Formulas, Cell References and Functions

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Formulae

Using a formula can help you analyse data on a worksheet. With a formula you can perform operations, such as addition, multiplication, and comparisons on worksheet values. Use a formula when you want to enter calculated values on a worksheet.

To enter a formula into a cell, you enter an equals sign = in formula bar.

A simple formula combines constant values (numeric or text value) with operators, such as a plus or minus sign, in a cell to produce a new value from existing values. Formulas should be thought of as one side of an equation whose result is shown in the cell. A simple formula may take the form of =G5/H5*100.

The formula bar

When you type the equals sign, a formula bar will appear:

From left to right, the components of the formula bar are as follows:

- A drop down list of the most recently used functions, the last option in the list is 'More Functions…' which displays a Paste Function dialog box.
- The Cancel Formula icon  cancels the entry in the formula bar.
- The Enter Formula icon  accepts the entry in the formula bar.
- The Edit Formula icon  displays the Formula Palette if you click this instead of typing = Excel assists you in building a formula as shown below.

A formula can include any of the following elements: operators, cell references, values, worksheet functions, and names. To enter a formula in a worksheet cell, you type a combination of these elements in the formula bar.

Operators

If you combine several operators in a single formula, Excel performs the operations in the order shown in the following table:

Operator	Description
-	Negation (as in -10)
%	Percent
^	Exponentiation
* and /	Multiplication and division
+ and -	Addition and subtraction
&	Text joining
= < >	Comparison
<= >= <>	

If a formula contains operators with the same priority, Excel evaluates the operators from left to right. If you want to alter the order of evaluation, use parentheses to prioritise evaluation. Excel will then first calculate expressions within parentheses and then uses those results to calculate the remainder of the formula.

This formula	Produces this value
=5-2*2	1
=(5-2)*2	6

Displaying formulae

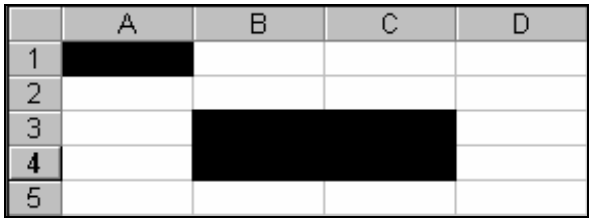
A cell usually displays the results of the formula. When you select a cell containing a formula, however, the formula is always displayed in the formula bar. You can display formulas, rather than the results in cells by choosing **Tools | Options**, clicking the View tab and checking Formulas in the Window Options box.

References

With references you can use data located in different areas in one formula and use one cell's value in several formulae.

- References identify cells or groups of cells on a worksheet.
- References tell Excel which cells to look in to find the values to be used in a formula.
- References are based on the column and row headings in a worksheet.

Columns are labelled with letters (A through IV, for a total of 256 columns) and rows are labelled with numbers (1 through 65536). This is known as A1 reference style. The reference of the active cell is displayed in the name box at the far left of the formula bar. The references of the lone black shaded cell displayed above is A1. The reference of the black shaded range of cells is B3:C4.



Relative cell references

When another cell is referred to in a formula the reference is relative to the cell containing the formula. Using a relative reference is like giving directions that explain where to go from where you started, e.g. one cell to the left. Such references allow Excel to take account of changes made to the worksheet (e.g. inserting rows of data).

Absolute cell references

Sometimes when copying a formula that contains a cell reference, it is important that the reference is not relative, i.e. it stays the same when a formula is copied. In this case the reference to the cell must be made *absolute*, or not changeable. The **$** symbol is used to indicate absolute referencing.

- A $ before the column letter and row number, e.g. **A1**, means both the row and column will be referred to absolutely.

Sometimes cell references are mixed, i.e. either the column or row reference is absolute but not both the column and row reference. Thus:

- A $ before the column letter only, e.g. $A1, means only the column will be referred to absolutely but the row reference will remain relative.
- A $ before the row number only, e.g. A$1 means only the row will be referred to absolutely but the column reference will remain relative.

No $ in front of either the column letter or row number, e.g. A1, means the whole reference is relative which is the normal case.

