

## Excel Tips #4: Complex Logic (altavia.com, 2016)

In our last article we discussed the basic logical function IF. We are going to build on that here by introducing the AND and OR functions, which can take your logic to a whole new level. Next month's article will discuss mathematical functions that employ logic, such as SUMIF and COUNTIF.

As a quick review, the syntax for the basic IF function is:

IF(logical\_test, value\_if\_true, value\_if\_false)

We also discussed nesting IF functions within the same formula:

IF(logical\_test1, value\_if\_1true, IF(logical\_test2, value\_if\_2true, value\_if\_both\_false))

### AND and OR Functions

In addition to nesting, there's another way to make multiple tests within an IF function by using the AND and OR functions. The syntax for the AND function is:

AND(condition\_1, condition\_2, condition\_3,...)

The AND function returns a TRUE if *all three* (or however many) conditions are TRUE, that is condition\_1 is TRUE AND condition\_2 is TRUE AND condition\_3 is TRUE. If any one of the conditions tests FALSE, then the AND function returns a FALSE.

The syntax for the OR function is similar:

OR(condition\_1, condition\_2, condition\_3,...)

OR returns a TRUE if *any of the three* (or however many) conditions is TRUE. That is condition\_1 is TRUE OR condition\_2 is TRUE OR condition\_3 is TRUE. If all three of the conditions test FALSE, then the OR function returns a FALSE. For an OR function to return a TRUE it doesn't matter how many of the conditions are TRUE or FALSE as long as at least one of the conditions is TRUE.

Let us put this altogether in an expanded example from last month's article. Below is our starting point, where in the last article we determined the 'Number FTEs' (Col E) from the column 'Full Time or Part Time' (Col B) using the IF function. Now we need to slot the FTE number (Col E) into 'Direct FTEs' (Col F), 'Reimbursable FTEs' (Col G), or 'Indirect FTEs' (Col H) from the two new columns 'Direct or Reimb' (Col C) and 'Direct or Customer' (Col D).

**Table 3 [expanded example]**

	A	B	C	D	E	F	G	H
1	NAME	Full Time or Part Time	Direct or Reimb	Direct or Customer	Number FTEs	Direct FTEs	Reimb FTEs	Indirect FTEs
2	Employee Name - 1	FT	Direct	Direct	1.00	?	?	?
3	Employee Name - 2	PT	Reimb	Customer	0.50	?	?	?
4	Employee Name - 3	FT	Direct	Custom				
5	Employee Name - 4	FS	Indirect	Custom				

Use columns C and D to slot Number FTEs into Direct FTEs, Reimb FTEs or Indirect FTEs

**Table 3 Revised [showing formula and result]**

	A	B	C	D	E	F	G	H
1	NAME	Full Time or Part Time	Direct or Reimb	Direct or Customer	Number FTEs	Direct FTEs	Reimb FTEs	Indirect FTEs
2	Employee Name - 1	FT	Direct	Direct	1.00	=IF(AND(C2="Direct",D2="Direct"),E2,0)	=IF(OR(AND(C2="Direct",D2="Customer"),C2="Reimb"),E2,0)	=IF(C2="Indirect",E2,0)
3	Employee Name - 2	PT	Reimb	Customer	0.50	0.00	0.50	0.00
4	Employee Name - 3	FT	Direct	Customer	1.00	0.00	1.00	0.00
5	Employee Name - 4	FS	Indirect	Customer	0.25	0.00	0.00	0.25
6	Employee Name - 5	PT	Direct	Direct	0.50	0.50	0.00	0.00

The formula for Direct FTEs in cell F2 in Table 3 [=IF(AND(C2="Direct",D2="Direct"),E2,0)] says:

IF the value in C2 is equal to "Direct" AND the value in D2 is equal to "Direct" (as in rows 2 and 6), that is if both conditions within the AND function are TRUE, then assign the value in E2 (which is the Number FTEs). Otherwise, assign 0.

The formula for Reimb FTE's in cell G2 [=IF(OR(AND(C2="Direct",D2="Customer"),C2="Reimb"),E2,0)] is a bit more complicated. The first part of the formula uses an OR function [OR(AND(C2="Direct",D2="Customer"),C2="Reimb")], which contains two tests:

1. AND(C2="Direct",D2="Customer")
2. C2="Reimb"

If either of the two tests inside the OR function is TRUE, then the OR function returns a TRUE. Note that one of the tests inside the OR function is an AND function [AND(C2="Direct",D2="Customer")]. So the AND will return a TRUE if both C2="Direct" AND D2="Customer", which is the case in row 4. If the AND function returns a TRUE, then the OR is TRUE (i.e., the first of the two tests is TRUE and an OR returns a TRUE if any of its tests are TRUE). On the other hand, if the AND function is FALSE (either C2 does not equal "Direct" or D2 does not equal "Customer"), then the OR could still be TRUE if the second test C2="Reimb" is TRUE, as in row 3. To summarize, Excel will first determine if the AND function is TRUE or FALSE, then it will determine if the OR function is TRUE or FALSE. If the OR function is TRUE, then it assigns the value in E2. If the OR function is FALSE, then it assigns a value of 0.

The formula for Indirect FTEs in cell H2 [=IF(C2="Indirect",E2,0)] is the simple IF function discussed in the last article.

Using the IF, AND and OR functions together can quickly produce somewhat complex query logic to copy down in your spreadsheets. It's complex logic. Formula on, dudes...