





## SECTION 1: Working with Functions and Formulas 4

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## Intro: Excel 2007 Overview – What's New?

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**In this section you will be introduced to:**

- New results-oriented interface
- More row and columns, and other new limits
- Office themes and Excel styles
- Rich conditional formatting
- Easy formula writing
- Improved sorting and filtering
- Excel table enhancements
- New look for charts
- Shared charting
- Easy to use PivotTables
- New file formats
- Better printing experience
- Quick access to more templates

## SECTION 1: Working with Functions and Formulas

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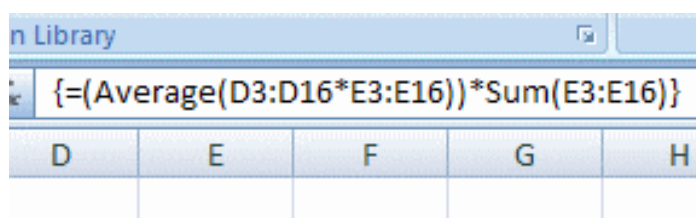
In this section you will learn about:

- Relative and absolute cell references
- Basic mathematical operators
- Using formulas with multiple cell references
- Fixing formula errors with the formula auditing tools
- Displaying and printing formulas
- Functions
- Finding the right function
- Some useful and simple functions
- Inserting functions
- Using the If function
- Using nested functions
- Working with range names
- Selecting non adjacent ranges
- Array formulas
- Using functions with array formulas
- Using the If function with array formulas

## Lesson 1.1: Using Formulas in Excel

As you probably already know, Excel 2007 is a great tool for organizing and presenting your data. However, Excel 2007 can do much more than neatly arrange and total rows and columns of information. The real power of Excel lies in the number and variety of functions and formulas that you can apply to your data.

When you enter or change your data, the Excel worksheets are automatically recalculated based on the mathematical formulas and functions that connect your information. Needless to say, a good understanding of how to build and use formulas and functions will help you improve the functionality and efficiency of your worksheets.



In this lesson you will learn about absolute and relative cell references, basic mathematical operations, and using formulas that involve multiple cell references. You will also become familiar with the formula auditing toolbar and you will practice fixing formula errors. Finally, you will learn how to display and print formulas in Excel.

### Understanding Relative and Absolute Cell References

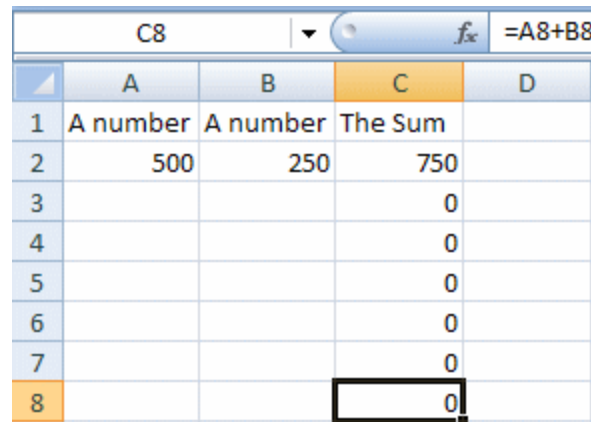
In Excel, a specific cell can be named or referred to with a cell reference. A simple cell reference is just the letter at the top of the cell's column, paired with the number at the left of the cell's row. Cell A1, for example, is the first cell in the top left corner of the Excel grid (first column letter, A, and first row number, 1).

	C2		fx =A2+B2		
	A	B	C	D	E
1	A number	A number	The Sum		
2	500	250	750		
3					
4					

In the image above, Cell A2 contains the value 500 while cell B2 contains the value 250. Cell C2 contains a formula (`=A2+B2`, visible in the formula bar) that adds these two numbers by using their respective cell references.

The first rule of formulas is that all formulas must begin with an equals sign. This tells Excel that what follows is a formula.

If you use your mouse to drag the cell containing the formula (E3) down to fill part of the column (using the thin cross mouse pointer), you will see zeros in the cells that you drag the formula to.



	A	B	C	D
1	A number	A number	The Sum	
2	500	250	750	
3			0	
4			0	
5			0	
6			0	
7			0	
8			0	

You should also notice that the formula for cell C8 (the active cell) can be read from the formula bar as =A8+B8. But remember, the original formula in C2 (the cell we filled from) was =A2+B2. The formula has changed to reflect the relative positions of the cells. The formula in cell C2 adds the two cells to its immediate left. Each cell that this formula has been filled to will contain a formula that adds the two cells to its immediate left.

In other words, the formula adopts cell references that are relative to its position in the worksheet. This maintains the same relative positioning of the original formula. This results in zeros in the locations where the cells to the immediate left of the formula are empty.

This is called a relative cell reference, meaning that if the formula is moved (dragged, filled, or copied) the cells involved will change to reflect the formula's new position.

In the example on the next page, we have mouse dragged a formula with absolute references to fill the six cells beneath it.

	C8		$\sum$	= \$A\$2 + \$B\$2	
	A	B	C	D	E
1	A number	A number	The Sum		
2	500	250	750		
3			750		
4			750		
5			750		
6			750		
7			750		
8			750		

Notice that this time, the value of 750 is in each cell, and the formula contained in the active cell, C8, contains dollar signs. These dollar signs tell Excel that the references in the cell are absolute: no matter where the formula is copied or filled to, it will always use the same cell references.

The original formula at cell C2 is = \$A\$2 + \$B\$2. When this formula is copied or dragged or filled anywhere on the worksheet, the formula will retain the same cell references because they are marked with dollar signs.

To summarize, a reference like A1 it is a relative cell reference because there are no dollar signs included. The cell reference \$A\$1 is an absolute cell reference, because of the dollar signs in front of the letter and number. The cell reference \$A1 has an absolute column reference (because the column letter has a dollar sign in front). In this case, the column reference will never change. The cell reference A\$1 has an absolute row reference, meaning the row reference will never change.

If you want to copy or fill a formula across cells, and you want the cells in the formula and the result of the formula to change relative to location, use relative references.

If you want to copy or fill a formula across cells, and you always want the specific cells used in the formula to remain the same, use absolute references.



## Basic Mathematical Operators

To build formulas in Excel, you will have to use the basic mathematical operators as shown in the following table.

<b>^</b>	<b>Exponent ( <math>10^2 = 100</math> )</b>
<b>*</b>	<b>Multiplication ( <math>10 * 2 = 20</math> )</b>
<b>/</b>	<b>Division ( <math>10 / 2 = 5</math> )</b>
<b>+</b>	<b>Addition ( <math>10 + 2 = 12</math> )</b>
<b>-</b>	<b>Subtraction ( <math>10 - 2 = 8</math> )</b>
<b>=</b>	<b>Equivalence</b>
<b>&gt;</b>	<b>Greater than ( <math>10 &gt; 2</math> )</b>
<b>&lt;</b>	<b>Less than ( <math>2 &lt; 10</math> )</b>

These operators are listed from top to bottom in order of precedence. This means that the following expression,  $3 * 2 + 4$ , will have the answer 10. This is because  $3 * 2$  is evaluated first, and then 4 is added (multiplication takes precedence over addition).

The equation  $3^2 * 4$  will have 36 as a result, because  $3^2$  is evaluated first, and the result is then multiplied by 4 (exponentiation takes precedence over multiplication).

You can impose your own order of operations by enclosing expressions in parentheses (). The operations inside the parentheses will be evaluated before the operations outside. If you have parenthesis within parenthesis as in  $((2+3)*4)$ , the expression in the inner parentheses,  $(2+3) = 5$ , will be evaluated first, and the result will be used to evaluate the expression in the outer parentheses,  $(5 * 4) = 20$ .

Examples:

- $(3+2)*2=10$ ,  $3+2*2=7$
- $(10+20)/2=15$ ,  $10+20/2=20$
- $((4+6)*2)^2=400$ ,  $4+6*2^2=27$

## Using Formulas with Multiple Cell References

In the following spreadsheet we have columns for Items Sold, Price, Total Sales, Cost per Item, Overhead, and Profit.

	A	B	C	D	E	F	G	H
1		Items Sold	Price	Total Sales	Cost per Item	Overhead	Profit	
2	Region1	400	10.5		2.3	45		
3	Region2	356	10.5		2.3	45		
4	Region3	25	10.5		2.3	45		
5	Region4	780	10.5		2.3	50		
6	Region5	23	10.5		2.3	70		
7	Region6	360	10.5		2.3	70		
8								

To come up with a figure for the profit column, we must evaluate the total sales (items sold multiplied by the price per item) and the total expenses (items sold multiplied by the cost per item, and then added with the overhead).

To do this, we can click on cell D2 and enter `=B2*C2` in the formula bar. If we then drag this formula to fill cells D2:D7, we will have the total sales for each location.

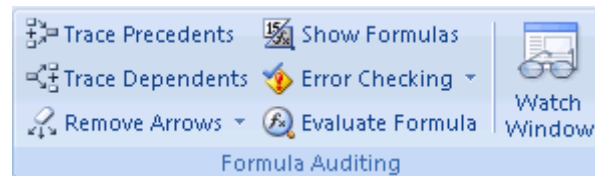
Profit is the total expenses subtracted from the total sales. In this instance, the total expenses for the row labeled Region1 would be `B2*E2+F2` (items sold \* cost per item + overhead). Remember, we have total sales in column D, so if we enter `=D2-(B2*E2+F2)` into cell G2, and then fill down to G7, we will have completed our profit column.

G2		<div><div></div><div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> <div><div></div><div></div><div></div></div> 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## The Formula Auditing Buttons

Excel 2007 provides some great features for working with formulas in the formula auditing button group. To display these buttons, click the Formulas tab to show the Formulas Ribbon.

This group of formula auditing buttons can help you trace errors and show the cells that are referenced in a formula.

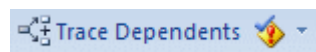


If you let your mouse pointer hover over each button in the button group, you will see a brief description of the button's function.

The Trace Precedents button will display blue arrows to cells that supply data to the formula (arrows may be red if a supplying cell has an error).

	A	B	C	D	E	F	G	H
1		<b>Items Sold</b>	<b>Price</b>	<b>Total Sales</b>	<b>Cost per Item</b>	<b>Overhead</b>	<b>Profit</b>	
2	Region1	400	10.5	4200	2.3	45	3235	
3	Region2	356	10.5	3738	2.3	45	2874.2	
4	Region3	25	10.5	262.5	2.3	45	160	
5	Region4	780	10.5	8190	2.3	50	6346	
6	Region5	23	10.5	241.5	2.3	70	118.6	
7	Region6	360	10.5	3780	2.3	70	2882	
8							15615.8	
9								

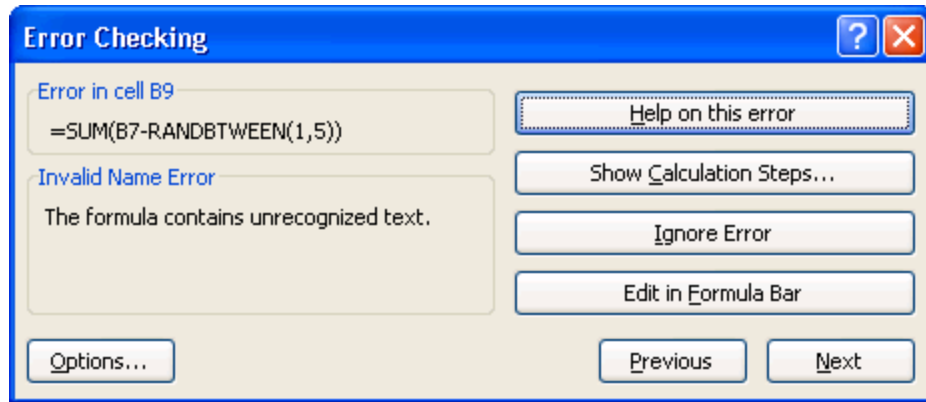
The Trace Dependents button will display arrows to the other cells that depend on a given cell's data.



