

Excel: Functions and Data Analysis Tools



Instructional Services at KU Libraries
A Division of Information Services

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Abstract: This workshop focuses on the functions and data analysis tools of Microsoft Excel. Topics included are the functions such as AVERAGE and SUM, and data analysis tools such as pivot tables and conditional summations.

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Introduction

Microsoft Excel consists of three basic parts: its spreadsheet, chart, and list management utilities. Using a single set of data, these separate utilities can work together or individually. This workshop concentrates on inserting and using functions and other data analysis tools.

Objectives

The goal of this workshop is to introduce participants to the more complex features of Excel. After today's workshop participants will be able to:

- define terms related to using functions
- create and edit a function
- identify add-in functions
- perform data analysis using Data Analysis Tools
- create a formula with the Conditional Sum wizard
- learn to troubleshoot a formula

Prerequisites

It is assumed that the participants in this workshop have either taken the *Excel: Data Management* workshop or have equivalent skills.

Related Training Available from Instructional Services

All workshops offered by Instructional Services are free to KU students, staff, faculty, and [approved affiliates](#).

To learn more about or register for workshops, receive automatic announcements of upcoming workshops, and track workshops you've registered for and have attended, visit www.lib.ku.edu/instruction/workshops. For further workshop related questions, please email training@ku.edu.

