

Advanced topics in Excel

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Basic Computer Science AA 1819

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1. COUNT functions

The **COUNT** function counts the number of cells that contain numbers, and counts numbers within the list of arguments. Use the **COUNT** function to get the number of entries in a number field that is in a range or array of numbers. For example, you can enter the following formula to count the numbers in the range A1:A20: **=COUNT(A1:A20)**. In this example, if five of the cells in the range contain numbers, the result is **5**.

Syntax

COUNT(value1, [value2], ...)

The COUNT function syntax has the following arguments:

- **value1** Required. The first item, cell reference, or range within which you want to count numbers.
- **value2, ...** Optional. Up to 255 additional items, cell references, or ranges within which you want to count numbers.

Note: The arguments can contain or refer to a variety of different types of data, but only numbers are counted.

Remarks

- Arguments that are numbers, dates, or a text representation of numbers (for example, a number enclosed in quotation marks, such as "1") are counted.
- Logical values and text representations of numbers that you type directly into the list of arguments are counted.
- Arguments that are error values or text that cannot be translated into numbers are not counted.
- If an argument is an array or reference, only numbers in that array or reference are counted. Empty cells, logical values, text, or error values in the array or reference are not counted.
- If you want to count logical values, text, or error values, use the **COUNTA** function.
- If you want to count only numbers that meet certain criteria, use the **COUNTIF** function or the **COUNTIFS** function.

The **COUNTA** function counts the number of cells that are not empty in a range.

Syntax

COUNTA(value1, [value2], ...)

The COUNTA function syntax has the following arguments:

- **value1** Required. The first argument representing the values that you want to count.
- **value2, ...** Optional. Additional arguments representing the values that you want to count, up to a maximum of 255 arguments.

Remarks

- The **COUNTA** function counts cells containing any type of information, including error values and empty text (""). For example, if the range contains a formula that returns an empty string, the **COUNTA** function counts that value. The **COUNTA** function does not count empty cells.
- If you do not need to count logical values, text, or error values (in other words, if you want to count only cells that contain numbers), use the **COUNT** function.
- If you want to count only cells that meet certain criteria, use the **COUNTIF** function or the **COUNTIFS** function.

Use **COUNTIF**, one of the statistical functions, to count the number of cells that meet a criterion; for example, to count the number of times a particular city appears in a customer list.

In its simplest form, **COUNTIF** says:

- =**COUNTIF**(Where do you want to look?, What do you want to look for?)

For example:

	A	B
1	Data	Data
2	apples	32
3	oranges	54
4	peaches	75
5	apples	86

=**COUNTIF**(A2:A5,"apples")

Counts the number of cells with apples in cells A2 through A5. The result is 2.

=**COUNTIF**(A2:A5,A4)

Counts the number of cells with peaches (the value in A4) in cells A2 through A5. The result is 1.

=**COUNTIF**(A2:A5,A2)+**COUNTIF**(A2:A5,A3)

Counts the number of apples (the value in A2), and oranges (the value in A3) in cells A2 through A5. The result is 3. This formula uses **COUNTIF** twice to specify multiple criteria, one criteria per expression. You could also use the [COUNTIFS](#) function.

=**COUNTIF**(B2:B5,">55")

Counts the number of cells with a value greater than 55 in cells B2 through B5. The result is 2.

=**COUNTIF**(B2:B5,"<>"&B4)

Counts the number of cells with a value not equal to 75 in cells B2 through B5. The ampersand (&) merges the comparison operator for not equal to (<>) and the value in B4 to read =**COUNTIF**(B2:B5,"<>75"). The result is 3.

=**COUNTIF**(B2:B5,">=32")-
COUNTIF(B2:B5,">85")

Counts the number of cells with a value greater than (>) or equal to (=) 32 and less than (<) or equal to (=) 85 in cells B2 through B5. The result is 3.

2. Text functions

<http://www.excel-easy.com/>

Excel has many functions to offer when it comes to manipulating **text strings**.

Join strings

The CONCATENATE function in Excel is designed to join different pieces of text together or combine values from several cells into one cell.

The syntax of Excel CONCATENATE is as follows:

CONCATENATE(text1, [text2], ...)

Where **text** is a text string, cell reference or formula-driven value.

Below you will find a few examples of using the CONCATENATE function in Excel.

Note. In Excel 2016, Excel 2019, Excel Online and Excel Mobile, CONCATENATE is replaced with the CONCAT function, which has exactly the same syntax. Although the CONCATENATE function is kept for backward compatibility, it is recommended to use CONCAT instead because Microsoft does not give any promises that CONCATENATE will be available in future versions of Excel.

Concatenating the values of several cells

The simplest CONCATENATE formula to combine the values of cells A1 and B1 is as follows:

=CONCATENATE (A1, B1)

Please note that the values will be knit together without any delimiter, as in row 2 in the screenshot below.

To separate the values with a space, enter " " in the second argument, as in row 3 in the screenshot below.

=CONCATENATE (A1, " ", B1)

	A	B	C	D
1	Source data	Result		Formula
2	Project	1	Project1	=CONCATENATE(A2, B2)
3			Project 1	=CONCATENATE(A2, " ", B2)

To separate the concatenated values with other delimiters such as a comma, space or slash, please see [Excel CONCATENATE formulas with special characters](#).

Concatenating a text string and cell value

There is no reason for the Excel CONCATENATE function to be limited to only joining cells' values. You can also use it to concatenate various text strings to make the result more meaningful. For example:

=CONCATENATE(A1, " ", B1, " completed")

The above formula informs the user that a certain project is completed, as in row 2 in the screenshot below. Please notice that we add a space before the word " completed" to separate the concatenated text strings.

Naturally, you can add a text string in the beginning or in the middle of your Concatenate formula as well:

=CONCATENATE("See ", A1, " ", B1)

A space (" ") is added in between the combined values, so that the result displays as "Project 1" rather than "Project1".

	A	B	C	D
1	Source data	Result	Formula	
2	Project	1	Project 1 completed	=CONCATENATE(A2, " ", B2," completed")
3			See Project 1	=CONCATENATE("See ", A2, " ", B2)

Concatenating a text string and a formula-calculated value

To make the result returned by some formula more understandable for your users, you can concatenate it with a text string that explains what the value actually is.

For example, you can use the following formula to return the current date:

=CONCATENATE("Today is ",TEXT(TODAY()), "dd-mmm-yy")

	A	B
1	Result	Formula
2	Today is 14-Jul-15	=CONCATENATE("Today is ", TEXT(TODAY()), "dd-mmm-yy"))

Using CONCATENATE in Excel - things to remember

To ensure that your CONCATENATE formulas always deliver the correct results, remember the following simple rules:

- Excel CONCATENATE function requires at least one "text" argument to work.
- In a single CONCATENATE formula, you can concatenate up to 255 strings, a total of 8,192 characters.
- The result of the CONCATENATE function is always a text string, even when all of the source values are numbers.
- Excel CONCATENATE does not recognize arrays. Each cell reference must be listed separately. For example, you should write =CONCATENATE(A1, A2, A3) instead of =CONCATENATE(A1:A3).
- If at least one of the CONCATENATE function's arguments is invalid, the formula returns a #VALUE! error.

"&" operator to concatenate strings in Excel

In Microsoft Excel, & operator is another way to concatenate cells. This method come in very handy in many scenarios because typing the ampersand sign (&) is much quicker than typing the word "concatenate" :)

Similarly to the CONCATENATE function, you can use "&" in Excel to combine different text strings, cell values and results returned by other functions.

Excel "&" formula examples

To see the concatenation operator in action, let's re-write the CONCATENATE formulas discussed above:

Concatenate the values in A1 and B1:

=A1&B1

Concatenate the values in A1 and B1 separated with a space:

=A1&" "&B1

Concatenate the values in A1, B1 and a text string:

=A1 & B1 & " completed"

Concatenate a string and the result of the TEXT / TODAY function:

="Today is " & TEXT(TODAY()), "dd-mmm-yy")

As demonstrated in the screenshot below, the CONCATENATE function and "&" operator return identical results:

1	Concatinating strings using "&" operator			
2	Source data	Result	Formula	
3	Project	1 Project1	=A3 & B3	
4				
5	Paul	Smith	Paul Smith	=A5 & " " & B5
6				
7	Project	1 Project1 completed	=A7 & B7 & " completed"	
8				
9	Project	2 See Project 2	="See "& A9 & " " & B9	
10				
11		Today is 29-Jun-15	="Today is " & TEXT(TODAY()), "dd-mmm-yy")	

Excel "&" operator vs. CONCATENATE function

Many users wonder which is a more efficient way to concatenate strings in Excel - CONCATENATE function or "&" operator.

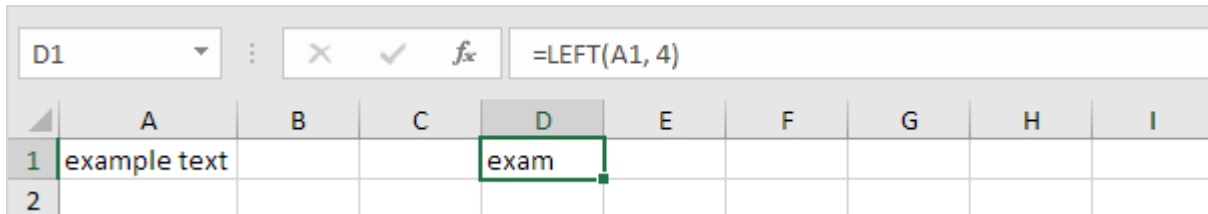
The only essential difference between CONCATENATE and "&" operator is the 255 strings limit of the Excel CONCATENATE function and no such limitations when using the ampersand. Other than that, there is no difference between these two concatenation methods, nor is there any speed difference between the CONCATENATE and "&" formulas.

And since 255 is a really big number and in real-life tasks someone will hardly ever need to combine that many strings, the difference boils down to the comfort and ease of use. Some users find CONCATENATE formulas easier to read, I personally prefer using the "&" method. So, simply stick to the concatenation technique that you feel more comfortable with.

Extract info

Left

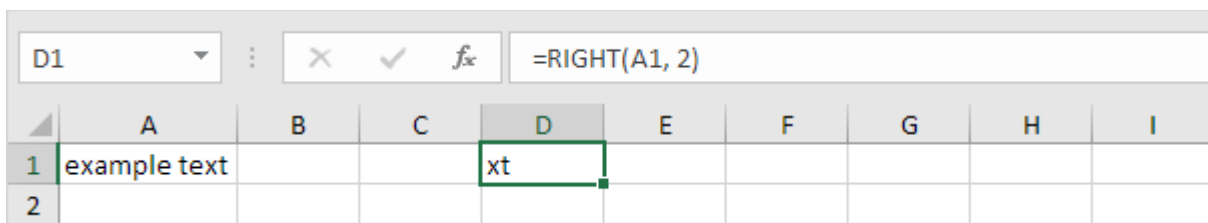
To extract the leftmost characters from a string, use the LEFT function.



	A	B	C	D	E	F	G	H	I
1	example text			exam					
2									

Right

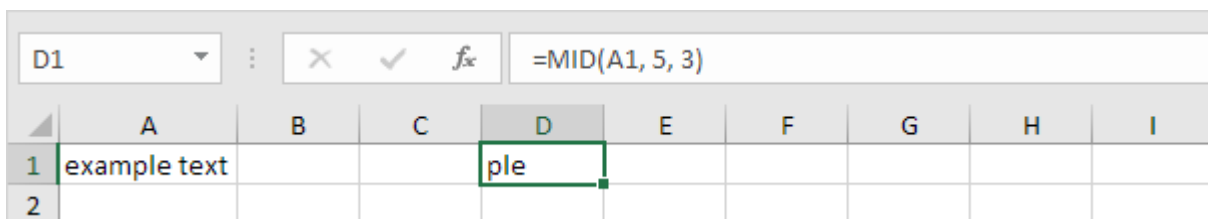
To extract the rightmost characters from a string, use the RIGHT function.



	A	B	C	D	E	F	G	H	I
1	example text			xt					
2									

Mid

To extract a substring, starting in the middle of a string, use the MID function.