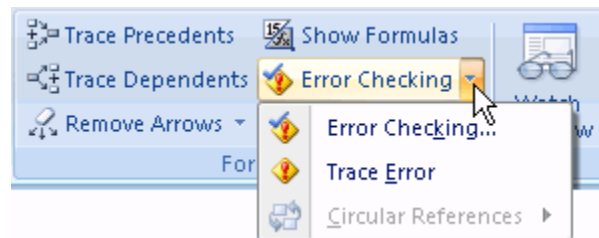
The Remove Arrows button will remove both precedence and dependence arrows from your Excel screen.

The Show Formulas button will toggle between showing results and formulas in the worksheet.

The Error Checking option will check the entire worksheet for formula errors. If any are found, you will be alerted with an error checking dialogue (like the one below) that pertains to the specific error in question.

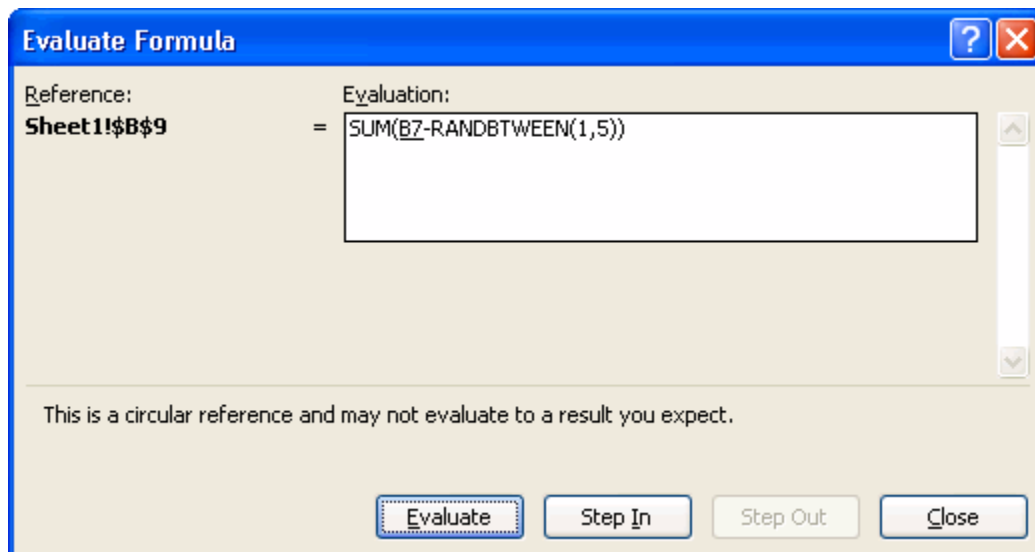


You can also click the down arrow next to the Error Checking button to see additional options.

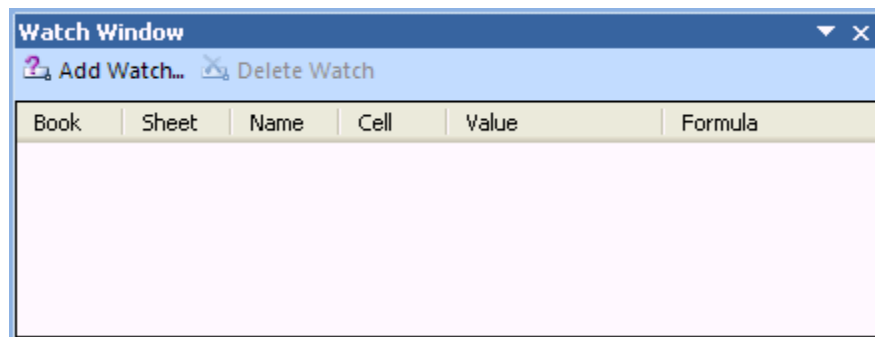


The first option (Error Checking) will perform the same action as if you clicked the Error Checking button directly. The Trace Error option will display arrows to the cells referenced in an incorrect formula. The Circular References menu will display cells that contain circular references, if there are any in the worksheet.

The Evaluate Formula dialog will help you analyze, interpret, and correct formulas.



Last but not least, the Watch Window button will display the watch window dialogue (shown below).



You can use this dialogue to watch a cell or selection of cells (perhaps from another worksheet) while you make changes to the data in another area.

If you find that your formula just isn't producing the correct results, try the formula auditing buttons. These features can help you fix formula mistakes by checking your worksheet for errors and tracing cell dependencies so you can see all of the cells that are referenced in a formula.

## Fixing Formula Errors

Formulas in Excel can range from the simple to the complex. When entering formulas, there are a number of mistakes that you can make, like leaving out a parenthesis or referencing the wrong cells. If you have a long formula with several cell references and it just doesn't seem to work, pinpointing the error can be tricky.

A good first step in fixing formulas is learning to understand Excel's error messages. When you see a number sign (#) followed by some text, rather than the expected result, your formula contains some kind of error.

Profit	
3235	
2874.2	
160	
6346	
118.6	
2882	#NAME?

**#NAME?** Means that you entered something in your formula that Excel interprets as an

incorrect cell reference, range, or function name.

- #REF!** Indicates that you might have relocated or deleted a cell that is referenced in the formula.
- #VALUE!** Tells you that you are probably using text in a formula when another argument (probably a number) is required.
- #DIV/0!** Occurs when you divide a number by zero or divide by a reference to an empty cell. Remember, division by zero is mathematically undefined.
- #NUM!** Can occur when you try to pass an incorrect argument, like text, to a function that is expecting a numerical value.
- #####** Means that a number is too wide to be displayed in the cell. Double-click the column separator to resolve this error.

When you see an error message, make sure that the cell with the message is the active cell, and carefully examine the cell contents in the formula bar.



If you cannot find the error based on Excel's error message, try to trace the precedent cells or dependent cells of the formula in question by using the formula auditing buttons. When you locate these cells, examine them for typing mistakes or incorrect cell references. Use the kind of error message you are getting as a clue for what you are looking for (i.e. division by zero or text being used in an equation).

Try to examine the contents of every cell involved in the formula to make sure that the data types (number, text) are appropriate. Remember, you can still have an error in your formula even if you do not get an error message. The formula may produce a numerical result as expected, but the result is incorrect. If this happens, examine the mathematics of your formula. Did you place the parentheses in the right places? Are you using the right functions? Are you using the right mathematical operators?

Finally, try to avoid errors by planning out long and complex formulas before you enter them. We will come back to the topic of correcting errors in the practice exercise, where you will troubleshoot an incorrect formula step by step.

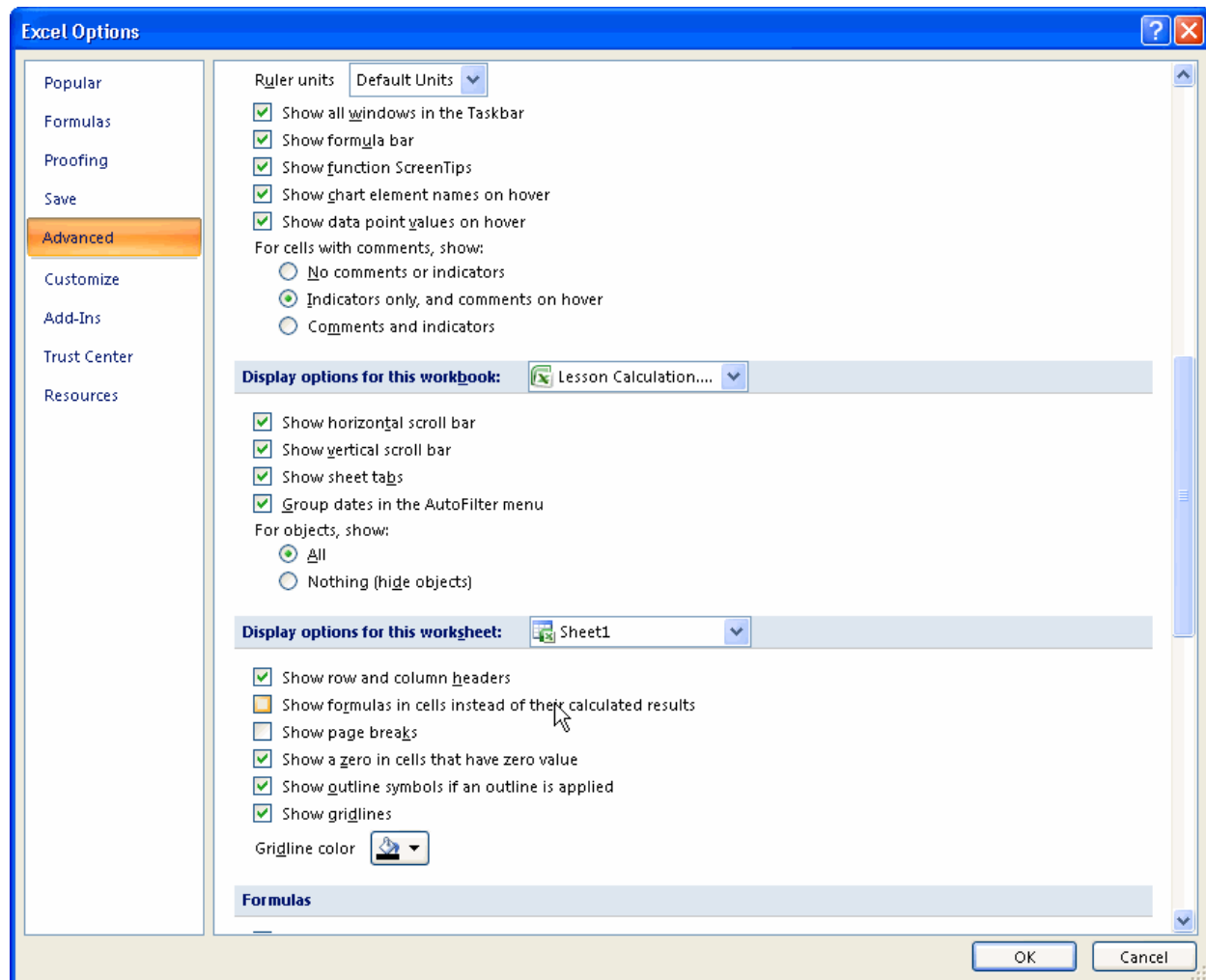
## Displaying and Printing Formulas

By default, Excel 2007 will show the results of a formula rather than the formula itself in a cell.

