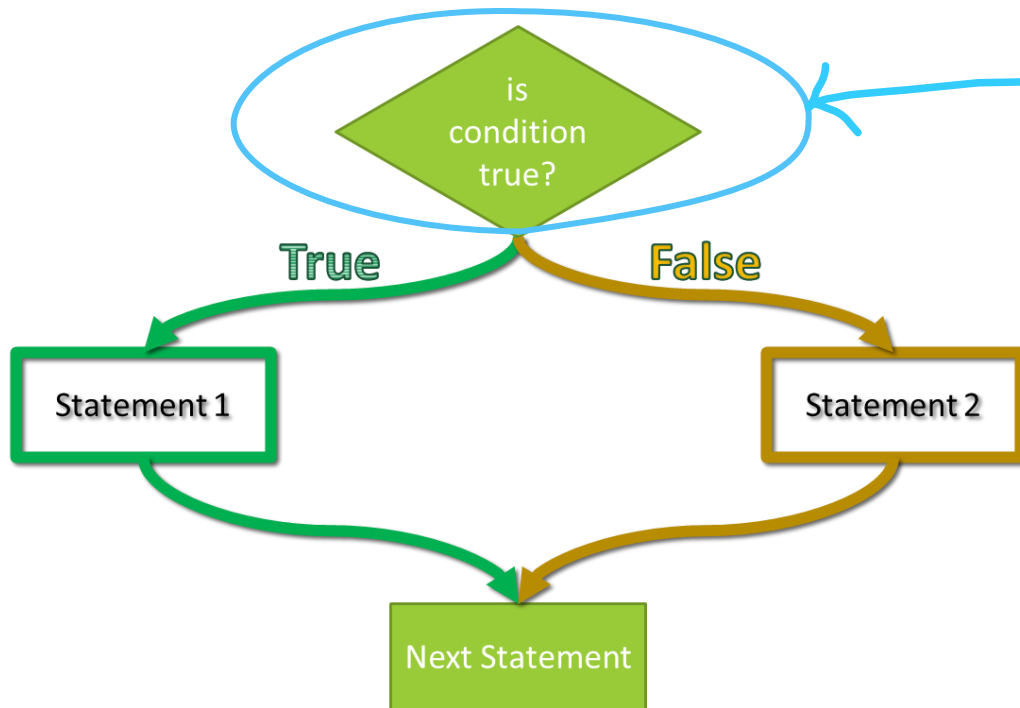# Making Truth Tables in Excel

Last Class...

We looked at C++ if-else statements.

Today I want to examine this part in further detail.

Question from last class

To test a year, y, to see if it is a leap year we needed one of the following to be true:

1. y is divisible by 400, or
2. y is divisible by 4 but not divisible by 100

$y \mathbin{\%} 400 == 0$

$y \mathbin{\%} 4 == 0$

$y \mathbin{\%} 100 \mathbin{!}= 0$

$\overline{}$ assign

$==$ compare

Today we will look at how to evaluate these kinds of logical expressions using truth tables.

* This exact question will be exercise 8 in your homework

Let's look at the 8 standard truth tables:

* Don't worry about copying these down. I give them to you later on.

not   and   or   xor

if-then   if-and-only-if

nor   nand

Not

Negates the truth value of an expression.

◦ TRUE becomes FALSE

◦ FALSE becomes TRUE
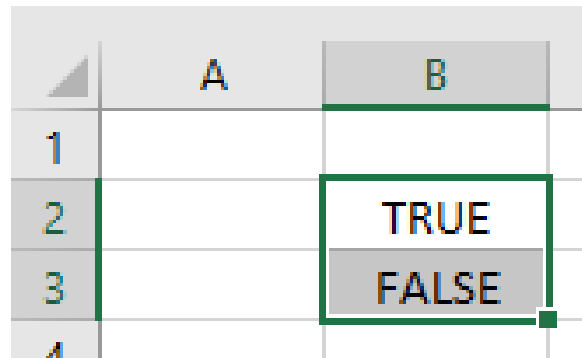
Excel – how to get conditional colour

You only need to do this once, after that you can use the format painter to copy/paste the formatting.