Definitions

Term	Definition																		
Formula	A formula is an equation that performs a calculation on data in your worksheet. Formulas calculate simple values such as addition or multiplication, or more complex values using Excel's built-in <i>functions</i> . In Excel, all formulas begin with an equal sign (=) and are followed by any valid combination of data, references, operators, or built-in functions.																		
Formula syntax	Formula syntax is the required structure or order of <i>formula</i> elements. All formulas begin with an equal sign (=) followed by operands (the data to be calculated) and operators. Operands can be values that don't change (constants), range references, labels, names, or built-in <i>functions</i> .																		
Formula bar	The formula bar is the area located at the top of the worksheet window that is used to enter or edit values or <i>formulas</i> in cells. The formula bar displays the constant value or formula in the active cell. To display or hide the formula bar, click Formula Bar on the View menu.																		
Order of precedence	<p><i>Formulas</i> are calculated left to right, using order of precedence rules, unless the use of parentheses changes the order of calculation.</p> <p style="text-align: center;">Example: = 10+10*4 or = (10+10)*4</p> <p>Excel performs operations in the order shown in the following table. If a formula contains operators with the same order of precedence, Excel evaluates the operators from left to right. For example, if you enter the formula = 7 + 7 - 5, the calculation is performed left to right since both + and - have the same precedence. If you enter the formula = 7 + 7 * 5, Excel performs the multiplication first since * has a higher precedence than +.</p> <p>To change the order of evaluation, enclose the part of the formula to be calculated first in parentheses.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th data-bbox="776 1381 889 1413">Operator</th> <th data-bbox="915 1381 1062 1413">Description</th> </tr> </thead> <tbody> <tr> <td data-bbox="500 1444 889 1476">: (colon), (comma) (single space)</td> <td data-bbox="915 1444 1159 1476">Reference operators</td> </tr> <tr> <td data-bbox="876 1497 889 1528">-</td> <td data-bbox="915 1497 1133 1528">Negation (as in -1)</td> </tr> <tr> <td data-bbox="863 1549 889 1581">%</td> <td data-bbox="915 1549 1013 1581">Percent</td> </tr> <tr> <td data-bbox="873 1602 889 1633">^</td> <td data-bbox="915 1602 1094 1633">Exponentiation</td> </tr> <tr> <td data-bbox="808 1665 889 1696">* and /</td> <td data-bbox="915 1665 1224 1696">Multiplication and division</td> </tr> <tr> <td data-bbox="802 1717 889 1749">+ and -</td> <td data-bbox="915 1717 1208 1749">Addition and subtraction</td> </tr> <tr> <td data-bbox="867 1770 889 1801">&</td> <td data-bbox="915 1770 1159 1801">String Concatenation</td> </tr> <tr> <td data-bbox="672 1833 889 1864">=, <, >, <=, >=, <></td> <td data-bbox="915 1833 1062 1864">Comparison</td> </tr> </tbody> </table>	Operator	Description	: (colon), (comma) (single space)	Reference operators	-	Negation (as in -1)	%	Percent	^	Exponentiation	* and /	Multiplication and division	+ and -	Addition and subtraction	&	String Concatenation	=, <, >, <=, >=, <>	Comparison
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
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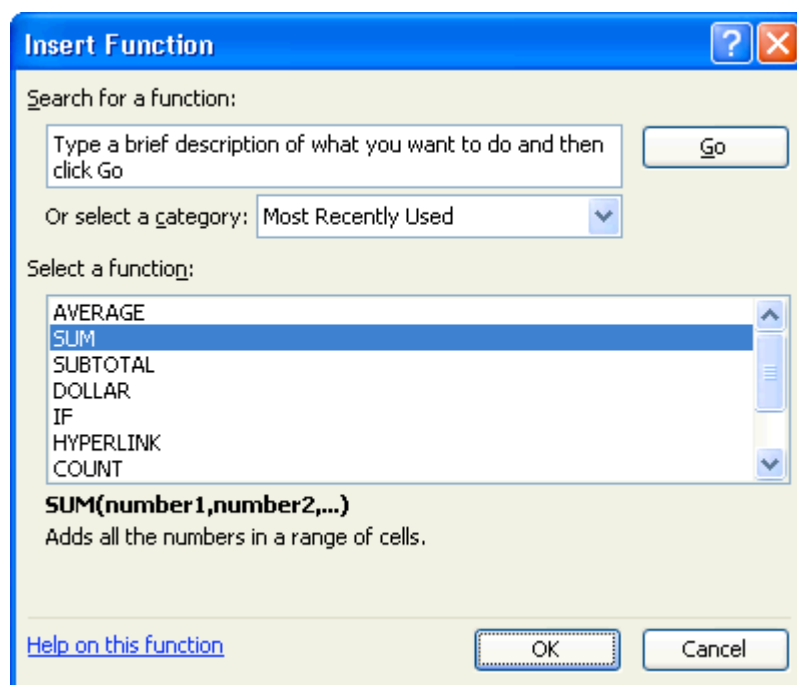
Function	<p>A function is a predefined <i>formula</i> that performs calculations by using specific values in a particular order. The values used in the function are called <i>arguments</i>, and these arguments must appear in a specific order. For example, the AVERAGE function calculates the average of its arguments.</p>
Arguments	<p>Arguments can be numbers, text, logical values such as TRUE or FALSE, arrays, error values such as #N/A, dates and times, or cell references. The argument you designate must produce a valid value (i.e., if the <i>function</i> is expecting a number, text is not a valid value for that argument). Arguments can also be <i>formulas</i> or other functions.</p>
Function syntax	<p>The syntax of a <i>function</i> begins with the function name, followed by an opening parenthesis, the <i>arguments</i> for the function separated by commas, and a closing parenthesis. If the function starts a <i>formula</i>, an equal sign (=) should be placed before the function name.</p> <p>Example: SUM(D2:F8)</p> <p>In the above example, the function name is SUM and the argument for the function is the range D2:F8.</p>
Function Arguments window	<p>The Function Arguments window helps you create or edit a <i>function</i> and also provides information about functions and their <i>arguments</i>.</p>
Add-ins	<p>Add-ins are programs that provide optional commands and features. To make an add-in available, you must first install the add-in and then load it. Once an add-in is loaded, it is available within Excel. Add-ins might place additional commands on Excel menus.</p> <p>Add-ins use a lot of memory, so unload add-ins you do not use often. Unloading an add-in only removes its features and commands from Excel, it does not delete the add-in. An add-in that has been unloaded can be reloaded since it remains on your computer.</p> <p>A list of all add-ins automatically installed with Excel is available in the online help. On the Help menu, click Microsoft Excel Help and enter Add-in programs included with Excel.</p> <p>You can also use Visual Basic programs as custom add-ins.</p>

Inserting Functions

The **Insert Function** dialog box is designed to help in the construction and use of the various built-in functions and their arguments.

To insert a function:

1. Select the cell in which you want the results of the function to display.
2. Click the **Insert Function** button on the **Formula Bar** () or select **Insert > Function** in the menu. The **Insert Function** dialog box appears.
3. Choose the function you wish to use by either
 - Typing a description of the function and clicking **Go**, or
 - Selecting a function category from the drop-down menu.