G2		 =D2-(B2*E2+F2)					
	A	B	C	D	E	F	G
1		Items Sold	Price	Total Sales	Cost per Item	Overhead	Profit
2	Region1	400	10.5	4200	2.3	45	3235
3	Region2	356	10.5	3738	2.3	45	2874.2

Notice that the formula is visible in the formula bar, but you see only the result (3235) in the cell (G2) containing the formula. If this worksheet is printed you will see only numerical results in the cells, and not formulas.

If you wish to see formulas in your printouts, Excel provides a way to display formulas in cells so they will be printed. To do this, display the Excel Options window by clicking the Excel Options button under the Office menu. When you see the Excel Options window, click the Advanced option from the panel on the left, and use the scroll bar to scroll the large viewing area on the right down to the Display Options for this Worksheet.



Then, check the “Show formulas in cells instead of their calculated results” option.

If you click the OK button in the lower right of the window, you will now see formulas in the cells instead of the formula results.

	A	B	C	D	E	F	G
1		Items Sold	Price	Total Sales	Cost per Item	Overhead	Profit
2	Region1	400	10.5	=B2*C2	2.3	45	=D2-(B2*E2+F2)
3	Region2	356	10.5	=B3*C3	2.3	45	=D3-(B3*E3+F3)
4	Region3	25	10.5	=B4*C4	2.3	45	=D4-(B4*E4+F4)
5	Region4	780	10.5	=B5*C5	2.3	50	=D5-(B5*E5+F5)
6	Region5	23	10.5	=B6*C6	2.3	70	=D6-(B6*E6+F6)
7	Region6	360	10.5	=B7*C7	2.3	70	=D7-(B7*E7+F7)

You can also use the Show Formulas button on the Formula Auditing button group.

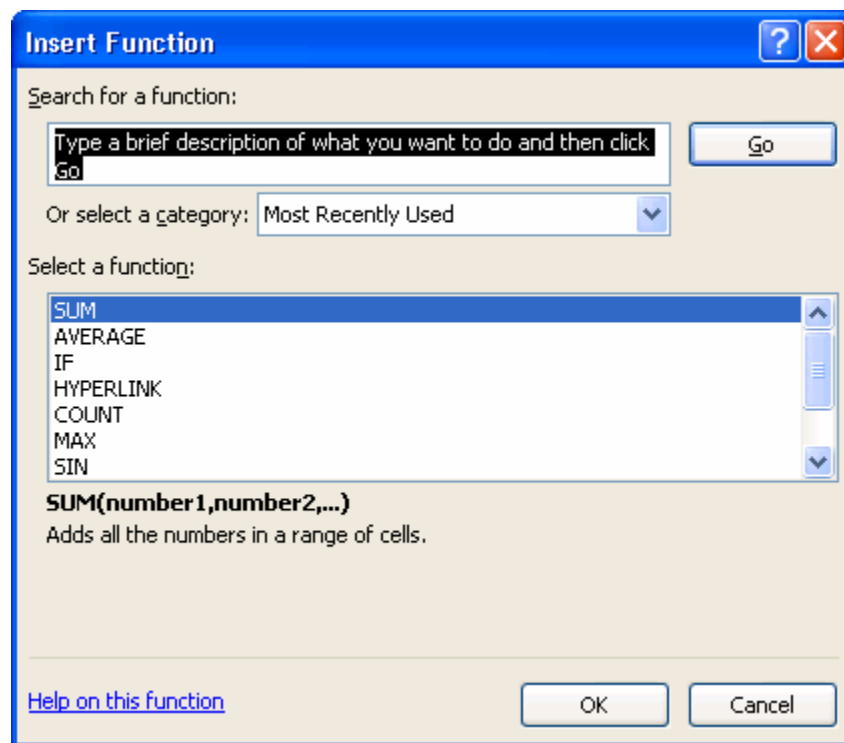
If you proceed to print this spreadsheet, the formulas will be printed in the cells instead of the formula results.



## Lesson 1.2: Exploring Excel Functions

Functions are an important feature in Excel. They allow you to complete complex or tedious mathematical tasks without having to create elaborate formulas. Excel's built in functions can do a lot of heavy calculation and data manipulation for you. Excel has such a wide variety of functions available, you can probably find an appropriate function or combination of functions for almost any situation.

In this lesson you will learn what functions are and how to find the function you need. You will also explore some common Excel functions, and then practice using the sum and average functions.



### What are Functions?

In Excel, a function can be described as a built in tool for performing mathematical or logical tests. Quite often, you may need to perform operations in your worksheets that involve many cells, like totaling a lengthy column of numbers or averaging a large group of data. When dealing with financial data, you might have to evaluate loan amortizations or future values. In statistical applications, you might have to determine the standard deviation or variance for a group of numbers. Excel's functions can help you with all of these tasks.

Functions can also be used to perform searches for specific values or to perform operations based on conditions that you set.

Operations that are complex and involve many cell references can be difficult or even impossible to implement with basic arithmetic formulas. Thankfully, Excel provides a wide range of built in functions that help make even very complex or repetitive calculations easy.

Excel's functions are broken down into the following categories. Under each heading is a list of some of the more common functions that belong to that category.

### **Financial Functions**

These functions perform common financial tasks, like finding future values, calculating loan payments, calculating depreciation, and finding interest paid over a time period.

<b>Function</b>	<b>Description</b>
DB	Finds the depreciation of an asset based on the fixed declining balance method.
DDB	Finds the depreciation of an asset using the double declining balance method.
FV	Calculates a future value based on constant payments and constant interest rate.
IPMT	Finds the interest payment based on constant payments and interest rate.
ISPMT	Finds the interest paid on an investment over a specific period.
NPER	Finds the number of periods for an investment based on constant interest and payments.
NPV	Calculates the net present value of an investment.
PMT	Calculates loan payments based on a constant interest rate.
PPMT	Calculates the payment on the principle for an investment based on constant payments and interest rate.
PV	Gives the present value of an investment.
RATE	Finds the interest rate per period on a loan or investment.

## Date and Time Functions

These functions provide representations and conversion options for dates and times.

<b>DAY</b>	Returns the number of the day from 1 to 31.
<b>DAYS360</b>	Calculates the number of days between two dates based on 360 day years.
<b>HOUR</b>	Gives the hour as a number from 0 to 23.
<b>MINUTE</b>	Gives the minute as a number from 0 to 59.
<b>MONTH</b>	Gives the month as a number from 1 to 11.
<b>NOW</b>	Gives the current date and time.
<b>SECOND</b>	Gives the second as a number from 0 to 59.
<b>TIME</b>	Converts hours minutes and seconds to an Excel serial number time.
<b>TODAY</b>	Provides the current date.
<b>WEEKDAY</b>	Gives the day as a number from one to seven.
<b>YEAR</b>	Gives the year of a serial number date, from 1900 to 9999.

## Mathematical and Trigonometric Functions

These functions are intended for mathematical calculations that can involve logarithms, trigonometry, rounding, or matrices.

<b>ABS</b>	Gives the absolute value of a number.
<b>ACOS</b>	Calculates the arc cosine of a number in radians.
<b>ASIN</b>	Calculates the arc sin.
<b>ATAN</b>	Calculates the arc tangent of a number in radians.
<b>CEILING</b>	Rounds a number up to the nearest integer.
<b>COMBIN</b>	Calculates the number of possible combinations.
<b>COS</b>	Calculates the cosine of a given angle.
<b>EVEN</b>	Rounds a number up to the nearest even integer.

<b>EXP</b>	Raises the mathematical constant e to a given power.
<b>FACT</b>	Calculates the factorial of a number.
<b>FLOOR</b>	Rounds a number down to the nearest significant number.
<b>INT</b>	Rounds a number down to the nearest integer.
<b>LN</b>	Finds the log to the base e of a given number.
<b>LOG</b>	Finds the log to any given base for a given number.
<b>LOG10</b>	Finds the log to the base 10 for a given number.
<b>MINVERSE</b>	Finds the inverse of a matrix.
<b>MMULT</b>	Returns the product of two matrices.
<b>MOD</b>	Returns the remainder when a given number is divided by another number.
<b>ODD</b>	Rounds a number up to the nearest odd integer.
<b>PI</b>	Gives the value of the mathematical constant Pi to 14 decimal places.
<b>POWER</b>	Raises a given number to a given power.
<b>PRODUCT</b>	Multiplies a series of numbers.
<b>RAND</b>	Generates a random number between 1 and 0.
<b>ROMAN</b>	Converts to roman numerals.
<b>ROUND</b>	Will round a number to a specified number of digits.
<b>ROUNDDOWN</b>	Rounds a number down.
<b>ROUNDUP</b>	Rounds a number up.
<b>SIGN</b>	Will indicate if the number is negative positive or zero.
<b>SIN</b>	Will calculate the sine of an angle.
<b>SQRT</b>	Will calculate the square root of a number.
<b>SUBTOTAL</b>	Gives the subtotal for a list of data.
<b>SUM</b>	Calculates the sum for a range of cells.

<b>SUMIF</b>	Calculates the sum of cells that satisfy a given condition.
<b>SUMPRODUCT</b>	Calculates the sum of the products of corresponding cell ranges.
<b>TAN</b>	Gives the tangent of an angle.
<b>TRUNC</b>	Truncates a floating point number to an integer.

## Statistical Functions

Excel 2007 has a wide range of statistical functions including many that have been improved from previous versions. You can use these functions to find averages, counts, medians, probabilities, standard deviations, and much more. The following is a sample of some of the more common statistical functions in Excel.

<b>AVERAGE</b>	Returns the mean for a range of numbers.
<b>AVERAGEA</b>	Returns the mean for a range of values that might include text or logical values.
<b>BINOMDIST</b>	Gives a probability based on the binomial distribution.
<b>CONFIDENCE</b>	Calculates the confidence interval for a population mean.
<b>CORREL</b>	Calculates the correlation between two ranges of data.
<b>COUNT</b>	Will count the number of cells in a list that contain numbers.
<b>COUNTIF</b>	Will count the number of cells in a list that satisfy a specified condition.
<b>LARGE</b>	Will find the nth largest number in a set of numbers, where n can be any given number.
<b>MAX</b>	Returns the largest number from a range of numbers.
<b>MAXA</b>	Finds the largest value in a set of values that may include text or logical values.
<b>MEDIAN</b>	Finds the median of a range of numbers.
<b>MIN</b>	Finds the minimum number in a range of numbers.
<b>MINA</b>	Finds the minimum number in a range of numerical, text, or logical values.
<b>MODE</b>	Gives the most frequently occurring number in a set of numbers.

<b>PERCENTRANK</b>	Gives the rank of a number as a percentage of the numbers in the range of data.
<b>PERMUT</b>	Calculates the number of permutations for given numbers.
<b>RANK</b>	Gives the rank of a number relative to the other numbers in the dataset based on size.
<b>SMALL</b>	Returns the nth smallest number from a range of numbers for any given n.
<b>STDEV</b>	Gives an estimate of the standard deviation based on a sample.
<b>STDEVP</b>	Calculates the standard deviation for an entire population.
<b>VAR</b>	Will estimate the variance based on a sample.
<b>VARP</b>	Will calculate the variance of an entire population.

