CALCULATED FIELDS WITH DAX

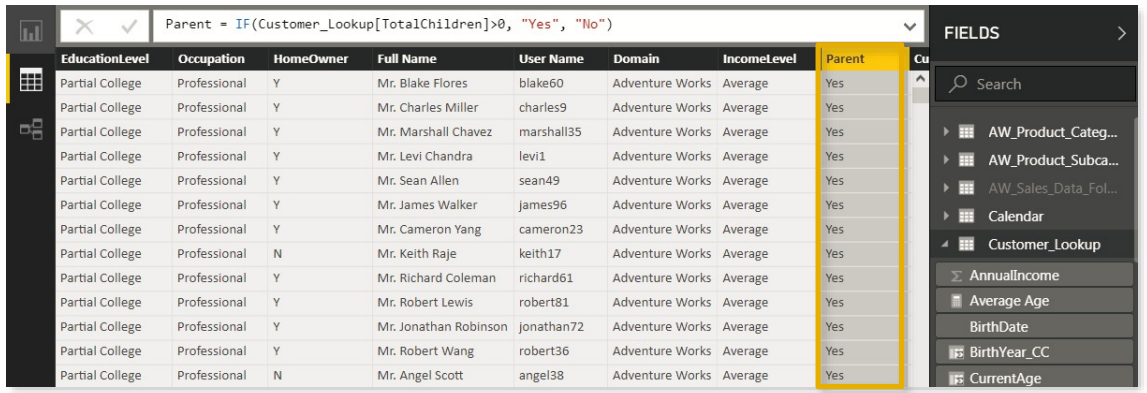
MEET **DAX**

Data Analysis Expressions, commonly known as **DAX**, is the formula language that drives Power BI. With DAX, you can:

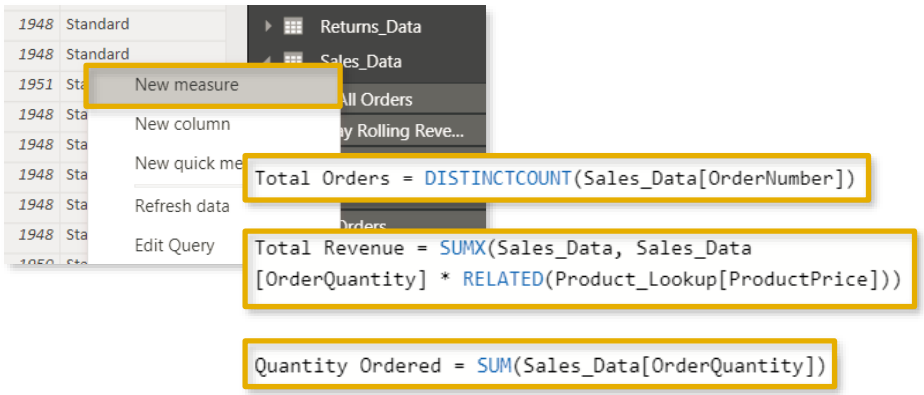
- Add ***calculated columns*** and ***measures*** to your model, using intuitive syntax
- Go beyond the capabilities of traditional "grid-style" formulas, with powerful and flexible functions built specifically to work with relational data models

Two ways to use DAX

1) Calculated Columns



2) Measures



CALCULATED COLUMNS

Calculated columns allow you to add new, formula-based columns to tables

- No "A1-style" references; calculated columns refer to **entire tables** or **columns**
- Calculated columns generate values for each row, which are **visible within tables in the Data view**
- Calculated columns understand **row context**; they're great for defining properties based on information in each row, but generally useless for aggregation (*SUM, COUNT, etc*)

HEY THIS IS IMPORTANT!