Functions

A function is a special prewritten formula that takes a value or values, performs an operation, and returns a value or values. Functions can be used alone or as building blocks in larger formulas. Using functions simplifies and shortens formulas in your worksheets, especially those that perform lengthy or complex calculations.

For example, instead of typing the formula:

=A1+A2+A3+A4

you can use the SUM function to build the formula:

=SUM(A1:A4)

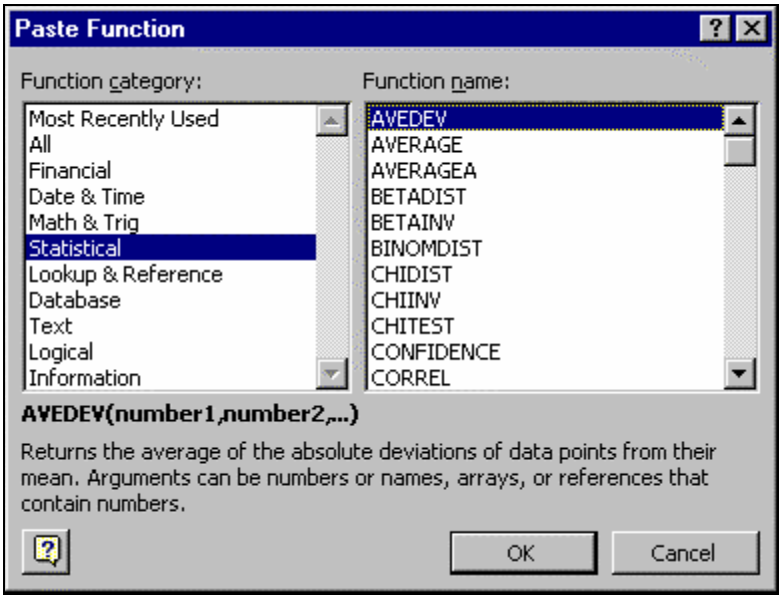
AutoSum

The SUM function is probably the most frequently used of all functions. If you wish, however,

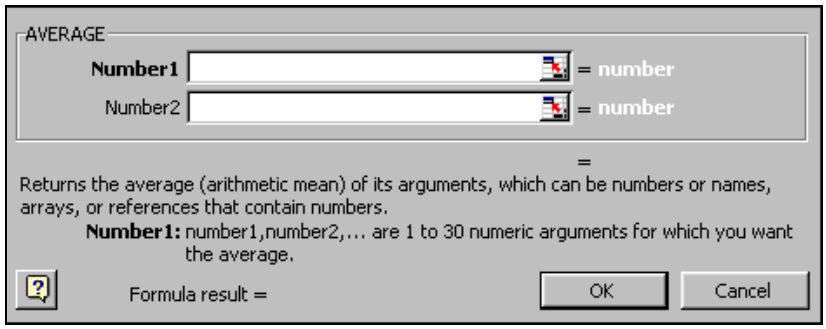
to sum a row or column, it is more convenient to use the AutoSum button  on the Standard toolbar. To enter the AutoSum formula, select a cell adjacent to a row or column of numbers you want to add, and click the AutoSum button.

Paste Function Wizard 

Whenever you want to use a built in Excel function (such as SUM, AVERAGE, MIN, MAX, etc.) you can use the Function Wizard to help you select a function, assemble the arguments correctly, and insert the function into your formula.