### Lookup and Reference Functions

The lookup and reference functions can help you gather information about cell ranges and references and determine the location of specific data elements in a range. Some of the more important lookup and reference functions are:

<b>COLUMN</b>	Finds the column number for a reference.
<b>COLUMNS</b>	Tells you the number of columns in a given range.
<b>HLOOKUP</b>	Finds a specified value in the top row of a range, and from the same column, returns a value from a specified row.
<b>HYPERLINK</b>	Creates a hyperlink to a document stored locally, on your network, or the Internet.
<b>INDIRECT</b>	Returns the value associated with a given text reference.
<b>LOOKUP</b>	Looks up a specified value in a one row or one column range of data.
<b>ROW</b>	Finds the row number for a given reference.
<b>ROWS</b>	Tells you the number of rows in a given range.
<b>VLOOKUP</b>	Finds a specified value in the far left column of a table and returns from the same row, a value from a column you specify.

## Database Functions

Database functions allow you to search for and perform operations on data in a table or list, according to conditions that you specify. Some useful database functions are:

<b>DAVERAGE</b>	Averages values in a column according to conditions you specify.
<b>DCOUNT</b>	Count cells that contain numbers matching conditions you specify.
<b>DGET</b>	Gets a record from an Excel database matching conditions that you specify.
<b>DMAX</b>	Gets the largest number from a column in your Excel database where the number satisfies conditions you specify.
<b>DMIN</b>	Retrieves the smallest number that meets your conditions from a column in the database.
<b>DSUM</b>	Sums numbers in a database that satisfy conditions you specify.

## Text Functions

Text functions help you manipulate individual characters and strings of characters that are entered in a worksheet as text. Some useful text functions are:

<b>CLEAN</b>	Removes all characters that cannot be printed from the text.
<b>CONCATENATE</b>	Joins together strings of text into one larger string.
<b>DOLLAR</b>	Converts a number to currency formatted text.
<b>EXACT</b>	Will test two text strings to see if they are exactly the same.
<b>FIND</b>	Will find the starting location of a string of characters within a larger string.
<b>LEFT</b>	Returns a specified number of characters from the start (left) of a string.
<b>LEN</b>	Gives the number of characters in a text string.
<b>LOWER</b>	Converts any uppercase letters in a string to lowercase.
<b>REPLACE</b>	Will replace a part of a string with another string.
<b>RIGHT</b>	Will give you the specified number of characters from the end or right of a string.

<b>T</b>	Tests if a cell value is text or not.
<b>TEXT</b>	Converts a value to number formatted text.
<b>TRIM</b>	Removes all extra spaces from a text string (spaces between words will stay).
<b>UPPER</b>	Converts a text string to uppercase.

## Logical Functions

The logical functions allow you to perform logical tests and build logical expressions based on the arguments you provide. You can test conditions and proceed according to the result.

<b>AND</b>	Will return the logical value true if all of the arguments you specify are true, and will return a logical value of false otherwise.
<b>FALSE</b>	Will return the logical value false.
<b>IF</b>	Will test if a condition that you set is true, and return a specified value if it is, and another specified value if it isn't.
<b>NOT</b>	Will change logical values from true to false or false to true (not true is false, and not false is true).
<b>OR</b>	Will return a logical value of true if any of the arguments are true and a value of false if both or all arguments are false.
<b>TRUE</b>	Returns the logical value of true.

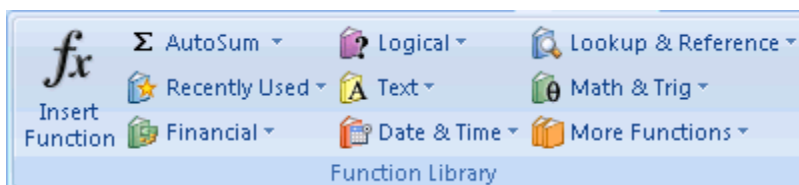


## Information Functions

Information functions can help you gather information about cell values, formatting, errors, and even your current operating environment. Some of Excel's information functions are:

<b>CELL</b>	Provides information on the formatting, location, or contents of the upper left cell in a specified range.
<b>INFO</b>	Provides information about your operating environment.
<b>ISBLANK</b>	Tests if a reference refers to an empty cell.
<b>ISERROR</b>	Will test if a cell value is one of Excel's error messages; you can specify which one.
<b>ISNUMBER</b>	Tests if a value in a cell is a number.
<b>ISREF</b>	Tests if a value in a cell is a reference.
<b>ISTEXT</b>	Tests if a value in a cell is text.
<b>TYPE</b>	Gives a number representing the type of value in a cell (1=number, 2=text, 4=logical value, 16=error, 64= array).

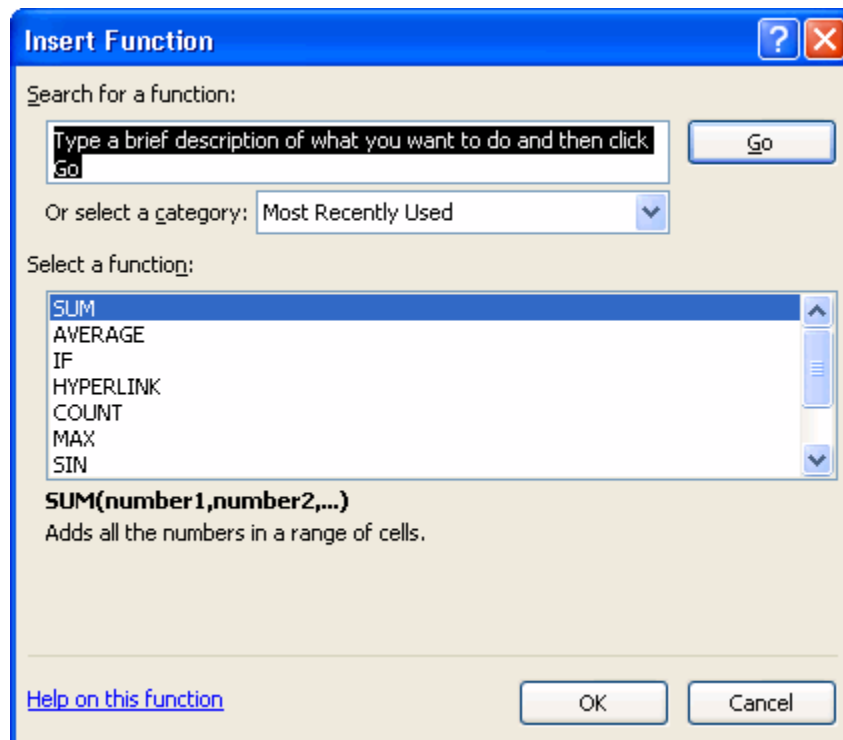
In addition to these function categories, Excel 2007 also provides a selection of Engineering functions, OLAP (On Line Analytical Processing) Cube functions, and Information functions. All of the functions listed here and more can be accessed from the Function Library button group on the Formulas Ribbon.



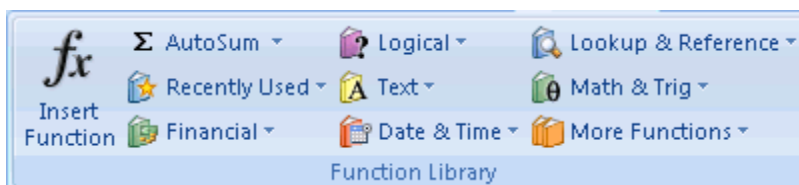
## Finding the Right Function

What do you do if you have to perform a calculation that is mathematically complex or involves a large number of cells? One suggestion is to try and find a function that will perform the calculation for you. Excel 2007 has such a wide variety of built in functions that you are likely to find a function or combination of functions that will solve your problem.

In Excel 2007, you can use the Insert Function dialogue box to help you find the function you need for a given situation.



The Insert Function dialogue box can be displayed by clicking the Insert Function button from the Function Library button group.

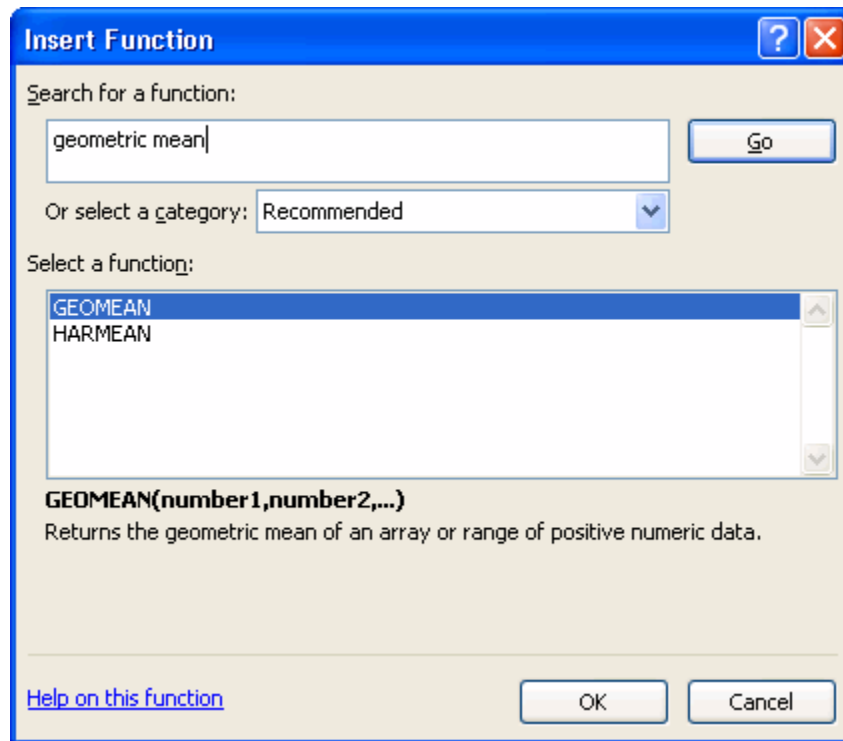


You can also click the small fx button next to the formula bar to display the Insert Function box.

You will notice that the Insert Function box has a drop list of function categories next to the words Select a category. When you select a category that seems appropriate for your given situation, you will see a list of possible functions in the Select a Function area.

If you select a function, an example of the function and its parameter list will be shown in bold near the bottom of the dialogue box. You will also see a brief description of the function that you have selected. For additional help on using the selected function you can click the blue text link (Help on This Function) to open a help window with more links and information.

If you type a function name or a description of what you are trying to do, in the Search for a function field, you can then click the GO button to have Excel search through its library of functions to find one that may suit your purposes.



If you think you need a function in your worksheet, consider the context of the data and the work you are doing. For example, if you are working with monetary data, you may be looking for a financial function or a function like sum that will total columns or rows. If you are analyzing scientific data or survey results, it is possible that you may be looking for a statistical function. If you are building complex formulas based on engineering specifications, you might require a function from the Math and Trig category or from the Engineering category. If you need to extract data from a table based on certain conditions, explore the Lookup or Database functions.

Remember, the functions that you use most frequently will be available in the Recently Used category.

If there is no single function that suits your needs, consider combinations of functions. Perhaps you require an average of sums or a maximum of averages. If need be, you can even include and combine functions with your formulas.