The Insert Function dialog box

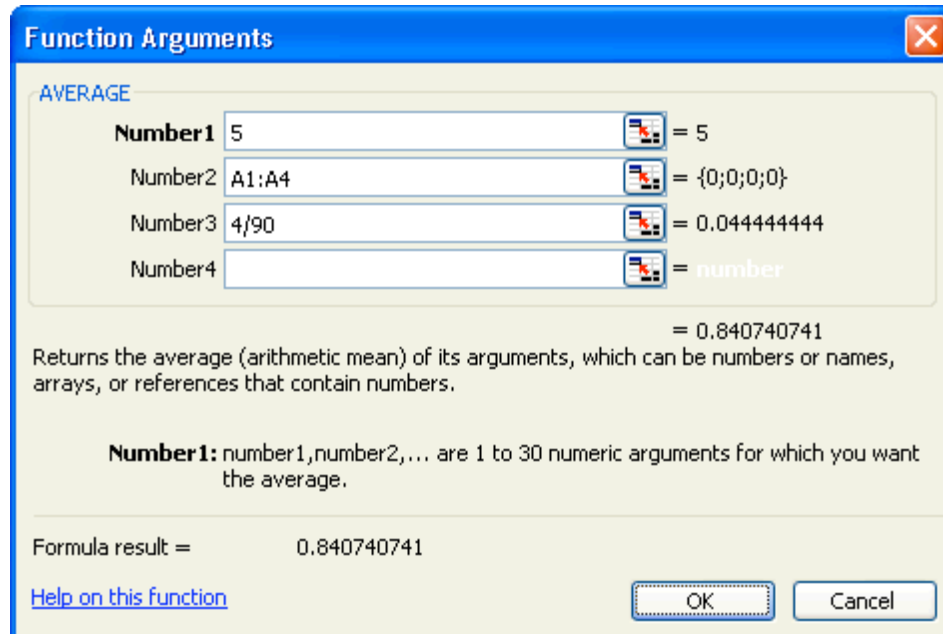
4. Double-click the name of the function, or click the function and click **OK**.
5. The **Function Arguments** dialog box appears. Some things to note about it include:
 - When you click in the blank field beside each argument name, a description of that argument appears at the bottom of the window. A description of the function itself also appears.
 - Each argument can be a constant value (i.e., a number), a reference to another cell or range, or the result of another formula.
 - Some functions have a predefined number of arguments, while others can have a variable number of arguments. For those functions that can take a variable

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number of arguments, Excel automatically provides you with a blank field for an additional argument after each argument you add.

- The value of each individual argument is calculated and displayed to the right of the argument's input field, and the overall result of the function is displayed at the bottom next to **Formula result** =.



The Function Arguments window for the AVERAGE function. Note that the three arguments entered take the form of a number, a range reference, and a formula result, respectively. The value of each argument is displayed to the right of its input field.

6. Fill in the arguments. To select ranges on your worksheet, click  beside the appropriate field. Excel collapses the **Function Arguments** window so that you can click and drag to select the correct range on your worksheet. To return to the expanded **Function Arguments** window, click  or press Return.
7. Click **OK**. The **Function Arguments** window closes and returns you to your worksheet with the results in the active cell. The formula appears in the **Formula Bar**.

Sample Functions

CONCATENATE

The CONCATENATE function joins several text strings into one text string. The “&” operator can be used instead of CONCATENATE to join text items.

Syntax

CONCATENATE(text1,text2,...)

Arguments

Text1, text2, ... are 1 to 30 text items that are joined into a single item. The text items can be text strings, numbers, or single-cell references.

Notes

CONCATENATE("Instructional Services ","at ","KU Libraries") is equivalent to "Instructional Services at KU Libraries". (Note the extra space after "Instructional Services" and "at". It is important to note that **CONCATENATE** does not insert spaces for you.) If cell A2 contains "Instructional Services " and B2 contains "at " then **CONCATENATE(A2,B2,"KU Libraries")** is equivalent to " Instructional Services at KU Libraries".

COUNT

Counts the number of its arguments that contain numbers.

Syntax

COUNT(*value1,value2,...*)

Arguments

Value1, value2, ... are 1 to 30 arguments that can contain or refer to a variety of different types of data, but **only** numbers are counted. (Excel treats dates and times as numbers, so they will be counted.)

COUNTA

Counts the number of cells that are not empty. Use **COUNTA** to count the number of cells that contain data in a range or array.

Syntax

COUNTA(*value1,value2,...*)

Arguments

Value1, value2, ... are 1 to 30 arguments representing the values you want to count. In this case, a value is any type of information, including empty text ("") but not including empty cells.

COUNTBLANK

Counts empty cells in a specified range of cells. Cells with formulas that return "" (empty text) are also counted (thus cells with empty text are counted by both **COUNTA** and **COUNTBLANK**). Cells that evaluate to zero are not counted.

