



University
of Glasgow

Excel 2016 – Logic Calculations and Functions

V1.0

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Introduction

Frequently within Excel worksheets we need to compare the contents of one or more cells to others. This capability greatly increases what we can calculate, analyse and display in our worksheet. This course will examine both the logic and logic-based functions that Excel can perform. Attendees to this course are expected to have a basic knowledge of Excel, including the ability to create formulas and use functions.

Objectives

On successful completion of this course, participants will be able to:

- Use Logical Operators in formulas
- Use functions that calculate based on single criteria such as SUMIF and COUNTIF
- Use functions that calculate based on multiple criteria such as SUMIFS, COUNTIFS and AVERAGEIFS
- Use logic functions such as IF, AND and OR
- Use functions to convert errors and not applicable answers to other values.

Excel 2016 – Logic Calculations and Functions

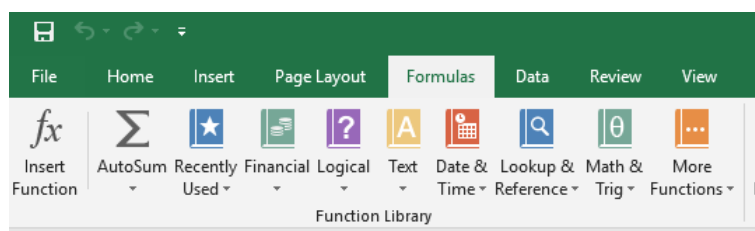
1 Getting Help with Functions

1 PLEASE NOTE:

This section is just for reference, so do not try to follow through instructions now just remember how you can use the help available within Excel.

- Excel 2016 has several features that help to make using spread sheets quicker and easier. One of these is the **Insert Function** utility, which saves you from typing complicated function syntax into your spread sheet. To use this utility, open a new workbook and click on the **Insert Function** button.

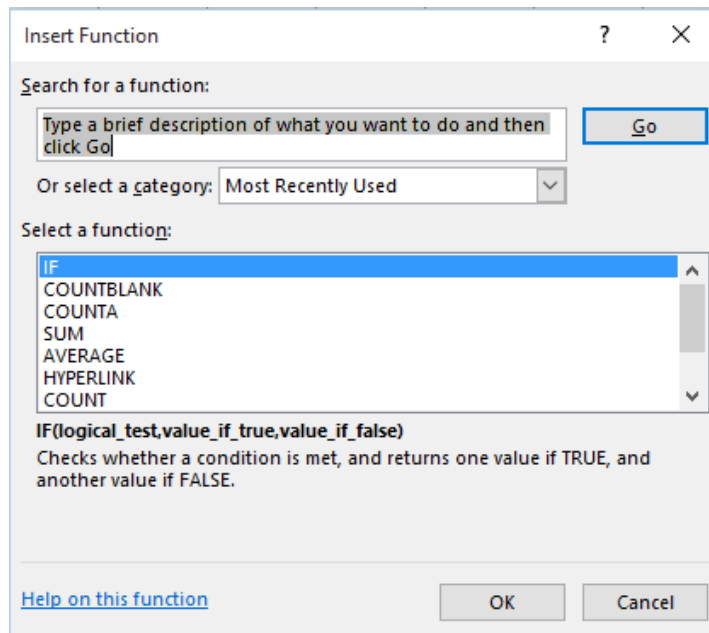
This button is located under the **Formulas** tab within the **Function Library** group.



You can also access this feature from the formula bar, click **fx**

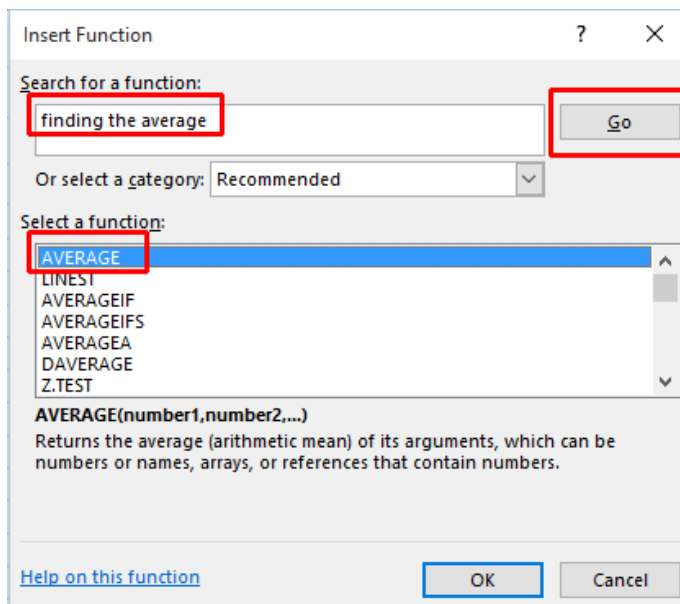


- Clicking on the **Insert Function** button will display the **Insert Function** dialog box.



- 4 Since few people know the full details of every single Excel function, it is sometimes difficult to choose a function that will allow you to perform a desired task. Luckily, the **Insert Function** utility contains a function wizard that can assist you in finding that perfect function.
- 5 Let's try an example. Pretend that you want to find the average price in a hypothetical cell range. Within the **Search for a function box**, type.