## Some Useful and Simple Functions

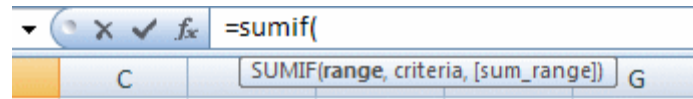
It is probably a good idea to become familiar with some basic but useful Excel functions. You are probably already familiar with Excel's AutoSum feature, which applies a sum function automatically to a row or column that you select. One useful variation on the idea of sums is the SUMIF function. You would use the SUMIF function if you wanted to add all the numbers in a column or row that met a certain condition.

	A	B
1		Profit/Loss
2	Month1	30000
3	Month2	34000
4	Month3	38000
5	Month4	42000
6	Month5	46000
7	Month6	41500
8	Month7	37000
9	Month8	32500
10	Month9	28000
11	Month10	23500
12	Month11	19000
13	Month12	-3000
14	Month13	-5000
15	Month14	1000
16	Month15	1204
17	Month16	1408
18	Month17	1612
19	Month18	-500
20	Month19	1450
21	Month20	-1000
22	Month21	12000
23	Month22	25000
24	Month23	38000

In this worksheet, we may want to find the total losses for a 24 month period. A loss for the month is indicated with a negative number.

To find the total losses, you would select a cell (let's say B27) and enter `=SUMIF (B2:B25,"<0")` into the formula bar and press enter. This tells Excel to sum the numbers in cells B2 through B25 only if they are less than zero (<0). Notice that the condition "<0" is entered in the function inside quotation marks and that the function's arguments (the range and the condition) are separated by a comma.

When you type the name of a function followed by an opening parenthesis in the formula bar, a small information box will appear giving you a clue as to how to specify arguments for the function.



When you have to enter a cell range in the function, you can type it manually. Or, you can put your cursor in the position in the formula bar where the range is to be typed, and select the desired range with your mouse. Remember, a function requires an equal sign (=) in front of it, just like a formula.

Another useful function is the Average function. If you wanted to find the average of your monthly profits, you could select a cell (like B28) and enter =AVERAGE (B2:B25) in the formula bar. This will compute the average profit and display it in cell B28.

You can tell at a glance that the largest profit was 46000. It is easy to see this because there are only 25 rows of data. If there were 2500 rows of data, finding the maximum by visual inspection would be difficult. Excel provides a function to help with this kind of situation. If you select a cell, B29 for example, and enter the function =MAX (B2:B25), the maximum profit for the specified range will be displayed in the cell.

Now suppose you wanted to find the number of months with a profit that was greater or equal to 20,000. To do this, you could select a cell (let's say B30) and enter =COUNTIF(B2:B25,">=20000") in the formula bar. The COUNTIF function will only count the data if the condition is satisfied. The number of entries that are greater than or equal to 20,000 will be displayed in the cell. Notice that the condition ">=20000" was entered into the function in quotation marks.

## Lesson 1.3: Using Functions in Excel

This lesson will continue on from the ideas introduced in lesson 1.2, and look at Excel functions in a little more depth. Once you get comfortable using functions, you will be surprised at how much you can improve your worksheets. Your options for analyzing data and automating calculations will expand, allowing you to take your worksheets to a higher level.

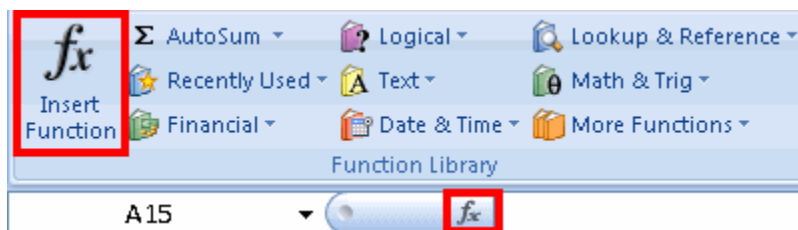
In this lesson you will learn more about Excel's Insert Function feature. In addition, you will become familiar with conditional if functions and explore the concept of nested functions. You will also examine the binomial distribution function as an example of how Excel can help you handle complex statistical calculations. In the practice exercise you will go step by step through the process of creating nested If functions.

Remember, you can use the fx symbol to invoke the Insert Function dialogue.

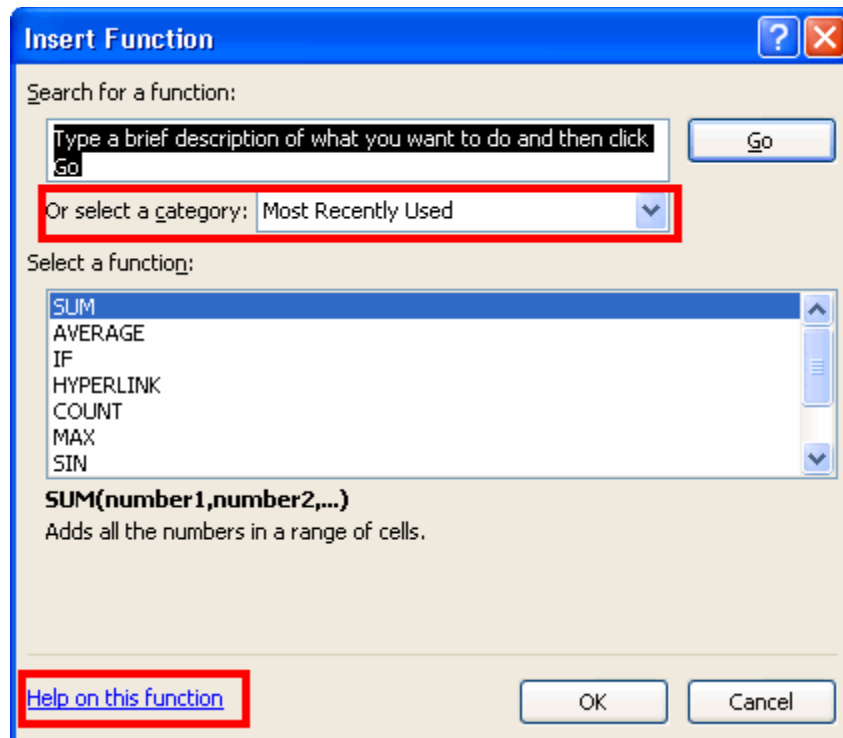


### Inserting Functions

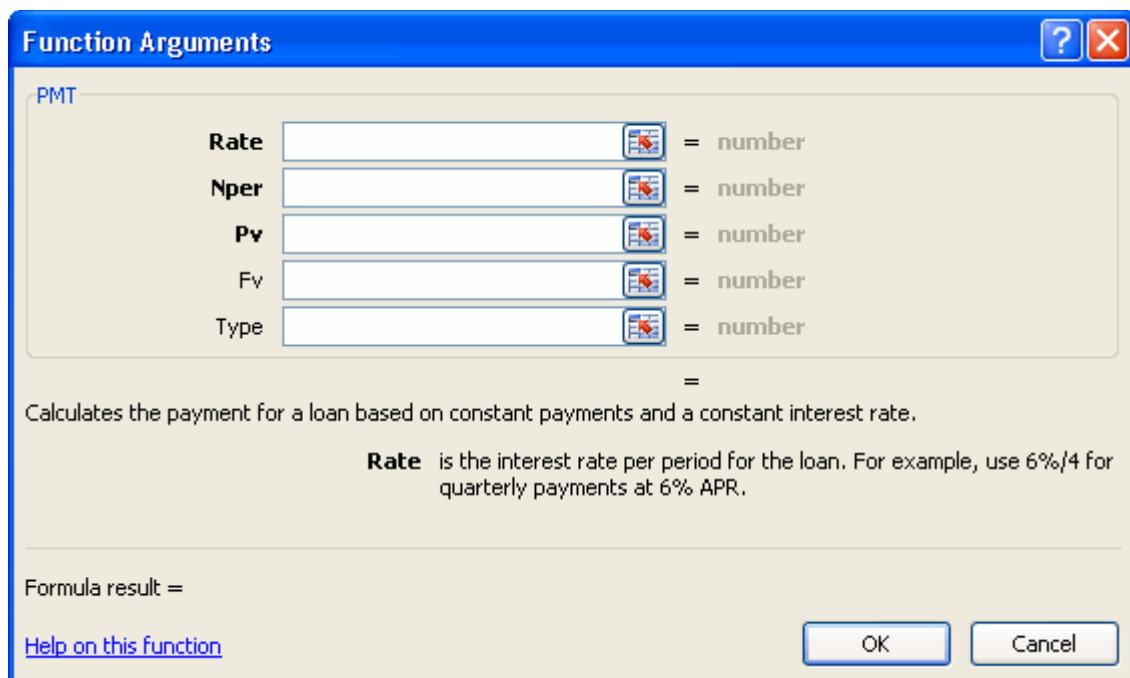
The first step in inserting a function is to choose a cell to contain the function result. Once you select a cell, display the Insert Function dialogue box by clicking the fx button next to the formula bar. You can also choose the Insert Function button from the Formulas Ribbon.



As discussed in lesson 1.2, the Insert Function dialogue box lets you select functions by category via a drop down list. The Help on This Function link is also available if you need clarification on the use of a selected function.



Once you choose a function you can click OK to move to the next step: the Function Arguments box.



For this example the PMT function has been selected from the financial category. The PMT function will calculate the payment amount for a loan based on the arguments you provide.

In the upper part of the box, you will see a series of text fields, one for each possible argument to the function. If you click on an argument field, a brief description of the argument will appear at the bottom of the dialogue box. In the previous image, you can see the description for the Rate argument.

You can also see argument names to the left of the argument fields. The ones in bold type (Rate, Nper, and Pv) are required arguments. As for the arguments without bold type names, Excel 2007 will enter a default value when required if the argument fields are left empty.

You can enter raw data directly onto the argument fields, or if the data is stored in your worksheet, you can type the appropriate cell references. You can also click on an argument field and then click on the cell that contains the data to enter it without typing. You can navigate between fields in the dialogue box by pressing the Tab key.

The image shows the 'Function Arguments' dialog box for the PMT function in Excel. The title bar is blue with a question mark and a close button. The main area is light beige. At the top left, 'PMT' is written in blue. Below it, there are five argument fields with labels to their left: 'Rate' (bold), 'Nper' (bold), 'Pv' (bold), 'Fv', and 'Type'. Each field has a small icon to its right. To the right of each field is an equals sign followed by a value. Below the fields, there is a description of the function and a detailed description of the 'Rate' argument. At the bottom, there is a 'Formula result' field and two buttons: 'OK' and 'Cancel'. A link 'Help on this function' is also present.

Argument	Value	Default/Description
Rate	C6/12	= 0.75
Nper	B7	= 43
Pv	D16	= 50000
Fv		= number
Type		= number

Calculates the payment for a loan based on constant payments and a constant interest rate.

**Rate** is the interest rate per period for the loan. For example, use 6%/4 for quarterly payments at 6% APR.

Formula result = (\$37,500.00)

[Help on this function](#)

OK Cancel

Here you can see the completed PMT function arguments. Cell references for the cells that contain the data can be seen in the argument fields. The raw data itself can be seen just to the right of the argument fields. The Rate field contains C6/12 because the payments are to be made monthly, requiring us to divide the yearly rate of 6% (in C6) by 12 for a monthly rate. The monthly payment of \$430.33 will be visible in the cell that was selected to contain the formula.

