CMPT 473
Software Quality Assurance

Logic Based Criteria

Nick Sumner
Material from Ammonn & Offutt

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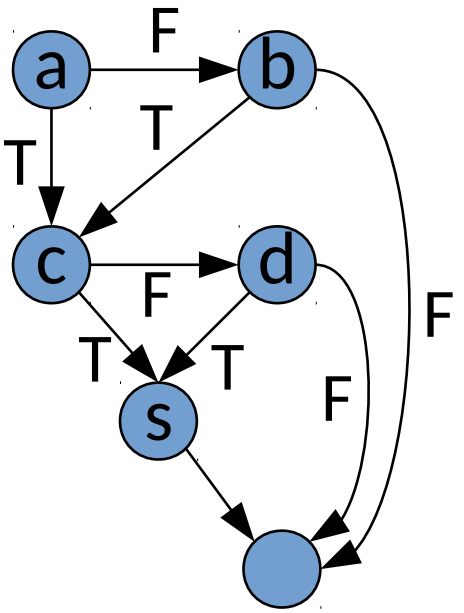

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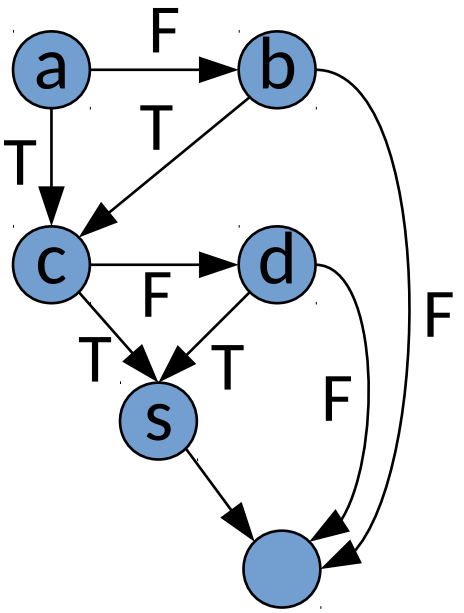

What doesn't branch coverage test?

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1) Scalability
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if (a | b) & (c | d):
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3) Other languages (e.g., SQL)

Logic Based Coverage Criteria

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- Logical coverage criteria identify a set values for clauses to test.

(a>0)	foo(b)	c	result
T	T	T	T
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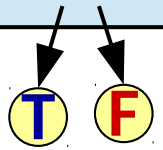


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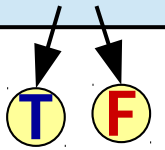

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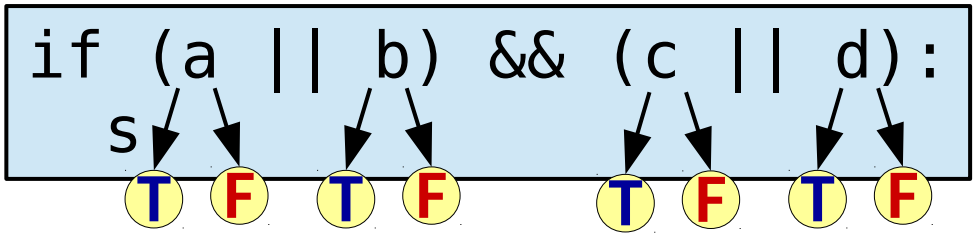

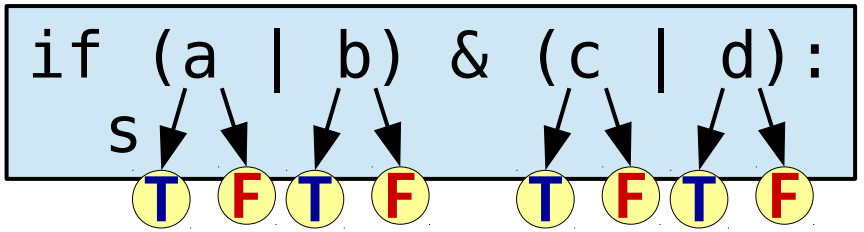

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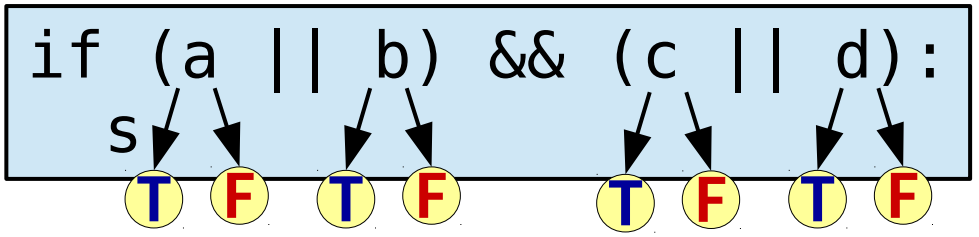