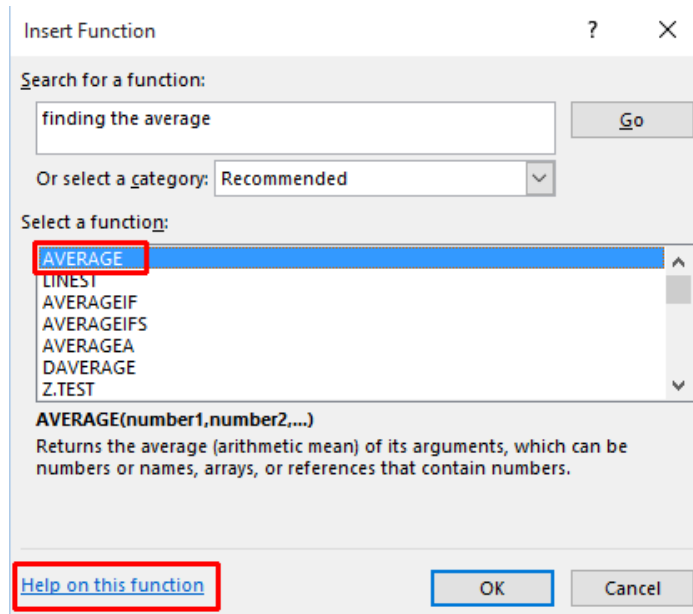
Finding the average



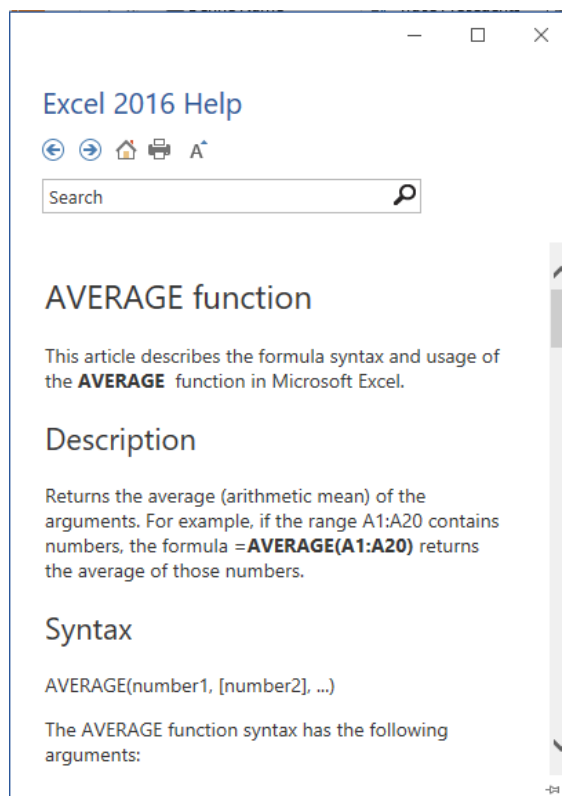
- 6 Click on the **Go** button to perform the search.

NOTE: Click on the **GO** button, **NOT** the **OK** button.

- 7 You will see that the wizard has compiled a list of possible correct functions in the **Select a function** section of the dialog box, which will assist you making your decision. There is also a brief description of the selected function at the bottom of the dialog box to further help you in making your choice, as illustrated below.



- 8 If you need further assistance, be sure to click on **Help on this function**, which will provide you with more detailed help online.



- 9 Use these features; they are there to help you.

2 Logic Operators

Before we can start to understand logical functions within excel, we must understand how logical operators operate. Logical operators allow us to compare two values in several ways. Logical operators always return the answers **TRUE** or **FALSE**.

The following operators are available for use:

Condition	Operator	Formula Example	Description
Equal to	=	=B2=C2	The formula returns TRUE if a value in cell B2 is equal to the values in cell C2; FALSE otherwise.
Not equal to	<>	=B2<>C2	The formula returns TRUE if a value in cell B2 is not equal to the value in cell C2; FALSE otherwise.
Greater than	>	=B2>C2	The formula returns TRUE if a value in cell B2 is greater than a value in cell C2; otherwise it returns FALSE.
Less than	<	=B2<C2	The formula returns TRUE if a value in cell B2 is less than in cell C2; FALSE otherwise.
Greater than or equal to	>=	=B2>=C2	The formula returns TRUE if a value in cell B2 is greater than or equal to the values in cell C2; FALSE otherwise.
Less than or equal to	<=	=B2<=C2	The formula returns TRUE if a value in cell B2 is less than or equal to the values in cell C2; FALSE otherwise.

- 1 Open a workbook called **Functions – Logic Operators**
- 2 Select cell **D2**
- 3 Input the following formula

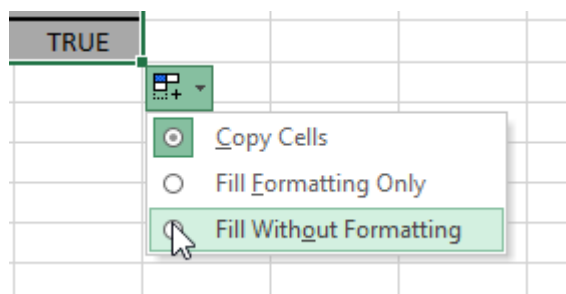
=B2=C2
- 4 Hit **TAB**
- 5 Complete the formulas for row 2, using the appropriate logical operators

6 Select cells **D2:I2**

	A	B	C	D	E	F	G	H	I	J
1	Student	Exam 1	Exam 2	=	<>	>	>=	<	<=	
2	Mohammed	67	72	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	
3	Judith	65	65							
4	May	93	82							
5	Gavin	54	50							
6	Greta	45								
7	Sam	71	76							
8										

7 Autofill the selection

8 Using the Smart Tag on the bottom right hand side of the selection, change the autofill behaviour to **Fill Without Formatting**



9 Examine the results that your calculations have produced

10 Select cell **C6**

11 Type **NA** into the cell and hit **ENTER**

12 Examine the results for row 6.

You will see that logical operators allow us to compare numbers to text, however the results you get may not be the answers that you are expecting.

13 **Save** and **close** the file

The answers **TRUE** and **FALSE** are not especially useful to us, however combined with logical functions these operators can be used to create very powerful calculations.

3 Mathematical Functions

Although not classified within Excel as Logical Functions, certain statistical and mathematical functions have a logical component. In this section of the course we will examine a few of the more commonly used of these functions.

a. SUMIF Function

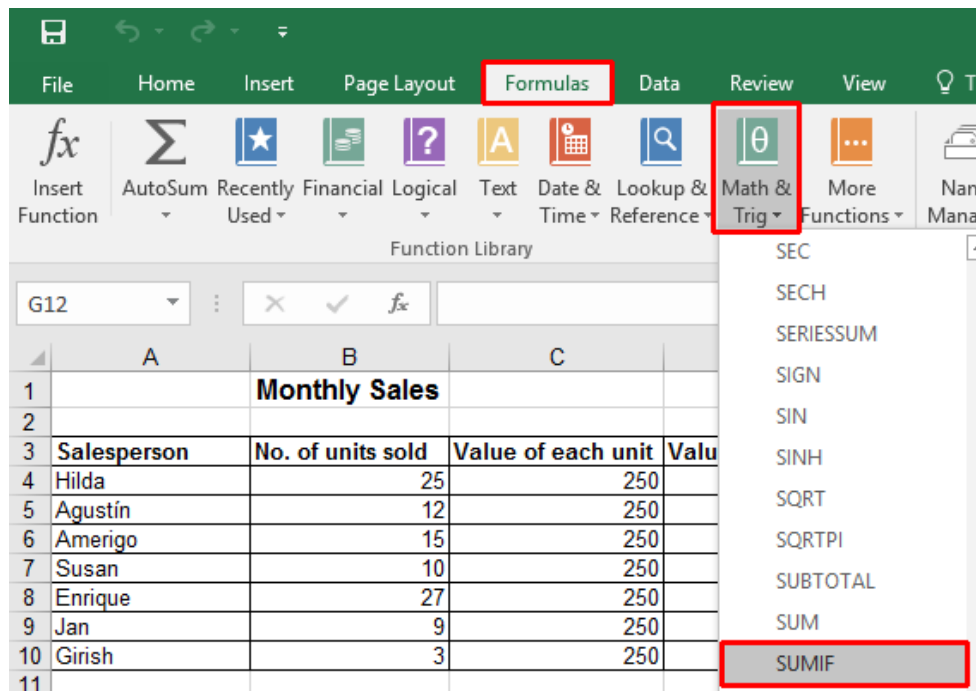
The **SUMIF** function is very commonly used in Excel