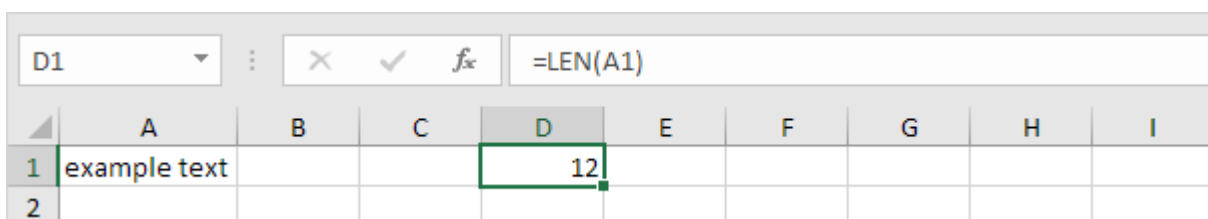


	A	B	C	D	E	F	G	H	I
1	example text			ple					
2									

Note: started at position 5 (p) with length 3.

Len

To get the length of a string, use the LEN function.



	A	B	C	D	E	F	G	H	I
1	example text			12					
2									

Note: space (position 8) included!

Find

To find the position of a substring in a string, use the FIND function.

D1										=FIND("am", A1)	
	A	B	C	D	E	F	G	H	I		
1	example text			3							
2											

Note: string "am" found at position 3.

Substitute

To replace existing text with new text in a string, use the SUBSTITUTE function.

D1										=SUBSTITUTE(A1, "Tim", "John")	
	A	B	C	D	E	F	G	H	I		
1	Hi Tim			Hi John							
2											

Separate Strings

This example teaches you how to **separate strings** in Excel.

B2											
	A	B	C	D	E	F	G	H			
1	Full Name	First Name	Last Name								
2	Smith, Mike										
3	Johnson, Matthew										
4	Williams, Janet										
5	Brown, Sandra										
6	Jones, Lisa										
7	Millar, Peter										
8											

The problem we are dealing with is that we need to tell Excel where we want to separate the string. In case of Smith, Mike the comma is at position 6 while in case of Williams, Janet the comma is at position 9.

1. To get the first name, use the formula below.

		=RIGHT(A2,LEN(A2)-FIND(",",A2)-1)						
	A	B	C	D	E	F	G	H
1	Full Name	First Name	Last Name					
2	Smith, Mike	Mike						
3	Johnson, Matthew							
4	Williams, Janet							
5	Brown, Sandra							
6	Jones, Lisa							
7	Millar, Peter							
8								

Explanation: to find the position of the comma, use the FIND function (position 6). To get the length of a string, use the LEN function (11 characters). =RIGHT(A2,LEN(A2)-FIND(",",A2)-1) reduces to =RIGHT(A2,11-6-1). =RIGHT(A2,4) extracts the 4 rightmost characters and gives the desired result (Mike).

2. To get the last name, use the following formula.

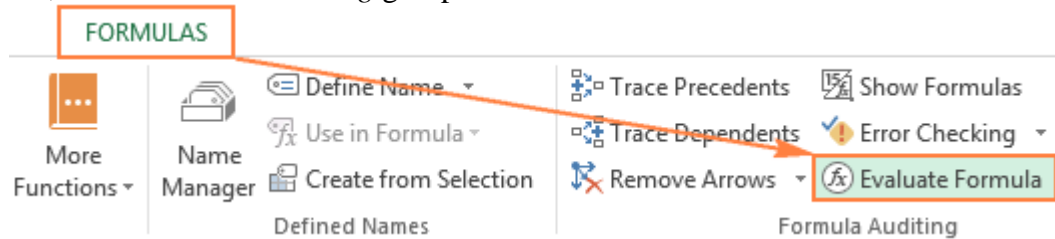
		=LEFT(A2,FIND(",", A2)-1)						
	A	B	C	D	E	F	G	H
1	Full Name	First Name	Last Name					
2	Smith, Mike	Mike	Smith					
3	Johnson, Matthew							
4	Williams, Janet							
5	Brown, Sandra							
6	Jones, Lisa							
7	Millar, Peter							
8								

Explanation: to find the position of the comma, use the FIND function (position 6). =LEFT(A2,FIND(",", A2)-1) reduces to =LEFT(A2,6-1). =LEFT(A2,5) extracts the 5 leftmost characters and gives the desired result (Smith).

3. Select the range B2:C2 and drag it down.

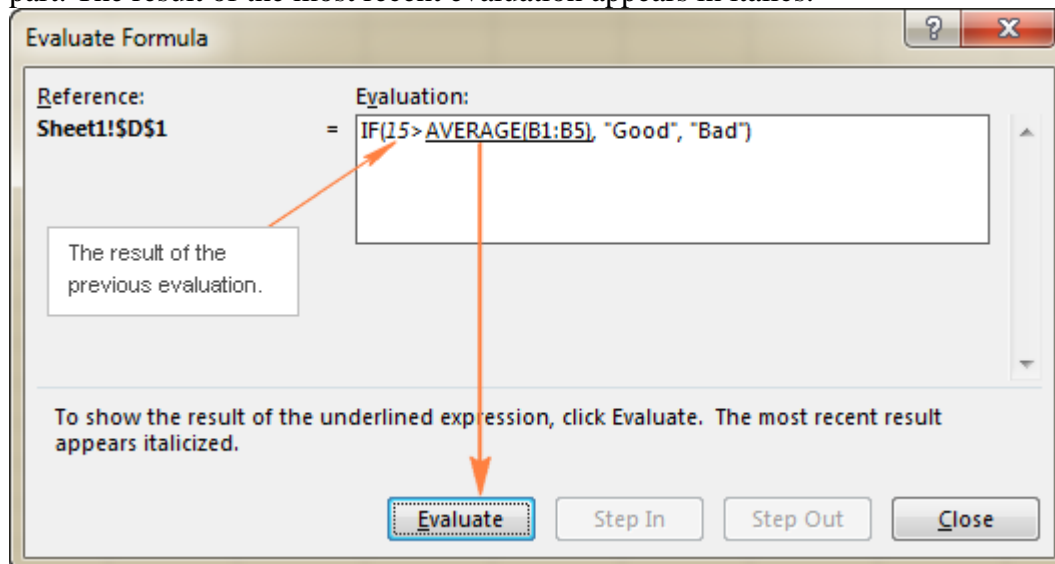
3. Debug a formula by using the Evaluate Formula feature

A way to evaluate formulas in Excel is the **Evaluate Formula** option that resides on the *Formulas* tab, in the *Formula Auditing* group.



As soon as you click this button, the *Evaluate Formula* dialog box will pop up, where you can inspect each part of your formula in the order the formula is calculated.

All you need to do is click the **Evaluate** button and examine the value of the underlined formula part. The result of the most recent evaluation appears in italics.



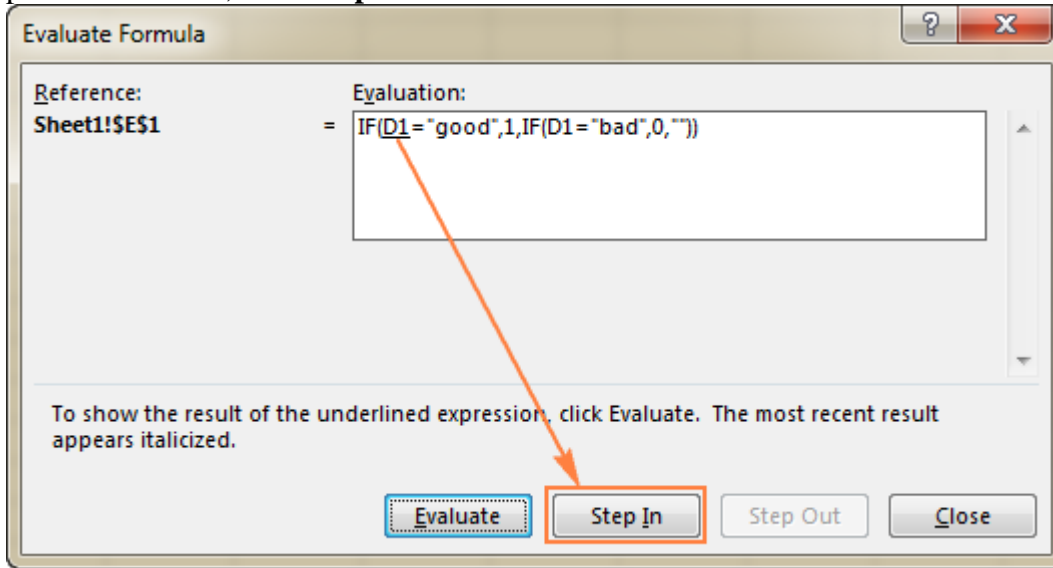
Continue clicking the **Evaluate** button until each part of your formula has been tested.

To end the evaluation, click the **Close** button.

To start the formula evaluation from the beginning, click **Restart**.

If the underlined part of the formula is a reference to a cell containing another formula, click the **Step In** button to have that other formula displayed in the *Evaluation* box. To get back to the

previous formula, click **Step Out**.

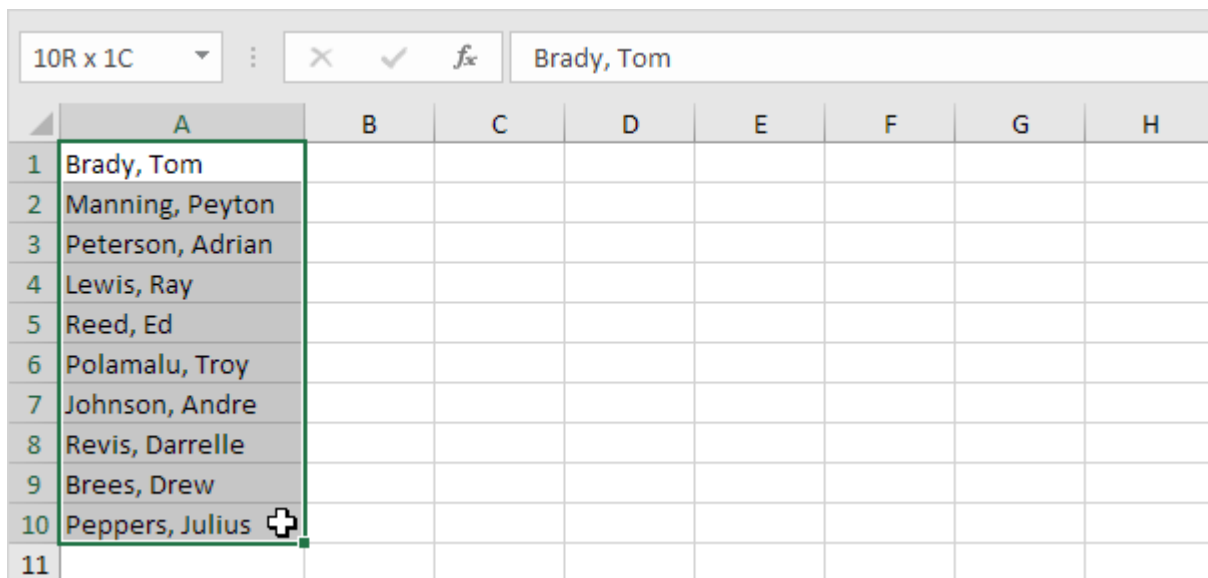


Note. The *Step In* button is not available for a cell reference pointing to another formula in a different workbook. Also, it is not available for a cell reference that appears in the formula for the second time (like the second instance of D1 in the screenshot above).

4. Text to Columns

To separate the contents of one **Excel cell** into **separate columns**, you can use the 'Convert Text to Columns Wizard'. For example, when you want to separate a list of full names into last and first names.

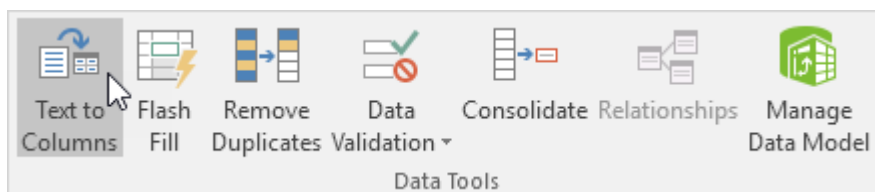
1. Select the range with full names.