This process lets us insert functions into a worksheet without having to manually type them. The resulting function is exactly the same as if we typed =PMT (C6/12, B7, D16, 0) directly into the formula bar. By using the Insert Function feature, you do not have to worry about



parentheses and commas. You can also clearly see the argument descriptions and how many arguments are required.

## Using Functions and AutoFill to Perform Difficult Calculations

Excel's binomial distribution function is a good example of how Excel can make complex calculations easier.

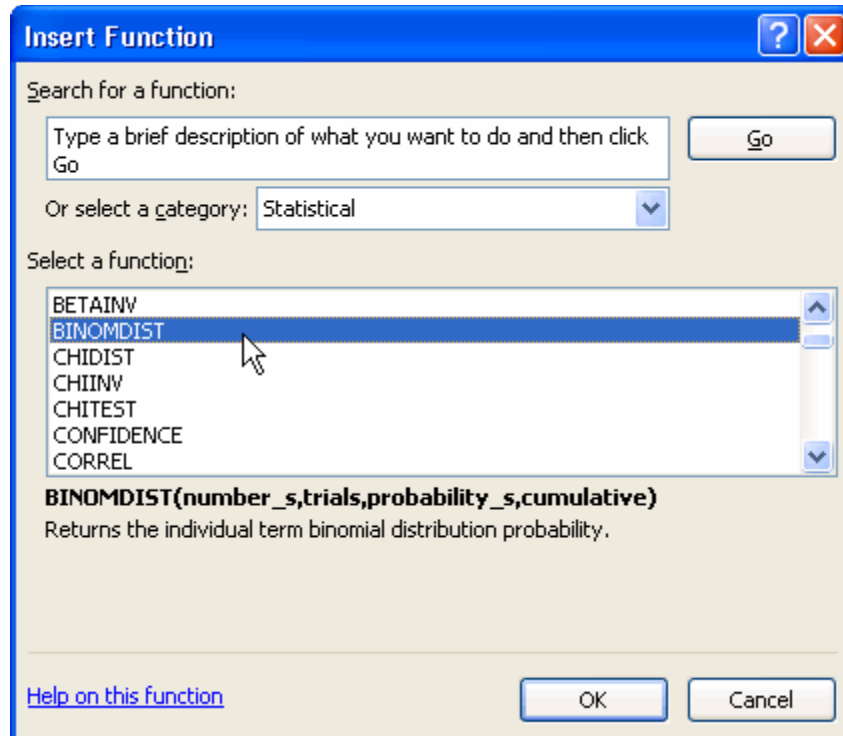
	A	B	C	D	E
1	Assembly Line				
2					
3	Event	Probability of Event	Number of Failures	Number of runs	Probability of getting C failures in D trials
4	Product fails	0.1	1	10	
5			2	10	
6			3	10	
7			4	10	
8			5	10	
9			1	50	
10			2	50	
11			3	50	
12			4	50	
13			5	50	
14					

Probability calculations, like those involving the binomial distribution, can be difficult and tedious to perform manually. With Excel 2007 you can perform complex statistical calculations like this with just a few simple steps.

The binomial distribution function is used to calculate the probability of a certain number of events in a given number of trials. Let's say, for example, that you have a computer assembly line. If you know that each computer that comes off the line has a 10% (.1) chance of failing to work, you could use the binomial distribution function to find the probability of getting exactly one failure, or exactly two failures, and so on, in a given number of runs of the assembly line. (Each run builds one computer.)

In the example worksheet shown above, the event of getting a failure has been assigned a probability of .1 (10% chance for a single run of the assembly line). To find the chances of getting exactly one failure (no more or no less) in 10 runs, we should use the BINOMDIST function.

To start, you would select cell E4 and invoke the Insert Function dialogue box by clicking the function button (fx) next to the formula bar. The next step is to select the BINOMDIST function from the statistical category and click OK.



When the Function Arguments box is displayed, click the first argument field in the box (Number\_s) and then click on cell C4 to enter the number of successes (in this case, a success is when the computer fails to work) we are looking for.

To continue, you would click the next argument field, Trials, and then click the cell representing the number of assembly line runs, D4. Next, you would select the Probability argument field, and click cell B4 to assign a probability of .1 to the function. In the final Cumulative argument field, you would type False, because we want the chances of getting exactly one failure (no more or no less). After you enter your selections, the Function Arguments box should look like this.

Function Arguments

?

✕

BINOMDIST

Number\_s

C4

= 1

Trials

D4

= 10

Probability\_s

B4

= 0.1

Cumulative

False

= FALSE

= 0.387420489

Returns the individual term binomial distribution probability.

Cumulative

is a logical value: for the cumulative distribution function, use TRUE; for the probability mass function, use FALSE.

Formula result = 0.387420489

[Help on this function](#)

OK

Cancel

You can see that the probability of getting exactly one failure in 10 runs of the assembly line is around .3874. Clicking OK would make this result visible in cell E4.

Once you have a result in E4, you can AutoFill down to E13 and the function will calculate the probabilities accordingly for each cell in the column. (Notice that the 0.1 probability of failure has been entered in each cell of column B).

	A	B	C	D	E
1					
2		Assembly Line			
3	Event	Probability of Event	Number of Failures	Number of runs	Probability of getting C failures in D trials
4	Product fails	0.1	1	10	0.387420489
5		0.1	2	10	0.193710245
6		0.1	3	10	0.057395628
7		0.1	4	10	0.011160261
8		0.1	5	10	0.001488035
9		0.1	1	50	0.028632084
10		0.1	2	50	0.077942897
11		0.1	3	50	0.13856515
12		0.1	4	50	0.180904501
13		0.1	5	50	0.184924601
14					

This demonstrates how you can perform multiple complex calculations easily, by using a built in function and the AutoFill feature.

## Using the IF Function

Excel's IF function can often prove to be very useful. You can use this function to branch to different values or actions depending on a specified condition. The structure of an If function is as follows: IF (logical test, value if true, value if false)

IF functions are called conditional functions because the value that the function returns will depend on whether or not a specific condition is satisfied. As an example, consider the following function: IF (A1=10, 5, 1)

This function states that if cell A1 has a value of 10 the cell that contains the function will have the value of 5. But if A1 doesn't have a value of 10, the cell that contains the function will have a value of 1. In other words, the function reads: if A1 equals 10 then return the number 5, else, return the number 1.

Let's say that this next IF function is entered into cell B2: IF (A1<=100, A1\*.5, C3\*2)

This function states that if the contents of cell A1 is less than or equal to 100, the value in cell B2 will be the value in A1 multiplied by .5; else, the value in B2 will be the value of cell C3 multiplied by 2.

You can insert an IF function by invoking the Insert Function dialogue and looking under the Logical category, or by typing it directly into the formula bar.

The logic of the IF function can be a little confusing until you get used to it. The best way to get comfortable with IF functions, is to practice using them.

## Working with Nested Functions

In Excel, you can actually place (or nest) a function within a function. Look at the following worksheet as an example.

E7		fx		=AVERAGE(SUM(B2:B6),SUM(C2:C6),SUM(D2:D6))					
	A	B	C	D	E	F	G	H	
1		Type1	Type2	Type3					
2		22	1	100					
3		34	45	4					
4		56	7	6					
5		78	8	45					
6		98	23	0					
7		288	84	155	175.6667				

By looking in the formula bar, you can see that the average function for cell E7 contains three sum functions (the sums of the three type columns). This means that the value in E7 is the average of the sums of columns B, C, and D.

The following function is also possible:

```
=AVERAGE(SUM(B2:B6),SUM(C2:C6),SUM(AVERAGE(B2:B6),AVERAGE(C2:C6),AVERAGE(D2:D6)))
```

Notice that this function has 3 average functions nested within a sum function, which is in turn nested in another average function. This may seem confusing, but if you carefully step through the function from right to left, it becomes clear. The average of range D2:D6, the average of C2:C6, and the average of B2:B6, are summed together. This sum is then averaged with the sum of C2:C6 and the sum of B2:B6 for a final result.

In terms of nested functions, nesting averages within sums and sums within averages is probably not that practical; however, nested IF functions can be extremely useful for a wide variety of situations.

This IF function has two additional IF functions nested inside.

```
=IF(A1<100, A1*1.5,IF(A1<200, A1*2,IF(A1<300, A1*1.5,A1*3)))
```

Start at the left and examine each IF statement carefully. The first IF tests to see whether the value in cell A1 is less than 100. If it is, the result of this function will be the value of A1 multiplied by 1.5. If the value in A1 is equal to or greater than 100, the test condition will be false, and the second value will come into play. In this case, the second value is a nested IF function that tests whether the value in A1 is less than 200. If it is, the value in A1 multiplied by 2 will be the result of the function. If the value in A1 is greater than or equal to 200 the third IF function will be used. This function tests whether the value in A1 is less than 300. The value in A1 will be multiplied by 1.5 if it is less than 300, and multiplied by 3 if it is greater than or equal to 300.

In the practice exercise, you will develop this kind of nested IF function and apply it in a practical way. Remember, when nesting functions always make sure that there are as many closing parentheses as there are opening parentheses.

## Lesson 1.4: Working with Names and Ranges

Working with numbers isn't always easy. A complex formula involving several cell ranges can be difficult to understand. Individual cells that contain important data can be hard to find on a large worksheet. Cell references like D5:D22 or A33:C33 are somewhat abstract, and don't really communicate anything about the data they contain.

In Excel, you can create meaningful names for cells or ranges that can be used to overcome these difficulties.

In this lesson you will learn what range names are and how to define and use them. You will learn about nonadjacent ranges and you will become familiar with Excel's powerful AutoCalculate features.

Average: 36062.5    Count: 8    Numerical Count: 8    Min: 23500    Max: 46000    Sum: 288500

### What Are Range Names?

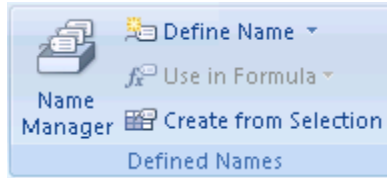
Range names are meaningful character strings that you can assign to individual cells or cell ranges. You can use a range name practically anywhere you can use a cell or range reference. The advantage of using names comes from the fact that a name, like Employees, is more meaningful and less abstract than a reference like C2:C55. Also, named ranges are by default absolute, so if you copy or AutoFill a formula using named ranges, it will maintain its original cell references.

fx =totalsales-totalexpenses			
C	D	E	F
	Profit		
	-1000		

Range names will make formulas much more readable and they will make it easier to find and reference individual cells. When you are first designing your worksheet, you can create formulas using names instead of traditional cell references, and then define the names for the corresponding ranges of data as required. Basically, using range names in your worksheet improves clarity, improves organization, and aids in the overall design.

### Defining and Using Range Names

To define a range name, select either a cell or cell range and choose the Define Name button from the Defined Names button group on the Formulas Ribbon.



This will display the New Name dialogue box.

 The 'New Name' dialog box is shown with a blue title bar and standard window controls. It contains four main sections:
 

- Name:** A text input field that is currently empty.
- Scope:** A dropdown menu set to 'Workbook'.
- Comment:** A large text area for adding a comment, currently empty.
- Refers to:** A text field containing the formula reference '=Sheet1!\$B\$4:\$B\$10'. To the right of this field is a small icon for selecting a range.