You use the **SUMIF** function to add up (sum) numbers in one column, when the values in another column meet your criteria

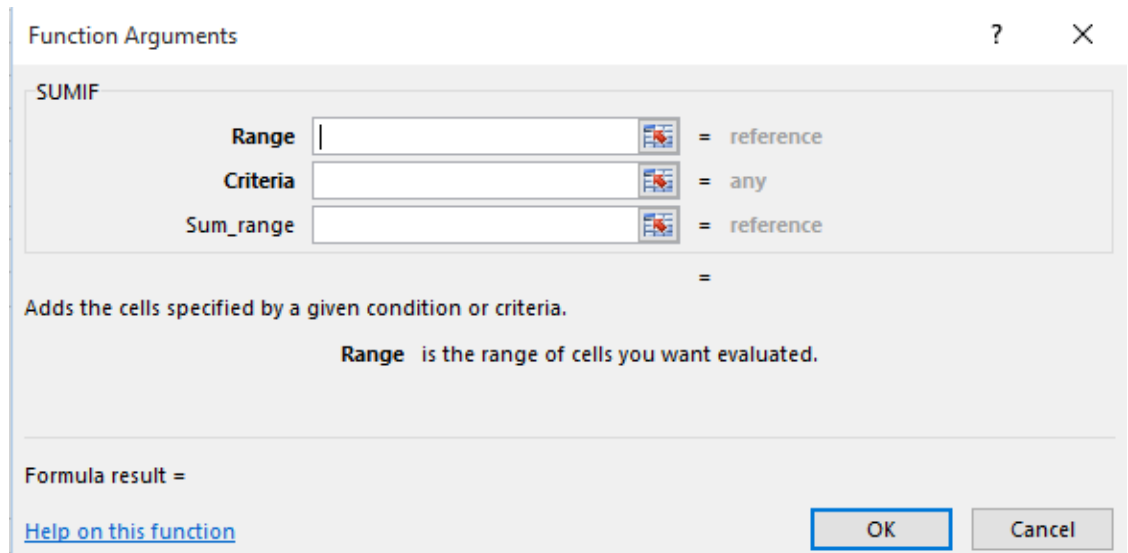
SYNTAX: =SUMIF(range, criteria, [sum_range])
 WHERE: range is the range of cells you wish evaluated
 criteria is the criterial you wish to test (for each row)
 sum_range is the actual cells to sum
 Example: =SUMIF(B2:B25, ">5", C2:C5)
 add up column C when column B is greater than 5

Task

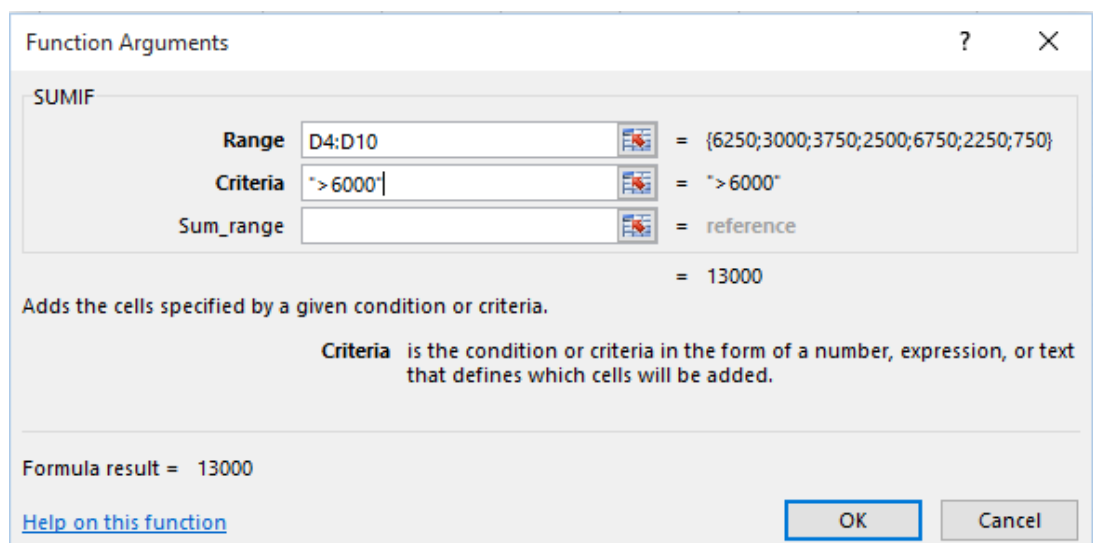
- 1 Open a workbook called **Functions - Sumif**.
- 2 The **SUMIF** sums the values within a range that meet specified criteria. In this case, we want to see the total value of all sales, where the salesperson earned over 6000 a month.
- 3 First, we would need to click on the cell in which we wish the result of our function to be displayed, in this case cell **G12**.
- 4 Click on the **Formulas** tab and within the **Function Library** group click on the **Math & Trig** button. From the drop-down list displayed, click on the **SUMIF** function.



- 5 The **Function Arguments** dialog box is displayed.



- 6 Within the **Range** section of the dialog box, enter the range **D4:D10**.
- 7 Within the **Criteria** section of the dialog box, enter **>6000**. The screen should now resemble the illustration.