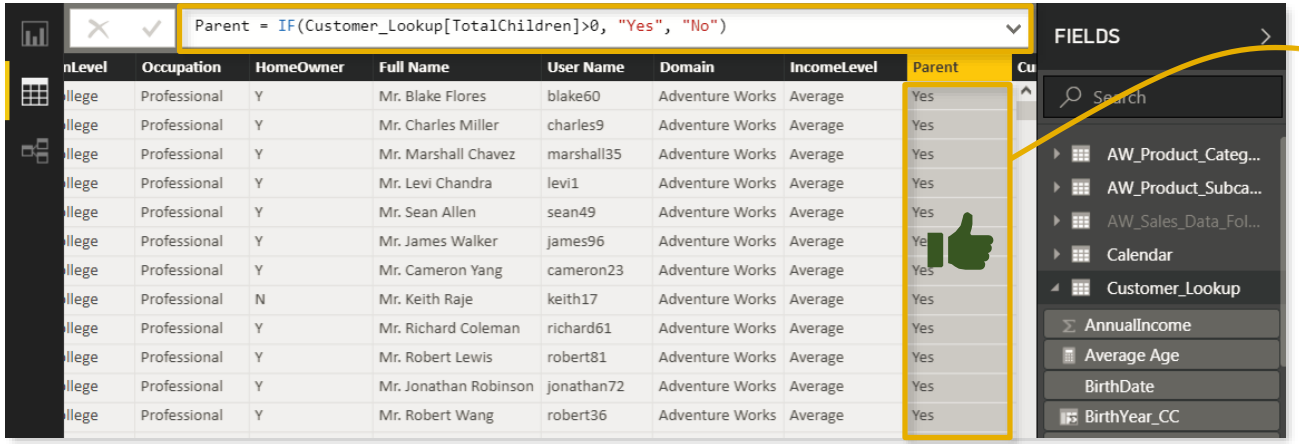
As a rule of thumb, use calculated columns when you want to "stamp" static, fixed values to each row in a table (*or use the Query Editor!*)

DO NOT use calculated columns for aggregation formulas, or to calculate fields for the "Values" area of a visualization (use **measures** instead)

PRO TIP:

*Calculated columns are typically used for **filtering** data, rather than creating numerical values*

CALCULATED COLUMNS (EXAMPLES)



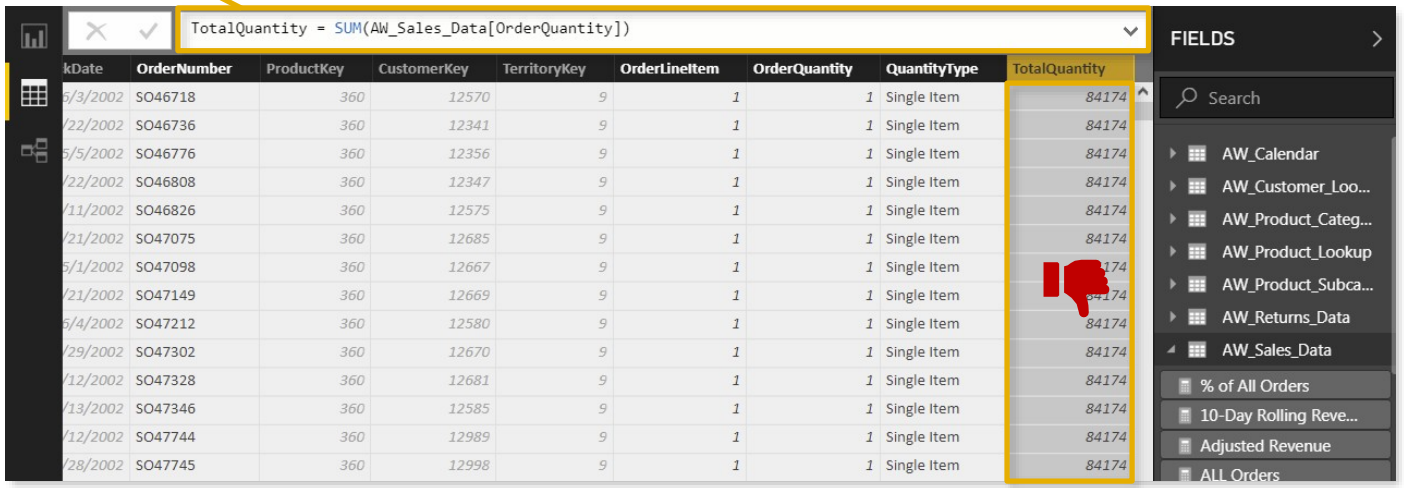
nLevel	Occupation	HomeOwner	Full Name	User Name	Domain	IncomeLevel	Parent	Cu
llege	Professional	Y	Mr. Blake Flores	blake60	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Charles Miller	charles9	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Marshall Chavez	marshall35	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Levi Chandra	levi1	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Sean Allen	sean49	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. James Walker	james96	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Cameron Yang	cameron23	Adventure Works	Average	Yes	
llege	Professional	N	Mr. Keith Raje	keith17	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Richard Coleman	richard61	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Robert Lewis	robert81	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Jonathan Robinson	jonathan72	Adventure Works	Average	Yes	
llege	Professional	Y	Mr. Robert Wang	robert36	Adventure Works	Average	Yes	