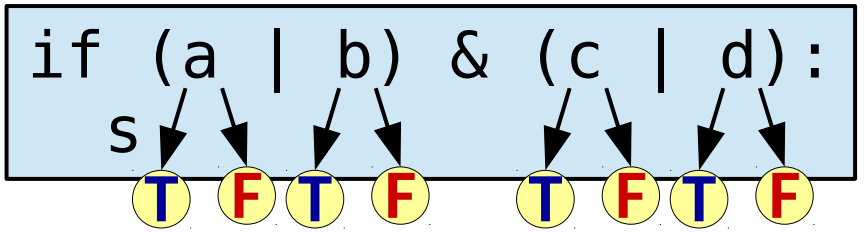

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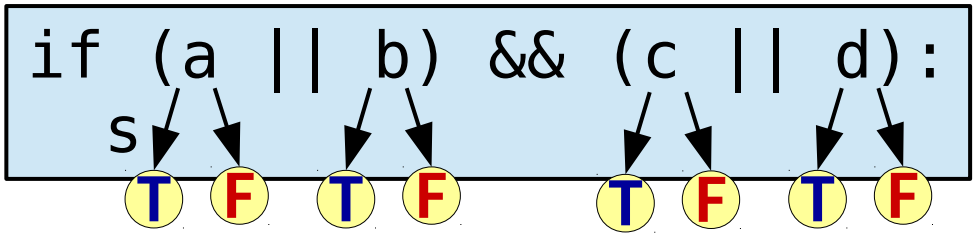

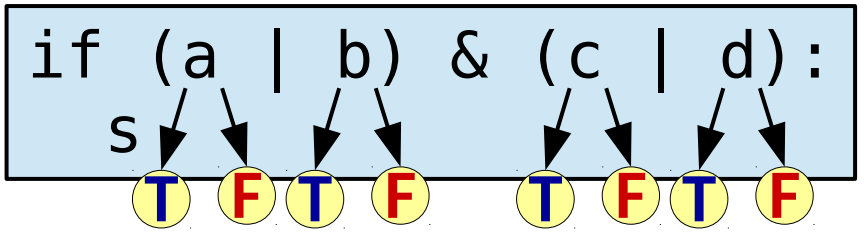

Minimum of **2** tests

a=true, b=true, c=false, d=false
a=false, b=false, c=true, d=true

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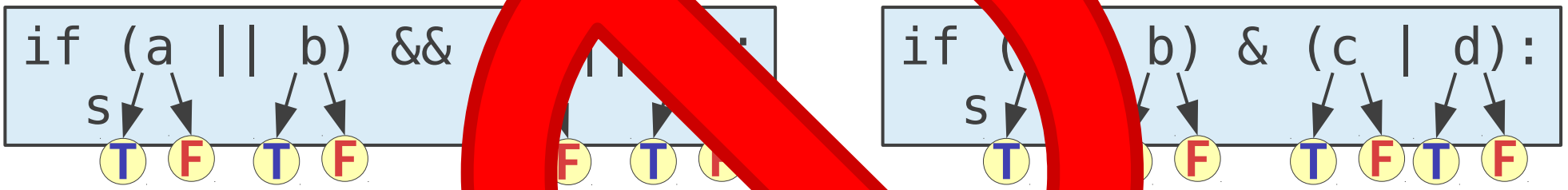

Minimum tests

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How many tests?

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How can we test the impact of a clause?

The *relative* behavior when changing one clause matters.

Defining a Better Goal

- Clause coverage takes each clause into account.
- Combinatorial coverage tests the impact of a combination.
- Can we test for the impact of each clause?
  - This is the intuition behind MC/DC testing…

Modified Condition/Decision Coverage

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- Use in safety critical systems: avionics, spacecraft, …
- Not only ensures that clauses are tested,
  but that each has an impact

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a=F	a=F
b=T	b=T
c=T	c=F
T	F

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This pair of tests shows the impact of c.

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Let's try:
a & b
a | b
a | (b & c)

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  a has impact ↔ #T | (b & c) ≠ #F | (b & c)

by definition

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  ↔ **#T** ≠

How To Show a Clause Has Impact

- Given **a | (b & c)**, generate tests for a

$$\text{a has impact} \leftrightarrow \#T \mid (b \,\&\, c) \neq \#F \mid (b \,\&\, c)$$
$$\leftrightarrow \#T \neq \mathbf{b \,\&\, c}$$

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\begin{aligned}
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&\leftrightarrow \#T \neq b \,\&\, c \\
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&\leftrightarrow \textbf{b is false or c is false}
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Have b be #F

a=#T, b=#F, c=#T
a=#F, b=#F, c=#T

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defines two different ways to test a

Have b be #F	Have c be #F
a=#T, b=#F, c=#T	a=#T, b=#T, c=#F
a=#F, b=#F, c=#T	a=#F, b=#T, c=#F

Showing Impact

- What about (a & b) | (a & ¬b)?
  - Can you show the impact of a?
  - Can you show the impact of b?