- 8 Click on the **OK** button to display the result. You can see the function syntax displayed in the **Function Bar**, as illustrated.

b. COUNTIF Function

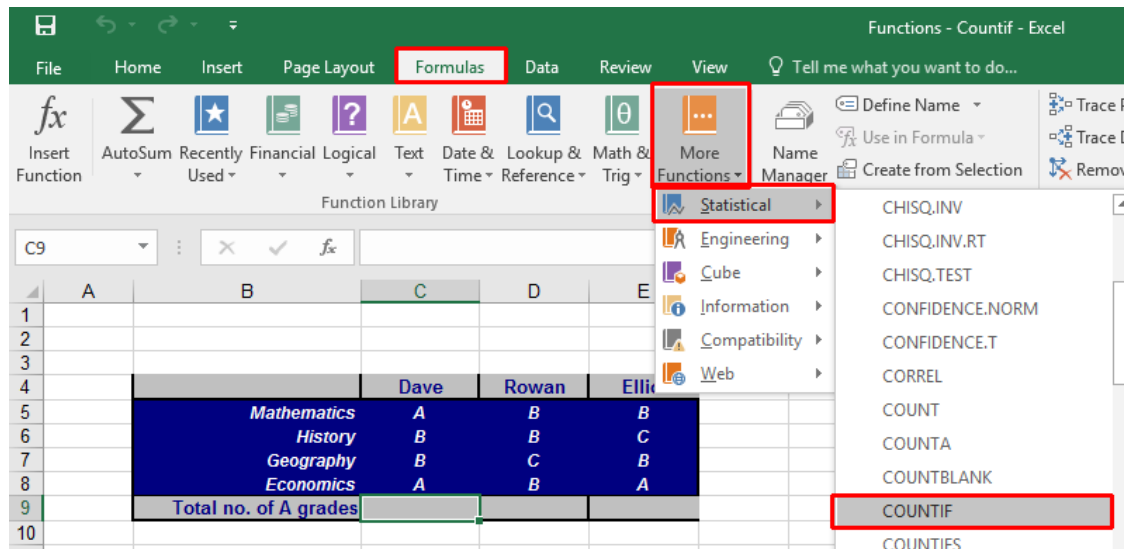
The **COUNTIF** function behaves in a similar way to the **SUMIF** function we have just tried. Instead of adding up values, the **COUNTIF** function

Task

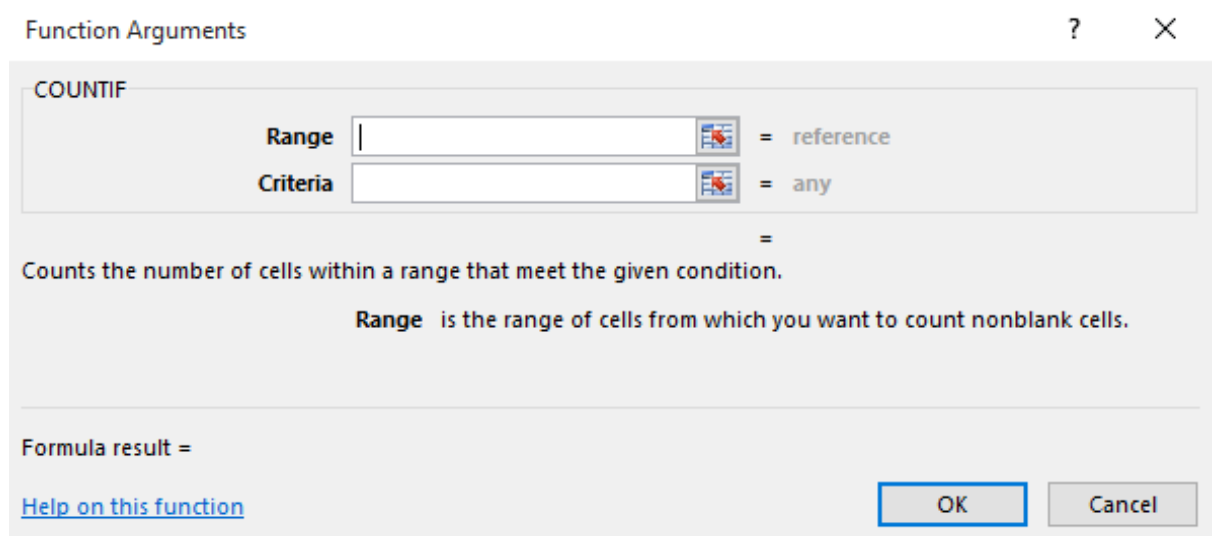
- 1 Open a workbook called **Functions - Countif**. This sheet contains examination results and grades. We shall use the **COUNTIF** function to see how many 'A' grades Dave has, how many Rowan has and how many Elliot has.

	A	B	C	D	E
1					
2					
3					
4			Dave	Rowan	Elliot
5		Mathematics	A	B	B
6		History	B	B	C
7		Geography	B	C	B
8		Economics	A	B	A
9		Total no. of A grades			

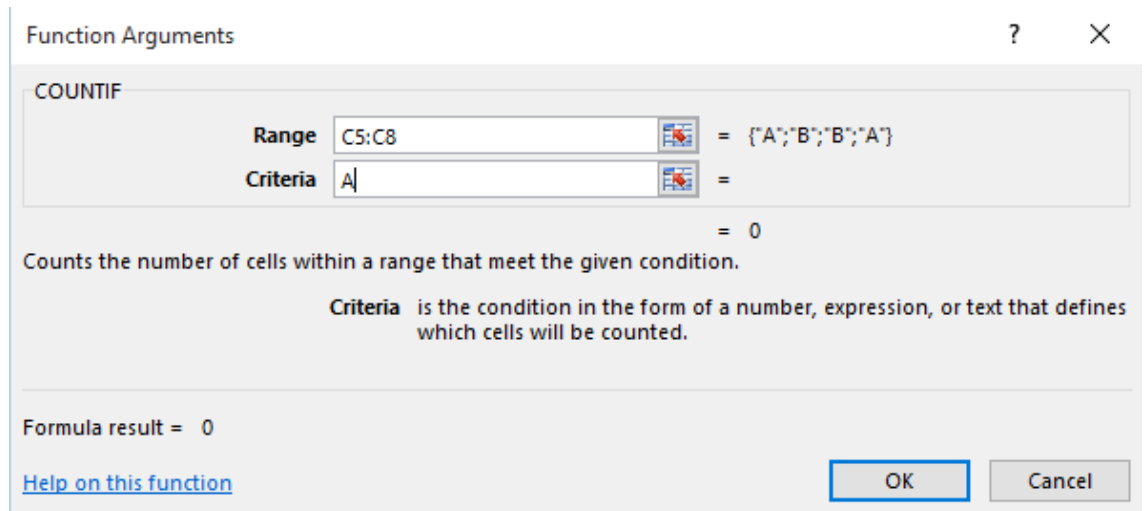
- 2 Click on cell **C9**.
- 3 Click on the **Formulas** tab and within the **Function Library** group click on the **More Functions** button. From the drop down list displayed click on **Statistical**. From the submenu displayed click on the **COUNTIF** function.