In this case we've added a **calculated column** named **"Parent"**, which equals "***Yes***" if the [TotalChildren] field is greater than 0, and "***No***" otherwise (*just like Excel!*)

- Since calculated columns understand **row context**, a new value is calculated in each row based on the value in the [TotalChildren] column
- This is a **valid use** of calculated columns; it creates a new row "property" that we can now use to filter or segment any related data within the model

Here we're using an aggregation function (SUM) to calculate a new column named **TotalQuantity**

- Since calculated columns do not understand **filter context**, the same grand total is returned in *every single row* of the table
- This is **not a valid use** of calculated columns; these values are statically "stamped" onto the table and can't be filtered, sliced, subdivided, etc.



kDate	OrderNumber	ProductKey	CustomerKey	TerritoryKey	OrderLineItem	OrderQuantity	QuantityType	TotalQuantity
6/3/2002	SO46718	360	12570	9	1	1	Single Item	84174
/22/2002	SO46736	360	12341	9	1	1	Single Item	84174
6/5/2002	SO46776	360	12356	9	1	1	Single Item	84174
/22/2002	SO46808	360	12347	9	1	1	Single Item	84174
/11/2002	SO46826	360	12575	9	1	1	Single Item	84174
/21/2002	SO47075	360	12685	9	1	1	Single Item	84174
6/1/2002	SO47098	360	12667	9	1	1	Single Item	174
/21/2002	SO47149	360	12669	9	1	1	Single Item	174
6/4/2002	SO47212	360	12580	9	1	1	Single Item	84174
/29/2002	SO47302	360	12670	9	1	1	Single Item	84174
/12/2002	SO47328	360	12681	9	1	1	Single Item	84174
/13/2002	SO47346	360	12585	9	1	1	Single Item	84174
/12/2002	SO47744	360	12989	9	1	1	Single Item	84174
/28/2002	SO47745	360	12998	9	1	1	Single Item	84174

MEASURES

Measures are DAX formulas used to generate new calculated values

- Like calculated columns, measures reference **entire tables** or **columns** (*no A1-style or "grid" references*)
- *Unlike* calculated columns, **measure** values aren't visible within tables; they can only be "*seen*" within a visualization like a chart or matrix (*similar to a calculated field in an Excel pivot*)
- Measures are evaluated based on **filter context**, which means they recalculate when the fields or filters around them change (*like when new row or column labels are pulled into a matrix or when new filters are applied to a report*)

HEY THIS IS IMPORTANT!

As a rule of thumb, use measures (*vs. calculated columns*) when a single row can't give you the answer (*in other words, when you need to **aggregate***)

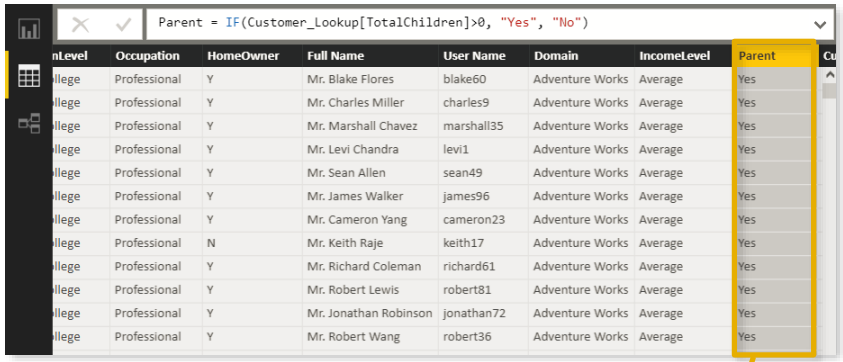
PRO TIP:

*Use measures to create **numerical, calculated values** that can be analyzed in the "**values**" field of a report visual*

RECAP: CALCULATED COLUMNS VS. MEASURES

CALCULATED COLUMNS

- Values are calculated based on information from each row of a table (has **row context**)
- Appends static values to each row in a table and stores them in the model (*which increases file size*)
- Recalculate on data source refresh or when changes are made to component columns
- Primarily used as **rows**, **columns**, **slicers** or **filters**



