

Advanced Statistical Functions

Perform Data Analysis: Manage Multiple Arguments

Students will be able to:

Concept: Statistical, the “s” of the sample population, as well as the Statistical Functions in Excel

Identify the difference between a SUMIF and SUMIFS function.

Use statistical functions, including AVERAGEIFS, MAXIFS

Use statistical functions: Mean (Average), Mode, and Median

Use Named Ranges in Statistical Functions

Excel Expert Certification Exam Objectives

Perform logical operations in formulas

Perform logical operations by using nested functions including the IF(), IFS(), SUMIF(), AVERAGEIF(), COUNTIF(), SUMIFS(), AVERAGEIFS(), COUNTIFS(), MAXIFS(), MINIFS()



	A	B
1	Item	Calculation
2	Total bridge area with Owner: Washtenaw County	=SUMIF(OWNER,"Washtenaw County",AREA)
	owned by Washtenaw and rating of >8	=COUNTIFS(OWNER,"Washtenaw County",Lowest_Rating,">=8")
	the Max value for number of for bridges owned by MDOT in Washtenaw County	=MAXIFS(LANES,OWNER,"MDOT",COUNTY,"WASHTENAW")
	the oldest bridge (lowest value) in Washtenaw County	=MINIFS(YEARBUILT,COUNTY,"Washtenaw")
	average time since last inspection for bridges with a rating of >6 owned by MDOT.	=AVERAGEIFS(INSPFREQ,OWNER,"MDOT",Lowest_Rating,">6")

STATISTICAL FUNCTIONS: SEEKING SOLUTIONS

Unit Check List

Complete the Lesson

Advanced Statistical Functions: Pages 41-68

Task

Complete the following: Determine the condition of the County bridges and the time since the last inspection. Identify the owner of the infrastructure for maintenance.

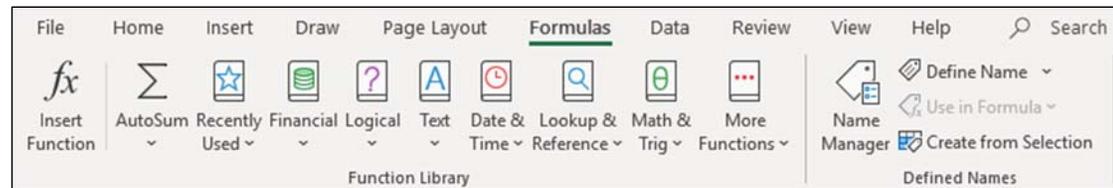
Downloads

Advanced Statistical Functions Sample.xlsx

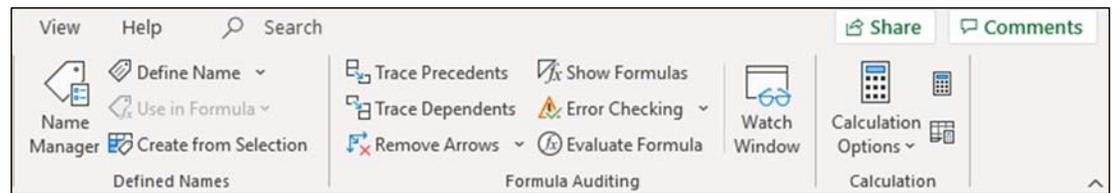
Test Yourself:

Unit Review Pages 67-68

Formulas Ribbon (left)



Formulas Ribbon (right)



Menu Maps

1. Formula->Function Library-> AutoSum-> Average
2. Formula->Function Library-> More Functions-> Statistical->MEDIAN
3. Formulas-> Function Library-> More Functions-> Statistical->MODE.SNGL.
4. Formulas-> Function Library-> More Functions-> Statistical->MODE.MULTI
5. Formulas-> Function Library-> More Functions-> Statistical-> COUNTIFS



WORKING WITH STATISTICAL DATA



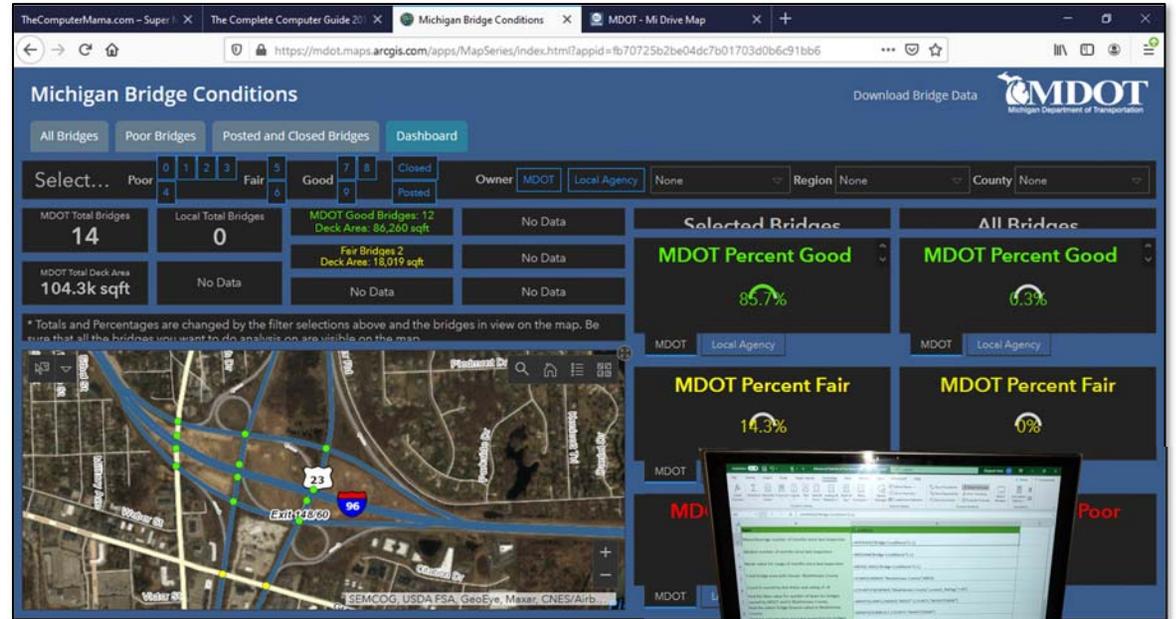
Statistics is a field of study that collects, organizes, interprets and presents data. The field is divided into two primary methods: descriptive statistics to summarize data or inferential statistics to draw conclusions from data.

Statistical data often relies on a sample (or portion) of the whole data set (known as the population). The sample is a smaller data set, and usually easier to work with. Conclusions drawn from the sample are then applied to the larger data set.

Statistics doesn't answer yes or no. Instead, it shows the probability of an outcome. A probability may be more or less likely.

In our traffic data, we will look at the statistical functions to summarize our data set. We will only be looking briefly at the tools that statisticians use, but not getting too much into the calculating of statistics or probability.

MDOT Bridge Statistics displayed as a Dashboard



Optional: Learn more about Statistics: <https://libguides.wccnet.edu/oer-subjects/statistics-calculus>

TRAFFIC CONCEPTS



Bridges need to be inspected on regular basis to monitor their condition. Bridge inspections record information about the condition of the bridge, including superstructure, bridge deck, and substructure.