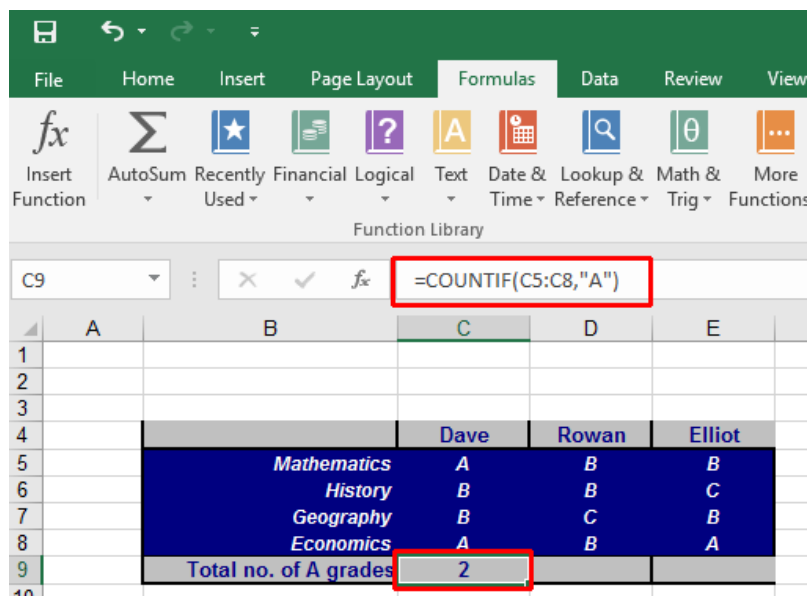
- 4 The **Function Arguments** dialog box is displayed.



- 5 In the **Range** section of the dialog box, enter the cell range **C5:C8**.
- 6 In the **Criteria** section of the dialog box, enter **A**.



- 7 Click on the **OK** button to insert the function. Your worksheet will now look like this.



- 8 You can see the function syntax displayed within the **Formula Bar**.

=COUNTIF(C5:C8,"A")

- 9 Use the normal drag and drop techniques to copy this function to cells **D9** and **E9**. Your worksheet will now look like this.

The screenshot shows the Microsoft Excel interface with the 'Formulas' tab selected. The ribbon includes options like 'Insert Function', 'AutoSum', 'Recently Used', 'Financial', 'Logical', 'Text', 'Date & Time', 'Lookup & Reference', 'Math & Trig', and 'More Functions'. Below the ribbon, the formula bar shows 'E12'. The worksheet grid displays a table with the following data:

	A	B	C	D	E
1					
2					
3					
4			Dave	Rowan	Elliot
5		Mathematics	A	B	B
6		History	B	B	C
7		Geography	B	C	B
8		Economics	A	B	A
9		Total no. of A grades	2	0	1

- 10 Save your changes and close the workbook.

4 Mathematical functions with multiple criteria

In the previous section we looked at functions such as **SUMIF** and **COUNTIF**. These functions are useful, but test only one logical criteria. If we want to perform calculations based on more than one criteria we have functions that can do that for us.

Task

- 1 Open the workbook named **Functions - ifs functions.xlsx**
- 2 Have a quick look through the data, it is organised into columns. We are going to analyse data for constituencies where more than 20 people have signed a petition. We will further break down our answers by country
- 3 Select cell **I3**

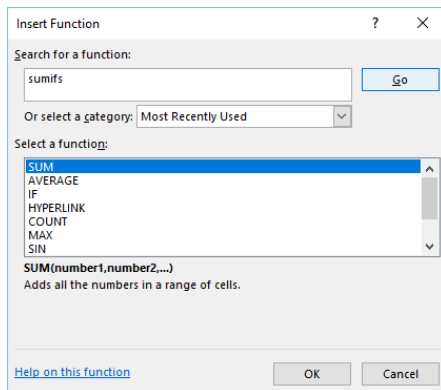
The screenshot shows an Excel spreadsheet with the following data:

H	I
Sumifs	
Country	Over 20 Signature
England	+
Scotland	
Wales	
Northern Island	

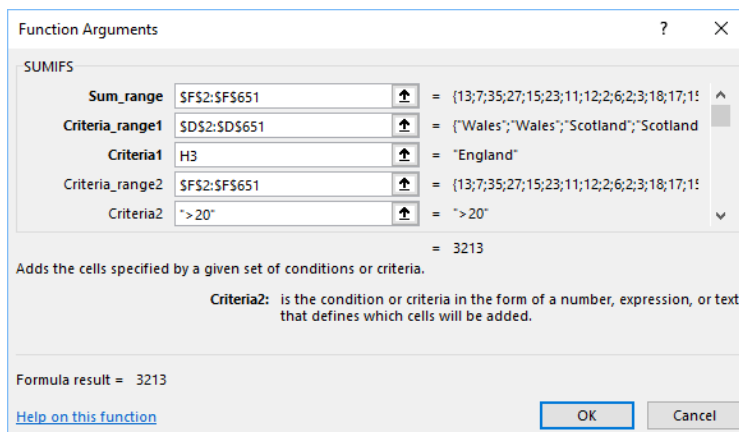
- 4 Click the **Insert Function** button in the formula bar



- 5 In the Search for a function box type **sumifs**



- 6 Click **Go**
- 7 Check that **SUMIFS** is selected in the search results and then click **OK**
- 8 Fill in the following **Function Arguments**

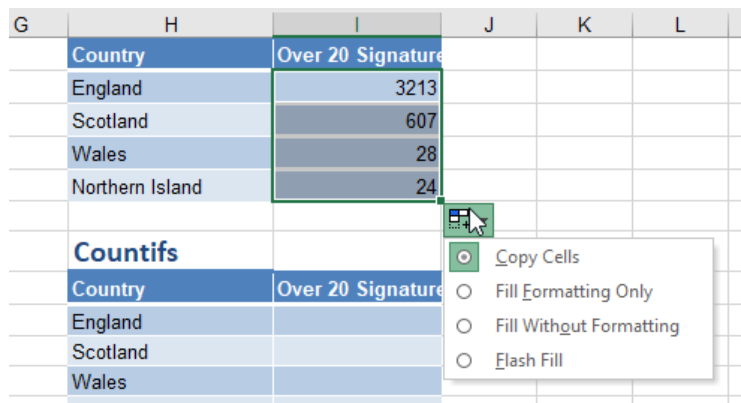


hint: The **F4** key can be used to quickly convert relative cell references to absolute.
(i.e. the dollar signs)

- 9 Click **OK**
- 10 Autofill cells **I4:I6**

11 Using the smart tag select **Fill Without Formatting**

G	H	I	J	K	L
	Country	Over 20 Signatures			
	England	3213			
	Scotland	607			
	Wales	28			
	Northern Ireland	24			
	Countifs				
	Country	Over 20 Signatures			
	England				
	Scotland				
	Wales				



b. COUNTIFS and AVERAGEIFS

Although the **COUNTIFS** and **AVERAGEIFS** functions perform different calculations, their operation is similar to the **SUMIFS** function. The arguments required to operate these functions are the same

Task

With the **Functions-ifs.xlsx** workbook that is currently open:

- 1 Complete the calculations in cells **I10:I14**, calculating the number of constituencies that had more than 20 signatures broken down by country
- 2 Complete the calculations in cells **I10:I14**, calculating average number of signatures (for constituencies that had more than 20) broken down by country
- 3 **Save** and **Close** the workbook

5 Logical Functions

a. IF Function

In our last section we used and compared (with a logical test) the logical operators in several calculations. Whilst it is useful to be able to compare to values using operators, it is not especially powerful.