*Calculated columns "live" in **tables***

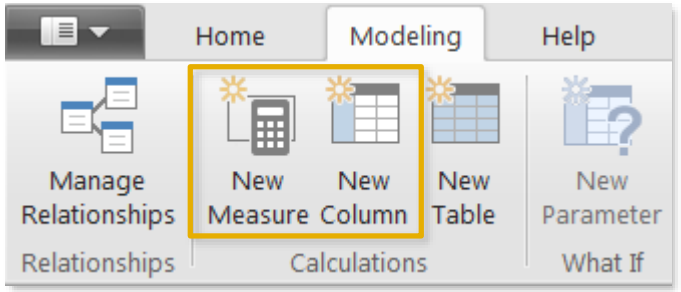
MEASURES

- Values are calculated based on information from any filters in the report (has **filter context**)
- Does not create new data in the tables themselves (*doesn't increase file size*)
- Recalculate in response to any change to filters within the report
- Almost *always* used within the **values** field of a visual

*Measures "live" in **visuals***

ADDING COLUMNS & MEASURES

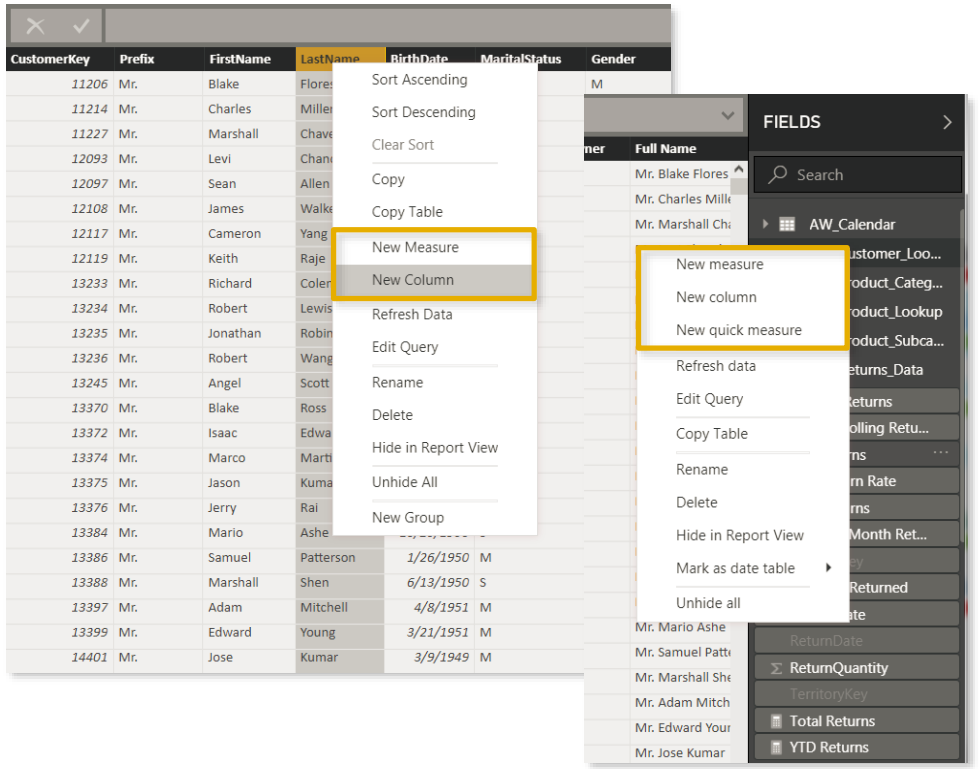
Option 1: Select "**New Measure**" or "**New Column**" from the **Modeling** tab