Michigan's infrastructure is aging faster than it is being repaired. MDOT offers the information on their Bridge Conditions Dashboard (and a download of the data in CSV format). State and local road agencies can use the condition ratings to prioritize funding and repair scheduling.

Bridge condition is rated based on the lowest-rating recorded for the bridge structures. The ratings range from 0-9. A bridge rated as failing may have posted loads reduced or be closed to traffic entirely until it can be rehabilitated or replaced.

The MDOT rating scale is shown here.

<https://mdot.maps.arcgis.com/apps/MapSeries/index.html?appid=fb70725b2be04dc7b01703d0b6c91bb6>

NBI Condition Ratings		
7-9	Good Condition <ul style="list-style-type: none"> Routine maintenance 	
5-6	Fair Condition <ul style="list-style-type: none"> Preventative maintenance or minor rehabilitation 	
4	Poor Condition	
2-3		Poor <ul style="list-style-type: none"> Major rehabilitation or replacement
0-1		Serious or Critical <ul style="list-style-type: none"> Emergency repair or high priority major rehabilitation or replacement Unless closely monitored it may be necessary to close until corrective action can be taken.
0-1	Imminent Failure or Failed <ul style="list-style-type: none"> Major rehabilitation or replacement Bridge is closed 	



MDOT Bridge Conditions: <https://mdot.maps.arcgis.com/apps/MapSeries/index.html?appid=fb70725b2be04dc7b01703d0b6c91bb6>

PUTTING EXCEL TO WORK



Let's Open Excel

In this unit we will be working with Statistical Functions. We will start with the basic statistical operations: Mean, Mode and Median. We will use *IF and *IFS groups of calculations. SUMIF will add data based on one criteria. SUMIFS will add data if it meets more than one criteria.

We will be working with the Advanced Statistical Functions Sample.xlsx.

This spreadsheet includes data about the location, ownership, structure conditions, overall bridge condition rating, bridge construction date, and other information as collected.

There are 1,853 rows in this sample spreadsheet. Please open the workbook and let's get started!

Note to Self: Even "poor" rated bridges are still rated for vehicles to travel over!

Screen images of the sample spreadsheet

	A	B	C	D	E	F	G	H	I
	OWNER	FACILITY	FEATINT	COUNTY	REGION	AREA	CLEAR_RDWY	LANES	YEARBUILT
1									
2	MDOT	I-96 BL(GR	CSX RR	Clinton	University	10363	50	4	1938
3	MDOT	I-96	HUSTED &	Clinton	University	3182	159	4	1957
4	MDOT	I-96 EB	CSX RR	Clinton	University	6258	39	2	1962

	A	B
1	Item	Calculation
2	Mean/Average number of months since last inspection	=AVERAGE('Bridge Conditions'!L:L)
3	Median number of months since last inspection	=MEDIAN('Bridge Conditions'!L:L)
4	Mode value for range of months since last inspection	=MODE.SNGL('Bridge Conditions'!L:L)
5	Total bridge area with Owner: Washtenaw County	=SUMIF('Bridge Conditions'!A:A,"Washtenaw County",'Bridge C
6	Count if owned by Ann Arbor and rating of >8	=COUNTIFS('Bridge Conditions'!A:A,"MDOT",'Bridge Conditions'
7	Find the Max value for number of lanes for bridges owned by MDOT and in Washtenaw County	=MAXIFS('Bridge Conditions'!H:H,'Bridge Conditions'!A:A,"MDO
8	Find the oldest bridge (lowest value) in Washtenaw County	=MINIFS('Bridge Conditions'!I:I,'Bridge Conditions'!D:D,"Washte
9	Find the average time since last Inspection for bridges with a rating less than 6 and owned by MDOT.	=AVERAGEIFS('Bridge Conditions'!L:L,'Bridge Conditions'!A:A,"M
10		

STATISTICAL FUNCTIONS: MEAN

Core statistical functions are the Mean, Median and Mode. These values are related. Excel includes statistical functions for each.

We'll start with the mean. Mean is the same as average. Excel uses the AVERAGE function to calculate the mean.

Task: Add an Average function

The Calculations sheet is open.

1. Select cell B2.
2. Go to Formula-->Function Library--> AutoSum--> Average
3. Select the range: Go to the Bridge Conditions sheet and select column L. Press enter to complete the formula.

What Do You See? The average, or mean, number of months since last inspection is 23 months.

Keep going.

Formula->Function Library-> AutoSum-> Average

The screenshot shows the Microsoft Excel interface. The 'Formulas' ribbon is active, and the 'Function Library' group is expanded to show the 'AutoSum' > 'Average' path. The formula bar displays the formula `=AVERAGE('Bridge Conditions'!L:L)`. The spreadsheet shows a table with the following data:

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	<code>=AVERAGE('Bridge Conditions'!L:L)</code>	2
Median number of months since last inspection	<code>AVERAGE(number1, [number2], ...)</code>	2
Mode value for range of months since last inspection		3
Total bridge area with Owner: Washtenaw County		3
Count if owned by Ann Arbor and rating of >8		4

The formula bar shows the formula `=AVERAGE('Bridge Conditions'!L:L)` being entered into cell B2. The spreadsheet shows the result of the formula, which is 23, displayed in cell B2.

STATISTICAL FUNCTIONS: MEDIAN

The median value of a range of numbers is the middle value. Normally, to find the median value, the list of numbers would need to be sorted from smallest to largest. Excel, however, can take a given list and find the median without the user needing to sort.

Task: Add a Median function

The Calculations sheet is open.

1. Select cell B3.
2. Go to Formula->Function Library-> More Functions-> Statistical. Select MEDIAN.

The function arguments dialogue box will open.

3. Select the range: Go to the Bridge Conditions sheet and select column L.

Press enter to complete the formula.

What Do You See? The median value is 24.

Formula->Function Library-> More Functions-> Statistical->MEDIAN

The screenshot shows the Microsoft Excel interface with the 'Function Arguments' dialog box for the MEDIAN function open. The dialog box shows the range 'Bridge Conditions'!L:L selected for the 'Number1' argument. The main spreadsheet shows the following data in column L:

Item	Calculation
Mean/Average number of months since last inspection	23
Median number of months since last inspection	24
Mode value for range of months since last inspection	
Total bridge area with Owner: Washtenaw County	

STATISTICAL FUNCTIONS: MODE

Mode is the most frequently occurring value in a list. Excel can quickly calculate which value occurs most often in a list of values. Excel has two options for Mode. We will start with the option that returns the single most frequently occurring value.

Task: Add a MODE.SNGL function

The Calculations sheet is still open.

1. Select cell B4.

2. Go to Formulas-> Function Library-> More Functions-> Statistical. Select MODE.SNGL.

The function arguments dialogue box will open.

3. Select the range: Go to the Bridge Conditions sheet and select column L.

Press enter to complete the formula.

What Do You See? The Mode, or most frequently occurring number is 24.

Formulas-> Function Library-> More Functions-> Statistical->MODE.SNGL.