The screenshot shows an Excel spreadsheet with a range of names selected in column A. The names are: Brady, Tom; Manning, Peyton; Peterson, Adrian; Lewis, Ray; Reed, Ed; Polamalu, Troy; Johnson, Andre; Revis, Darrelle; Brees, Drew; Peppers, Julius. The selection is highlighted with a green border. The formula bar at the top shows the text 'Brady, Tom'.

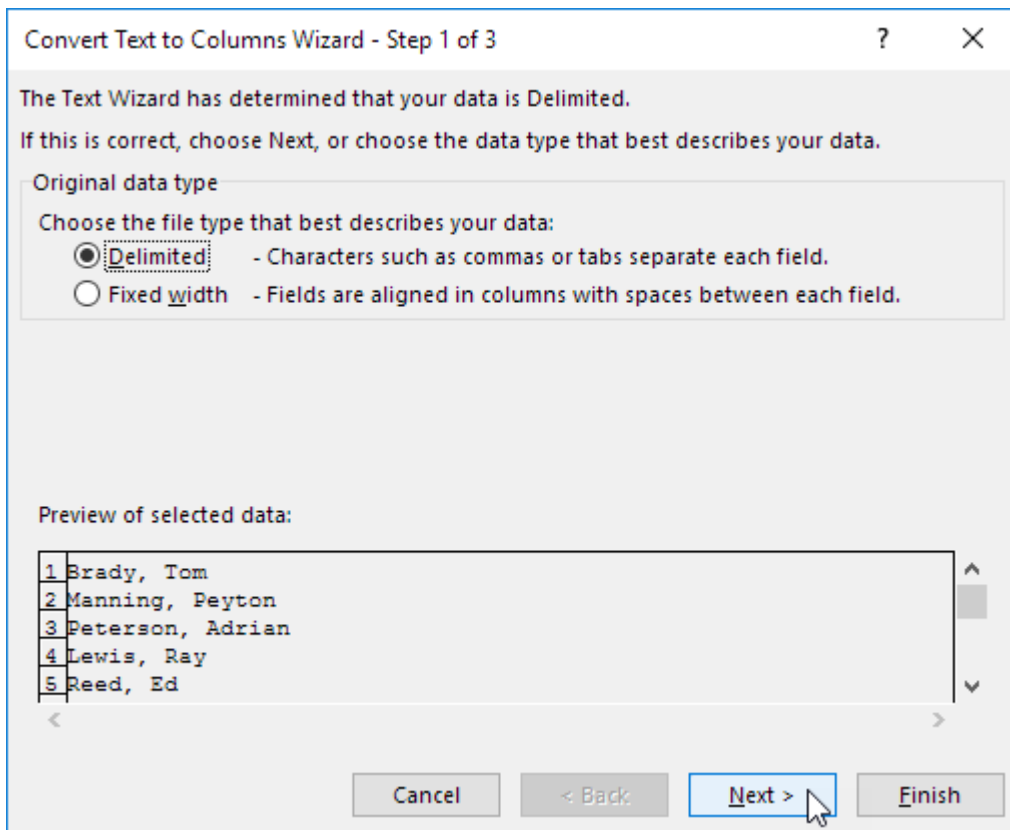
	A	B	C	D	E	F	G	H
1	Brady, Tom							
2	Manning, Peyton							
3	Peterson, Adrian							
4	Lewis, Ray							
5	Reed, Ed							
6	Polamalu, Troy							
7	Johnson, Andre							
8	Revis, Darrelle							
9	Brees, Drew							
10	Peppers, Julius							
11								

2. On the Data tab, in the Data Tools group, click Text to Columns.



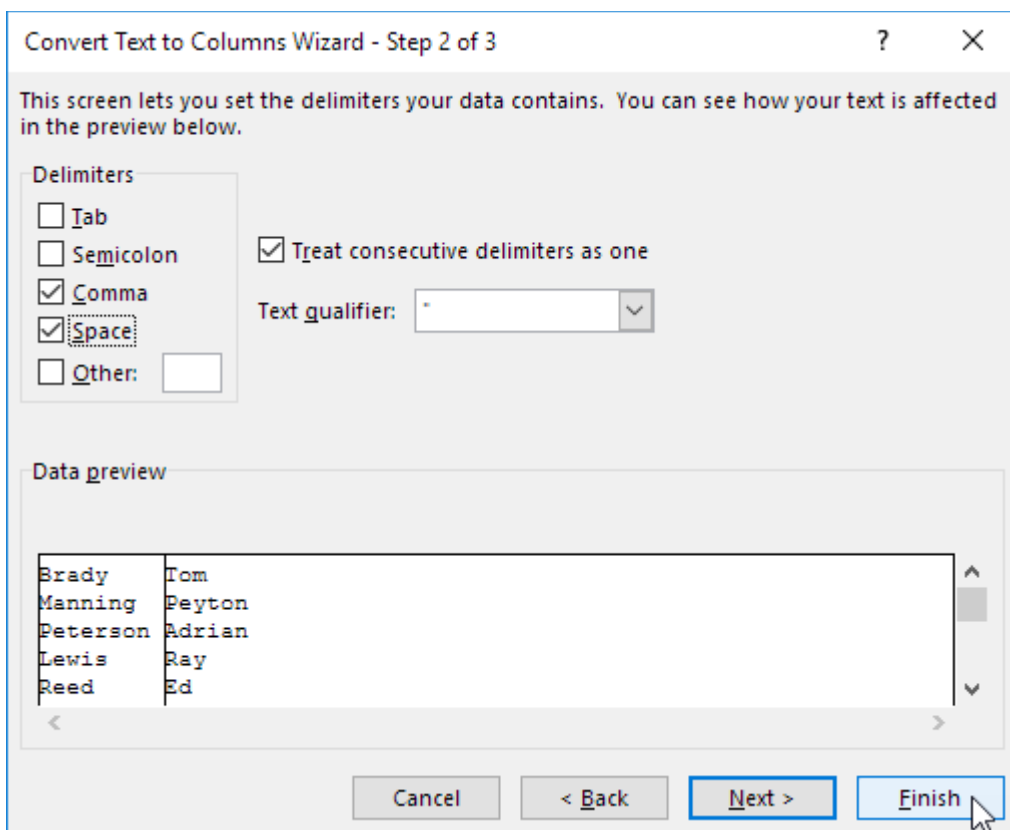
The following dialog box appears.

3. Choose Delimited and click Next.



4. Clear all the check boxes under Delimiters except for the Comma and Space check box.

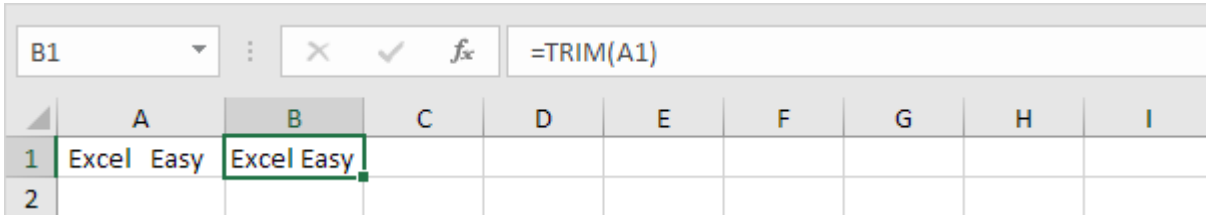
5. Click Finish.



5. Remove Unwanted Characters

The TRIM function returns a string with extra **spaces**, starting spaces and ending spaces removed. The CLEAN function **removes nonprintable characters** from a string.

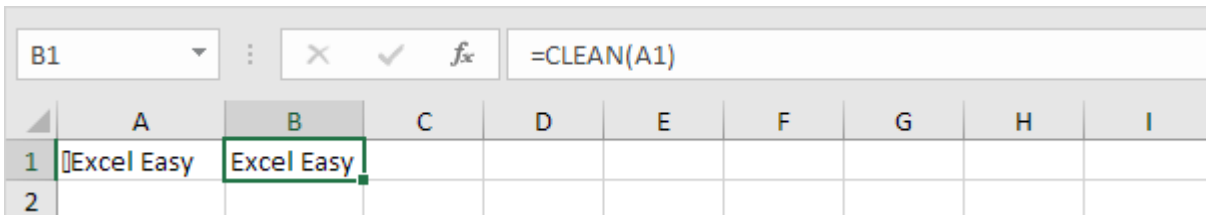
1. For example, cell A1 below contains the string " Excel Easy "



	A	B	C	D	E	F	G	H	I
1	Excel Easy	Excel Easy							
2									

Note: the TRIM function returns the string "Excel Easy".

2. For example, cell A1 below contains a nonprintable character.



	A	B	C	D	E	F	G	H	I
1	Excel Easy	Excel Easy							
2									

Note: the CLEAN function removes this nonprintable character. Text imported from other applications may contain nonprintable characters.

6. Excel VLOOKUP tutorial for beginners - syntax and formula examples

by Svetlana Cheusheva

This article begins a series covering one of the most useful Excel functions - **VLOOKUP**. At the same time, it's one of the most intricate and least understood.

In this VLOOKUP tutorial, I will try to explain the basics in a very plain language to make the learning curve for an inexperienced user as easy as possible. We will also explore some formula examples that address the most common usages of VLOOKUP in Excel.

Excel VLOOKUP function - basic description and syntax

So what is VLOOKUP? To begin with, it is an Excel function :) What does it do? It searches for the value you specify and returns a matching value from another column. More technically, the VLOOKUP function looks up a value in the first column of the specified range of cells, and returns a value in the same row from another column.

In its common usage, Excel VLOOKUP searches through your lists of data based on the unique identifier and brings you a piece of information associated with that unique identifier.

The letter "V" in VLOOKUP stands for "vertical". It is used to differentiate VLOOKUP from the HLOOKUP function that looks up a value in the top row of an array (H stands for "horizontal").

The VLOOKUP function is available in all versions of Excel 2013, Excel 2010, Excel 2007, Excel 2003, Excel XP and Excel 2000.

Excel VLOOKUP syntax

The syntax for the **VLOOKUP function** is as follows:

VLOOKUP(lookup_value, table_array, col_index_num, [range_lookup])

As you see, the Microsoft Excel VLOOKUP function has 4 parameters, or arguments. The first three parameters are required, the last one is optional.

1. `lookup_value` - the value to search for.

This can be either a **value** (number, date or text) or a **cell reference** (reference to a cell containing a lookup value), or the value returned by some other Excel function. For example:

- Look up for **number**: =VLOOKUP(40, A2:B15, 2) - the formula will search for the number 40.
- Look up for **text**: =VLOOKUP("apples", A2:B15, 2) - the formula will search for the text "apples".
- Look up for value in another **cell**: =VLOOKUP(C2, A2:B15, 2) - the formula will search for the value in cell C2.

Note. If the lookup value is a number and it's smaller than the smallest value in the first column of your lookup array, the VLOOKUP function returns the #N/A error.

2. `table_array` - two or more columns of data.

Remember, the VLOOKUP function always searches for the lookup value in the **first column** of `table_array`. Your `table_array` may contain various values such as text, dates, numbers, or logical values. Values are **case-insensitive**, meaning that uppercase and lowercase text are treated as identical.

So, our formula `=VLOOKUP(40, A2:B15, 2)` will search for "40" in cells A2 to A15 because A is the first column of the `table_array` A2:B15. Hopefully, everything is clear so far :)

3. `col_index_num` - the **column number** in `table_array` from which the value in the corresponding row should be returned.

The left-most column in the specified `table_array` is 1, the second column is 2, the third column is 3, and so on.

Well, now you can read the entire formula `=VLOOKUP(40, A2:B15, 2)`. The formula searches for "40" in cells A2 through A15 and returns a matching value from column B (because B is the 2nd column in the specified `table_array` A2:B15).

	A	B	C	D	E	F	G	H
1	Speed (mph)	Animal						
2	30	Cat		Ostrich				
3	32	Reindeer						
4	35	Rabbit						
5	35.5	Whippet						
6	39.35	Greyhound						
7	40	Ostrich						
8	42	Gray fox						
9	43	Coyote						
10	45	Elk						
11	50	Lion						
12	61	Antelope						
13	70	Cheetah						
14	200	Peregrine falcon						

Note. If your `col_index_num` argument is less than 1, the VLOOKUP formula will return the #VALUE! error. In case it is greater than the number of columns in `table_array`, your function will return the #REF! error.