The next step is to look at the if Logic Function.

The IF function is perhaps the most widely used logic function in Excel. Basically, it allows you to use a logical test (like the ones we just performed using logical operators) and return a value or calculation based on whether the answer to that is **TRUE** or **FALSE**.

To put it another way, if we compare two values, the **IF** function will convert the **TRUE** and **False** answers into something more useful for us!

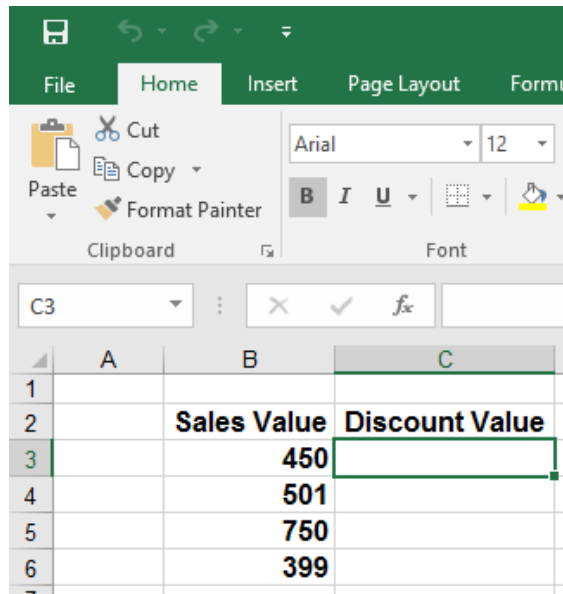
SYNTAX: =IF(logical_test, [value_if_true], [value_if_false])

Example: =IF(A1<B1,"OK",0)

EXPLANATION: If the value in A1 is less than the value in B1, the value "OK" is returned, otherwise return a 0.

Task

- 1 Open a workbook called **Functions - If**.

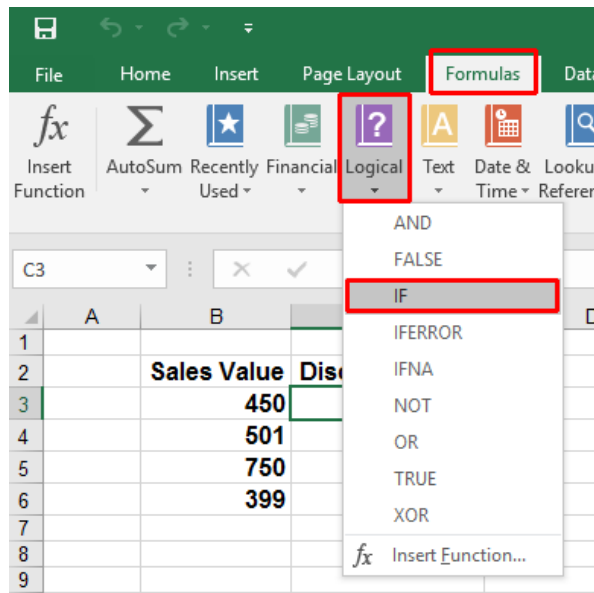


This example calculates a discount based on order quantity. The company offers its customers a 5% discount if the value of an order is above 500. There is no discount if the value is below 500.

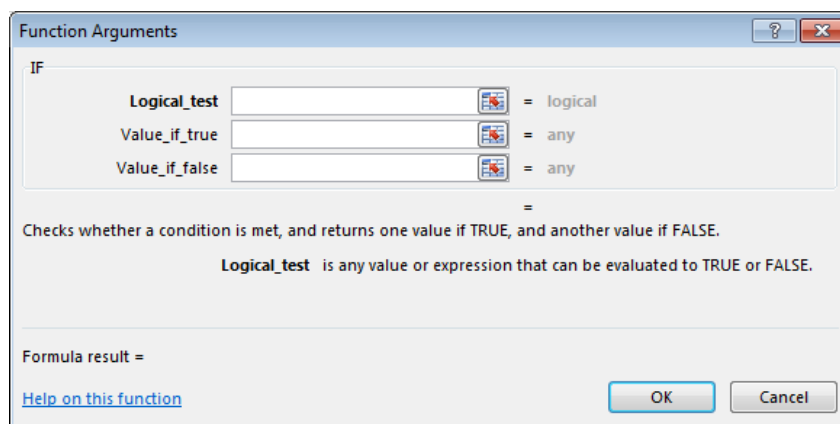
A way of simplifying the above statement is as follows.

If the sale value is greater than 500 give 5% discount otherwise give no discount.

- 2 Click on cell **C3**.
- 3 Click on the **Formulas** tab and within the **Function Library** group click on the **Logical** button. From the drop-down list displayed, click on the **IF** function.



- 4 The **Function Arguments** dialog box will be displayed.



- 5 Click on the **Logical test** section of the dialog box and enter **B3>500**.
- 6 Click on the **Value_if_true** section of the dialog box and enter **B3*5%**.
- 7 Click on the **Value_if_false** section of the dialog box and enter **0**.

Function Arguments

IF

Logical_test	B3>500	= FALSE
Value_if_true	B3*5%	= 22.5
Value_if_false	0	= 0

= 0

Checks whether a condition is met, and returns one value if TRUE, and another value if FALSE.

Value_if_false is the value that is returned if Logical_test is FALSE. If omitted, FALSE is returned.

Formula result = 0

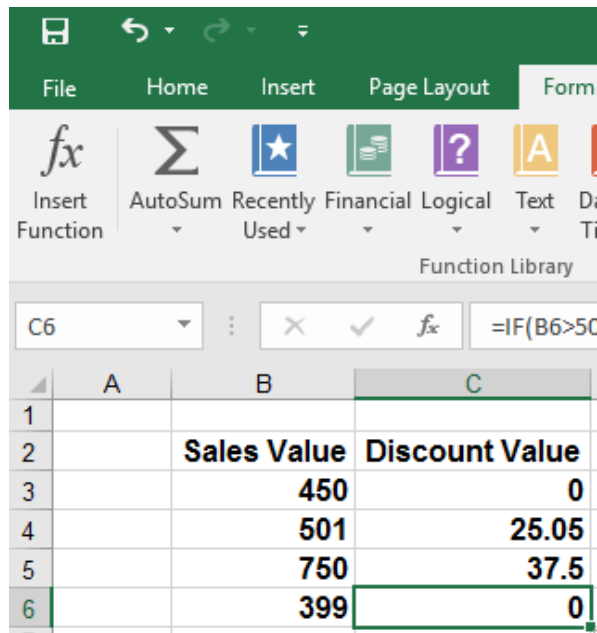
[Help on this function](#)

OK Cancel

- 8 When you press the **OK** button, you will see the following. As the value in cell **B3** is less than **500**, the discount value is **zero**.