The screenshot shows the Excel interface with the 'Formulas' ribbon active. The 'Function Library' group is expanded to 'More Functions' > 'Statistical'. The 'MODE.SNGL' function is selected, and its 'Function Arguments' dialog box is open. The 'Number1' argument is set to 'Bridge Conditions!L:L'. The formula bar shows '=MODE.SNGL('Bridge Conditions'!L:L)'. Below, a table shows the results of the calculation in column B.

Item	Calculation
Mean/Average number of months since last inspection	23
Median number of months since last inspection	24
Mode value for range of months since last inspection	24
Total bridge area with Owner: Washtenaw County	

MO-201: Microsoft Excel Create Advanced Formulas and Macros

3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions: MODE:SNGL

STATISTICAL FUNCTIONS: MODE MULTI

Excel can also find the most frequently occurring values in a set and return more than one result. This function requires that the most frequently occurring values each have the same number of occurrences.

Our bridge data doesn't quite support this, so we have a separate data set to work with.

Task: Add a MODE.MULTI function

The Calculations sheet is open.

1. Select cell I1.

2. Go to Formulas-> Function Library-> More Functions-> Statistical. Select MODE.MULTI.

The function arguments dialogue box will open.

3. Select the range: Stay on the Calculations sheet and select the range H2:H7.

Press OK to complete the formula.

Keep going, please...

Formulas-> Function Library-> More Functions-> Statistical->MODE.MULTI

The screenshot shows an Excel spreadsheet with the following data:

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	23	2
Median number of months since last inspection	24	2
Mode value for range of months since last inspection	24	3
Total bridge area with Owner: Washtenaw County		3
Count if owned		4
Find the Max va		5
by MDOT and in		
Find the oldest		
County		
Find the average		
a rating less tha		

The 'Function Arguments' dialog box for MODE.MULT is open, showing:

- MODE.MULT
- Number1: H2:H7 = {2;2;3;3;4;5}
- Number2: = array
- Formula result = 2
- Buttons: OK, Cancel

STATISTICAL FUNCTIONS: MODE MULTI

A Multi Mode Function will display the data over several cells. In this example, there will be two modes, so two cells for the results.

Task: Display the MODE.MULTI function Results

4. When you complete a Multi Mode function, Excel may prompt you that the data will be split into adjacent cells. Select OK.

What Do You See? Excel has returned two values in two cells: 2 and 3. These both have 2 occurrences in our data set.

Formulas-> Function Library-> More Functions-> Statistical->MODE.MULTI

The screenshot shows the Excel interface with the following data:

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	23	2
Median number of months since last inspection	24	2
Mode value for range of months since last inspection		3

The formula bar shows the formula: `=MODE.MULT(H2:H7)`

- MO-201: Microsoft Excel Create Advanced Formulas and Macros
- 3.1 Perform logical operations in formulas
- 3.1.1 Perform logical operations by using nested functions: MODE:MULTI

CREATE NAMED RANGES

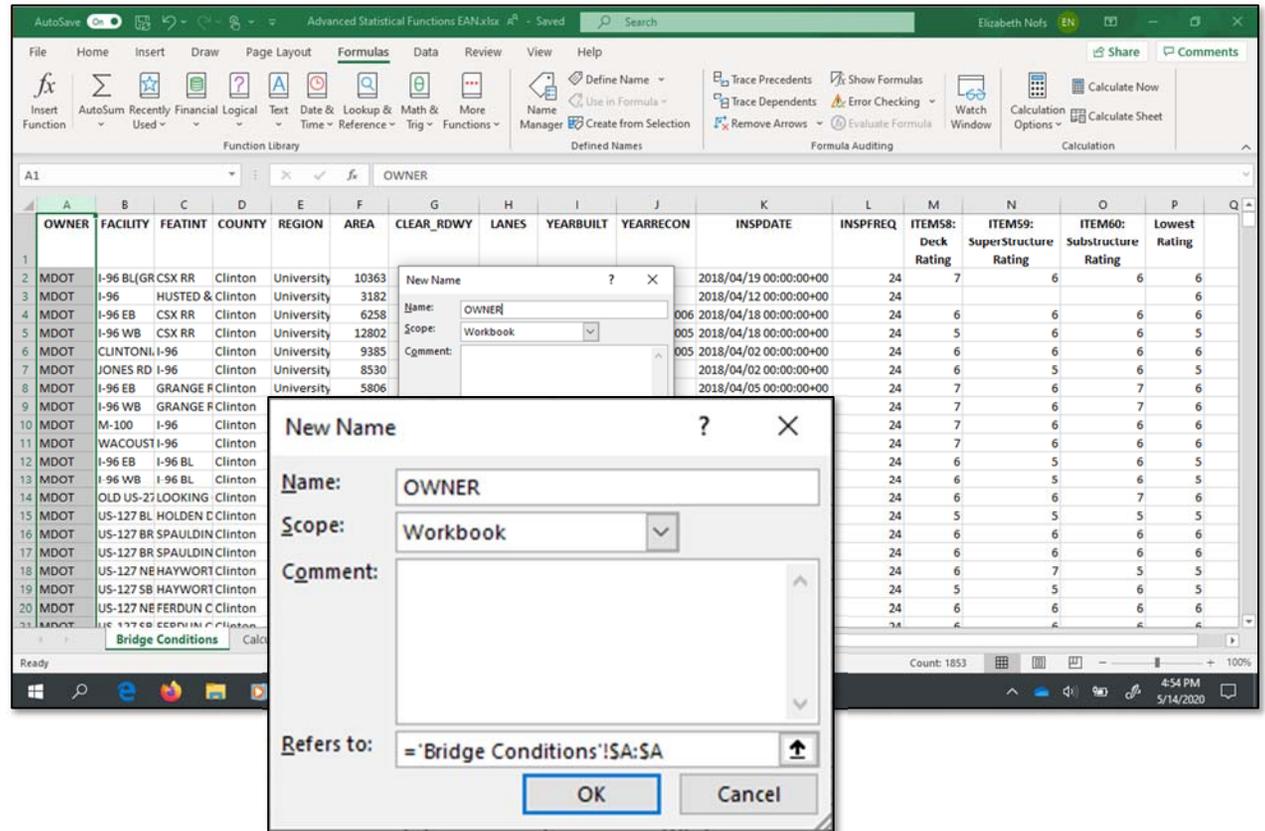
Large datasets are often easier to work with if the criteria is defined as a Named Range. A few moments preparation can save hours of tracing and troubleshooting later.

Task: Define Named Ranges

1. Select Column A.
2. Go to Formulas->Define Names->Define Name.
3. Define the Name: The New Name will be the Label in A1, the Header Row. The Range is Absolute: All of Column A. Click OK to accept the Name: OWNER.
4. Select Column D. Define the Name: COUNTY
5. Select Column F. Define the Name: AREA
6. Select Column H. Define the Name: LANES
7. Select Column I. Define the Name: YEARBUILT
8. Select Column L. Define the Name: INSPFREQ
9. Select Column P. Define the Name: Lowest_Rating

Keep going...

Formulas->Define Names->Define Name



REVIEW THE NAMED RANGES

Named Ranges can be reviewed or edited in the Name Manager. The Name Manager shows the Range, its name, and what it refers to, amongst other fields.