4. `range_lookup` - determines whether you are looking for an exact match (FALSE) or approximate match (TRUE or omitted). This final parameter is optional but very important. Further on in this VLOOKUP tutorial, I will provide [a few examples](#) explaining how to correctly make formulas for exact or approximate match.

Excel VLOOKUP examples

I hope the VLOOKUP function is starting to look a bit more familiar to you. Now let's explore a few examples of using VLOOKUP formulas on real data.

How to do vlookup in Excel from another worksheet

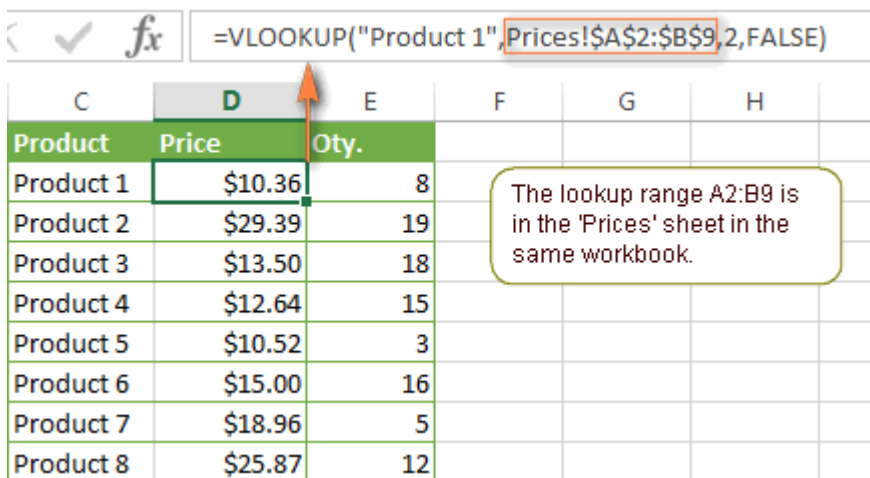
In practice, VLOOKUP formulas are rarely used to find data in the same worksheet. Most often you will have to look up and pull the matching data from a different sheet.

To do a vlookup from a different Excel sheet, you should enter the worksheet's name and an exclamation mark in the table_array argument before the range of cells, e.g. =VLOOKUP(40, Sheet2!A2:B15, 2). The formula indicates that the lookup range A2:B15 is located in Sheet2.

Of course, you don't have to type the sheet's name manually. Simply start typing the formula and when it comes to the table_array argument, switch to the lookup worksheet and select the range using a mouse.

The formula you see in the screenshot below searches for the text "Product 1" in column A (the 1st column of the lookup range A2:B9) in the *Prices* worksheet:

```
=VLOOKUP("Product 1",Prices!$A$2:$B$9,2,FALSE)
```



C	D	E	F	G	H
Product	Price	Oty.			
Product 1	\$10.36	8			
Product 2	\$29.39	19			
Product 3	\$13.50	18			
Product 4	\$12.64	15			
Product 5	\$10.52	3			
Product 6	\$15.00	16			
Product 7	\$18.96	5			
Product 8	\$25.87	12			

Please pay attention that you have to enclose a lookup text value in quotes ("") as you usually do in Excel formulas.

Tip. It is a good idea to always use **absolute cell references** (with \$) in the table_array parameter of VLOOKUP formulas. In this case, the lookup range will remain constant when you copy the formula to other cells.

How to do vlookup from a different workbook

To perform vlookup between two different Excel workbooks, you should supply the workbook's name in square brackets before the worksheet's name.

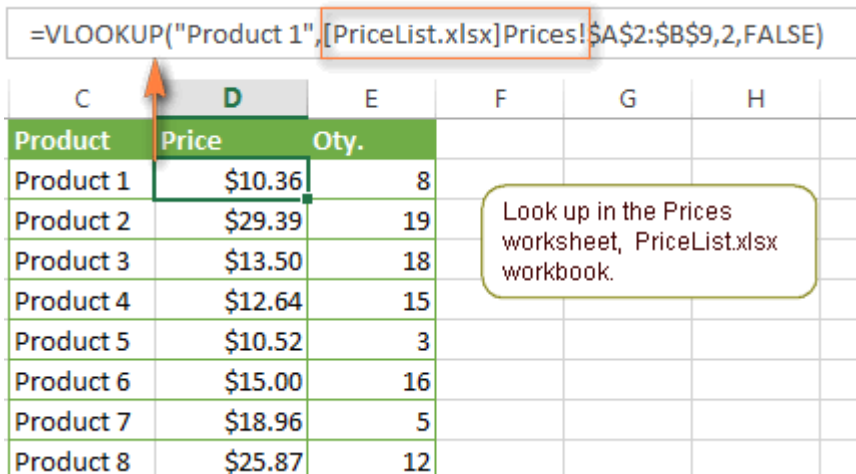
For example, the below formula will look up value "40" in *Sheet2* of the *Numbers.xlsx* workbook:

=VLOOKUP(40, [Numbers.xlsx]Sheet2!A2:B15,2)

The easiest way to create an Excel VLOOKUP formula that refers to another workbook is this:

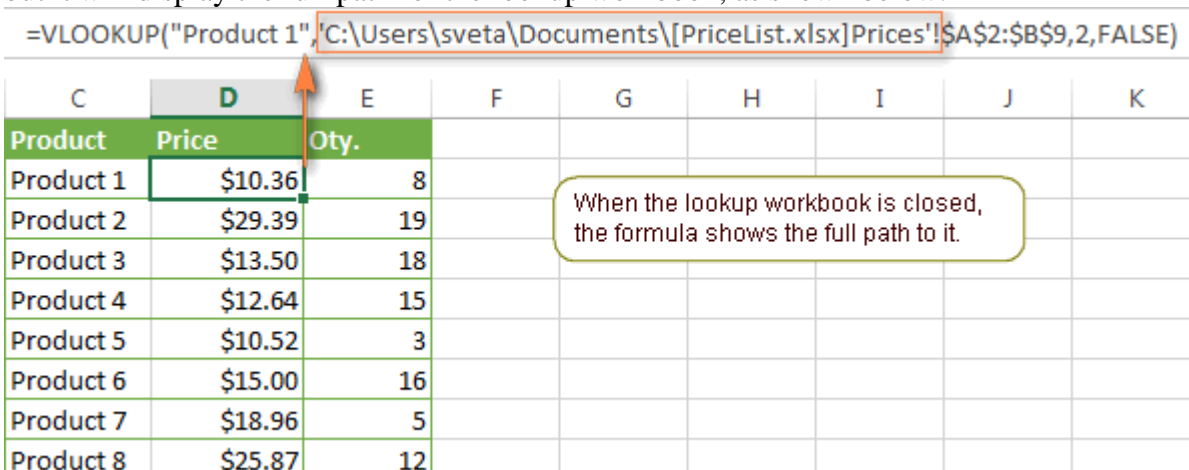
1. Open both workbooks. This step is not obligatory, but makes it easier to write a formula because you won't have to type the workbook's name manually, thus preventing misprints.
2. Start typing your VLOOKUP formula, and for the `table_array` argument, switch to the other workbook and select the lookup range there.

In the formula you see in the screenshot below, the lookup workbook is *PriceList.xlsx* and the lookup worksheet is *Prices*.



Product	Price	Qty.
Product 1	\$10.36	8
Product 2	\$29.39	19
Product 3	\$13.50	18
Product 4	\$12.64	15
Product 5	\$10.52	3
Product 6	\$15.00	16
Product 7	\$18.96	5
Product 8	\$25.87	12

Once you close the workbook with your lookup table, your VLOOKUP formula will work anyway, but it will display the full path for the lookup workbook, as shown below:



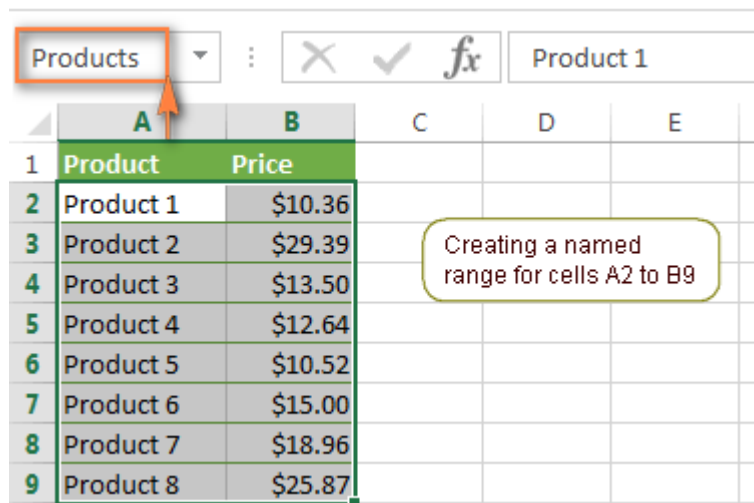
Product	Price	Qty.
Product 1	\$10.36	8
Product 2	\$29.39	19
Product 3	\$13.50	18
Product 4	\$12.64	15
Product 5	\$10.52	3
Product 6	\$15.00	16
Product 7	\$18.96	5
Product 8	\$25.87	12

Note. If either a workbook name or worksheet name contains spaces, you should add apostrophes around them: =VLOOKUP(40, '[Numbers.xlsx]Sheet2!A2:B15,2)

How to use a named range or table in VLOOKUP formulas

If you are supposed to use the same lookup range in several VLOOKUP formulas, you can create a [named range](#) for it and type the name directly in the `table_array` argument of your Vlookup formula.

To create a named range, just select the cells and type any name in the **Name box**, to the left of the Formula bar.



And now you can write the following VLOOKUP formula to get *Product 1*'s price:

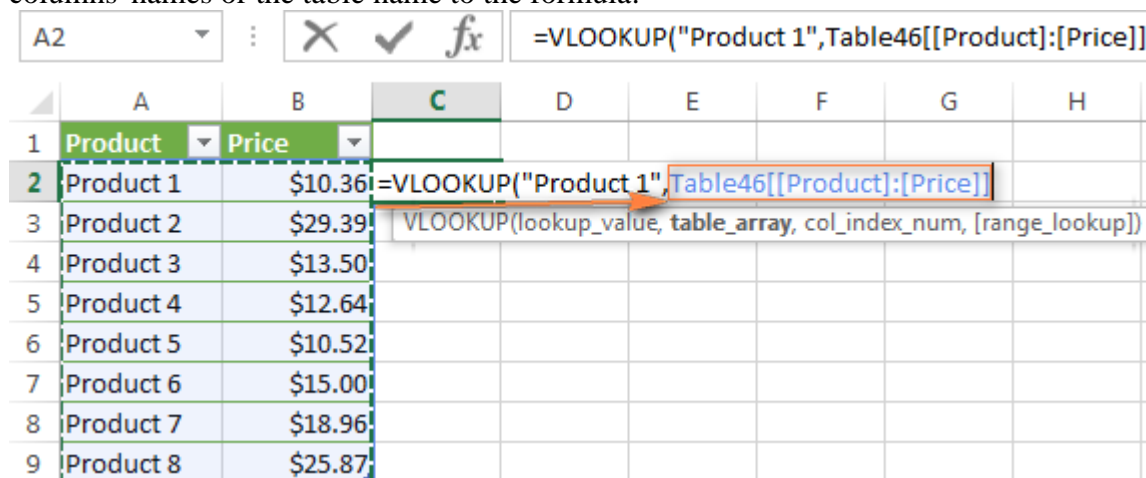
```
=VLOOKUP("Product 1",Products,2)
```

Most range names in Excel **apply to the entire workbook**, so you don't need to specify the worksheet's name, even if your lookup range resides in a different worksheet. If it is in another workbook, you have to put the workbook's name before the named range, for example:

```
=VLOOKUP("Product 1",PriceList.xlsx!Products,2)
```

Such formulas are far more understandable, aren't they? Besides, using named ranges can be a good alternative to absolute cell references. Since a named range doesn't change when a formula is copied to other cells, you can be sure that your lookup range will always remain correct.