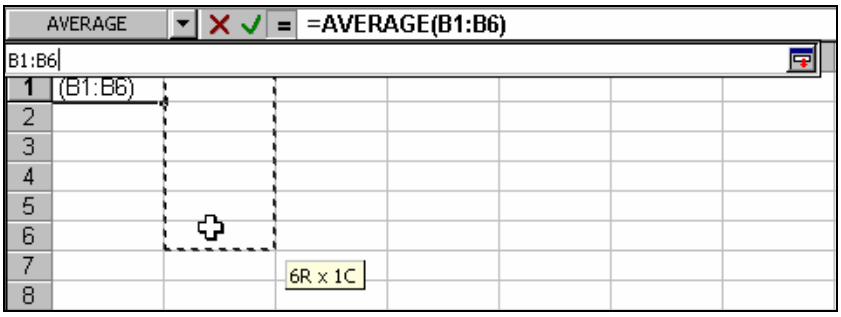


To add function to a formula, activate the Function Wizard by clicking the Function Wizard button. Select the type of function, e.g., Statistical or Date & Time, from the ***Function Category*** panel and the function you wish to use from the ***Function name*** panel of the *Paste Function* dialog box.
A dialog box for that function is then displayed. Alternatively, you can also click on the drop down list of functions on the Formula bar to identify the function and obtain the dialog box shown below.



For a simple Mean (Average) enter the range of cells that are used by the function, e.g. **A1:A10** in the ***Number1*** box. Click on OK. Further help on the function can be obtained by clicking on the Help icon  at the bottom left of the dialog box.

If you are not sure of the range of cells to be used, click the  button on the far right of the ***Number1*** text box. The AVERAGE dialog box is hidden and the cells in the spreadsheet displayed. Click on the first cell in the range and drag the cursor to identify the last cell in the range, in the example below this is B1 to B6.



The formula is written into the formula bar. To complete this action and return to the Paste Function wizard, click on the button.

If you know the syntax of the function you can type it directly in to the Formula bar e.g. =AVERAGE(A1:A10). This avoids using the Paste Function wizard.

Examples of other Functions

COUNT functions provide options for counting values.

COUNT	Counts the number of cells that contain numbers. Note: cells that contain numbers, dates, or text representations of numbers are counted
COUNTA	Counts the number of cells that are not empty
COUNTBLANK	Counts empty cells in a specified range of cell
COUNTIF	Counts the number of cells within a range that meet the given criteria

Using COUNTIF in adjacent cells can be used to count the number of 1's and 2's in a series of cells, for example to count 1's and 2's in cells A1 through to A10.

=COUNTIF(A1:A10,1)
=COUNTIF(A1:A10,2)

SUMIF, sums the cells specified by a given criteria, there are two ways of using this command.

=SUMIF(A1:A10, ">10") will sum the contents of cells A1:A10 where any of the cells is greater than 10.

and

=SUMIF(A1:A10,">10",B1:B10) will sum the contents of cells B1 to B10 where the contents of cells A1 to A10 are greater than 10. So if cells B1 to B10 contain 1's then this formla will tell us how many values are greater than 10.

IF, this function returns one value if a condition you specify evaluates to TRUE and another value if it evaluates to FALSE.

=IF(A2<50,"Less than 50","Greater than or equal to 50")

or

=IF(A2=B2,1,0) where if the cells A2 and B2 are the same the current cells displays the value 1, otherwise it shows 0.

Working with Dates

To find the difference in days between two dates (e.g. in cells A1 and B1) subtract the dates from each other (=A1-B1). The result will initially be displayed as a date in the cell containing the formula. Select this cell, click the right mouse button and select Format Cells. Select the Number options tab and change the category to General.

If you subtract 4-Jan-2003 from 1-Jan-2003 the result is displayed as either 3-Jan -00 or 3-Jan-1900 (yes 1900). Changing the cell format to number-general will display 3 which is the difference in days. (This is done by right click on the cell, Format Cells | Number options and selecting the General Category).

Note *The 3-Jan-1900, is because the cell is formatted to display a date and Excel can only work with dates starting from 1-Jan-1900, earlier dates are not recognised! If you enter 1-Jan-1890 and check the format of the cell. It is given a general format and not a date one and therefore treated as text.*

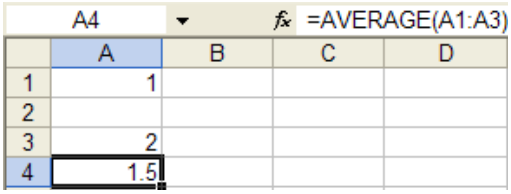
Date functions

Excel has a range of functions for manipulating date information. For example, the current date and time is given by the function =NOW(). To display just the date use =TODAY().