Syntax

COUNTBLANK(*range*)

Arguments

Range is the range of cells in which you want to identify blank cells.

COUNTIF

Counts the number of cells within a range that meet the given criteria

Syntax

COUNTIF(*range, criteria*)

Arguments

- *Range* is the range of cells in which you want to count cells.
- *Criteria* is a string that must be satisfied for the cell to be counted. Some examples:
 - **123456** or "**123456**" counts a cell only if it contains *exactly* 123456.
 - "**>123456**" counts a cell only if its contents are *greater than* 123456.
 - "**enrolled**" counts a cell only if it contains *exactly* the text *enrolled*.

VLOOKUP

In general, lookup functions are used to look up data in a list and return a corresponding value. VLOOKUP (vertical lookup) is one of several lookup functions, but since data is generally organized in columns, VLOOKUP is used frequently.

Syntax

VLOOKUP(*lookup_value, table_array, col_index_num, range_lookup*)

Arguments

- *Lookup_value* is the value to be found in the first column of the table array. The *lookup_value* can be a value, a reference, or a text string.
- *Table_array* is the table of information in which data is looked up. If you create a range name like List or Sales_Table, it is easy to copy the function without losing your reference to the table range. Otherwise you will need to use absolute addressing in specifying the table. The values in the first column of *table_array* can be text, numbers, or logical values.
- *Col_index_num* is the column number in the *table_array* from which the matching value must be returned. For example, a *col_index_num* of 2 returns the value in the second column in *table_array*. If *col_index_num* is less than 1, VLOOKUP returns the #VALUE! error value; if *col_index_num* is greater than the number of columns in *table_array*, VLOOKUP returns the #REF! error value.
- *Range_lookup* is a logical value that specifies whether you want VLOOKUP to find an exact match or an approximate match. If the *range_lookup* argument is omitted (and thus treated as TRUE), an approximate match is

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returned. If an exact match is not found, the next largest value that is less than *lookup_value* is returned. If *range_lookup* is FALSE, VLOOKUP will find an exact match and if an exact match is not found, the error value #N/A is returned.

Notes

If *range_lookup* is TRUE, the values in the first column of *table_array* must be placed in ascending order, otherwise VLOOKUP may not give the correct value. If *range_lookup* is FALSE, *table_array* does not need to be sorted.

Example

	A	B	C	D	E	F	G	H	I
1	table_array				lookup_value				
2	Sales Level	Bonus Rate		Rep	Sales	Bonus			
3	\$0	0%		Fred	23000	=VLOOKUP(E3,table_array,2,TRUE)			
4	\$10,000	4%		Mary	24000	0.06			
5	\$20,000	6%		Beth	16000	0.04			
6	\$30,000	8%		John	25000	0.06			
7	\$40,000	12%		Dave	32000	0.08			
8				Janet	30000	0.08			

Using the VLOOKUP function

Using the above image as an example, the VLOOKUP formula is placed in the **Bonus** column in the table on the right.

The **Sales** column is the *lookup_value* and, from the table on the left, the **Sales Level** column and the **Bonus Rate** column comprise the *table_array*, since you want to determine what rate should be paid for corresponding sales.

The *col_index_num* is 2 since the rate that you want to report is in the second column of the *table_array*. The *range_lookup* is TRUE because we don't need to match the sales exactly; in such a case, you can omit the *range_lookup* or type TRUE. Note that since the **Sales** value does not match the **Sales Level** exactly, the table on the left must be sorted by the **Sales Level** column in ascending order.

Add-In Commands and Functions

An *add-in* is a set of commands or functions that, once loaded, appears to be a part of the Excel program. Add-in commands or functions may be user-created macros or those included with Excel. Some Excel add-ins are automatically loaded when Excel is installed; the user loads others. Not all add-ins are automatically loaded because add-ins use a lot of memory.

Loading an Add-In

Once an add-in is loaded, it is always available until you unload it. To load an add-in,

1. On the **Tools** menu, click **Add-Ins**. The **Add-Ins** dialog box appears.
2. In the **Add-Ins available** list, click the checkbox next to the add-in you want to load. If the add-in you want to use is not listed, click **Browse** and then locate the add-in. If the add-in is not installed on your computer, you must install it.

3. Click **OK**.

Unloading an Add-In

Unloading add-ins that you don't use can save memory since all loaded add-ins are always loaded into memory when Excel is opened.