Task: Review the Named Ranges

1. Go to Formulas->Define Names->Name Manager.

What Do You See? There are seven Named Ranges in this Workbook. The Names are listed alphabetically.

The definitions refer to the columns on the Bridge Conditions worksheet. The reference is Absolute.

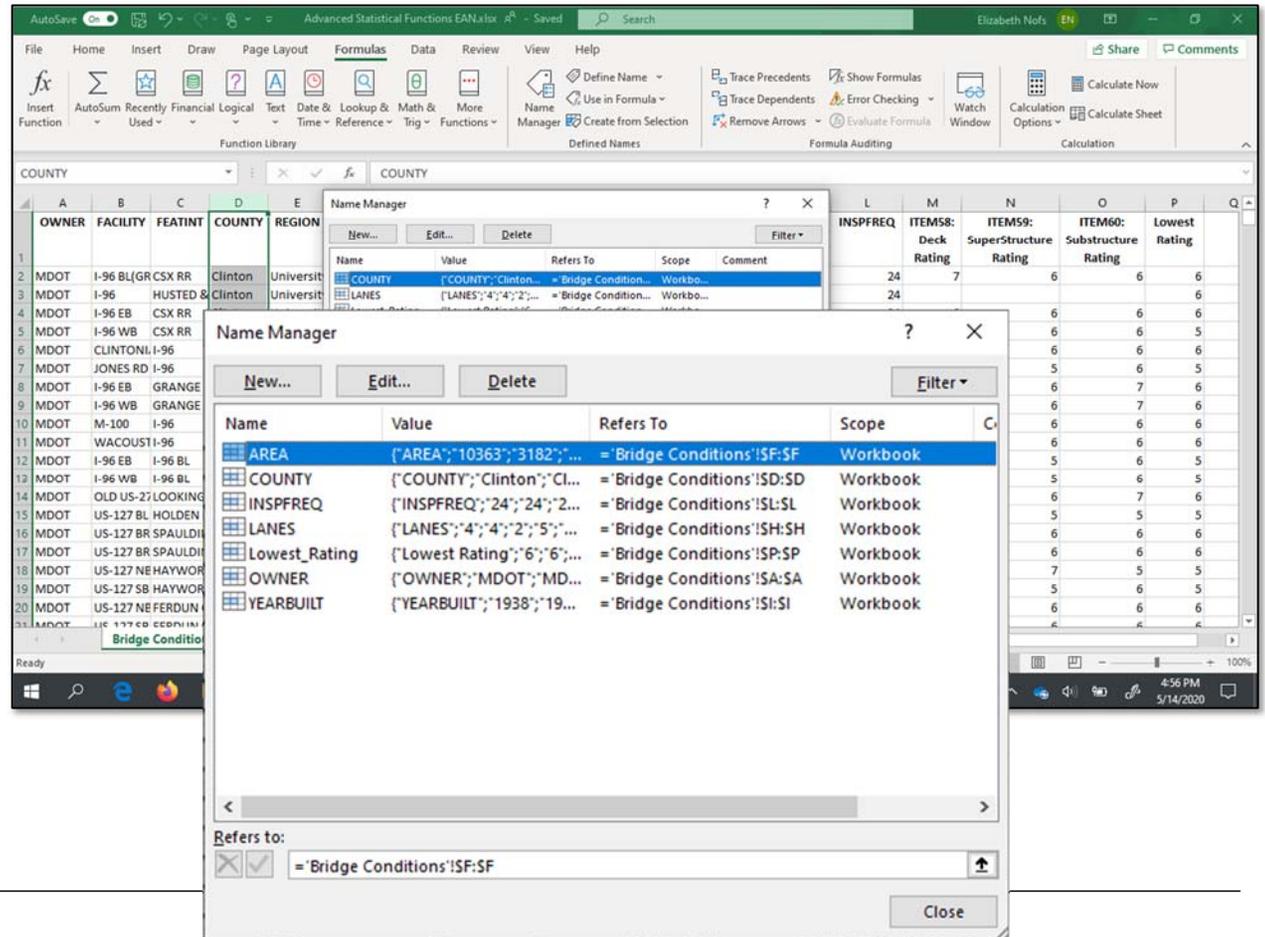
2. Close the Name Manager.

Keep going, please...

The More You Know: You can edit Named Range by using the selection arrow to the far right of Refers to.

The Name Manager will minimize, allowing you to navigate to the worksheet and highlight the correct column or cells.

Formulas->Define Names->Name Manager



MATH AND TRIG FUNCTIONS: SUMIF

Statistical functions include the *IF and *IFS groups of functions. The IF functions, like SUMIF, COUNTIF, and AVERAGEIF, will calculate based on a single criteria.

Our data set is very large. It is also Normalized. This means it only contains data—no calculations or logos. Best practices with large data sets and in databases is this level of normalization. It is called Third Normal Form. To keep the data normalized, we will be putting our calculations on a separate sheet

Task: Add a SUMIF function

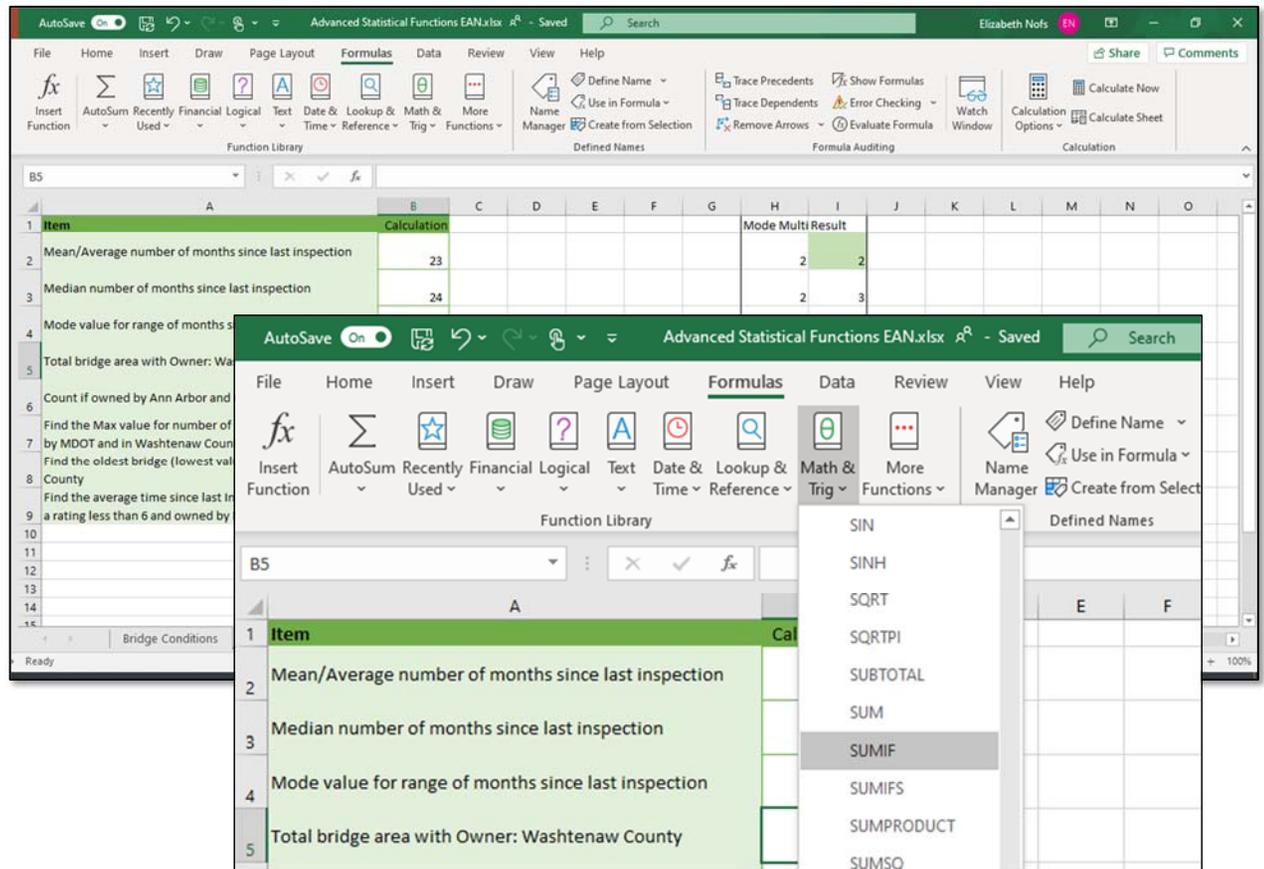
1. Go to the Calculations sheet. Go to cell B5
2. Go to Formulas->Function Library->Math and Trig.