	A	B	C	D
1				
2		Sales Value	Discount Value	
3		450	0	
4		501		
5		750		
6		399		
7				

- 9 Copy the formula in cell **C3** to cells **C4:C6** using the usual fill handle technique and you will see the following. As you can see where the sales value is above **500**, a discount value is displayed.



10 Save your changes and close the workbook.

b. AND Function

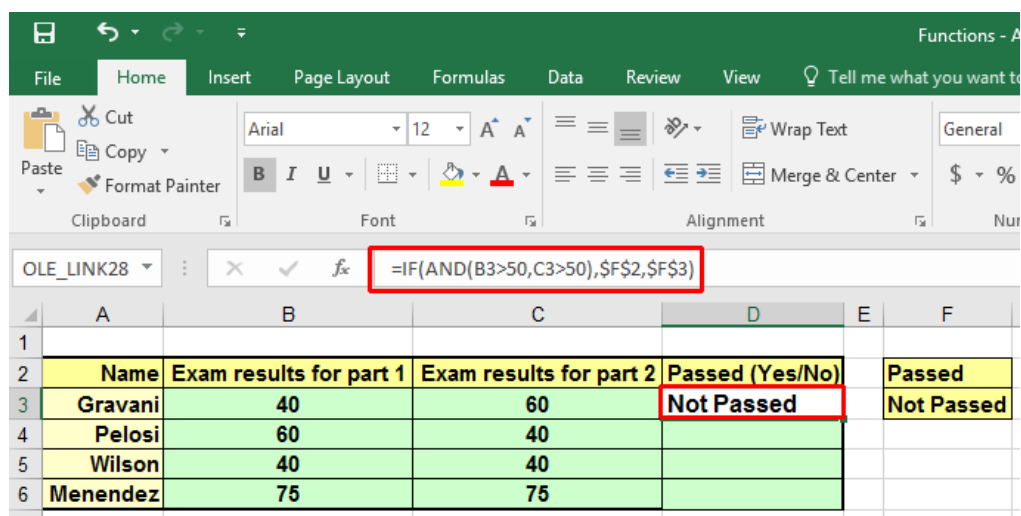
1 Open a workbook called **Functions - AND**.

In this example, we have the results of a two-part examination;
candidates must achieve **over 50 in EACH part** of the examination.

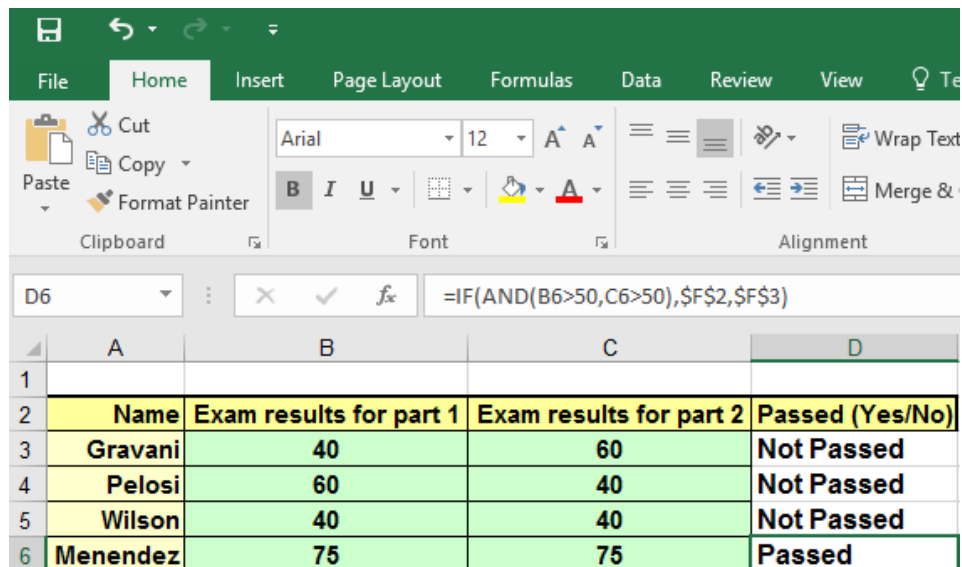
2 Click on cell **D3** and enter the following:

=IF(AND(B3>50,C3>50),\$F\$2,\$F\$3)

3 When you press **Enter** you should see the following, as the candidate scored less than **50** in the first part of the examinations:



- 4 Copy the formula in cell **D3** to the cell range **D4:D6** and you will see the following:



The screenshot shows the Microsoft Excel interface. The 'Home' tab is selected. The formula bar shows the formula `=IF(AND(B6>50,C6>50),F2,F3)` for cell D6. The worksheet contains a table with the following data:

	A	B	C	D
1				
2	Name	Exam results for part 1	Exam results for part 2	Passed (Yes/No)
3	Gravani	40	60	Not Passed
4	Pelosi	60	40	Not Passed
5	Wilson	40	40	Not Passed
6	Menendez	75	75	Passed

- 5 The only person to get **more than 50** in **both** parts of the examination is **Menendez**, who is the only person to pass the entire examination.
- 6 Save your changes and close the workbook.

c. OR Function

- 1 Open a workbook called **Functions - OR**.

In this example, we have the results of a two-part examination and candidates can pass the entire examination by achieving a score of **> 75** in **either** part of the examination.

- 2 Click on cell **D3** and enter the following:

`=IF(OR(B3>75,C3>75),F2,F3)`

- 3 When you press **Enter** you should see the following, as the candidate scored **less than 75** marks in both parts of the examination:

File

Home

Insert

Page Layout

Formulas

Data

Review

View

Tell me what you want to do.

Cut

Copy

Paste

Format Painter

Arial

12

A⁺

A⁻

Wrap Text

Merge & Center

General

\$

%

Clipboard

Font

Alignment

Number

OLE_LINK27

=IF(OR(B3>75,C3>75),F\$2,F\$3)

	A	B	C	D	E	F
1						
2	Name	Exam results for part 1	Exam results for part 2	Passed (Yes/No)		Passed
3	Gravani	40	40	Not passed		Not passed
4	Pelosi	78	20			
5	Wilson	50	80			
6	Menendez	89	79			

- 4 Copy the formula in cell **D3** to the cell range **D4:D6** and you will see the following:

FileHomeInsertPage LayoutFormulasDataReviewViewTell me what you want to do..