1. On the **Tools** menu, click **Add-Ins**.
2. In the **Add-Ins available** list, *clear* the checkbox next to the add-in you want to unload.
3. Click **OK**.

When you unload an add-in, it is *not* deleted from your computer.

Data Analysis Tools

Histogram

The Analysis ToolPak is one of several add-ins available with Excel. Its data analysis tools are used in the collection, organization, and interpretation of numeric data. A *histogram* is one tool in the Analysis ToolPak that shows how frequently values occur in each numeric interval of a specified range.

Setting Up the Data

A histogram counts how many of the values in a range (input range) fall within specified numeric intervals (bins). For example, in a group of people, you could determine the distribution of ages within age categories.

You need to set up your worksheet before running the **Histogram** data analysis tool. You need to specify the following:

- The *input range*: the range of values to analyze.
- The *bin range*: the range of cells that contain a set of boundary values. The bin range is optional. If you omit the bin range, the Histogram tool creates a set of evenly distributed bins between the data's minimum and maximum values. However, because these bin intervals may have little relation to your data, or the type of analysis you are looking for, it is recommended that you create your own bins.
- The *output range*: an area to display the histogram.

Input Range

In the example below, the **Age** column is the input range since this is the column of data to analyze.

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	A	B	C	D
1	Names	Age		Bin
2	Brown	23		20
3	Zeller	16		30
4	Smith	45		40
5	McGrath	33		50
6	Jefferson	29		60
7	Jones	55		
8	Whitehead	48		
9	Mancusi	21		
10	Yashima	38		
11	Winters	19		
12	Maher	51		
13	Griffin	28		

Bin Range

In the example above, the bin range contains the age intervals. When setting up a histogram, make sure the intervals for the bin range are specified in ascending order.

Output Location

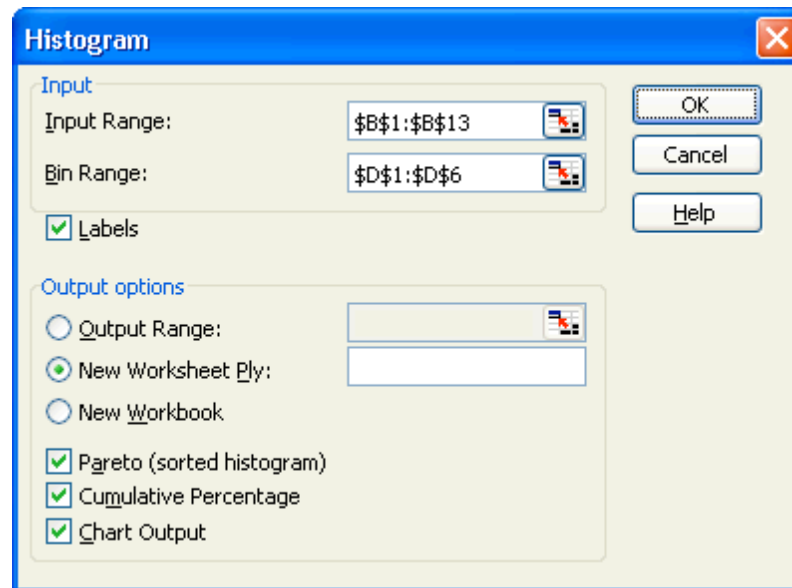
The results of the distribution can be placed in an area on the current worksheet, on another worksheet within the same workbook, or in another workbook.

Creating the Histogram

Before accessing the Histogram tool, make sure your worksheet is set up properly. See *Setting Up the Data*, above.

To create a histogram:

1. Choose **Data Analysis** from the **Tools** menu
2. Select **Histogram** from the **Analysis Tools** list in the **Data Analysis** dialog box.
3. Click **OK** to display the **Histogram** dialog box.



The Histogram dialog box

4. Enter the range of cells to analyze in the **Input Range** box.
5. Enter the bin range in the **Bin Range** box. If you omit the bin range, Excel creates a set of evenly distributed bins between the data's minimum and maximum values.
6. Specify the output location. See *Output Options*, below.

Output Options

Output Range

Enter the reference for the upper-left cell of the output table. The size of the output area is automatically determined and Excel displays a message if the output table might overwrite existing data.

New Worksheet Ply

Click to insert a new worksheet in the current workbook and paste the results starting at cell A1 of the new worksheet. You can name the worksheet by typing a name in the input area after selecting **New Worksheet Ply**.