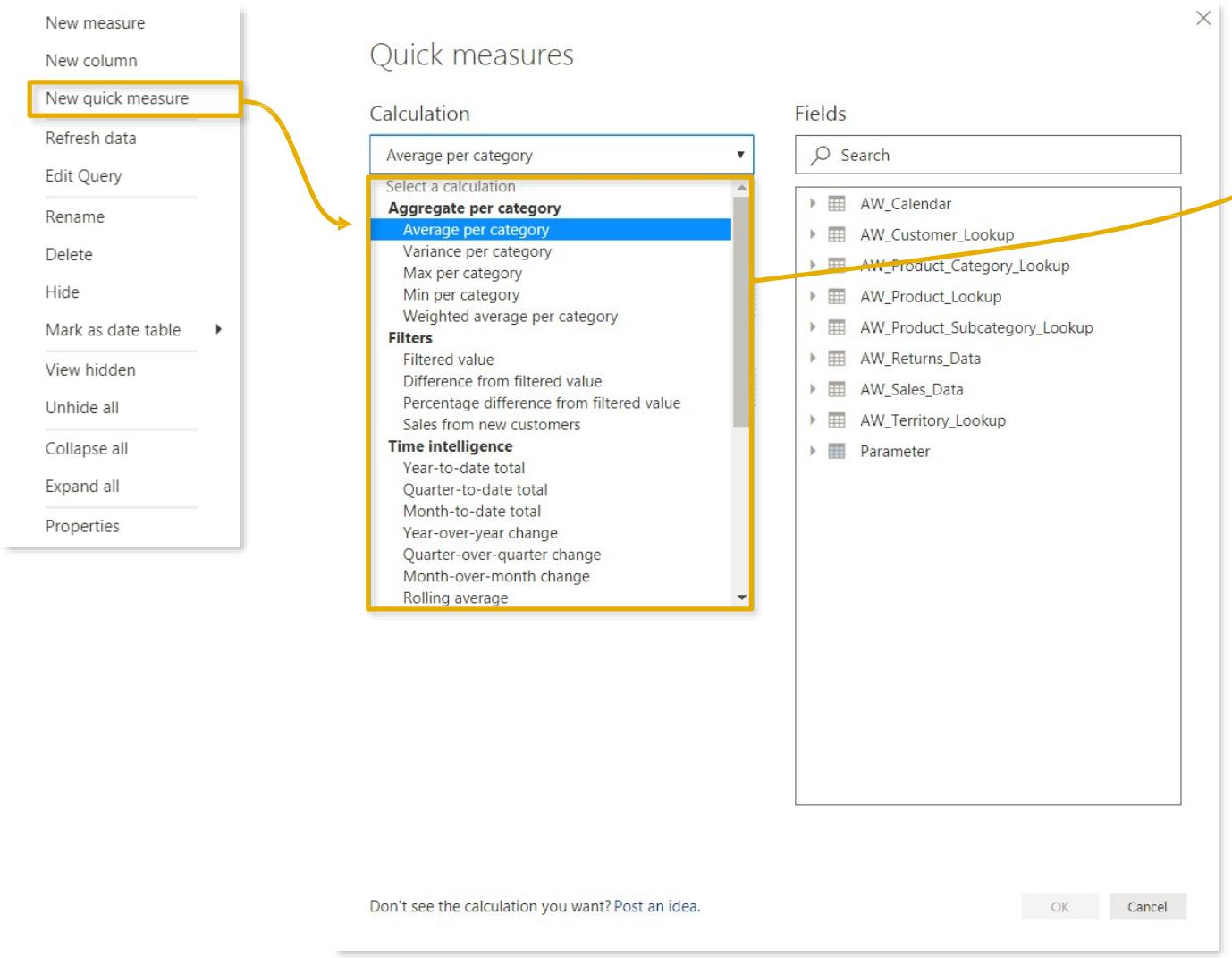
When you insert Columns or Measures using the **Modeling** tab (Option 1), they are assigned to whichever table is *currently selected*, or the *first table in the field list* by default

- Measures can be reassigned to new "Home" tables (under the "*Properties*" options in the **Modeling** tab), but the Option 2 allows you to be more deliberate about placing them
  - ***Note:*** *Assigning measures to specific tables doesn't have any impact on functionality – it's just a way to keep them organized*

Option 2: Right-click within the **table** (in the **Data** view) or the **Field List** (in either the **Data** or **Report** view)