What Do You See? There are several SUM functions including SUM, SUMIF, SUMIFS, SUMPRODUCT.

3. Click on SUMIF
4. The Function Arguments dialogue box will open.

Keep going...

Formulas->Function Library->Math and Trig



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3.1 Perform logical operations in formulas 3.1.1 Perform logical operations by using nested functions including the IF(), IFS(), SWITCH(), SUM(IF), AVERAGEIF(), COUNTIF(), SUMIFS(), AVERAGEIFS(), COUNTIFS(), MAXIFS(), MINIFS(), AND(), OR(), and NOT() functions

ADDING THE FUNCTION ARGUMENTS FOR SUMIF

An *IF or *IFS function will perform a specific calculation, such as SUM. The function arguments will include the range to use when evaluating based on the criteria. The data to be summed can be in the same range, or a different one.

Task: Enter Function Arguments

1. Enter the Range: OWNER

What Do You See? If the Named Range is spelled correctly, there should be data displayed on the right.

2. Enter the Criteria: Washtenaw County

3. Enter the Sum_range: AREA

4. Click OK to accept the Formula.

What Do You See, Now? The SUMIF function calculated how much bridge area is owned by Washtenaw County: 283,672 feet of area.

5. For readability, large numbers should have a comma separator. Select cell B5. Go to Home--> Numbers--> Comma separator to add a comma.

6. Go to Home--> Numbers--> Decrease decimal so the number displays no decimals.

Formulas->Function Library->Math and Trig-.SUMIF

The screenshot shows the Microsoft Excel interface with the SUMIF function arguments dialog box open. The dialog box displays the following information:

- Function: SUMIF
- Range: OWNER = ('OWNER';MDOT';MDOT';MDOT';
- Criteria: "Washtenaw County" = "Washtenaw County"
- Sum_range: AREA = ('AREA';10363;3182;6258;12802;938...
- Formula result = 283,672

The background spreadsheet shows a table with columns for Item, Calculation, and Mode Multi Result. The data is as follows:

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	23	2 2
Median number of months since last inspection		2 3
Mode value for range of months since last inspection		3

Note: Spelling matters!

If the Range or Criteria are entered incorrectly you will not see any results on the right side

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3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions SUMIFS(), AVERAGEIFS(), COUNTIFS(), MAXIFS(), MINIFS(), AND(), OR(), and NOT() functions

USING COUNTIFS

The COUNTIFS function, like the other *IFS functions, calculate if all criteria are met. We can input more than one criteria that we want added. With our sample data, we will count how many bridges have an excellent rating AND are owned by Washtenaw County.

Task: Enter a COUNTIFS function

1. Go to the Calculations sheet and go to cell B6.
2. Go to Formulas-> Function Library-> More Functions-> Statistical-> COUNTIFS

The Function Arguments dialogue box will open.

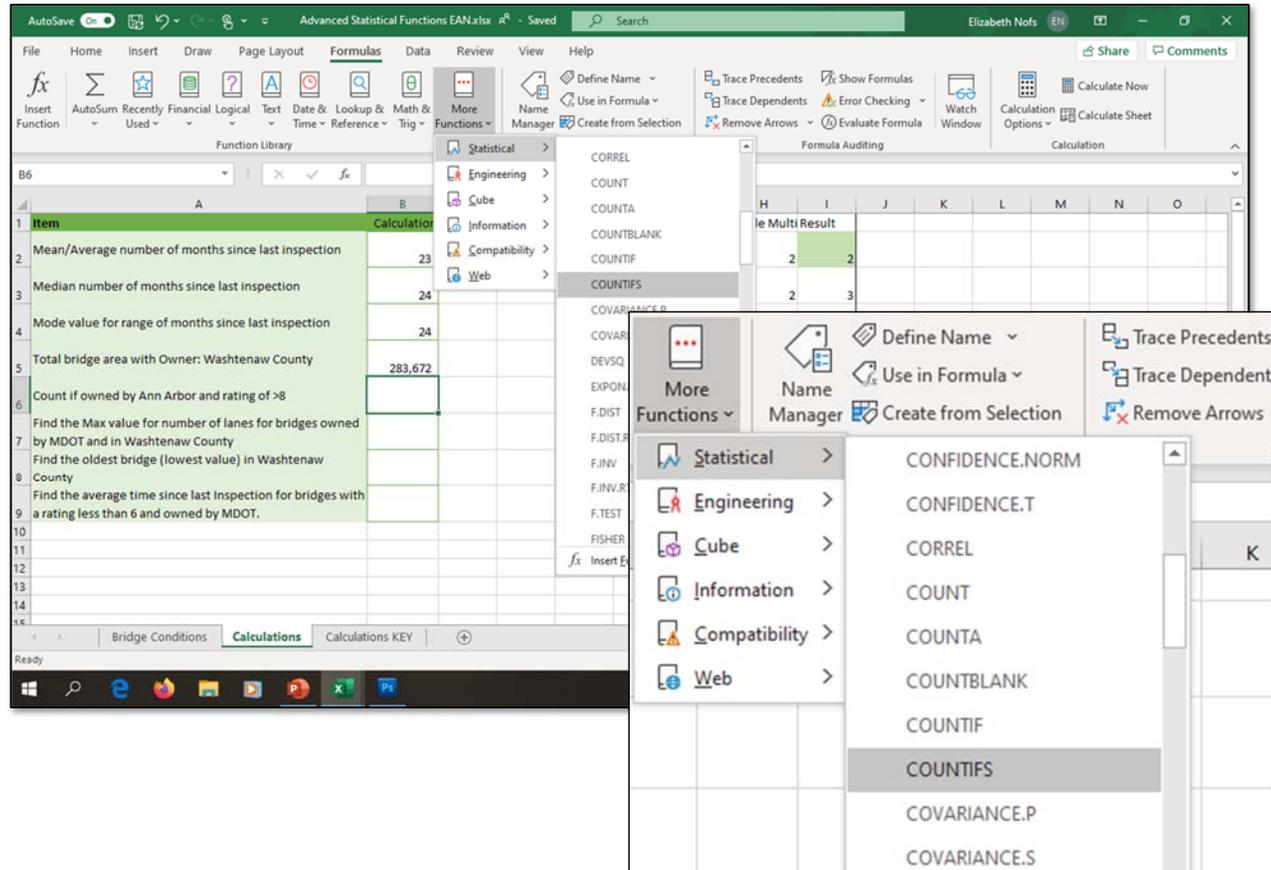
Keep going...