Missing Data in a Formula

If a cell, in the range of cells used by a function is empty, or if it is an inappropriate data type, the cell is ignored.

Test this by typing 1 into cell A1, leave cell A2 blank and type 2 into cell A3 Enter the formula, =AVERAGE(A1:A3) in cell A4.
Now enter 'missing' in cell A2. The mean is unaltered. You could use this approach to indicate missing values in some instances.



Error Values

If a formula cannot properly evaluate a result, Microsoft Excel will display an error value. Each error type has different causes, and different solutions

#VALUE!	Occurs when the wrong type of argument or operand is used
#DIV/0!	Occurs when a number is divided by zero (0)
NAME?	Occurs when Microsoft Excel doesn't recognize text in a formula
#N/A	Occurs when a value is not available to a function or formula
#REF!	Occurs when a cell reference is not valid
#NUM!	Occurs with invalid numeric values in a formula or function
#NULL!	Occurs when you specify an intersection of two areas that do not intersect. The intersection operator is a space between references

The example opposite illustrates two error values.
Data values (1, nothing, 'missing' and 2) have been entered in cells A1 to A4. Cell A2 was left blank.
The formulae =LOG(A1), =LOG(A2), = LOG(A3) and =LOG(A4) were entered into cells B1 to B4 respectively.
Cells B2 and B3 cannot calculate the logarithm of missing and text value respectively.

	A	B	C
1	1	0	
2		#NUM!	
3	missing	#VALUE!	
4	2	0.30103	
5			

One solution to this is to use a formula containing two Excel functions, IF and ISNUMBER. ISNUMBER has three parameters. (Cell reference, Action if Cell Reference is True, Action if Cell Reference is False). For example,

=IF(ISNUMBER(A1),LOG(A1),"Cannot convert to Log")

As shown for cell C1 and copied to cells C2 to C4. If the cell in column A is a valid number, then cells in column C display the logarithm of that number, otherwise the text missing is displayed. The only problem is when the number is zero or negative, you would need to use other functions in the expression to check for this!

Editing a Formula

To edit a formula, simply click the cell containing the formula and edit the contents of the formula bar. When complete click the enter formula icon  .

When using a formula that contains a cell reference, it is important to remember that if the value in the cell referred to is changed, then the dependent formula will recalculate to reflect the change.

Copying a Formula

It is possible to copy a formula to adjacent cells. Select the formula you wish to copy then position the mouse pointer over the fill handle (bottom right of the selected cell). The pointer changes to a black cross at the bottom right of the selected cell. Drag the fill handle in the direction you want to copy. If relative cell references are specified within the formula then Excel will handle these correctly. For example if the formula =A1+B1 in cell C1 is copied to cell C2 and C3, the formulae within cells will read =A2+B2 and =A3+B3, respectively.

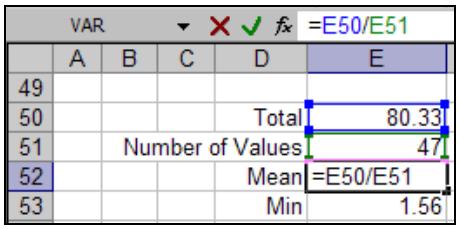
Some formulae may require absolute cell references, =A$1 +B1 copied to C2 and C3 will result in =A$1 +B2 and =A$1 +B3 respectively. The $ fixes the row of column A at 1 when the formula is copied.

Creating a formula using 'point and click'

Formulae can be created by pointing to the area of the worksheet you are interested in. For example to add cells A1 and B1 together in cell C1.
Select on cell C1
Enter the = symbol in C1
Click on cell A1
Enter the + symbol
Click on cell B1
Press <Enter> or tick the  enter formula.

Excel highlighting of formulae

Excel uses colours to highlight parts of a formula. This is a useful feature when trying to resolve problems with a formula. In the figure below cell C52 was selected and then the cursor was moved over the formula bar and clicked on =E50/E51.



Excel highlights parts of the formula. In this example E50 is highlighted (in blue) and E51 is highlighted (in green) both the cell borders and the text in the formula bar.