Week 3: Logical Tests and Nested Functions

# Logical Tests

Examples of logical tests:  
Is 1 equal to 1? Yes 🡪 TRUE  
Is 10 less than or equal to 3? No 🡪 FALSE

In the examples I just stated, when we say “equal to” or “less than or equal to” these are **logical operators**.

Slide 2 contains a table of the logical operators you can use in Excel. I specify Excel because while most or all these operators—sometimes called “comparison operators” or “relational operators”--exist in all programming languages, they don’t all use the same syntax.

### Exercise: Enter the logical tests in Column B as described in Column C of “Logical Tests” worksheet

Column A contains data to evaluate.  
We’ll enter the logical tests into Column B. The results will be TRUE or FALSE.  
Column C contains the description of the test we will enter in Column B.

In Row 2, we want to evaluate whether A2 is greater than 75.

1. Click B2
2. Enter formula: =A2>75
3. Press *Enter* to calculate

A picture containing graphical user interface

Description automatically generated

Try Rows 3 through 10 on your own. The answers are on the next page.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **B** | **Result** | **Notes** |
| **2** | =A2>75 | TRUE |  |
| **3** | =A3<50 | TRUE |  |
| **4** | =A4=100 | TRUE |  |
| **5** | =A2>A3 | TRUE |  |
| **6** | =A3<A4 | TRUE |  |
| **7** | =A4<>50 | TRUE |  |
| **8** | =A8=“apple” | TRUE |  |
| **9** | =A9=“banana” | TRUE | Not case sensitive for logical operator |
| **10** | =A10=“carrot” | FALSE | FALSE because there’s actually a space. I sometimes use the equality operator to verify the text is what I think it should be. |

You can also use **logical functions** to create more complex logical tests. Slide 3 has a table of the most common logical functions, and how to use them.

### Exercise: Use logical functions to enter the logical tests Rows 11-13

Answers are on the next page.

|  |  |  |
| --- | --- | --- |
|  | **B** | **Result** |
| **11** | =AND(A11>50,A11<75) | TRUE |
| **12** | =OR(A12>50,A11<75) | TRUE |
| **13** | =NOT(A2=99) | FALSE |

XOR, the function for Exclusive OR, only returns TRUE if one—and only one—of the conditions are met.

The following exercises using the “Registrants” worksheet should help you better understand the difference between OR and XOR.

### Exercise: Use the OR function to create the logical test in Column F using the Eligibility criteria in green box

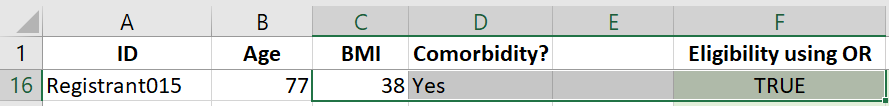
1. In F2, enter formula: =OR(C2>30,D2=”Yes”).   
   Graphical user interface, application, table

   Description automatically generated
2. Press *Enter* key to calculate.  
   A picture containing graphical user interface

   Description automatically generated
3. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.  
   Text

   Description automatically generated with medium confidence  
     
   Table

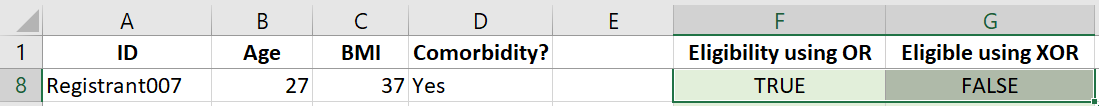
   Description automatically generated

If we look at the result for Registrant015, we can see that OR is not the correct function to use.  


It has identified this registrant as eligible for the study, but they meet *both* criteria instead of *only one*.

### Exercise: Use the XOR function to create the logical test in Column G using the Eligibility criteria in green box

1. The formula for G2 will look exactly like the formula for F2 but uses XOR instead of OR.  
   Table

   Description automatically generated
2. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.
3. You may notice that some differences in the results between Columns F and G.  
   

### Bonus Exercise: Use a logical test and conditional formatting to quickly compare results between Columns F and G

1. In H2, enter formula: =F2=G2  
   A picture containing schematic

   Description automatically generated
2. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.
3. Select cells H2 through H25.
4. Under the **Home** tab, click **Conditional Formatting**. Hover over **Highlight Cell Rules** then select **Equal To**  
   Graphical user interface, application

   Description automatically generated
5. Input “FALSE” and click **OK**  
   Graphical user interface, text, application, Word

   Description automatically generated
6. You should now easily identify the discrepancies in results between Columns F and G.  
   Table

   Description automatically generated

Using XOR is the correct way to determine which of these registrants are eligible for the study, since one and only one condition can be met.

# IF Statements

The IF function allow you to display a value (or evaluate another function) depending on whether the specified condition has been met.

In the “Cake” worksheet, cells A2 through A7 contain Things that may or may not be Cake.

### Exercise: Use an IF statement in column B to determine whether the Things in Column A match the word “cake”

1. In B2, enter the formula from Slide 6  
   A picture containing graphical user interface

   Description automatically generated
2. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.  
   Graphical user interface, text, application, table

   Description automatically generated
3. To confirm whether these are correct, select cells A2 through A7.  
   Table

   Description automatically generated
4. Under the **Home** tab, change the font color to black.  
   Bar chart

   Description automatically generated with low confidence
5. You can now confirm whether your formula was correct.  
   Table, Excel

   Description automatically generated

### Exercise: In the “Grades” worksheet, use an IF statement in column C to display “PASS” or “FAIL” using the scoring criteria in the blue box.

1. In cell C2, enter the formula in the screenshot:  
   Table

   Description automatically generated  
   You could also have used: IF(B2>69,”PASS”,”FAIL”)
2. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.  
   Table

   Description automatically generated

# Nested Functions

You can also use a function within another function. Slide 8 shows how we will use an IF function as an argument for another IF function. Slide 9 has a workflow diagram to better explain how the nested function is evaluated.

In the “Cake” worksheet, we will consider not only “Cake” but also “Cupcake” to be cake.

### Exercise: Use a nested IF statement to re-check whether the Things in Column A are cake.

1. In C2, enter the formula from Slide 8   
   Graphical user interface

   Description automatically generated with low confidence  
   Note that the color of the parentheses indicate the set it belongs to: the red parentheses are a set, and the black parentheses are a set. This visual cue helps make sure you close all your parentheses to avoid an error.
2. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.  
   Table

   Description automatically generated
3. A5 is now considered Cake.  
   

### Exercise: Use a nested IF statement to display the Age Group in Column I of “Registrants” worksheet according to the Age Stratification in the blue box

1. In I2, enter the formula from Slide 10  
   Table

   Description automatically generated  
   You could also have used: IF(B2>=65,”Group C”,IF(B2>=40,”Group B”,”Group A”))  
   The workflow diagram in Slide 10 demonstrates how the nested function is evaluated.
2. Use Auto Fill to copy down the formula by double-clicking when your cursor turns into a solid black plus.  
   Table

   Description automatically generated