Note: Make sure to read the function name carefully. There are several with similar names!

For example, the COUNT functions include:

- COUNTA: Count TEXT data
- COUNTBLANK: Count BLANK data
- COUNTIF: Count determined by 1 criteria
- COUNTIFS: Count determined by more than 1 criteria

Formulas-> Function Library-> More Functions-> Statistical-> COUNTIFS



MO-201: Microsoft Excel Create Advanced Formulas and Macros

3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions SUMIFS(), AVERAGEIFS(), COUNTIFS(), MAXIFS(), MINIFS(), AND(), OR(), and NOT() functions

ADDING ARGUMENTS TO AN *IFS FUNCTION

Statistical functions compare the interaction, if any, of different criteria. We can use the Function arguments to define where to look up the data and how to apply the criteria.

An *IFS function can have multiple criteria to evaluate. For each argument, there will be a range and a criteria. The range will be different for each criteria in this example as well.

Task: Add Function Arguments for COUNTIFS

1. Enter Criteria_range1: OWNER
2. Enter Criteria1 : Washtenaw County

Where OWNER is the Named Range for Column A.

What Do You See? The Function Arguments returned a COUNT of 120 records that met Criteria1.

Keep going...

The More You Know: As you entered the 1st Criteria, Excel expanded the number of available function arguments. Criteria_range2 and Criteria2 became available. As you edit the second Criteria, a third will then become available. There can be up to four criteria.

Formulas-> Function Library-> More Functions-> Statistical-> COUNTIFS

The screenshot shows the Microsoft Excel interface with the 'Formulas' tab selected. The 'Function Library' group is expanded to 'More Functions' > 'Statistical' > 'COUNTIFS'. The 'Function Arguments' dialog box is open, showing the formula `=COUNTIFS(OWNER, "Washtenaw County")` and the following arguments:

- Criteria_range1: OWNER
- Criteria1: "Washtenaw County"
- Criteria_range2: (empty)
- Criteria2: (empty)

The dialog box also displays the formula result as 120 and includes an explanation: "Counts the number of cells specified by a given set of conditions or criteria. Criteria_range2: is the range of cells you want evaluated for the particular condition." The 'OK' button is highlighted.

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3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions SUMIFS(), AVERAGEIFS(), COUNTIFS(), MAXIFS(), MINIFS(), AND(), OR(), and NOT() functions

STATISTICAL FUNCTION ARGUMENTS

We can enter an exact value, like typing the name or number. We can also use operators: signs for greater than and less than. Wild cards are also supported.

Task: Use a Greater than or Equal to Operator

The Function Arguments dialogue box is open. The first arguments for the COUNTIFS function are entered.

1. Enter the Criteria_range2: Lowest_Rating

Where Lowest Rating is the Named Range for Column P.

2. Enter Criteria2: >=8

This means greater than or equal to.

3. Click OK to complete the function.

What Do You See? Excel calculated the number of bridges owned by Washtenaw County with a score of 8 or 9. There are 18

The More You Know:

>= means greater than or equal to

<= means less than or equal to

<> means not equal to or excluding

Formulas-> Function Library-> More Functions-> Statistical-> COUNTIFS

The screenshot shows the Microsoft Excel interface with the 'Function Arguments' dialog box for the COUNTIFS function. The dialog box is open over a spreadsheet. The spreadsheet has a table with columns A through O. The formula bar shows =COUNTIFS(OWNER, 'Washtenaw County', Lowest_Rating, '>=8'). The dialog box shows the following arguments: Criteria_range1: OWNER, Criteria1: 'Washtenaw County', Criteria_range2: Lowest_Rating, Criteria2: '>=8'. The formula result is 18.

MO-201: Microsoft Excel Create Advanced Formulas and Macros

3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions SUMIFS(), AVERAGEIFS(), COUNTIFS(), MAXIFS(), MINIFS(), AND(), OR(), and NOT() functions

STATISTICAL FUNCTIONS: MAXIFS

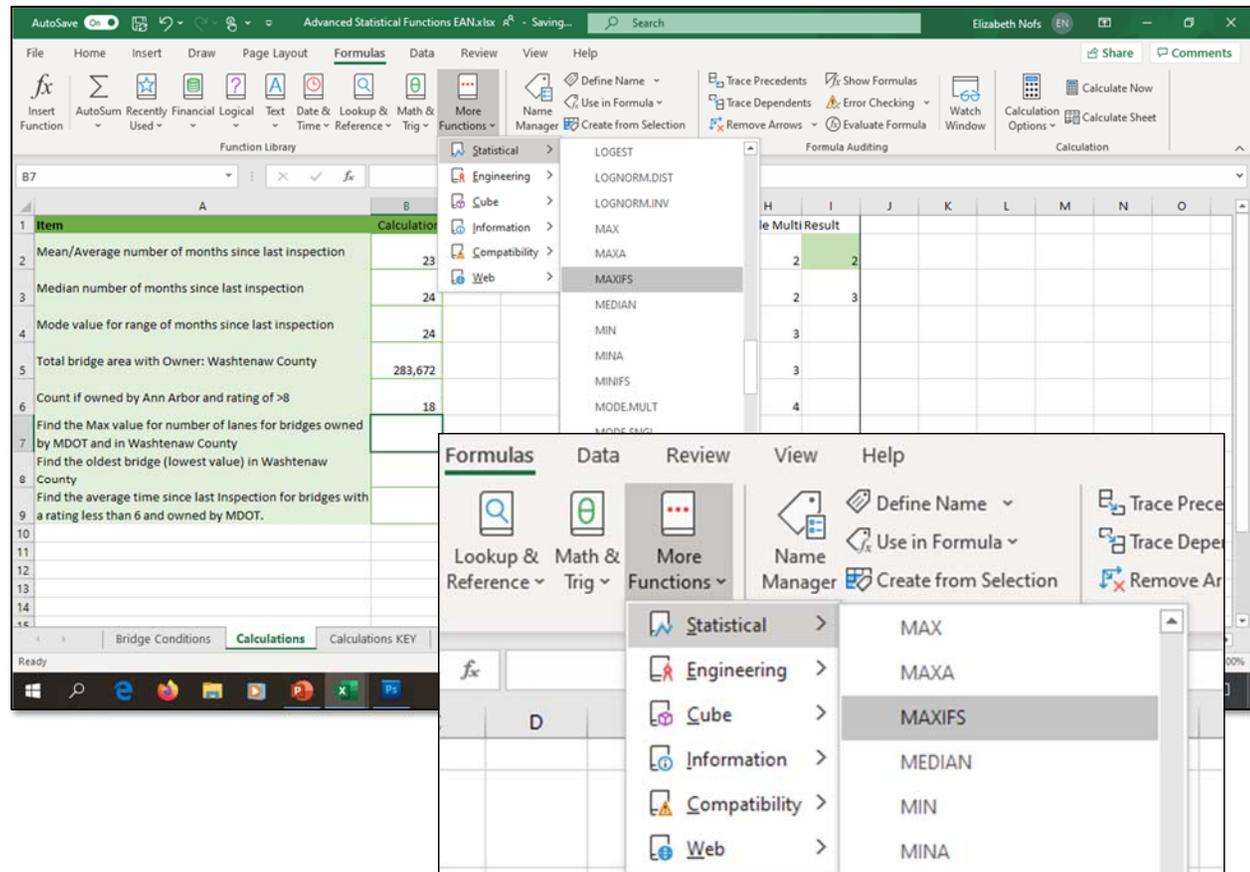
The MAX function finds the largest value in a data set. We can use the MAXIFS function to find the largest value based on multiple conditions. For example, we can find the largest number of lanes crossing a particular bridge.