If you have converted a range of cells into a fully-functional [Excel table](#) (*Insert tab > Table*), then you can select the lookup range using a mouse, and Microsoft Excel will automatically add the columns' names or the table name to the formula:



The complete formula may look similar to this:

```
=VLOOKUP("Product 1",Table46[[Product]:[Price]],2)
```

or even `=VLOOKUP("Product 1",Table46,2)`.

As well as named ranges, columns names are constant and your cell references won't change no matter where the VLOOKUP formula is copied within the same workbook.

Using wildcard characters in VLOOKUP formulas

As well as in many other formulas, you can use the following wildcard characters in the Excel VLOOKUP function:

- *Question mark (?)* to match any single character, and
- *Asterisk (*)* to match any sequence of characters.

Using wildcard chars in your VLOOKUP formulas may prove really useful in many cases:

- When you do not remember the exact text you are looking for.
- When you want to find some word that is part of the cell's contents. Be aware that the VLOOKUP function searches by the entire content of a cell, as if you selected the option "Match entire cell content" in the standard Excel Find dialog.
- When a lookup column contains extra leading or trailing spaces. If it is the case, you may rack your brain trying to figure out why the normal formula does not work.

Example 1. Look up text starting or ending with certain characters

Suppose, you want to find a certain customer in the below database. You cannot remember his surname, but you know it starts with "ack". So, the following VLOOKUP formula will work a treat:

```
=VLOOKUP("ack*", $A$2:$C$11, 1, FALSE)
```

	A	B	C	D	E	F	G
1	Customer	Order No.	Sum	Ackerly			
2	Abbett	111957	\$175				
3	Abrahams	111816	\$154				
4	Acey	111998	\$79				
5	Ackerly	111854	\$117				
6	Acreman	111568	\$55				
7	Adkinson	111888	\$133				
8	Adley	111646	\$126				
9	Adrian	111689	\$103				
10	Adwell	111776	\$170				
11	Alderman	111610	\$108				

Once you are sure you've found the correct name, you can use a similar VLOOKUP formula to get the sum paid by that customer. You only have to change the 3rd parameter in the formula to the appropriate column number, column C (3) in our case:

```
=VLOOKUP("ack*", $A$2:$C$11, 3, FALSE)
```

Here a few more examples of VLOOKUP formulas with wildcard characters:

=VLOOKUP ("*man", \$A\$2:\$C\$11, 1, FALSE) - find the name ending with "man".

=VLOOKUP ("ad*son", \$A\$2:\$C\$11, 1, FALSE) - find the name starting with "ad" and ending with "son".

=VLOOKUP ("?????", \$A\$2:\$C\$11, 1, FALSE) - find a 5-character last name.

Note. For a wildcard VLOOKUP formula to work correctly, you always have to add FALSE as the last parameter. If your lookup range contains more than one entry that meets the wildcard criteria, the first found value will be returned.

Example 2. Wildcard VLOOKUP formulas based on cell's value

And now let's discuss a bit more complex example of how to do a vlookup on the value in some cell. Suppose, you have license keys in column A and license names in column B. You also have part (a few characters) of some license key in cell C1 and you want to find a matching License Name.

This can be done using a VLOOKUP formula like this:

=VLOOKUP ("*"&C1&"*", \$A\$2:\$B\$12, 2, FALSE)

This formula searches for the value in C1 through the specified range and returns a corresponding value in column B. Please notice that we use an ampersand (&) before and after a cell reference in the 1st parameter to concatenate a text string.

As you can see in the screenshot below, my VLOOKUP function returns "Jeremy Hill" because his license key contains the group of chars stated in cell C1:

	A	B	C	D
1	License key	License name	ABCD	Jeremy Hill
2	37UX-KZG9-2RKA-JSRW	David White		
3	60LK-ZYGF-ND7T-PPTT	Ronnie Anderson		
4	TFDJ-VGD7-5T24-KT8K	Tom Boone		
5	AIRC-35FN-VB7W-GGTJ	Sally Brooke		
6	0VZM-ABCD-TTLB-Y1DL	Jeremy Hill		
7	RV2M-33OI-ULHB-Z7SO	Robert Furlan		
8	VOM2-T6PP-U44C-6J96	Mattias Waldau		
9	U3FV-CC3A-DB90-MSU9	Dan Brown		
10	9RM2-TJXO-2CIT-5PWO	Lilly Smith		
11	BRKC-GEWN-5EW1-VHMK	Matt White		
12	EEKG-EBPH-PU2A-HJ0E	Robert Acey		

Also, please pay attention to the *table_array* argument in screenshot above. It contains the table name ("Table7") instead of a range of cells, as we discussed in the [example above](#).

Using VLOOKUP formulas with exact or approximate match

And finally, let's have a closer look at the last argument you supply to the Excel VLOOKUP function - `range_lookup`. As already mentioned at the beginning of this tutorial, this parameter is highly important because you are likely to get different results in the same formula depending on whether you enter TRUE or FALSE.

First off, let's see what Microsoft Excel actually means by "exact match" and "approximate match".

- If `range_lookup` is set to FALSE, the formula searches for **exact match**, i.e. for the lookup value exactly as you've entered it in the first parameter (`lookup_value`).

If there are two or more values in the first column of `table_array` that match the lookup value, the 1st value found is returned. If an exact match is not found, the #N/A error is returned.

For example, if you use the formula `=VLOOKUP(4, A2:B15, 2, FALSE)`, but your data does not contain value 4 in cells A2 through A15, the formula will return #N/A.

- If `range_lookup` is set to TRUE or omitted, the formula searches for **approximate match**. More precisely, your VLOOKUP formula will search for an exact match first and if an exact match is not found, it will return an approximate match. An approximate match is the next largest value that is less than `lookup_value`.

Important Note! If you enter TRUE or omit the `range_lookup` argument, the values in the first column of the lookup range must be sorted in **ascending order**, i.e. from smallest to largest. Otherwise, the Excel VLOOKUP function may not find the correct value.

To further explore the importance of specifying TRUE vs. FALSE, let's try out a few more VLOOKUP formulas and see what results they return.

Example 1. How to do a vlookup in Excel with exact match

As you remember, to search for exact match, you have to put FALSE as the final argument in a VLOOKUP formula in Excel.

Let's take the 'Animal speed' table from the very first example again and find out which animal can run 50 miles per hour. I believe you won't have any difficulties with the formula:

=VLOOKUP(50,\$A\$2:\$B\$15,2,FALSE).

	A	B	C	D	E	F
1	Speed (mph)	Animal		Gazelle		
2	200	Peregrine falcon				
3	70	Cheetah				
4	61	Antelope				
5	50	Gazelle				
6	50	Lion				
7	45	Elk				
8	43	Coyote				
9	42	Gray fox				
10	40	Ostrich				
11	39.35	Greyhound				
12	35.5	Whippet				
13	35	Rabbit				
14	32	Reindeer				
15	30	Cat				

If several values match the lookup value, a VLOOKUP formula with exact match returns the 1st found value.

Please note, our lookup range (column A) contains two "50" values in cells A5 and A6; and the formula returns a value from cell B5. Why is that? Because the VLOOKUP function with exact match returns the 1st found value that matches the lookup value.

Example 2. Using vlookup in Excel with approximate match

When using VLOOKUP formulas with approximate match, i.e. with range_lookup set to TRUE or omitted, the first thing you need to do is sort the first column in your lookup range in **ascending order**.

This is very important because your VLOOKUP formula is going to return the next largest value for the lookup value you specify and then stop searching. If you neglect to sort your data properly, you

will end up having really strange results or the #N/A error.

	A	B	C	D	E	F
1	Speed (mph)	Animal				
2	30	Cat				
3	32	Reindeer				
4	35	Rabbit				
5	35.5	Whippet				
6	39.35	Greyhound				
7	40	Ostrich				
8	42	Gray fox				
9	43	Coyote				
10	45	Elk				
11	50	Gazelle				
12	50	Lion				
13	61	Antelope				
14	70	Cheetah				
15	200	Peregrine falcon				

Step 1. Sort the 1st column in the lookup range in ascending order.

And now you can utilize either of the following formulas:

- =VLOOKUP (69, \$A\$2:\$B\$15, 2, TRUE)
- =VLOOKUP (69, \$A\$2:\$B\$15, 2)

As you see, I am trying to find the animal whose speed is closest to 69 mph. And here's what the VLOOKUP formula returns:

	A	B	C	D	E
1	Speed (mph)	Animal			
2	30	Cat			
3	32	Reindeer			
4	35	Rabbit			
5	35.5	Whippet			
6	39.35	Greyhound			
7	40	Ostrich			
8	42	Gray fox			
9	43	Coyote			
10	45	Elk			
11	50	Gazelle			
12	50	Lion			
13	61	Antelope			
14	70	Cheetah			
15	200	Peregrine falcon			

D1 : Antelope

A VLOOKUP formula with approximate match returns the next largest value that is **less than** the lookup value.

As you see, the formula returns "Antelope" whose speed is 61mph, while we also have Cheetah that runs 70 mile per hour, and 70 is much closer to 69 than 61, isn't it? So, why is that? Because the VLOOKUP function with approximate match returns the next largest value that is **less than the lookup value**.

Hopefully, these examples have shed some light on using VLOOKUP in Excel and this function is not alien to you any longer :) Now it may be a good idea to sum up the essentials you have learned to remember the key points better.

Excel VLOOKUP - things to remember!

1. Excel VLOOKUP function cannot look at its left. It always searches for the lookup value in the **left-most column** of the lookup range (table_array).
2. In VLOOKUP formulas, all values are **case-insensitive**, meaning that uppercase and lowercase characters are treated as equivalent.
3. If the lookup value is smaller than the smallest value in the first column of your lookup range, the VLOOKUP function returns the #N/A error.
4. If the 3rd parameter (col_index_num) is less than 1, the VLOOKUP formula will return the #VALUE! error. In case it is greater than the number of columns in your lookup range (table_array), the formula will return the #REF! error.
5. Use **absolute cell references** in the table_array argument of your VLOOKUP formulas to have the correct lookup range when copying the formulas. Consider using named ranges or Excel tables as an alternative.
6. When searching with approximate match (range_lookup set to TRUE or omitted), always have the data in the first column in your lookup range sorted in **ascending order**.
7. And finally, remember about the importance of the final parameter. Supply TRUE or FALSE when appropriate and you will avoid a lot of headache :)

In the next part of our Excel VLOOKUP tutorial we will explore more advanced examples such as performing various calculations with VLOOKUP, extracting values from several columns and more. I thank you for reading and hope to see you next week!

7. Pivot Tables

Pivot tables are one of **Excel's** most powerful features. A pivot table allows you to extract the significance from a large, detailed data set.

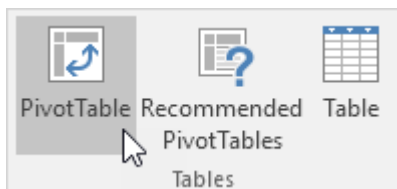
Our data set consists of 213 records and 6 fields. Order ID, Product, Category, Amount, Date and Country.