1. Select the cell(s) that you want to add the conditional formatting to:

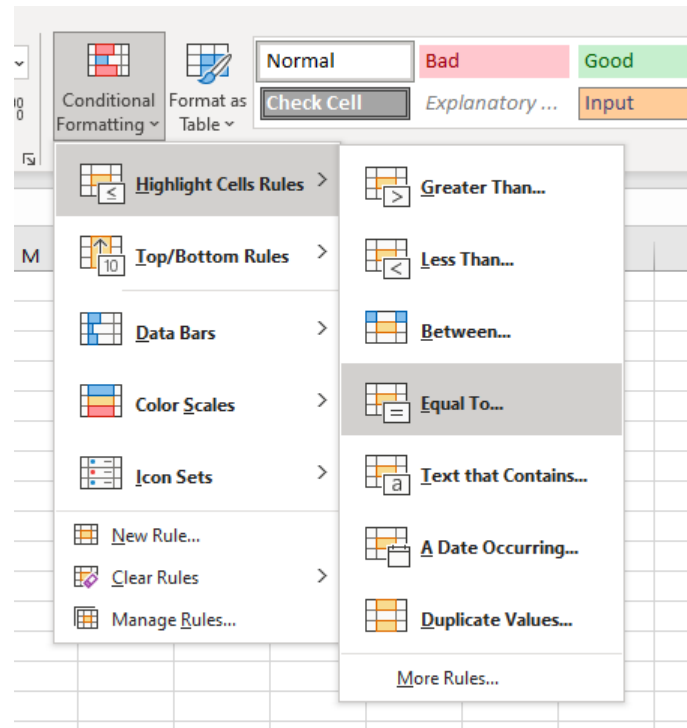# Excel – how to get conditional colouring

2. Click on Conditional Formatting → Highlight Cells Rules → Equal To...

Excel – how to get conditional colouring

3. Enter FALSE into the first cell and select the colour you want for false in the second cell.

Excel – how to get conditional colouring
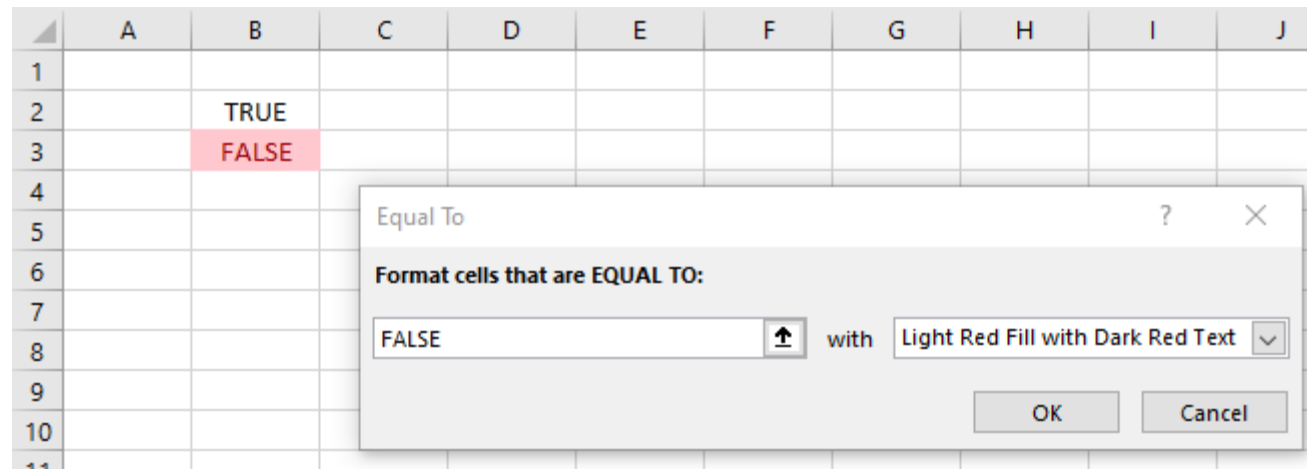
4. Repeat for TRUE
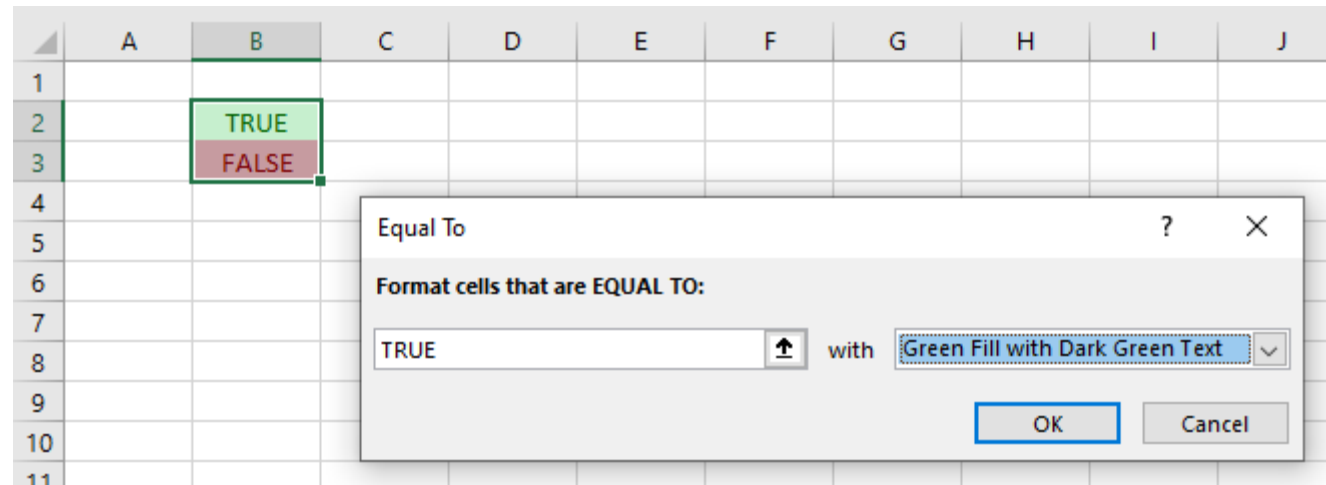
After this you can use the format painter