New Workbook

Click to create a new workbook and paste the results on a new worksheet in the new workbook.

Other Histogram Options

Labels

Select **Labels** if the first row or column of your input range contains labels. Clear this checkbox if your input range has no labels; Excel generates appropriate data labels for the output table.

Pareto

If the **Pareto** box is checked, the output data table includes the results displayed in descending order of frequency.

Cumulative Percentage

If the **Cumulative Percentage** box is checked, Excel generates an output table column for cumulative percentages. Leave unchecked to omit the cumulative percentages.

Chart Output

Select **Chart Output** to generate an embedded histogram chart with the output table.

Conditional Sum

Use the *Conditional Sum Wizard*, another add-in, to summarize values in a list based on specific conditions. The Conditional Sum Wizard can help you determine the number of records in a table that meet a certain criteria. In the example below, the conditional sum function can determine how many people are on academic probation that transferred from other schools. In this example, there are two criteria that need to be defined and then a sum of those who meet both.

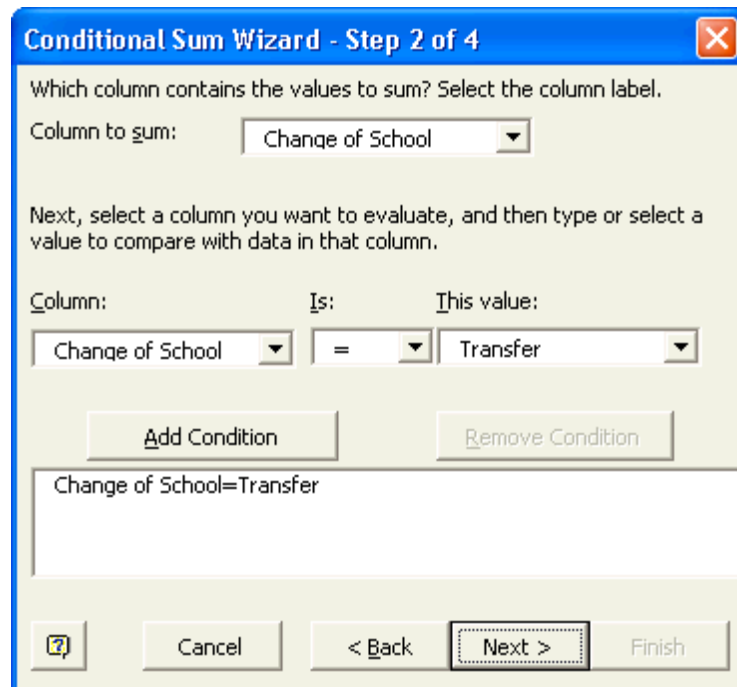
	A	B	C
1	Name	Status	Change of School
2	Jim	Enrolled	Transfer
3	Mary	Probation	KU - College
4	Fred	Enrolled	KU - Business
5	Alice	Enrolled	Transfer

To start the wizard:

1. Click a cell within the table or list.
2. On the **Tools** menu, click **Conditional Sum**.

The Conditional Sum Wizard is an add-in. If the **Conditional Sum** command is not on the **Tools** menu, install and load the wizard. (See *Add-In Commands and Functions*, page 10.)

3. Enter the information requested. (See the image on the next page.) Use the drop-down menu to select available options for the **Column to sum**. Also use drop-down menus to determine the criteria for the data to sum. Click the **Add Condition** button to add criteria to the list; you can define more than one criterion.
4. After all selections are complete, click **Finish** in the last dialog box.



The Conditional Sum Wizard

Analyzing Data with the PivotTable

A *PivotTable* is an interactive table that summarizes, or *cross-tabulates*, large amounts of data. You can “pivot” rows and columns in and out of the table to view various summaries of data. You can also filter data by displaying different “pages”, or by selecting specific areas of interest.

The PivotTable summarizes data by using a summary function that you choose, such as SUM, COUNT, or AVERAGE. You can include subtotals and grand totals automatically, or use your own formulas by adding calculated fields and items.

In a PivotTable, each column in your source data becomes a PivotTable *field* that summarizes multiple rows of information. For example, if we have a list of data with a column called **Name**, there would be a PivotTable *field* called **Name** that you could place as a row label or column label in the PivotTable. All the unique values in this **Name** column become items in the PivotTable. So if there are five rows with “John Doe” under the **Name** column, all the data from those five rows would be collapsed and summarized into a single PivotTable item labeled “John Doe”.