 At the bottom are 'OK' and 'Cancel' buttons.

In the New Name box, you will see the reference to the cell or range you selected in the bottom text field. This is the reference that will be associated with the name you choose. To name your range, type a name in the top text field and click OK. (If you wish, you can also add a comment to be associated with your new named range.) The Scope refers to the parts of the workbook where your named range will be valid.

Another way to name a cell or range is to select it, type the name in the name box on the formula bar, and press Enter.

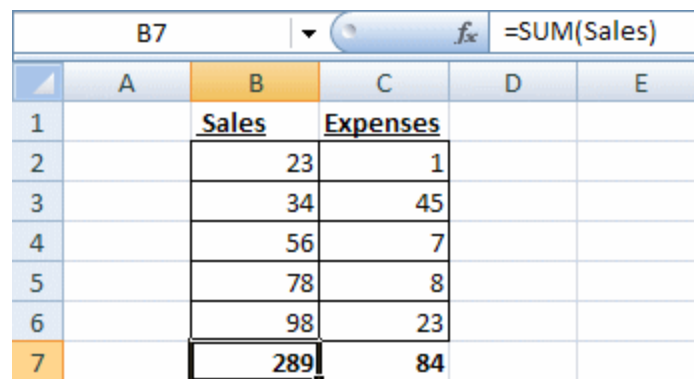
NewRange		
	A	B
1		30000
2	Month1	34000
3	Month2	38000
4	Month3	42000
5	Month4	46000
6	Month5	41500
7	Month6	37000

In this example, the cells B1 to B6 were selected and the name NewRange was entered into the name box. (If you click the down pointing arrow just to the right of the name box, you will display a list of range names used in the spreadsheet.)

Excel will not accept spaces between words in the names you choose. For example, “newrange” or “newRange” would be acceptable, but “New Range” would not.

Once you have defined your named ranges, you can use them in formulas and functions just as you would a regular cell or range reference.

As an example, if you named a range of figures Sales, and you named another range of data Expenses, you could calculate the total sales or total expenses by entering the function =SUM(sales) or =SUM(expenses) respectively.



	A	B	C	D	E
1		<u>Sales</u>	<u>Expenses</u>		
2		23	1		
3		34	45		
4		56	7		
5		78	8		
6		98	23		
7		289	84		

In the above image, notice the function =SUM (sales) in the formula bar. This will produce the same result as =SUM (B2:B7).

Using names for ranges and cells in this way makes your formulas and functions much clearer. When you want to enter a range in a formula or function, it is much easier to remember and type the name of the range, rather than specific cell references.

For example, = (TotalSales-TotalExpenses) is a more meaningful formula than = (B2-C2), Similarly, =AVERAGE(Height) is more meaningful than =AVERAGE(B2:B100).

## Selecting Nonadjacent Ranges

Excel makes it easy to select nonadjacent ranges. This technique is useful if you want to format a number of nonadjacent ranges and cells the same way, or if you want to define a single name for many non adjacent cells. Selecting nonadjacent ranges is also helpful when using AutoCalculate.

To select non adjacent ranges, press and hold the Ctrl (control) button as you select the first range. Keep holding the Ctrl button as you select each additional non adjacent range or cell with your mouse. The normal rules of mouse dragging to select a range and clicking to select cells apply. When you are finished, you should have multiple ranges or cells shaded in blue.



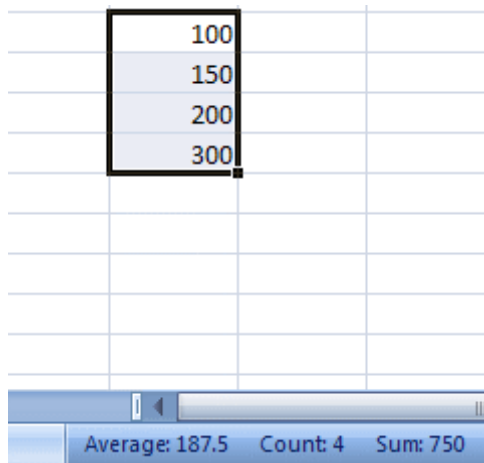
	A	B	C	D	E	F
1			Sales	Expenses	Profit	
2			1000	23	977	
3			200	24	176	
4			230	24	206	
5			450	24	426	
6		Totals	1880	95	1785	
7						

You can format the multiple selections all at once by clicking a formatting button on the Home Ribbon, or you can give them a defined name.

### Using AutoCalculate

AutoCalculate is an Excel feature that lets you see the results of some basic calculations without having to enter a formula or function. This can be used for quick calculations that you don't want to enter into the worksheet, or even for troubleshooting simple formula errors. (Is my formula result the same as the AutoCalculate result?)

To use AutoCalculate, just select a range of cells with some numerical data in it.

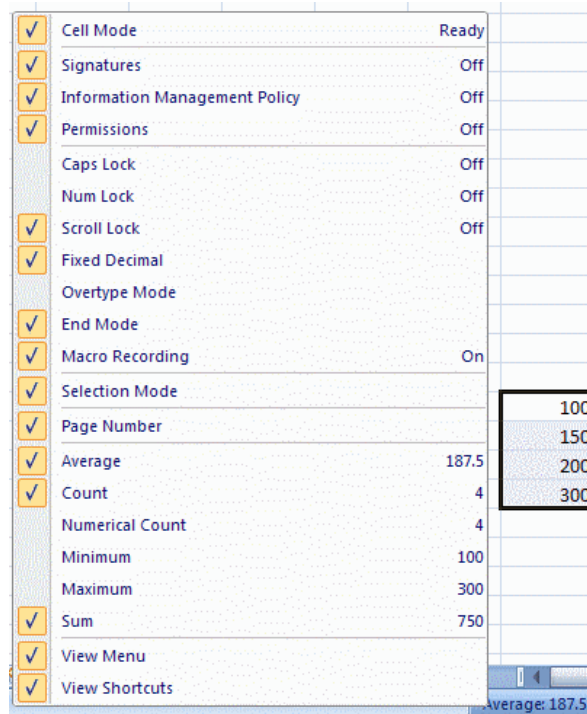


100
150
200
300

Average: 187.5 Count: 4 Sum: 750

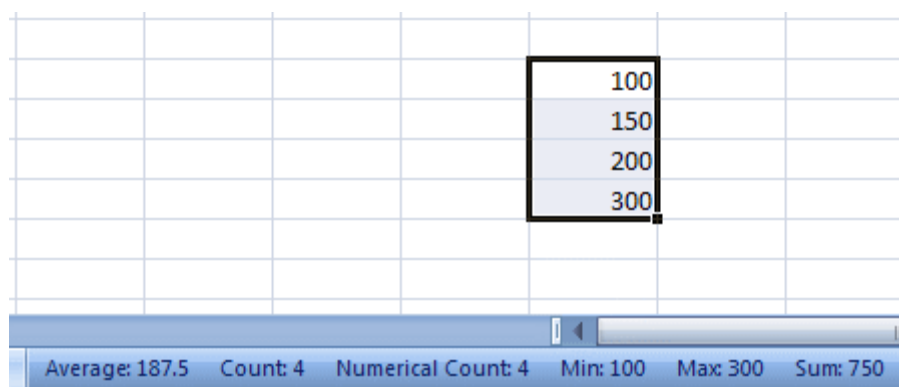
You can see the Sum, Count, and Average of your selection in the status bar at the bottom of the Excel 2007 screen.

If you right click on the status bar, you will see a menu of AutoCalculate options.



You can now place a check mark next to the calculation that you want AutoCalculate to perform when you select a range. For example, you can find the minimum or maximum of a selection by using Min and Max. You can get a count on the number of cells that you have selected by checking the Count option, or you can get a count of the number of cells in your selection that contain numbers by checking the Numerical Count option. The Sum and Average options will calculate the sum or average of your selection respectively.

In this image, the numerical count, min, max, sum, count, and average calculations have all been activated.



You can also use the AutoCalculate feature with nonadjacent ranges or cell selections. This is a topic that will be explored further in the practice exercise.

## Lesson 1.5: Working with Array Formulas

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As you have already seen, Excel 2007 puts an impressive variety of formulas and functions at your disposal. There is still another powerful and flexible mathematical tool available that we have not yet explored: array formulas.

In this lesson you will learn what array formulas are and how to use them. You will learn how to combine array formulas with Excel 2007 functions, with an emphasis on using array formulas with the IF function.

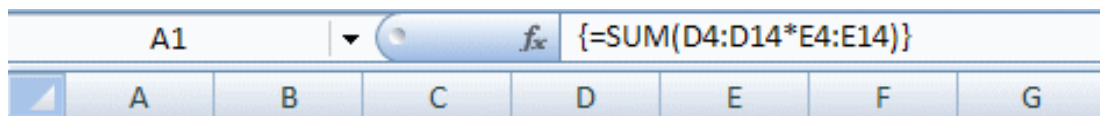
### What are Array Formulas?

You have already worked with standard formulas, functions, and cell references. Now it is time to explore the subtle but powerful concept of array formulas.

In Excel, an array can be described as a grouping of two or more cells. If you make a selection of empty cells on a worksheet, type some text or a number in one of the cells and press Ctrl + Shift + Enter at the same time, you will see the value you just typed in appear in every cell in the selection. When you press Ctrl + Shift + Enter, Excel will treat the selection as a single entity or array. When a selection is defined as an array, operations are performed on every cell in the selection rather than on just a single cell. You can perform operations involving corresponding cells in a number of ranges using array formulas. This is a powerful technique that can be used to enhance Excel formulas and functions.

If you enter a formula involving selections of multiple cells, and press Ctrl + Shift + Enter, Excel will automatically place curly braces { } around the formula. This means that Excel will treat this formula as an array formula.

Note that you cannot type the curly braces manually to create array formulas: they must be created by pressing Ctrl + Shift + Enter. Some people even refer to array formulas as CSE (Control Shift Enter) formulas.



### Using Basic Array Formulas

Using array formulas is fairly straightforward once you understand the basic concepts. An important thing to remember is that you should select arrays of the same size to use in array

formulas (same number of rows and columns). Array formulas that involve cell ranges (arrays) of different sizes will not work.

Take the following worksheet as an example of a basic array formula.

	A	B	C	D	E	F
1			<b>Numbers</b>			
2			110	210	44	
3			133	211	53	
4			362	212	62	
5			355	213	71	
6			136	108	80	
7			83	75	89	
8			30	42	98	
9			23	9	107	
10			76	24	116	
11			129	57	125	
12			182	90	134	
13			235	123	143	
14			288	156	152	
15			341	189	161	
16			394	222	170	
17						

Here we have a simple group of numbers, made up of 15 rows by 3 columns of data. Let's say that you want another block of numbers the same size, containing each of the original numbers divided by 3 and increased by 100.

To do this, you could select a block of cells the same size as the original and type the formula `=C2:E16 /3 +100` into the formula bar, being sure to press Ctrl + Shift + Enter after the formula has been typed.

