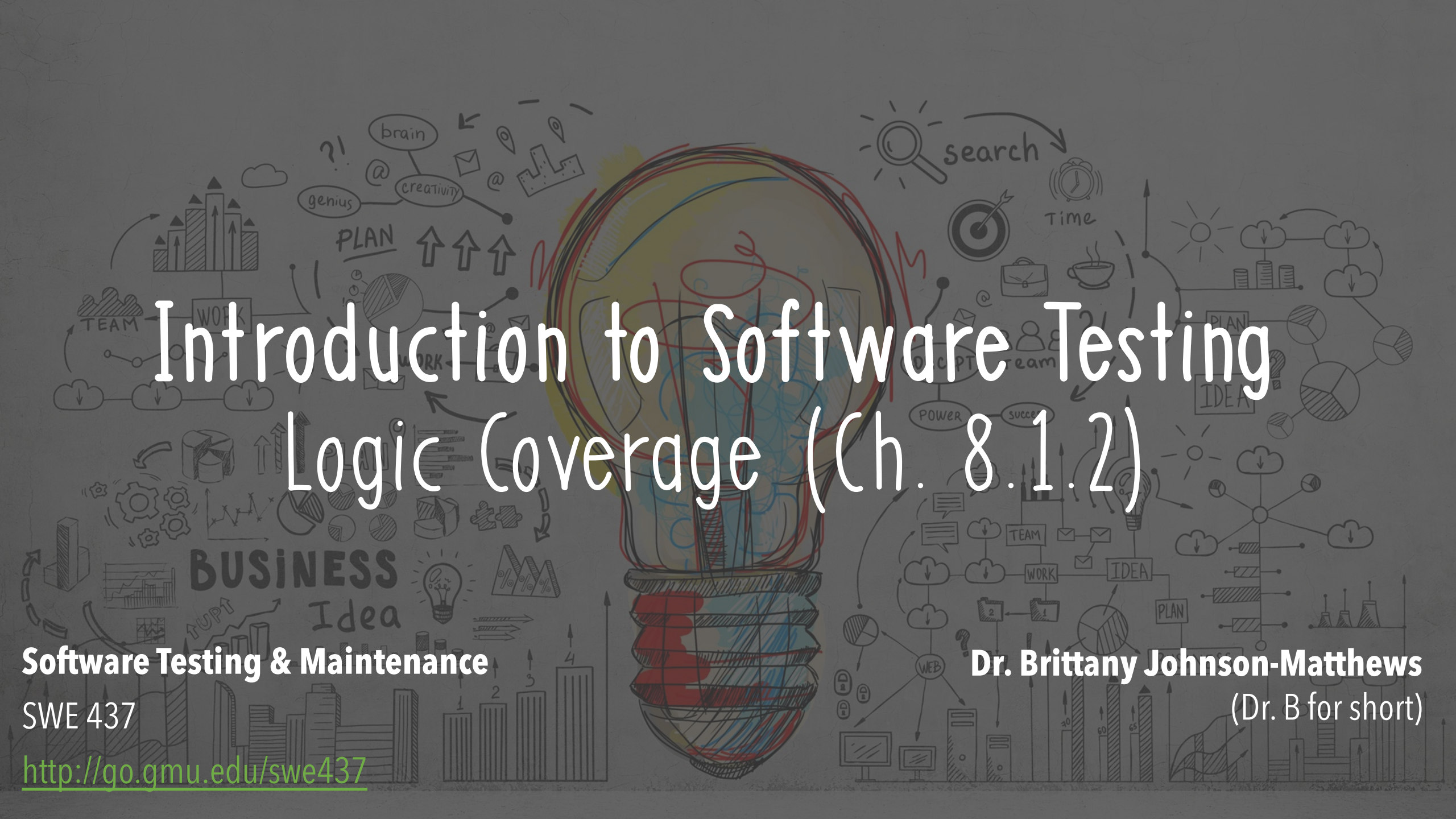

Introduction to Software Testing
Logic Coverage (Ch. 8.1.2)

Software Testing & Maintenance

SWE 437

http://go.gmu.edu/swe437

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(Dr. B for short)

Combinatorial Coverage (CoC)

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 – Determination

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

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

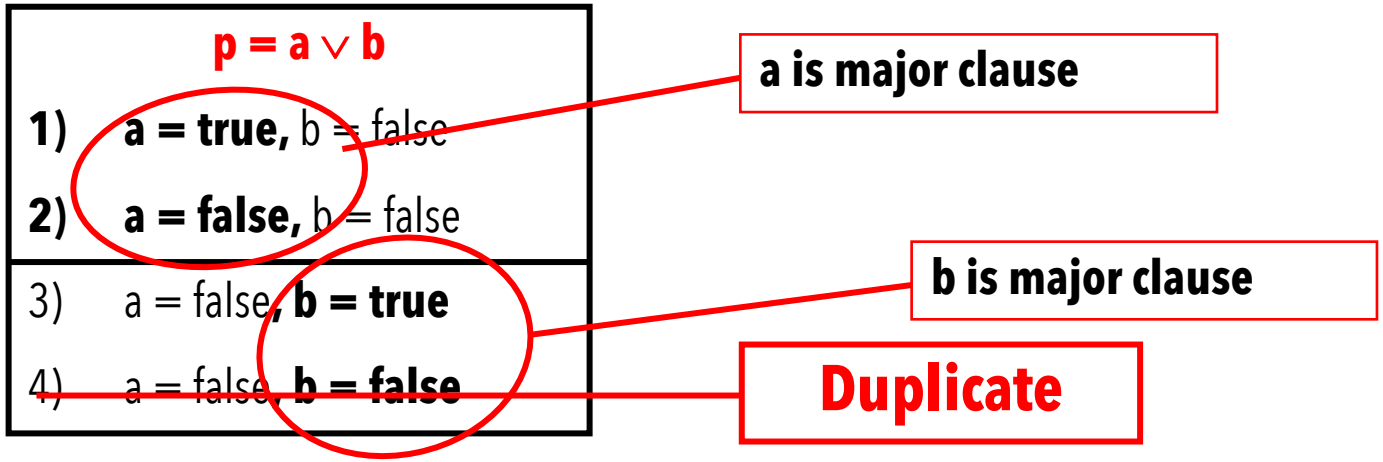
Write truth values for **a and c** that make clause **b** active

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



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 ANY 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

Extra Credit!

Making clauses active

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

Pick any **one** of the 5 clauses (call it $\mathbf{c_i}$)

Solve for $\mathbf{c_i}$

Answer by giving truth values for the other 4 clauses that make your $\mathbf{c_i}$ determine the value of the predicate

Show your work!

In-class Exercise

Making clauses active

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

Pick any **one** of the 5 clauses (call it $\mathbf{c_i}$)

Solve for $\mathbf{c_i}$

Answer by giving truth values for the other 4 clauses that make your $\mathbf{c_i}$ determine the value of the predicate

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