A PivotTable wizard provides help in creating PivotTables.

Before creating a PivotTable

Before starting the PivotTable wizard,

1. Your worksheet data must be organized in a list or database format. (See the *Excel: Data Management* handout.)
2. Place your cursor inside the list.

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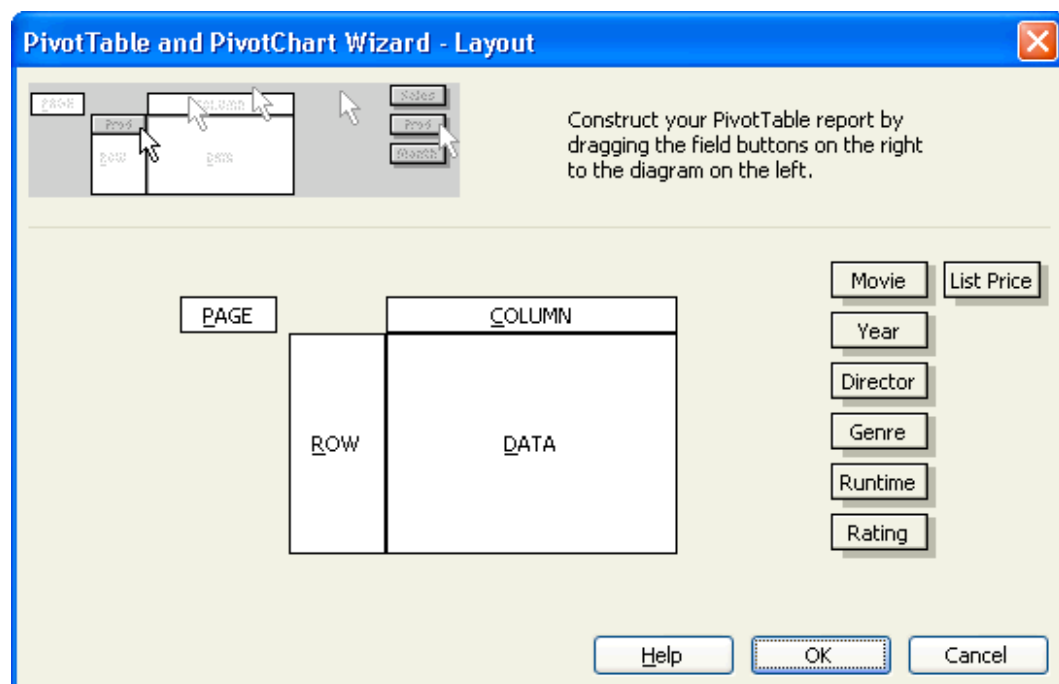
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3. Remove any subtotals created with the **Data > Subtotals** command, since grand and subtotals are automatically created as part of the PivotTable. (See the *Excel: Data Management* handout.)

Creating a PivotTable

Before beginning the PivotTable wizard, make sure you have followed the instructions above.

1. Select **PivotTable and PivotChart Report** from the **Data** menu. The first step of the Wizard displays.
2. Identify the location of your PivotTable data source. The default setting is an Excel list or database on your current worksheet. Click **Next**.
3. Select the range of cells that comprise your list. If your cursor is inside the list or database area, Excel selects the data automatically. You can redefine the list if necessary by using your mouse to select the data source and then press **Enter** to return to the dialog box.
4. Click **Next**.
5. Choose whether you want the PivotTable to appear on a new worksheet or an existing one.
6. Click **Layout**, in the bottom left corner of the wizard.
7. A sample PivotTable layout displays.



The PivotTable wizard.

Any column labels on your list are displayed as buttons and referred to as fields. Each field can be placed in one of four parts of the PivotTable.

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ROW: Any field placed in the ROW area becomes a row label.

COLUMN: Any field placed in the COLUMN area becomes a column label.

DATA: Any numeric field placed in the DATA area is summarized (using the summary function you specify, such as SUM, AVERAGE, etc.).

PAGE: Any field you want to use as a filter is placed the PAGE area.

8. To place a field in the pivot table, drag its name to the appropriate area.
9. Click **OK** when the layout is complete.
10. Click **Finish**.

Editing the PivotTable

You can edit and format many components of the PivotTable. To select areas of the PivotTable, use the following table as a guide.

