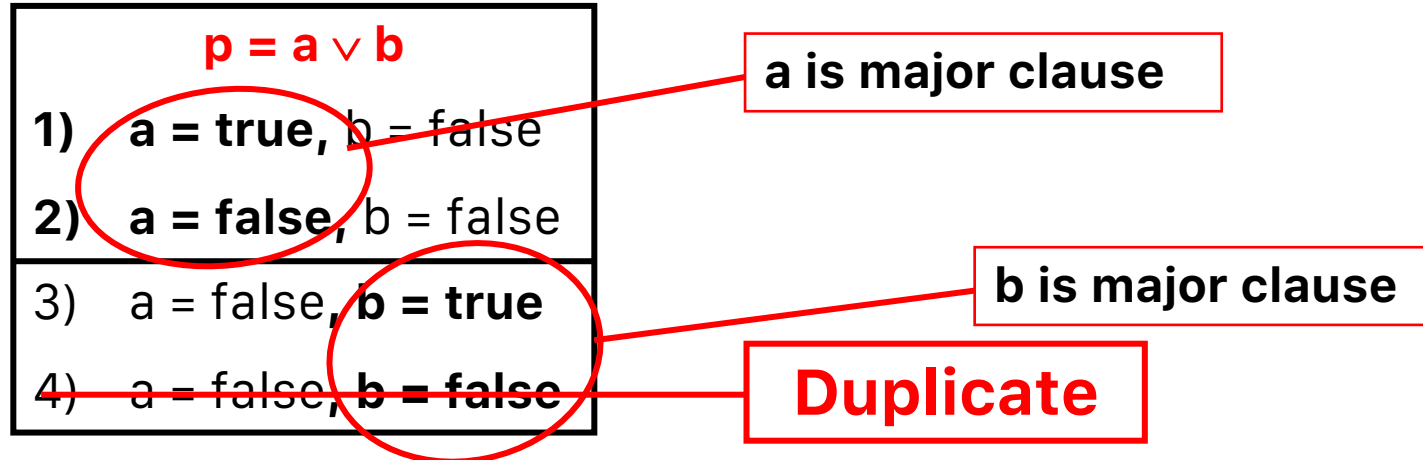For example: Pa : b=?? or c=??
Write truth values for **a and c** that make clause **b** active
Write truth values for **a and b** that make clause **c** active

Active Clause Coverage

> **Active Clause Coverage (ACC)** **: For each clause c_i in each predicate *p, choose values for the other clauses to make c_i active***
>
> *Create two tests, one where c_i evaluates to true and the other where c_i evaluates to false*

p = a ∨ b

1) **a = true,** b = false
2) **a = false,** b = false

3) a = false, **b = true**
4) a = false, **b = false**

a is major clause

b is major clause

Duplicate

- This is a form of MCDC, which is required by the FAA for safety critical software

ACC Ambiguity

Do the minor clauses have to have the same values for both tests?
- Restricted ACC: They do
- **Correlated ACC: They do not, but the predicate has to have different values**
- General ACC: They do not, and the predicate does not have to have different values either

The FAA requires **MCDC** (modified condition decision coverage) for flight critical software
- Original definition of MCDC was GACC
- For years, some inspectors required RACC, some CACC
- **MCDC is now equivalent to CACC**
- We are skipping GACC and RACC

CACC Example

	a	b	c	a & (b | c)
1	T	T	T	T
2	T	T	F	T
3	T	F	T	T
4	T	F	F	F
5	F	T	T	F
6	F	T	F	F
7	F	F	T	F
8	F	F	F	F

For **a** to determine the value of the predicate

P_a : b=true or c = true

So we can use <u>ANY</u> OF the 9 pair of rows: (1,5), (1,6), (1,7), (2,5),(2,6),(2,7), (3,5),(3,6),(3,7)

For **b** to determine the value of the predicate

P_b : a=true and c = false

Rows 2 and 4

For **c** to determine the value of the predicate

P_c : a=true and b = false

Rows 3 and 4

In-Class Exercise

Making clauses active

P = ((a&b) | c | (d&e))

Pick any one of the 5 clauses
Call it **ci**
Solve for **ci**
Answer by giving truth values for the other 4 clauses that make your **ci** determine the value of the predicate

In-Class Exercise

Making clauses active

P = ((a&b) | c | (d&e))

Pick any one of the 5 clauses
Call it **ci**
Solve for **ci**
Answer by giving truth values for the ot
make your **ci** determine the value of the

Pa = b and !c and !(d and e)
   = b and !c and (!d or !e)
Pb = a and !c and !(d and e)
   = a and !c and (!d or !e)
Pc = !(a and b) and !(d and e)
   = (!a or !b) and (!d or !b)
Pd = !(a and b) and !c and e
   = (!a or !b) and !c and e
Pe = !(a and b) and !c and d
   = (!a or !b) and !c and d