G2		fx {=C2:E2/3+100}								
	A	B	C	D	E	F	G	H	I	J
1			<b>Numbers</b>							
2			110	210	44		136.6667	170	114.6667	
3			133	211	53		136.6667	170	114.6667	
4			362	212	62		136.6667	170	114.6667	
5			355	213	71		136.6667	170	114.6667	
6			136	108	80		136.6667	170	114.6667	
7			83	75	89		136.6667	170	114.6667	
8			30	42	98		136.6667	170	114.6667	
9			23	9	107		136.6667	170	114.6667	
10			76	24	116		136.6667	170	114.6667	
11			129	57	125		136.6667	170	114.6667	
12			182	90	134		136.6667	170	114.6667	
13			235	123	143		136.6667	170	114.6667	
14			288	156	152		136.6667	170	114.6667	
15			341	189	161		136.6667	170	114.6667	
16			394	222	170		136.6667	170	114.6667	

You can see that each number in the original block has been divided by three and added to 100 before being entered into the second block. You can also see the curly braces around the formula displayed in the formula bar. Every time you enter or edit an array formula you must press Ctrl + Shift + Enter to ensure that Excel recognizes it as an array formula.

In the following example we have two columns of numbers, C2:C16 and E2:E16. Note that both columns of numbers are the same size. You can select a third column of the same size, type the formula =C2:C16\*E2:E16, and press Ctrl + Shift + Enter.

G2				fx {=C2:C16*E2:E16}				
	A	B	C	D	E	F	G	H
1			Numbers					
2			110		44		4840	
3			133		53		7049	
4			362		62		22444	
5			355		71		25205	
6			136		80		10880	
7			83		89		7387	
8			30		98		2940	
9			23		107		2461	
10			76		116		8816	
11			129		125		16125	
12			182		134		24388	
13			235		143		33605	
14			288		152		43776	
15			341		161		54901	
16			394		170		66980	
17								

Each cell in the first column will be multiplied by the corresponding cell in the second column, with the result being displayed in the third column.

Take note of the curly braces around the formula displayed in the formula bar. If you only pressed Enter, the curly braces would not be added, and Excel would not recognize the ranges as arrays. As a result, you would only see the value of the first two cells multiplied together, 4840, in the cell G2.

When entering your formula into the formula bar, you can select the ranges in the formula with your mouse rather than typing them directly. Also, any changes made to the source data will be recalculated and automatically updated in the area containing the formula results. Always remember to press Ctrl + Shift + Enter if you want to enter an array formula. If you press Enter by mistake, just click on the cell containing the formula, press the F2 key, and then press Ctrl + Shift + Enter.

## Using Functions with Array Formulas

Suppose you want to take the average or sum of a large block of numbers after every number in the block has been multiplied by a constant. You can easily combine functions and arrays to perform this kind of operation.

First, select a single cell for the result of the function (assuming the function will return a single result). Enter the function as you would normally, and select the cell ranges that you need. When you have done this, instead of pressing Enter, use Ctrl + Shift + Enter.

As an example, the worksheet on the following page calculates the average area of a circle based on a table of many cells, each containing a number representing the radius of a circle. You can calculate the area of a circle by multiplying the square of the radius by the mathematical constant PI. The formula reads: `{=AVERAGE(C2:F15^2*PI ())}`

In this formula, C2:F15 is the range of cells containing the data. The ^2 raises each cell value (radius) to the second power. The \* PI () part multiplies the squared radius with the Excel PI function. The AVERAGE function calculates an average result. Finally, the curly braces { } enclose the entire function, letting Excel know that this formula involves an array, and that the mathematical operations are to be performed on each cell in the specified range.

The result of all this is that each and every number in the range C2:F15 will be squared and multiplied by PI and then averaged together for a final result.

H2		fx {=AVERAGE(C2:F15^2*PI())}								
	A	B	C	D	E	F	G	H	I	J
1				Radius				Array		Non array
2			10	10	10	10		2640.789		#VALUE!
3			10	10	10	43				
4			10	22	10	10				
5			10	10	2	11				
6			10	10	10	10				
7			10	10	5	10				
8			10	10	10	19				
9			198	10	10	12				
10			10	10	10	10				
11			10	10	10	6				
12			10	10	10	10				
13			14	10	10	12				
14			10	10	10	10				
15			14	10	10	3				
16										

You can see the formula for cell H2 in the formula bar. The formula uses the AVERAGE function, a calculation involving a nested PI function [ $^2*PI()$ ], and is enclosed in {}, making it an array formula. (Note: The parentheses are required after the text PI for Excel to recognize it as the PI function.)

The next image shows the formula in cell J2 which is identical to the previous formula except for the lack of curly braces. The formula is not an array formula and causes an error.

J2		fx =AVERAGE(C2:F15^2*PI())								
	A	B	C	D	E	F	G	H	I	J
1				Radius				Array		Non array
2			10	10	10	10		2640.789		#VALUE!
3			10	10	10	43				
4			10	22	10	10				
5			10	10	2	11				
6			10	10	10	10				
7			10	10	5	10				
8			10	10	10	19				
9			198	10	10	12				
10			10	10	10	10				
11			10	10	10	6				
12			10	10	10	10				
13			14	10	10	12				
14			10	10	10	10				
15			14	10	10	3				

Array formulas let you perform mathematical or logical operations with corresponding cells in two or more ranges of the same size. Additionally, array formulas allow you to perform mathematical or logical operations on every cell in a selected range. You can also combine array formulas and functions together to solve awkward problems. As a matter of fact, there are times when using array formulas may be the only solution for a tricky situation.

### Using the IF function in Array Formulas

A very interesting and useful way of working with array formulas, is to combine them with Excel's IF function. Remember, the IF function works like this:

IF (test condition, value if test is true, value if test is false)

To begin, suppose you have two cells, B4 and C4, and we construct an IF function as follows.

=IF(B4=C4,B4, 0)

This function will test if the content of cell B4 is the same as the content of cell C4. If they are the same, the value in cell B4 will be returned. If they are not equal, a value of zero will be returned.

Now suppose we use ranges of cells (arrays) instead of individual cells.

=IF(B4:B14=C4:C14, B4:B14, 0)

If we make this an array formula (Ctrl + Shift +Enter), the IF function will return the value in the B4:B14 array whenever that value is equal to the corresponding value in the C4:C14 array. When the values are not equal, zero will be returned.

The next step is to combine this with a Sum function in the following way.

{=Sum(IF(B4:B14=C4:C14,B4:B14,0))}

If we make this an array formula, the function will basically step through both ranges (arrays) row by row, and sum the values that are returned from the IF function.



F14		fx {=SUM(IF(B4:B14=C4:C14,B4:B14,0))}					
	A	B	C	D	E	F	G
1							
2							
3		Array1	Array2				
4		1	8				
5		2	8				
6		3	8				
7		4	4				
8		5	5				
9		3	7				
10		4	6				
11		4	5				
12		4	4				
13		12	12			Sum of common values	
14		11	13			25	
15							

The values returned from the If function are 0, 0, 0, 4, 5, 0, 0, 0, 4, 12, 0, for a result of 25.  
(You can see the array formula for the active cell in the formula bar.)

Now, if we edit the formula to read {=Sum (IF (B4:B14=C4:C14, 1, 0))}, the IF function will return a one every time there are matching numbers, and a zero otherwise. The sum of these ones and zeros will result in a count of the matching items in both arrays.

F14		fx {=SUM(IF(B4:B14=C4:C14,1,0))}					
	A	B	C	D	E	F	G
1							
2							
3		Array1	Array2				
4		1	8				
5		2	8				
6		3	8				
7		4	4				
8		5	5				
9		3	7				
10		4	6				
11		4	5				
12		4	4				
13		12	12			Count of common values	
14		11	13			4	

As another example of what can be done with array formulas, suppose we have a worksheet like the following.

	A	B	C	D
1		<b>Name</b>	<b>Department</b>	<b>Hours worked</b>
2		Stella	Accounting	12
3		Mike	Communications	8
4		Kevin	Marketing	8
5		Wally	Human Resources	8
6		Stacy	Accounting	10
7		Clair	Marketing	7
8		Janet	Marketing	4
9		Stella	Accounting	8
10		Janet	Marketing	8
11		Wally	Human Resources	4
12		Mike	Communications	8
13		Janet	Marketing	9
14		Kevin	Marketing	2
15		Mike	Communications	10
16		Janet	Marketing	8

If you wanted to find out how many hours Janet worked, you could create the following array formula.

`{=SUM(IF(B2:B16="Janet",D2:D16,0))}`

This formula will step through the arrays B2:B16 and D2:D16, returning the value in D2:D16 every time the name in B2:B16 equals Janet, and zero otherwise. The returned values will be summed in cell F2 for a total of 29.

F2		fx {=SUM(IF(B2:B16="Janet",D2:D16,0))}				
	A	B	C	D	E	F
1		<b>Name</b>	<b>Department</b>	<b>Hours worked</b>		<b>Janet</b>
2		Stella	Accounting	12		29
3		Mike	Communications	8		
4		Kevin	Marketing	8		
5		Wally	Human Resources	8		
6		Stacy	Accounting	10		
7		Clair	Marketing	7		
8		Janet	Marketing	4		
9		Stella	Accounting	8		
10		Janet	Marketing	8		
11		Wally	Human Resources	4		
12		Mike	Communications	8		
13		Janet	Marketing	9		
14		Kevin	Marketing	2		
15		Mike	Communications	10		
16		Janet	Marketing	8		

## Section 1: Review Questions

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- 1. A formula with relative cell references will...**
  - A. Possibly have a different result if it is AutoFilled or moved to a new location
  - B. Always have the same result
  - C. Be impossible to move or copy
  - D. Never cause a #DIV/0 error
- 2. In Excel, a function is...**
  - A. What you choose with the Formula button on the Home Ribbon
  - B. A built in formula to perform mathematical or logical operations
  - C. Another name for a user defined range
  - D. An Excel database connection
- 3. To calculate the total of a column of adjacent cells, you could use...**
  - A. The SUM function
  - B. The BINOMDIST function
  - C. The AVERAGE function
  - D. There is no function for calculating column totals.
- 4. The Average Function calculates the...**
  - A. Arithmetic mean
  - B. Geometric mean
  - C. Exponential mean
  - D. Median
- 5. A trigonometric function would be found in**
  - A. The financial group of functions
  - B. The statistical group of functions
  - C. The logical group of functions
  - D. None of the above
- 6. Which of the following statements is not true?**
  - A. Range names can be used in formulas
  - B. Range names can be used in functions
  - C. Range names are defined by clicking the Range button on the Insert Ribbon
  - D. Range names make formulas easier to understand

- 7. You can select nonadjacent ranges by...**
- A. Using the Nonadjacent button on the Home Ribbon
  - B. Using Paste Special
  - C. Pressing the Ctrl button when selecting with the mouse
  - D. None of the above
- 8. AutoCalculate is...**
- A. A function in the database group of functions
  - B. An Excel 2007 feature that will multiply large cell ranges quickly
  - C. A feature of Excel that will display the sum or count or average of a selection of cells
  - D. A and B
- 9. To enter a formula as an array formula you must...**
- A. Press Ctrl + Shift + Enter
  - B. Type Array= before the rest of the formula
  - C. Select multiple ranges of different sizes
  - D. Press F2
- 10. An array formula can...**
- A. Perform operations with multiple cell ranges of the same size
  - B. Be used with functions to perform calculations involving more than one range
  - C. Only A
  - D. A and B