	A	B	C	D	E	F	G	H
1	Order ID	Product	Category	Amount	Date	Country		
2	1	Carrots	Vegetables	\$4,270	1/6/2016	United States		
3	2	Broccoli	Vegetables	\$8,239	1/7/2016	United Kingdom		
4	3	Banana	Fruit	\$617	1/8/2016	United States		
5	4	Banana	Fruit	\$8,384	1/10/2016	Canada		
6	5	Beans	Vegetables	\$2,626	1/10/2016	Germany		
7	6	Orange	Fruit	\$3,610	1/11/2016	United States		
8	7	Broccoli	Vegetables	\$9,062	1/11/2016	Australia		
9	8	Banana	Fruit	\$6,906	1/16/2016	New Zealand		
10	9	Apple	Fruit	\$2,417	1/16/2016	France		
11	10	Apple	Fruit	\$7,431	1/16/2016	Canada		

Insert a Pivot Table

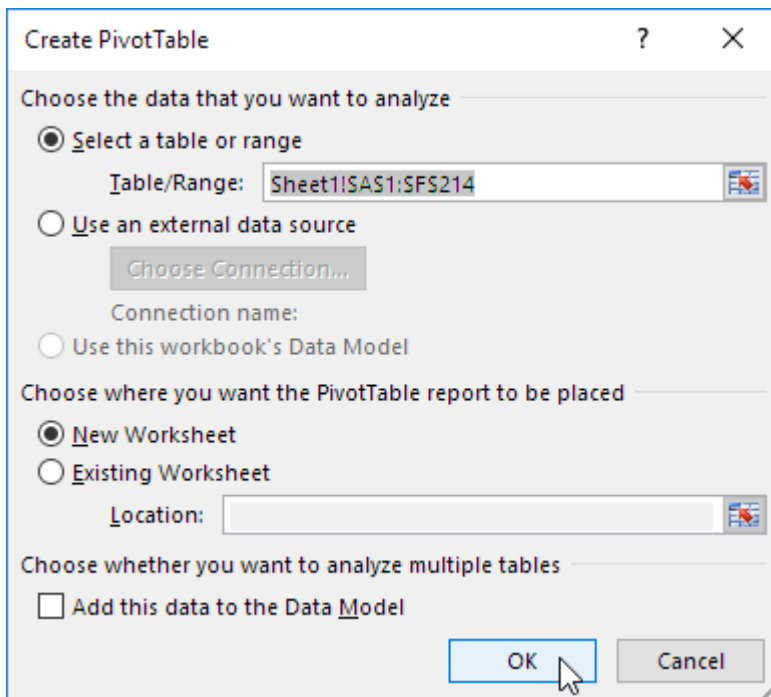
To insert a **pivot table**, execute the following steps.

1. Click any single cell inside the data set.
2. On the Insert tab, in the Tables group, click PivotTable.



The following dialog box appears. Excel automatically selects the data for you. The default location for a new pivot table is New Worksheet.

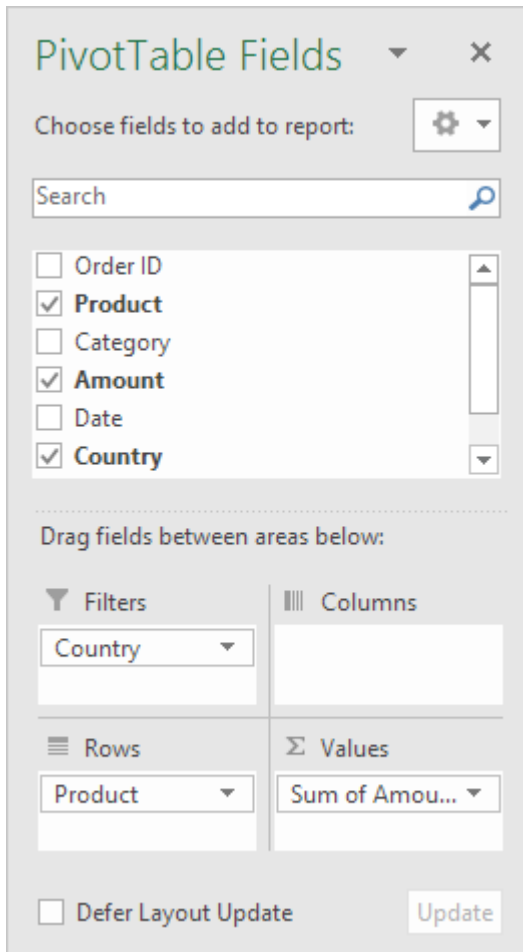
3. Click OK.



Drag fields

The **PivotTable Fields** pane appears. To get the total amount exported of each product, drag the following fields to the different areas.

1. Product field to the Rows area.
2. Amount field to the Values area.
3. Country field to the Filters area.



Below you can find the pivot table. Bananas are our main export product. That's how easy pivot tables can be!

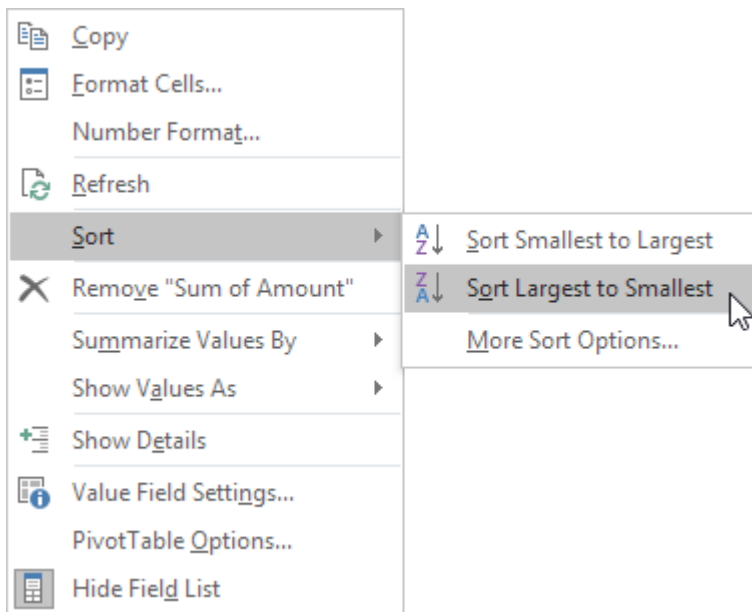
	A	B	C
1	Country	(All)	
2			
3	Row Labels	Sum of Amount	
4	Apple	191257	
5	Banana	340295	
6	Beans	57281	
7	Broccoli	142439	
8	Carrots	136945	
9	Mango	57079	
10	Orange	104438	
11	Grand Total	1029734	
12			

Sort

To get Banana at the top of the list, sort the pivot table.

1. Click any cell inside the Sum of Amount column.

2. Right click and click on Sort, Sort Largest to Smallest.



Result.

	A	B	C
1	Country	(All) ▾	
2			
3	Row Labels ▾	Sum of Amount	
4	Banana	340295	
5	Apple	191257	
6	Broccoli	142439	
7	Carrots	136945	
8	Orange	104438	
9	Beans	57281	
10	Mango	57079	
11	Grand Total	1029734	
12			

Filter

Because we added the Country field to the Filters area, we can filter this pivot table by Country. For example, which products do we export the most to France?

1. Click the filter drop-down and select France.

Result. Apples are our main export product to France.

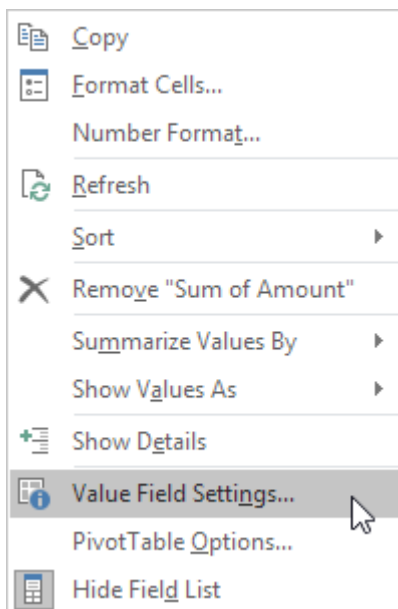
	A	B	C
1	Country	France	
2			
3	Row Labels	Sum of Amount	
4	Apple	80193	
5	Banana	36094	
6	Carrots	9104	
7	Mango	7388	
8	Broccoli	5341	
9	Orange	2256	
10	Beans	680	
11	Grand Total	141056	
12			

Note: you can use the standard filter (triangle next to Row Labels) to only show the amounts of specific products.

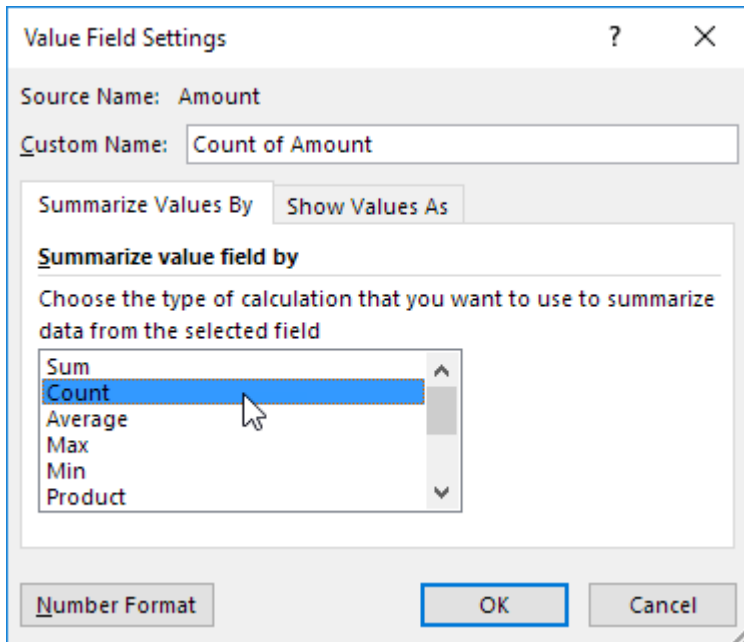
Change Summary Calculation

By default, Excel summarizes your data by either summing or counting the items. To change the type of calculation that you want to use, execute the following steps.

1. Click any cell inside the Sum of Amount column.
2. Right click and click on Value Field Settings.



3. Choose the type of calculation you want to use. For example, click Count.



4. Click OK.

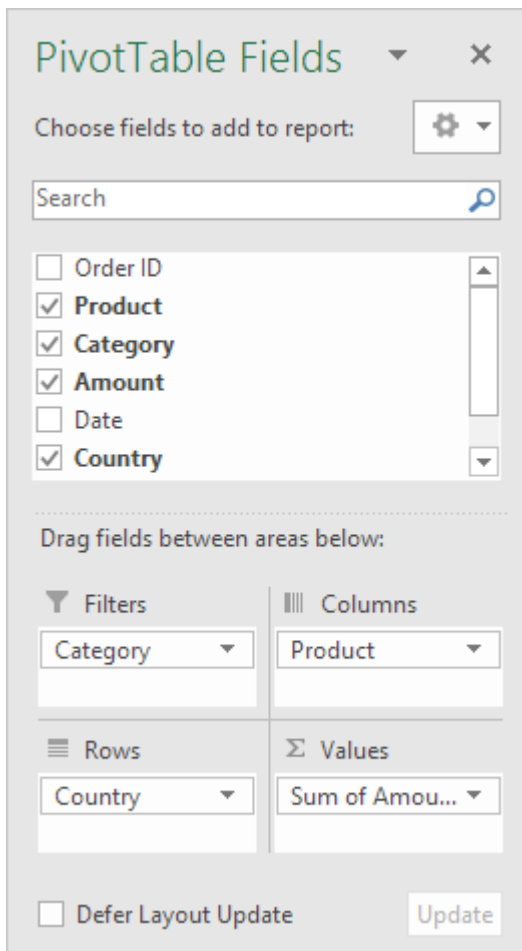
Result. 16 out of the 28 orders to France were 'Apple' orders.

	A	B	C
1	Country	France	
2			
3	Row Labels	Count of Amount	
4	Apple	16	
5	Banana	7	
6	Carrots	1	
7	Mango	1	
8	Orange	1	
9	Beans	1	
10	Broccoli	1	
11	Grand Total	28	
12			

Two-dimensional Pivot Table

If you drag a field to the Rows area and Columns area, you can create a two-dimensional pivot table. First, insert a pivot table. Next, to get the total amount exported to each country, of each product, drag the following fields to the different areas.