Showing Impact

- What about (a & b) | (a & ¬b)?
  - Can you show the impact of a?
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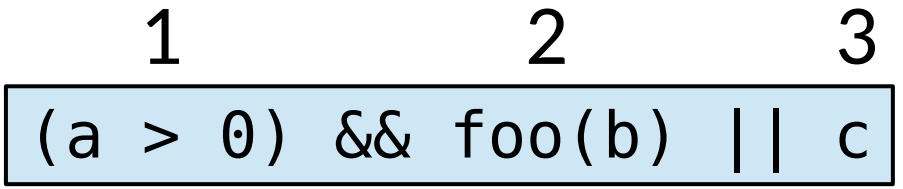
MC/DC coverage also identifies redundancies that are likely bugs.

Generating a Test Suite with MC/DC



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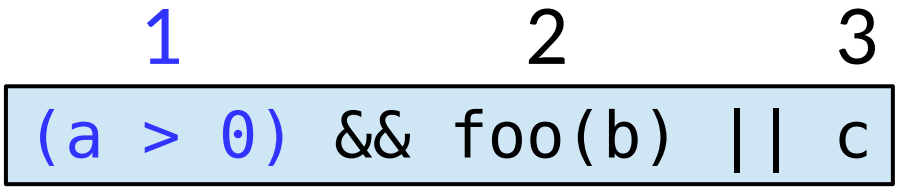
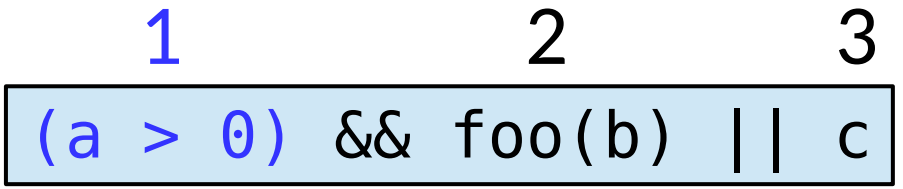


Select a first clause.

Generating a Test Suite with MC/DC



2=#T, 3=#F

Solve the constraints for other clauses.

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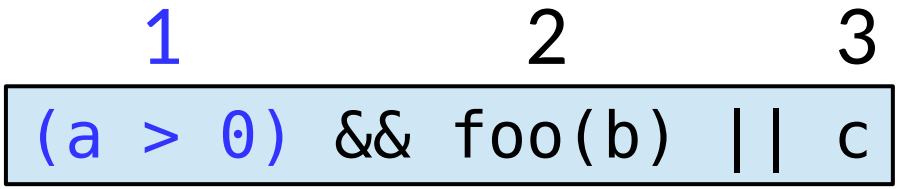

2=#T, 3=#F

Include tests for the clause in the test suite.

Tests:

1=#T, 2=#T, 3=#F
1=#F, 2=#T, 3=#F

Generating a Test Suite with MC/DC

Consider the next clause.

Tests:

1=#T, 2=#T, 3=#F
1=#F, 2=#T, 3=#F

Generating a Test Suite with MC/DC

Try to add a test for it based on existing tests.

Tests:

1=#T, 2=#T, 3=#F

1=#F, 2=#T, 3=#F

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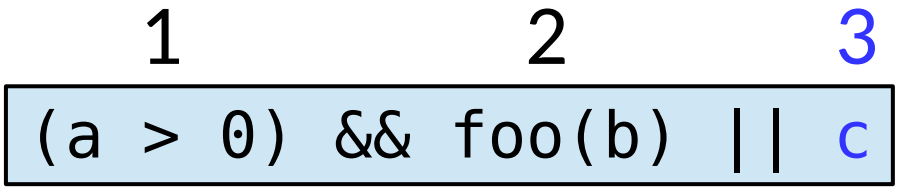
Generating a Test Suite with MC/DC



Repeat for the last clause.

Tests:

1=#T,	2=#T,	3=#F
1=#F,	2=#T,	3=#F
1=#T,	2=#F,	3=#F
1=#T,	2=#F,	3=#T

Generating a Test Suite with MC/DC?

- *BUT* NASA recommended *not* generating MC/DC coverage.

Generating a Test Suite with MC/DC?

- *BUT* NASA recommended *not* generating MC/DC coverage.
  - Use MC/DC as a means of evaluating test suites generated by other means

MC/DC Over Time

- Some historical ambiguities
  - Originally only required impact when changing clause
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  - Changing other clauses at the same time was allowed!
  - Why is this problematic?
- The form presented here is also known as *Restricted Active Clause Coverage*

Logic and MC/DC Testing

- Tests complex interactions in conditions.
- Required for avionics software.

Is it good? Bad?