This will allow you to copy this into any other cells.
- Double click to paint multiple times.
- Press escape to cancel.
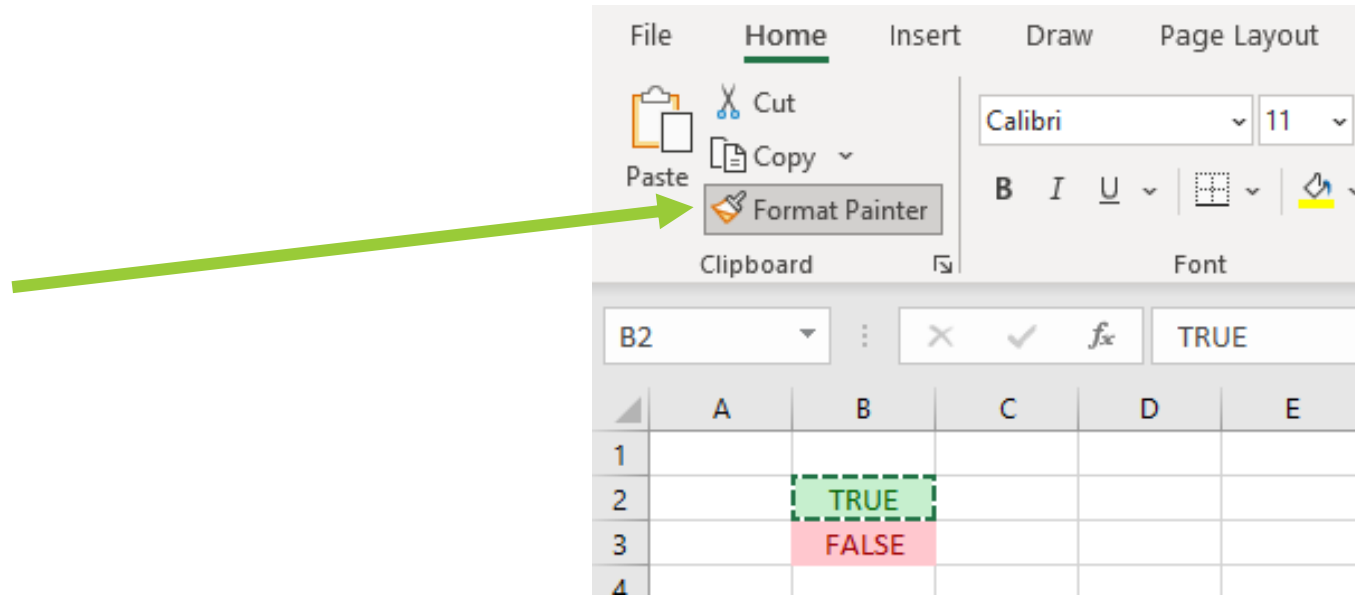
and