Task: Create a MAXIFS function

1. Go to the Calculations sheet. Go to cell B7.
2. Go to Formulas--> Function Library--> More Functions--> Statistical.
3. Select MAXIFS. The Function Arguments dialogue box will open.

Keep going...

Formulas--> Function Library--> More Functions--> Statistical->MAXIFS



MO-201: Microsoft Excel Create Advanced Formulas and Macros

3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions: MAXIFS(), MINIFS()

USING MAXIFS FUNCTION ARGUMENTS

Most *IFS functions are set up similarly. The first field is the range that will be used for the calculation, whether it's summing, averaging, or finding the max or min value.

Task: Enter the Function Arguments for MAXIFS

1. Enter the Max Range: LANES

Where LANES is the Named Range for Column H.

2. Enter Criteria_Range1: OWNER

3. Enter Criteria1: MDOT

4. Enter Criteria_Range2: COUNTY

5. Enter Criteria2: Washtenaw

What Do You See? We have found the largest value, which is 9 lanes. That is the most lanes crossing a bridge owned by MDOT in Washtenaw County.

Formulas--> Function Library--> More Functions--> Statistical->MAXIF

The screenshot shows the Microsoft Excel interface with the 'Function Arguments' dialog box for the MAXIFS function. The dialog box is open over a spreadsheet. The spreadsheet has a column 'Item' and a column 'Calculation'. The 'Calculation' column contains the following values: 2.2, 2, 2, 283.67, and 9. The 'Function Arguments' dialog box shows the following arguments: Max_range: LANES, Criteria_range1: OWNER, Criteria1: "MDOT", Criteria_range2: COUNTY, and Criteria2: "WASHTENAW". The formula result is 9. The dialog box also includes a description of the function: 'Returns the maximum value among cells specified by a given set of conditions or criteria. Criteria2: is the condition or criteria in the form of a number, expression, or text that defines which cells will be included when determining the maximum value.' The dialog box has 'OK' and 'Cancel' buttons.

MO-201: Microsoft Excel Create Advanced Formulas and Macros

3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions: MAXIFS(), MINIFS()

STATISTICAL FUNCTIONS: MINIFS

MINIF and MINIFS find the smallest value in the data set based on the criteria. MINIF is offered as a separate function.

However, you can also use the MINIFS function and enter only one criteria.

Task: Create a MINIFS function

1. Go to the Calculations sheet. Go to cell B8.
2. Go to Formulas-> Function Library-> More Functions-> Statistical. Choose MINIFS. The Function argument dialogue box will open.
3. Enter the Min_Range: YEARBUILT
Where YEARBUILT is the Named Range for Column I.
4. Enter Criteria_Range1: COUNTY
5. Enter Criteria1: Washtenaw

What Do You See? The first three fields are noted with bold labels. These are required fields. Additional fields are optional.

6. Click OK to complete the function.

What Do You See Now? The oldest bridge—which has the lowest value in the data set—was built in 1876.

Is that a wow or a yikes?

Formulas-> Function Library-> More Functions-> Statistical->MINIFS

The screenshot shows the Microsoft Excel interface with the 'Function Arguments' dialog box for the MINIFS function. The dialog box is open over a spreadsheet. The spreadsheet has a column 'Item' and a column 'Calculation'. The 'Calculation' column has values 2, 2, 2, and 283,67. The dialog box shows the formula =MINIFS(YEARBUILT,COUNTY,\"WASHTENAW\"). The 'Min_range' is YEARBUILT, 'Criteria_range1' is COUNTY, and 'Criteria1' is 'Washtenaw'. The formula result is 1876.

Function Arguments

MINIFS

Min_range YEARBUILT = ('YEARBUILT';1938;1957;1962;1962;195

Criteria_range1 COUNTY = ('COUNTY';'Clinton';'Clinton';'Clint...

Criteria1 "Washtenaw" = "Washtenaw"

Criteria_range2 = reference

= 1876

Returns the minimum value among cells specified by a given set of conditions or criteria.

Criteria1: is the condition or criteria in the form of a number, expression, or text that defines which cells will be included when determining the minimum value .

Formula result = 1876

Help on this function

OK Cancel

MO-201: Microsoft Excel Create Advanced Formulas and Macros

3.1 Perform logical operations in formulas

3.1.1 Perform logical operations by using nested functions: MAXIFS(), MINIFS()

USING AVERAGEIFS WITH FORMULA AUTOCOMPLETE

Excel offers a Formula AutoComplete tool for adding formulas and functions. Rather than a dialogue box with the function arguments as labeled fields, the Formulas AutoComplete will show a small tool tip showing the function with the field names.

Task: Use the Formula AutoComplete

1. Go to the Calculations sheet. Go to cell B9.
2. Type: =AVERA

What Do You See? As you are typing the AutoComplete tool will pop up, showing the matches. The more letters, the more likely the match.

At any point in typing, you may double-click to select the function AVERAGEIFS. Alternately, type the entire function.

Keep going...

Screen image of the Formula AutoComplete

Item	Calculation	Mode	Multi	Result
Mean/Average number of months since last inspection	23	2		2
Median number of months since last inspection	24	2		3
Mode value for range of months since last inspection	24		3	
Total bridge area with Owner: Washtenaw County	283,672		3	
Count if owned by Ann Arbor and rating of >8	18		4	
Find the Max value for number of lanes for bridges owned by MDOT and in Washtenaw County	9			5
Find the oldest bridge (lowest value) in Washtenaw County	1876			
Find the average time since last Inspection for bridges with a rating less than 6 and owned by MDOT.				

- MO-201: Microsoft Excel Create Advanced Formulas and Macros
- 3.1 Perform logical operations in formulas
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CONTINUE BUILDING A FORMULA WITH AUTOCOMPLETE

Some users may prefer working within the formula bar and entering the parts of the function for workflow. Understanding how the formula is structured can help with reviewing for accuracy.

Task: Add Function Arguments in the Formula Bar

Before You Begin: At the top in the formula bar is the function name and the first parentheses.