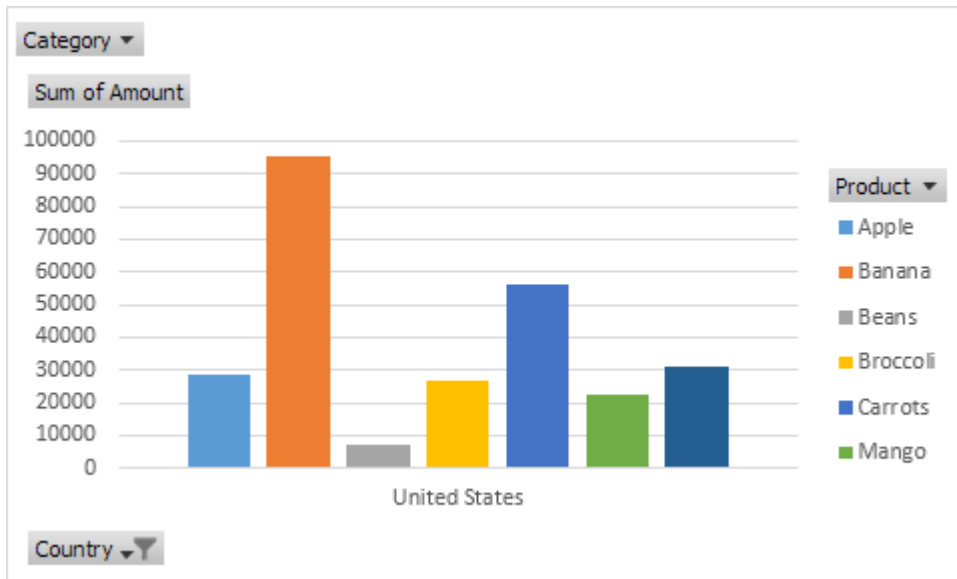
1. Country field to the Rows area.
2. Product field to the Columns area.
3. Amount field to the Values area.
4. Category field to the Filters area.



Below you can find the two-dimensional pivot table.

	A	B	C	D	E	F	G	H	I	J
1	Category	(All)								
2										
3	Sum of Amount	Column								
4	Row Labels	Apple	Banana	Beans	Broccoli	Carrots	Mango	Orange	Grand Total	
5	Australia	20634	52721	14433	17953	8106	9186	8680	131713	
6	Canada	24867	33775		12407		3767	19929	94745	
7	France	80193	36094	680	5341	9104	7388	2256	141056	
8	Germany	9082	39686	29905	37197	21636	8775	8887	155168	
9	New Zealand	10332	40050		4390			12010	66782	
10	United Kingdom	17534	42908	5100	38436	41815	5600	21744	173137	
11	United States	28615	95061	7163	26715	56284	22363	30932	267133	
12	Grand Total	191257	340295	57281	142439	136945	57079	104438	1029734	
13										

To easily compare these numbers, create a pivot chart and apply a filter. Maybe this is one step too far for you at this stage, but it shows you one of the many other powerful pivot table features Excel has to offer.



8. Find Quick Answers With Excel Goal Seek

Last Updated on 30-Mar-2017 by [AnneH](#)

The days after elections people often ask “**what-if**” questions. Some races are close and the vote count goes on for days. In other cases, people want to know how many votes would’ve been needed to win. **Excel Goal Seek** is good tool for answering these and other forecasting questions.

What is Goal Seek?

Goal Seek is a built-in Excel tool that allows you to see how one data item in a formula impacts another. You might look at these as “cause and effect” scenarios. For example, you might be looking at your local election results and see:

	Votes	% of Votes
YES	4478	63.90 *
NO	2530	36.10
Total	7008	100

* Needs approval from 2/3 of the voters

In our example, the YES votes are a majority, but shy of the required 2/3 approval to win the election. People quickly realize they were close, but which item do they change to find out how close. What would’ve made a difference?

Using Goal Seek we can change the value of various cells to see how the results change. This would allow you to answer these types of questions.

- *How many “NO” voters needed to be converted to YES to win the election?*
- *How many more votes were needed by the YES team to win the election?*
- *If 500 more people voted could the YES team have won?*

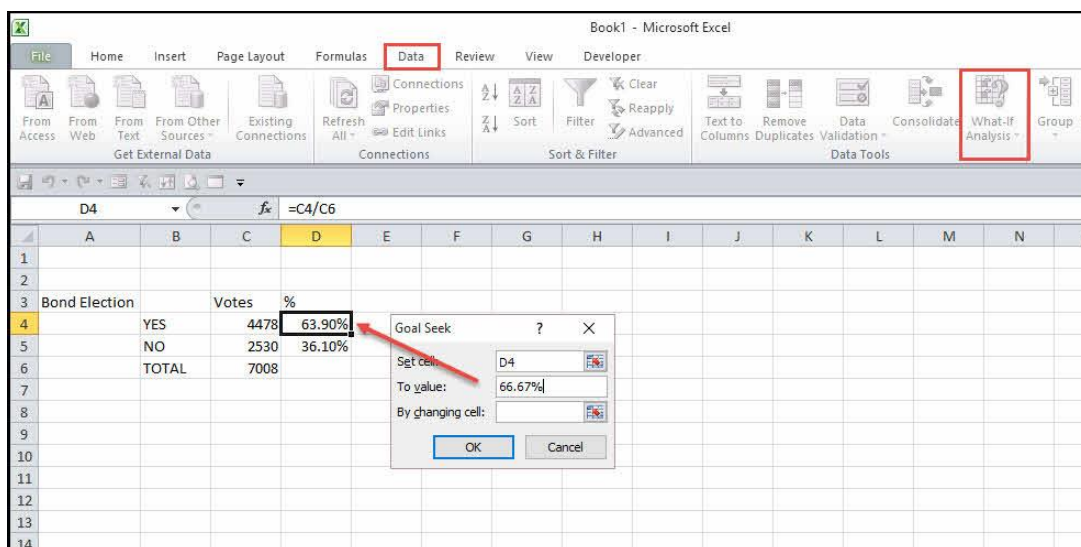
In each of these questions, the goal is to change a data value to see if the YES percentage went over that two-thirds mark or 66.67%. Rather than haphazardly changing cell values to see the results, Goal Seek can find the answers.

How to Use Excel Goal Seek

1. Create a spreadsheet in Excel that has your data.

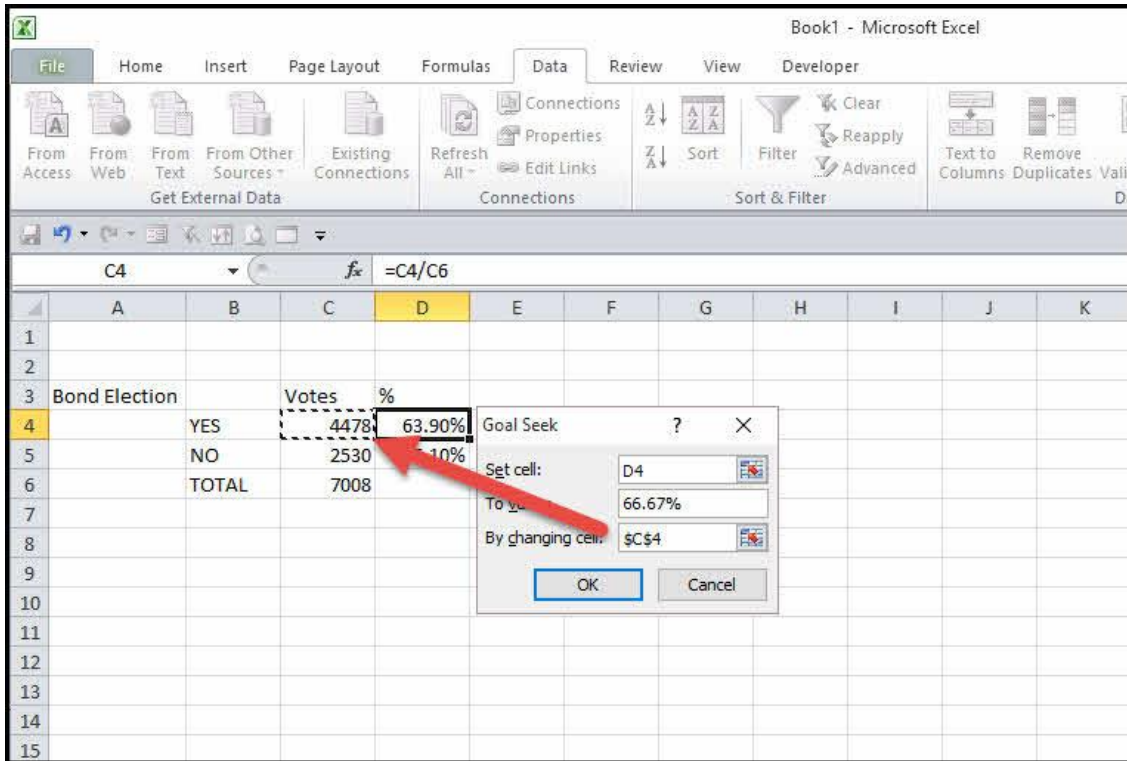
	A	B	C	D	E
1					
2					
3	Bond Election		Votes	%	
4		YES	4478	63.90%	
5		NO	2530	36.10%	
6		TOTAL	7008		
7					
8					

2. Click the cell you want to change. This is called the “**Set cell**”. In my example, this will be D4.
3. From the **Data** tab, select the **What if Analysis...** button
4. Select **Goal seek..** from the drop down menu
5. In the Goal Seek dialog, enter the new “what if” amount in the **To value** text box. (Remember to add the percentage sign if you have one.)

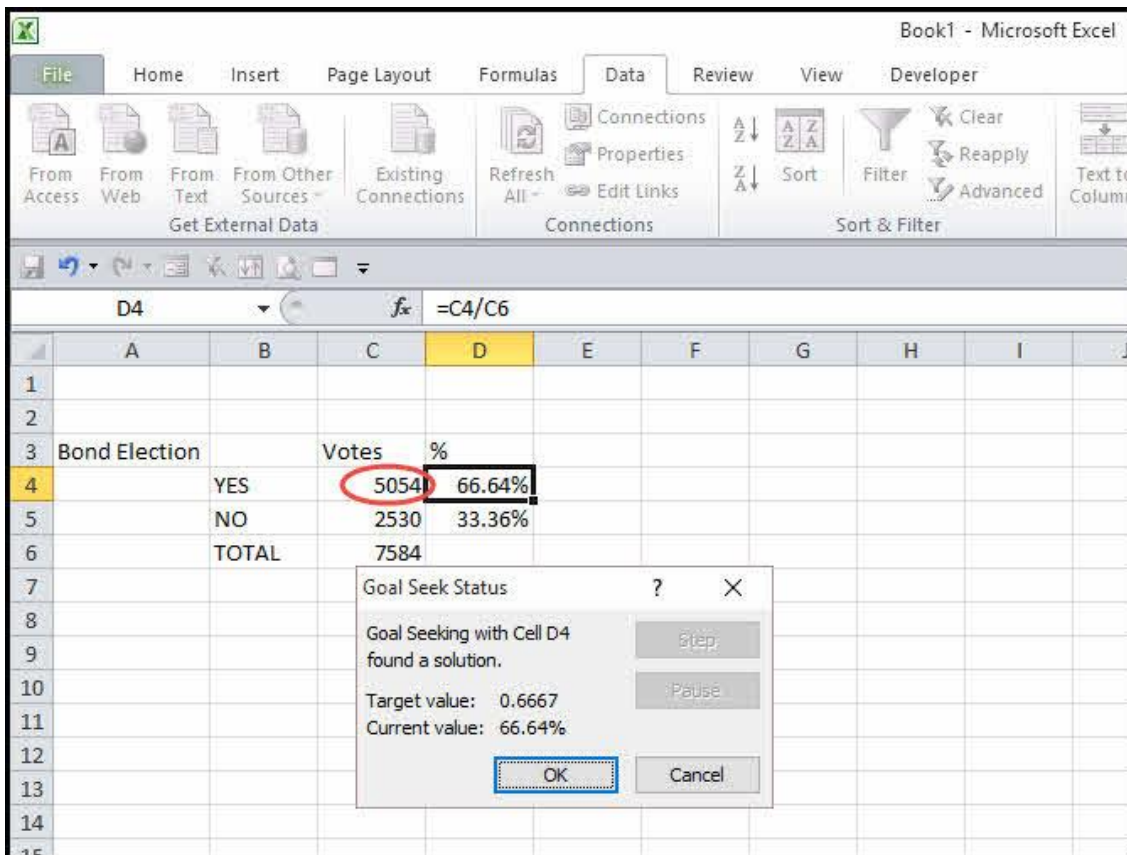


In this example, we’re asking Excel to replace the contents of cell D4 which is 63.90% with 66.67%. This is the percentage needed to win the election.

6. We also need to tell Excel which cell to change. Since we wanted to know the number of YES votes, we’ll click C4.



- Click **OK**. Excel will overwrite the previous cell value with the new one.