Given two expressions
◦ TRUE if both are TRUE

◦ FALSE otherwise

Excel behind the scenes		
A1	A2	=and(A1,A2)

AND		
p	q	p and q
FALSE	FALSE	FALSE
FALSE	TRUE	FALSE
TRUE	FALSE	FALSE
TRUE	TRUE	TRUE

or

Given two expressions
◦ TRUE if either are TRUE
◦ FALSE otherwise

Excel behind the scenes		
A1	A2	=or(A1,A2)

OR		
p	q	p or q
FALSE	FALSE	FALSE
FALSE	TRUE	TRUE
TRUE	FALSE	TRUE
TRUE	TRUE	TRUE

A note on the complexity after and/or/not:

Today is meant as an introduction to this topic and to expose you to something new.

We won't be perusing this topic any further so don't worry if you don't completely understand everything in the remainder of the lesson, just try your best.

If you are interested in pursuing the follow-up lessons, they would be:
1. Deductions
2. Boolean algebra

xor (exclusive or)

Given two expressions:
- ◦ TRUE if either are TRUE <u>but not both</u>
- ◦ FALSE otherwise

Excel behind the scenes		
A1	A2	=xor(A1,A2)

EXCLUSIVE OR		
p	q	p xor q
FALSE	FALSE	FALSE
FALSE	TRUE	TRUE
TRUE	FALSE	TRUE
TRUE	TRUE	FALSE

nand

The negation of AND

Excel behind the scenes		
A1	A2	=not(and(A1,A2))

NAND		
p	q	p nand q
FALSE	FALSE	TRUE
FALSE	TRUE	TRUE
TRUE	FALSE	TRUE
TRUE	TRUE	FALSE

nor

The negation of OR

Excel behind the scenes		
A1	A2	=not(or(A1,A2))

NOR		
p	**q**	**p NOR q**
FALSE	FALSE	TRUE
FALSE	TRUE	FALSE
TRUE	FALSE	FALSE
TRUE	TRUE	FALSE

If

Can be read as *"if p then q"* or *"p implies q"*
- Symbolically: $p \rightarrow q$

False when $true \rightarrow false$

True otherwise

IF		
p	q	p -> q
FALSE	FALSE	TRUE
FALSE	TRUE	TRUE
TRUE	FALSE	FALSE
TRUE	TRUE	TRUE

Excel behind the scenes		
A1	A2	=if(and(A1=TRUE,A2=FALSE), FALSE, TRUE)

If and only if

Symbolically: $p \leftrightarrow q$

Given two expressions.

True if the truth values are equal.

False otherwise

IF AND ONLY IF		
p	**q**	**p <-> q**
FALSE	FALSE	TRUE
FALSE	TRUE	FALSE
TRUE	FALSE	FALSE
TRUE	TRUE	TRUE

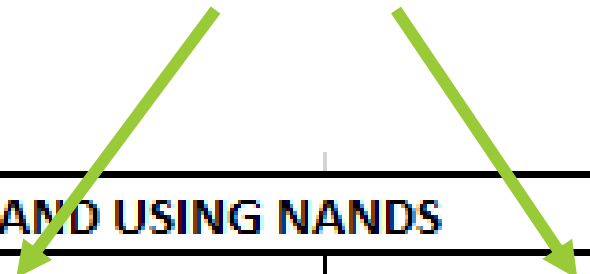| Excel behind the scenes		
A1	A2	=if(A1=A2, TRUE, FALSE)
Simplified:		= A1=A2

Criteria for your exercises

◦ Other than the possible values (p, q, r, s), all values should be calculated using Excel formulas.

◦ Use plenty of intermediate steps

  ◦ In questions 12-13 it's okay if you use NOT(OR(...)) in place of NOR(...) since it doesn't exist.

If you want to simplify things a bit:

You can assign intermediate steps their own letter and refer to it later. I do this in one of your later examples.

AND USING NANDS			
p	q	r = p nand q	r nand r
FALSE	FALSE	TRUE	FALSE
FALSE	TRUE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE
TRUE	TRUE	FALSE	TRUE