</

- 5 The only person to get **less than 75** marks in both parts of the examination is **Gravani**, who is the only person to not pass the entire examination.
- 6 Save your changes and close the workbook.

6 Dealing With Errors

a. Formula error messages

To err they say is human, but within spreadsheets we often get error messages when we attempt calculations, listed below are some common error messages:

#REF!

Indicates that a cell reference is invalid. This is often displayed when you delete cells which are involved in a formula.

#NAME?

Excel does not recognise text contained within a formula.

#DIV/0!

This indicates that you have tried to divide a number by zero (0).

Sometimes these errors are simply the result of an incorrect formula, however, sometimes those errors are created because of the datasets we are using or are an unavoidable consequence of performing certain calculations.

To make our worksheets look less messy and broken we can wrap the calculation we wish to achieve inside the brackets of another function IFERROR.

Syntax

=IFERROR(value, value_if_error)

In this case the value will be the existing formula. The value_if_error will be what we want to replace an error message with.

Task

- 1 Open the **Functions - error.xlsx** file
- 2 In this example we have a sample of students and their exam results. If you look at cells **G2:G10** you will see that the **AVERAGE** function is being used to calculate each student's average exam grade.

	A	B	C	D	E	F	G
1	Name	Exam 1	Exam 2	Exam 3	Exam 4	Exam 5	Average
2	Jane	77	83	68	93	72	78.6
3	John	63	73	89	81	51	71.4
4	Joseph	61	38	81	48	44	54.4
5	Jamiri	57	85	91	94	70	79.4
6	Jaqueline						#DIV/0!
7	Janvier	46	86	71	41	87	66.2
8	Jessica	91	42	65	44	75	63.4
9	Jayden	87	48	95	58	60	69.6
10	Jasmin	37	35	36	67	89	52.8
11							

In the case of Jacqueline, there are no exam results, and this is causing a divide by zero error in the worksheet.

- 3 Select cell **G2**
- 4 Press the **F2** key to edit the formula... You will see the formula is
`=AVERAGE(B2:F2)`
- 5 Edit the formula to read:
`=IFERROR(AVERAGE(B2:F2),0)`
- 6 Autofill the formula from **G3:G10**
- 7 Using the smart tag, select **Fill Without Formatting**

	A	B	C	D	E	F	G	H	I	J
1	Name	Exam 1	Exam 2	Exam 3	Exam 4	Exam 5	Average			
2	Jane	77	83	68	93	72	78.6			
3	John	63	73	89	81	51	71.4			
4	Joseph	61	38	81	48	44	54.4			
5	Jamiri	57	85	91	94	70	79.4			
6	Jaqueline						0			
7	Janvier	46	86	71	41	87	66.2			
8	Jessica	91	42	65	44	75	63.4			
9	Jayden	87	48	95	58	60	69.6			
10	Jasmin	37	35	36	67	89	52.8			
11										
12										
13										
14										
15										
16										
17										

- 8 **Save** and **close** the file

7 More Functions and Formulas

a. Nested functions

We have seen examples already of nested functions when we use IFERROR. In that formula the average calculation was nested inside the IFERROR function arguments. When you nest like this the answer from one function is supplying an argument or arguments to another function.

Task

- 1 Open a workbook called **Nested Functions**.

	A	B	C
1			
2	Sales person	Sales (North Region)	Sales (South Region)
3	Gravani	20	20
4	Pelosi	30	10
5	Wilson	50	10
6	Menendez	10	40
7			
8	Average Sales	28	20
9	Total Sales	110	80
10			
11			
12	Sales target average is 25		
13	Total, if average sales are achieved.		

This workbook contains sales results for the **North** and **South** regions, along with total and average sales results for the two regions.

The average sales target of a region is **25** (per sales person).

We want to be able to sum up only those sales of the regions that are above the sales target.

- 2 Click on cell **B13** and enter the following formula.

=IF(AVERAGE(B3:B6)>25,SUM(B3:B6),0)

File Home Insert Page Layout Formulas Data Review View			
<div> <div>Cut Copy Paste Format Painter</div> <div>Clipboard</div> <div> <div>Arial 12</div> <div>B I U</div> <div>Font</div> </div> <div> <div>Alignment</div> </div> </div>			
OLE_LINK35 <input type="text" value="=IF(AVERAGE(B3:B6)>25,SUM(B3:B6),0)"/>			
	A	B	C
1			
2	Sales person	Sales (North Region)	Sales (South Region)
3	Gravani	20	20
4	Pelosi	30	10
5	Wilson	50	10
6	Menendez	10	40
7			
8	Average Sales	28	20
9	Total Sales	110	80
10			
11			
12	Sales target average is 25		
13	Total, if average sales are achieved.	110	

- Once you have entered this formula, use drag and drop to copy this formula to cell **C13**. The result should be as illustrated.

Sales for the North region exceeded their targets, (i.e. the average is over **25**) so in cell **B13** you see the sales summed, while in cell **C13**, you see a **0** figure as sales for the **South** region were below an average of **25**:

File Home Insert Page Layout Formulas Data Review View			
<div> <div>Cut Copy Paste Format Painter</div> <div>Clipboard</div> <div> <div>Arial 12</div> <div>B I U</div> <div>Font</div> </div> <div> <div>Alignment</div> </div> </div>			
C13 <input type="text" value="=IF(AVERAGE(C3:C6)>25,SUM(C3:C6),0)"/>			
	A	B	C
1			
2	Sales person	Sales (North Region)	Sales (South Region)
3	Gravani	20	20
4	Pelosi	30	10
5	Wilson	50	10
6	Menendez	10	40
7			
8	Average Sales	28	20
9	Total Sales	110	80
10			
11			
12	Sales target average is 25		
13	Total, if average sales are achieved.	110	0

- Save your changes and close the workbook.

Useful Shortcut keys

Using keyboard shortcuts can help you become more efficient when creating documents in Microsoft applications. Most keyboard shortcuts require you to use two or more keys at the same time. To use a keyboard shortcut first press and hold down the modifier key or keys (i.e. SHIFT, CTRL, ALT) and then press the corresponding standard key on your keyboard.

Function	Shortcut
Go to "Tell me what you want to do"	ALT+Q
Open	CTRL+O
Save	CTRL+S
Close	CTRL+W
Cut	CTRL+X
Copy	CTRL+C
Paste	CTRL+V
Select all	CTRL+A
Bold	CTRL+B
Italic	CTRL+I
Underline	CTRL+U
Cancel	Esc
Undo	CTRL+Z
Re-do	CTRL+Y