- If you wish to accept the new value, click **OK**.

Goal Seek Requirements & Gotchas

I can hear some readers yelling “wait.... don’t accept the value”. Actually, people may be yelling for two reasons.

If you look closely in the Goal Seek Status box, you’ll see the **Target value:** reads: 0.6667 came from our 66.67%. But the **Current value:** shows as 66.64%. Excel rounded down and the revised YES value wouldn’t win the election since 66.64% is less than 66.67%.

Another group may be asking why Excel didn’t just take 66.67% of the TOTAL vote count 7008. And that leads us to a requirement of Goal Seek – formulas. **The Set cell in Step 2 must contain a formula.** In our example, the initial 63.90% was a formula using the YES value (C4) divided by TOTAL value (C6). So, we met that requirement.

	A	B	C	D	E
1					
2					
3	Bond Election		Votes	%	
4		YES	4478	63.90%	
5		NO	2530	36.10%	
6		TOTAL	7008		
7					

If I just typed the value 63.90% and tried to use Goal Seek, I would see an Excel error stating “**Cell must contain a formula**”.

Just as I used a formula in my set cell, I also used a formula for TOTAL in B6. This was the Sum of my YES and NO votes. Since this TOTAL cell was a formula, my TOTAL count automatically adjusted when Goal Seek changed the YES cell value. If I typed “7008” in cell C6, only the YES cell value would have changed.

The other requirement is **the cell you change in Step 6 can’t contain a formula.** It must be a typed value.

As this example shows, Goal Seek is a nice tool that can quickly find the answers to different situations. Although this was a simple example, you can use the same tool for complicated spreadsheets containing many variables and formulas. Just remember, you many not always like the results.

9. Paired Sample t Test

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Motivations

In **paired sample** hypothesis testing, a sample from the population is chosen and two measurements for each element in the sample are taken. Each set of measurements is considered a sample. Unlike the hypothesis testing studied so far, the two samples are not independent of one another. Paired samples are also called **matched samples** or **repeated measures**.

For example, if you want to determine whether drinking a glass of wine or drinking a glass of beer has the same or different impact on memory, one approach is to take a sample of say 40 people, and have half of them drink a glass of wine and the other half drink a glass of beer, and then give each of the 40 people a memory test and compare results. This is the approach with **independent** samples.

Another approach is to take a sample of 20 people and have each person drink a glass of wine and take a memory test, and then have the same people drink a glass of beer and again take a memory test; finally we compare the results. This is the approach used with **paired** samples.

The advantage of this second approach is the sample can be smaller. Also since the sampled subjects are the same for beer and wine there is less chance that some external factor (**confounding variable**) will influence the result. The problem with this approach is that it is possible that the results of the second memory test will be lower simply because the person has imbibed more alcohol. This can be corrected by sufficiently separating the tests, e.g. by conducting the test with beer a day after the test with wine.

It is also possible that the order in which people take the tests influences the result (e.g. the subjects learn something on the first test that helps them on the second test, or perhaps taking the test the second time introduces a degree of boredom that lowers the score). One way to address these **order effects** is to have half the people drink wine on day 1 and beer on day 2, while for the other half the order is reversed (called **counterbalancing**).

The following table summarizes the advantages of paired samples versus independent samples:

<i>Paired Samples</i>	<i>Independent Samples</i>
Need fewer participants	Fewer problems with fatigue or practice effects
Greater control over confounding variables	Participants are less likely to figure out the purpose of the study

Figure 1 – Comparison of independent and paired samples

Obviously not all experiments can use the paired sample design. E.g. if you are testing differences between men and women, then independent samples will be necessary.

How to perform paired t-test with Data analysis tool excel

Excel provides a data analysis tool that takes care of just about everything for matched samples. It's called t-test: Paired Two Sample for Means. In this section, I use it on the weight-loss data.

Null hypothesis: there is not loss of weight

Activate the data analysis tool

If you need to develop complex statistical or engineering analyses, you can save steps and time by using the Analysis ToolPak. You provide the data and parameters for each analysis, and the tool uses the appropriate statistical or engineering macro functions to calculate and display the results in an output table. Some tools generate charts in addition to output tables.

The data analysis functions can be used on only one worksheet at a time. When you perform data analysis on grouped worksheets, results will appear on the first worksheet and empty formatted tables will appear on the remaining worksheets. To perform data analysis on the remainder of the worksheets, recalculate the analysis tool for each worksheet.

1. Click the **File** tab, click **Options**, and then click the **Add-Ins** category.
2. In the **Manage** box, select **Excel Add-ins** and then click **Go**.

If you're using Excel for Mac, in the file menu go to **Tools > Excel Add-ins**.

3. In the **Add-Ins** box, check the **Analysis ToolPak** check box, and then click **OK**.
 - If **Analysis ToolPak** is not listed in the **Add-Ins available** box, click **Browse** to locate it.
 - If you are prompted that the Analysis ToolPak is not currently installed on your computer, click **Yes** to install it.

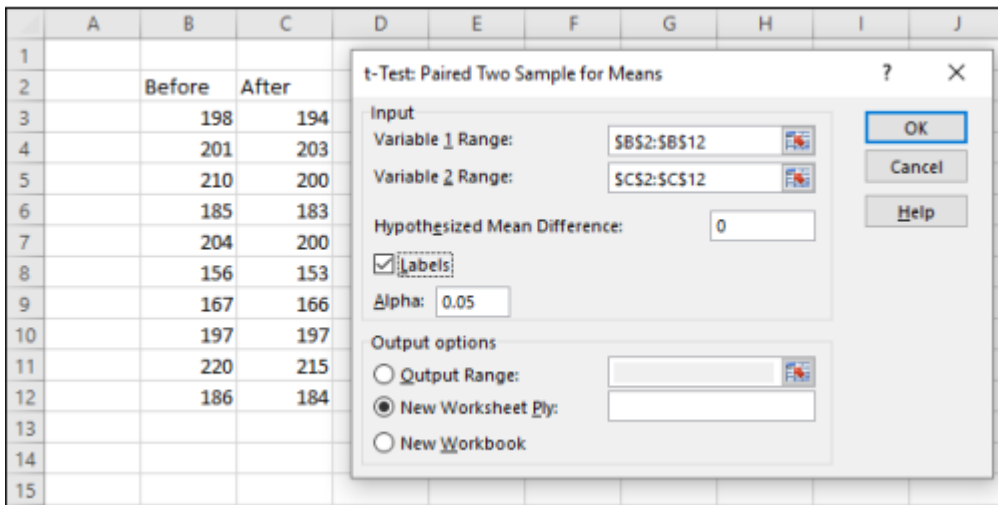
How to perform the t-test

Here are the steps to follow:

1. Enter the data for each sample into a separate data array.
For this example, the data in the Before sample are in column B and the data for the After sample are in column C.
2. Select Data | Data Analysis to open the Data Analysis dialog box.
3. In the Data Analysis dialog box, scroll down the Analysis Tools list, and select t-Test: Paired Two Sample for Means.

4. Click OK to open this tool's dialog box.

This is the dialog box



5. In the Variable 1 Range box, enter the cell range that holds the data for one of the samples. For the example, the Before data are in \$B\$2:\$B\$12, including the heading. (Note the \$ signs for absolute referencing.)
6. In the Variable 2 Range box, enter the cell range that holds the data for the other sample. The After data are in \$C\$2:\$C\$12, including the heading.
7. In the Hypothesized Mean Difference box, type the difference between μ_1 and μ_2 that H_0 specifies. In this example, that difference is 0.
8. If the cell ranges include column headings, select the Labels check box. I included the headings in the ranges, so I selected the check box.
9. The Alpha box has 0.05 as a default. Change that value if you want to use a different α .
10. In the Output Options, select a radio button to indicate where you want the results. I selected New Worksheet Ply to put the results on a new page in the work sheet.
11. Click OK.

Because I selected New Worksheet Ply, a newly created page opens with the results.

	A	B	C
1	t-Test: Paired Two Sample for Means		
2			
3		<i>Before</i>	<i>After</i>
4	Mean	192.4	189.5
5	Variance	377.6	342.9444444
6	Observations	10	10
7	Pearson Correlation	0.986507688	
8	Hypothesized Mean Difference	0	
9	df	9	
10	t Stat	2.824139508	
11	P(T<=t) one-tail	0.009955992	
12	t Critical one-tail	1.833112933	
13	P(T<=t) two-tail	0.019911984	
14	t Critical two-tail	2.262157163	
15			

Pearson Correlation Coefficient

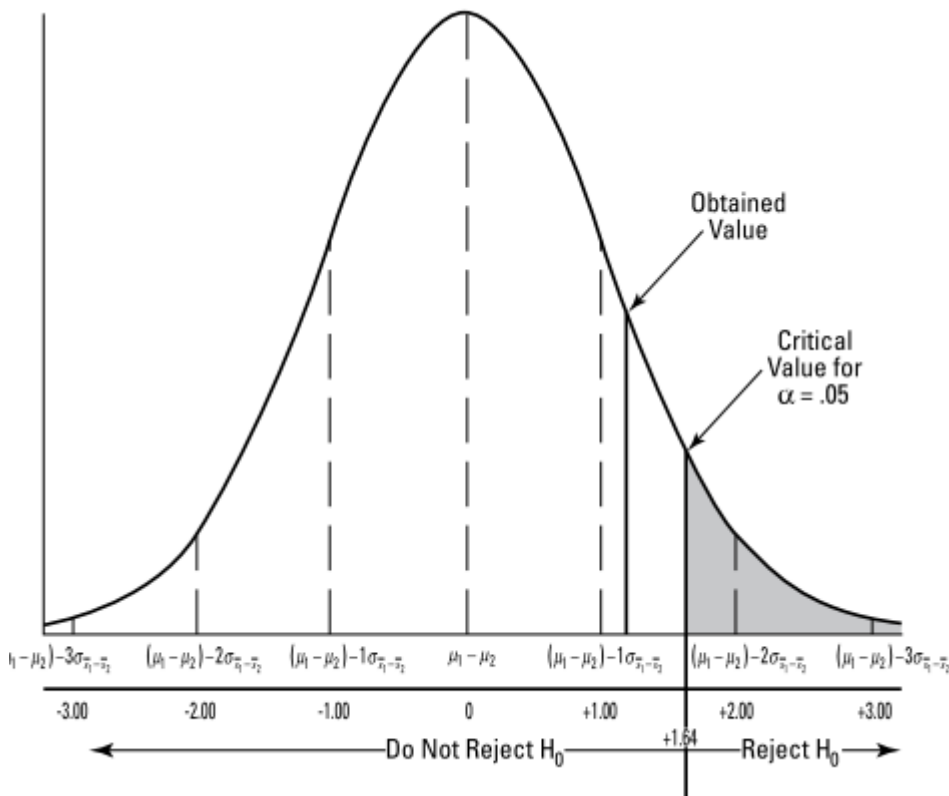
The only item that's new is the number in cell B7, the Pearson Correlation Coefficient. This is a number between -1 and $+1$ that indicates the strength of the relationship between the data in the first sample and the data in the second. If the number is close to -1 , high scores in the first sample are associated with low scores in the second, and low scores in the first are associated with high scores in the second. If the number is close to zero, scores in the first sample are unrelated to scores in the second. Because the two samples consist of scores on the same people, you expect a high value.

Cell B8 shows the H_0 -specified difference between the population means, and B9 shows the degrees of freedom.

The remaining rows provide t -related information. The calculated value of the test statistic is in B10. Cell B11 gives the proportion of area the positive value of the test statistic cuts off in the upper tail of the t -distribution with the indicated df (gdl in italiano).

Cell B12 gives the critical value for a one-tailed test: That's the value that cuts off the proportion of the area in the upper tail equal to α .

Cell B13 doubles the proportion in B11. This cell holds the proportion of area from B11 added to the proportion of area that the negative value of the test statistic cuts off in the lower tail. Cell B13 shows the critical value for a two-tailed test: That's the positive value that cuts off $\alpha/2$ in the upper tail. The corresponding negative value (not shown) cuts off $\alpha/2$ in the lower tail.



In brief:

If $p > \alpha$, we reject the H_0

If $p < \alpha$ we cannot reject H_0