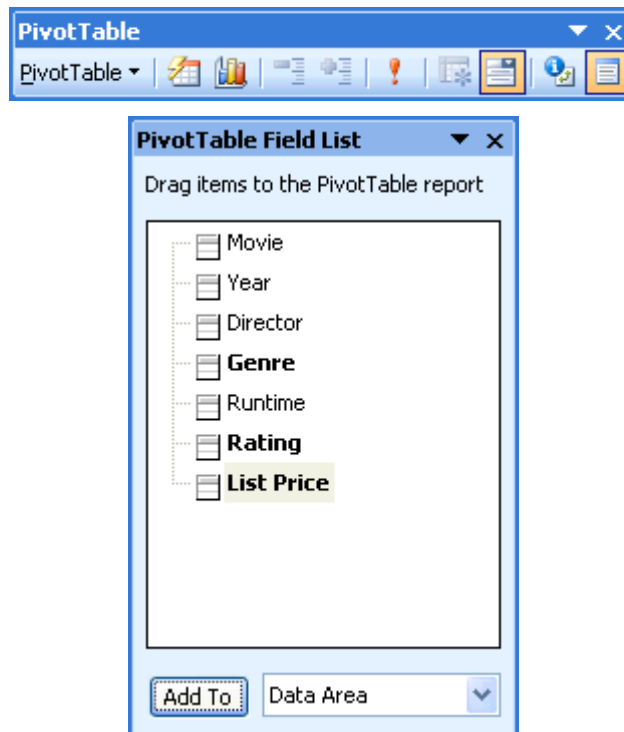
Clicking...	Selects
Row field	All row labels
Row item	All item data
Column field	All column labels
Column item	All item data
Summary label	Entire table
Grand Total label	Column or row totals

Table components and selection


Double-click the row or column fields to display the **PivotTable Field** dialog box. If the above methods do not select, from the **PivotTable** toolbar (see below), click **PivotTable**, point to **Select** and click **Enable Selection**.

PivotTable Toolbar

When a PivotTable is displayed on a worksheet, the **PivotTable** toolbar automatically displays. Excel also displays the **PivotTable Field List**, which allows you to dynamically alter fields in your table.



The PivotTable toolbar and PivotTable Field List

Click the **PivotTable** menu on the **PivotTable** toolbar and select **PivotTable Wizard** to access the original PivotTable wizard and  to access the **PivotTable Field List**. Both these can be used to change the PivotTable data display and values.

Deleting the PivotTable

To delete a Pivot Table,

1. On the **PivotTable** menu of the **PivotTable** toolbar, point to **Select** and click **Enable Selection**.
2. Click a cell in the PivotTable.
3. On the **PivotTable** menu of the **PivotTable** toolbar, point to **Select** and click **Entire Table**.
4. On the **Edit** menu, point to **Clear**, and then click **All**. When you delete a PivotTable, the source data is *not* deleted or changed.

Array Formulas

An *array formula* is a formula that performs multiple calculations and returns either a single result or multiple results. Array formulas act on two or more sets of values known as array arguments.

Each array argument must have the same number of rows and columns. You create array formulas the same way that you create basic, single-value formulas, with a slight exception.

Entering an Array Formula

To enter an array formula:

1. Select the cell or cells that will contain the formula.
2. Enter the formula.
3. Press **Ctrl+Shift+Enter** to enter the formula within the cell. Brackets {} display around the entire formula, including the equal sign.

If you want only a single result, Excel may need to perform several calculations to generate that result.

Troubleshoot errors in formulas

If you have problems when creating functions, check the following to troubleshoot your formulas:

- Double-click the cell that contains the formula to edit the formula. The worksheet ranges and the corresponding arguments within the formula display in colors to clearly define your formula arguments.
- Parentheses are part of a matching pair. When you create a formula, Excel displays parentheses in color as they are entered.
- Make sure you use the correct range operator when you refer to a range of cells. When you refer to a range of cells, use a colon (:) to separate the reference to the first cell in the range and the reference to the last cell in the range.
- Make sure you have entered all arguments that are required and not any extras. Some functions have required arguments.

You can enter, or nest, no more than seven levels of functions within functions.

- If the name of a workbook or a worksheet you refer to contains a non-alphabetic character, you must enclose the name within single quotation marks.
- Make sure each external reference contains a workbook name and the path to the workbook.
- Do not format numbers as you enter them in formulas. For example, even if the value you want to enter is "\$1,000", enter **1000** in the formula.

Getting Additional Help

The Help Desk provides consulting and Q&A help in a variety of ways:

785/864-0200

question@ku.edu

www.ku.edu/~helpdesk

Last Update: 02/06/2006