Beside the cell, there is a ToolTip box that shows the parts of the function, including punctuation and parentheses as a guide.)

1. The cursor is in place directly after the parentheses.
2. Type the average_range: INSPFREQ

Where INSPFREQ is the Named Range for Column L.

3. Type a comma to mark the end of the average_range. Keep going...

Make A Mistake? If you select the Calculations sheet, it will be entered as the sheet for the range. Use the backspace to remove the sheet name—including the apostrophe marks that indicate it is a sheet name.

Formulas-> Function Library-> More Functions-> Statistical->MINIFS

The screenshot shows an Excel spreadsheet with the following data:

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	23	2
Median number of months since last inspection	24	3
Mode value for range of months since last inspection	24	3
Total bridge area with Owner: Washtenaw County	283,672	3
Count if owned by Ann Arbor and rating of >8	18	4
Find the Max value for number of lanes for bridges owned by MDOT and in Washtenaw County	9	5
Find the oldest bridge (lowest value) in Washtenaw County	1876	
Find the average time since last inspection for bridges with a rating less than 6 and owned by MDOT.		

The formula bar shows the following text: `=averageifs(INSPFREQ`. A tooltip for the **AVERAGEIFS** function is displayed, showing the syntax: `AVERAGEIFS(average_range, criteria_range1, criteria1, ...)` and the description: "Finds average(arithmetic mean) for the cells".

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FUNCTION ARGUMENT CRITERIA PUNCTUATION

Criteria in a function are enclosed in quotation marks. When using the Function Argument dialogue box, Excel will add the quote marks to anything added to the Criteria field. They need to be typed in the formula bar when using the AutoComplete function.

Task: Edit the AVERAGEIFS Arguments

1. Add Criteria_Range1: OWNER.
2. Type a comma to end the Criteria_Range1.
3. Add Criteria1: "MDOT"
4. Type a comma to end the function argument.
5. Add Criteria_Range2: Lowest_Rating.
6. Type a comma to end the Criteria_Range2.
7. Add Criteria2: ">6"
8. Type a comma to end the function argument.
9. Type a close parentheses) to end the function.
10. Hit enter to complete the formula.

The formula should look like this:

`=AVERAGEIFS(INSPFREQ,OWNER,"MDOT",Lowest_Rating,">6")`

The AVERAGEIFS returned a value of 24.

Formulas-> Function Library-> More Functions-> Statistical->AVERAGEIFS

The screenshot shows an Excel spreadsheet with the following data:

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	23	2
Median number of months since last inspection	24	3
Mode value for range of months since last inspection	24	3
Total bridge area with Owner: Washtenaw County	283,672	3
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Find the Max value for number of lanes for bridges owned by MDOT and in Washtenaw County	9	5
Find the oldest bridge (lowest value) in Washtenaw County	1876	
Find the average time since last inspection for bridges with a rating less than 6 and owned by MDOT.		
for bridges owned	9	5
Washtenaw	1876	
tion for bridges with		

The formula bar shows the formula: `=AVERAGEIFS(INSPFREQ,OWNER,"MDOT",Lowest_Rating,">6")`

The formula bar also shows the autocomplete options: `AVERAGEIFS(average_range, criteria_range1, criteria1, [criteria_range2, criteria2], [criteria_range3, criteria3], ...)`

HANDLING A FORMULA ERROR

A formula or function can be edited by typing changes directly in the formula bar. This requires understanding the parts of the formula to make changes in the correct place and maintain the punctuation.

Task: Edit a Function incorrectly, then correct

1. Select cell B6.
Click the Formula Bar to edit the formula.
2. Change Criteria2 to: <7

Leave off the quotation marks to trigger the error. What does the error mean? Excel has noticed that the function is incomplete. Without the quotation marks, the function is missing the criteria.

Click OK to accept the error and continue.

3. Return to the formula bar. Edit the formula to change <7 to "<8"

Keep going...

Best Practice is to Read all warning and error messages before closing the message.

Start->Microsoft Excel

The screenshot shows the Microsoft Excel interface with a formula bar containing the following formula: `=COUNTIFS(OWNER,"Washtenaw County",Lowest_Rating,>7)`. The formula bar is highlighted, and the error message is displayed. The error message text is as follows:

Microsoft Excel

There's a problem with this formula.

Not trying to type a formula?
When the first character is an equal (=) or minus (-) sign, Excel thinks it's a formula:

- you type: =1+1, cell shows: 2

To get around this, type an apostrophe (') first:

- you type: '=1+1, cell shows: =1+1

Buttons: OK, Help

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REVIEW THE FUNCTION ARGUMENTS

Regardless of how the function was added to a cell, the function arguments window can be opened to review or edit the arguments. The Fx button to the left of the formula bar is one method to open the Function Arguments dialogue box.

Task: Open the Function Arguments on an existing Function

1. Go to B6.
2. Click the Fx button to the left of the formula bar.
3. Review the function arguments. We can see the fields have populated with the criteria we typed using Autocomplete.
4. Click OK to close the dialogue box again

The More You Know: Using the Insert Function button on the Formulas bar will also open the Function Arguments dialogue box if the cell contains an existing function.

Review a Formula

The screenshot shows the Microsoft Excel interface with the Function Arguments dialog box open for the COUNTIFS function. The dialog box displays the following criteria and ranges:

Criteria	Criteria Range	Criteria
Criteria1	OWNER	"Washtenaw County"
Criteria2	Lowest_Rating	">=8"

The dialog box also shows the formula result as 18 and provides a description of the function: "Counts the number of cells specified by a given set of conditions or criteria." The criteria are defined as: "Criteria2: is the condition in the form of a number, expression, or text that defines which cells will be counted."

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UNIT SUMMARY

Well done!

In this Unit we learned about Statistical Functions. We started with the basic functions of Mode, Median and Mean (Average).

Then we moved into the *IF and *IFS families of functions using one or more criteria. We looked at the use of operators and text values in functions.

We also explored using the Formula AutoComplete as well as how to handle errors in a formula.

You may save your work.

Screen image of the completed calculations

Item	Calculation	Mode Multi Result
Mean/Average number of months since last inspection	23	2
Median number of months since last inspection	24	3
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Find the average time since last Inspection for bridges with a rating less than 6 and owned by MDOT.	24	



UNIT REVIEW

1. SUMIF calculates based on a single criteria, while SUMIFS can calculate based on more than one criteria.

- A. True
- B. False

2. In SUMIF or other *IF function, the data to be summed must be in the same range that the criteria is based on.

- A. True
- B. False

3. Each function argument in a SUMIFS or other *IFS function includes what?

- A. A range and criteria
- B. A range and condition
- C. A function and a criteria
- D. A condition and a criteria

4. Which of the following can be used in a function argument for a SUMIFS and other *IFS functions? (Give all correct answers)

- A. an equation to find an exact number value
- B. an equation to find an exact text value
- C. operators such as greater than or less than in an equation
- D. Wild card characters

5. What happens when typing a formula in the formula bar?

- A. The Insert Function dialogue box will open
- B. The Formula AutoComplete tool tip will appear to show the parts of the function
- C. The AutoSum function will complete the formula