QUICK MEASURES



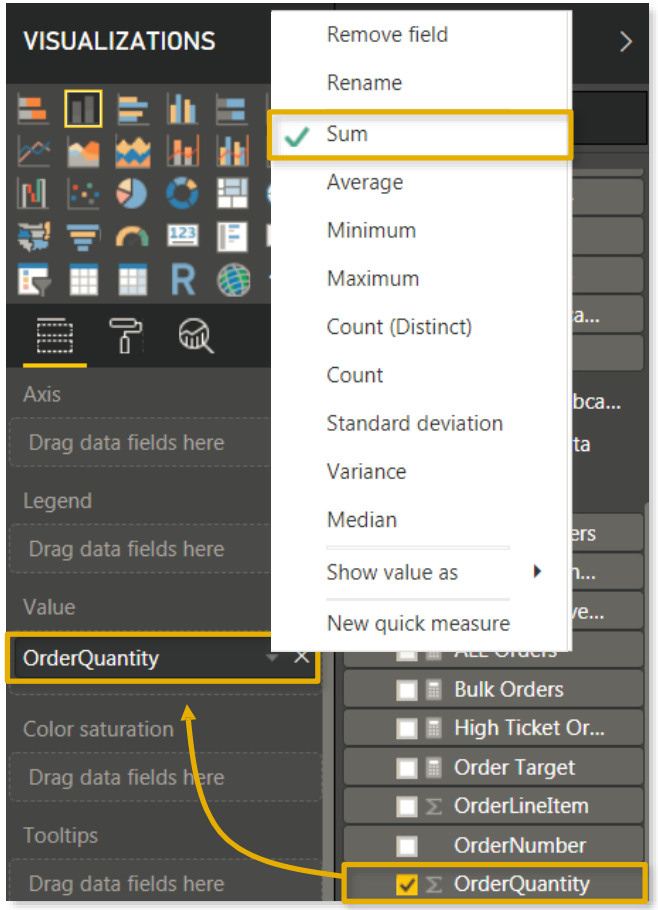
Quick Measures are pre-built formula templates that allow you to drag and drop fields, rather than write DAX from scratch

While these tools can be helpful for defining more complex measures (*like weighted averages or time intelligence formulas*), they encourage laziness and don't help you understand the fundamentals of DAX

PRO TIP:

*Just say "**NO**" to quick measures*
(you're better than that)

IMPLICIT VS. EXPLICIT MEASURES



*Example of an **implicit measure***

Implicit measures are created when you drag raw numerical fields (like "*OrderQuantity*") into the values pane of a visual and manually select the aggregation mode (*Sum, Average, Min/Max, etc*)

Explicit measures are created by actually entering DAX functions (or adding "*quick measures*") to define calculated columns or measures

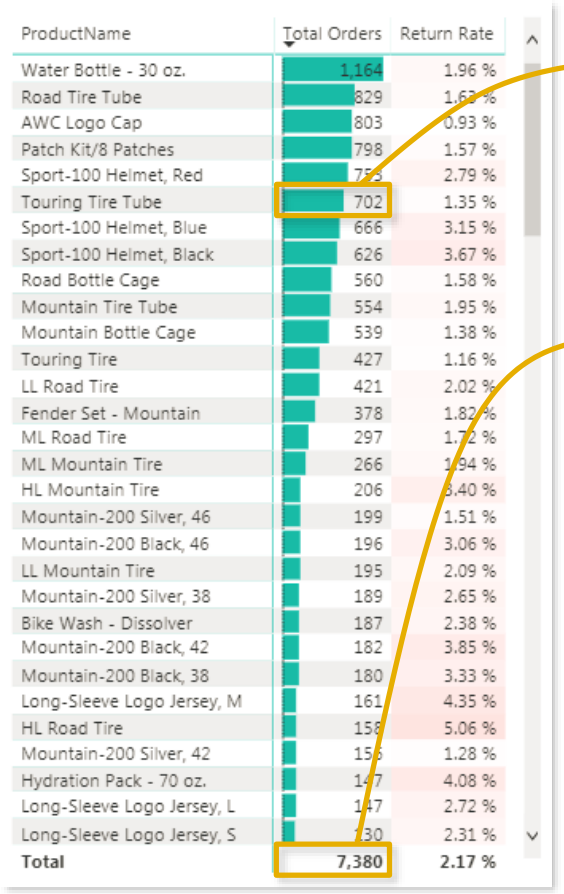
HEY THIS IS IMPORTANT!

Implicit measures are *only accessible* within the specific visualization in which it was created, and cannot be referenced elsewhere

Explicit measures can be used anywhere in the report, and referenced within other DAX calculations to create "measure trees"

UNDERSTANDING FILTER CONTEXT

Remember that measures are evaluated based on **filter context**, which means that they recalculate whenever the fields or filters around them change



ProductName	Total Orders	Return Rate
Water Bottle - 30 oz.	1,164	1.96 %
Road Tire Tube	829	1.63 %
AWC Logo Cap	803	0.93 %
Patch Kit/8 Patches	798	1.57 %
Sport-100 Helmet, Red	775	2.79 %
Touring Tire Tube	702	1.35 %
Sport-100 Helmet, Blue	666	3.15 %
Sport-100 Helmet, Black	626	3.67 %
Road Bottle Cage	560	1.58 %
Mountain Tire Tube	554	1.95 %
Mountain Bottle Cage	539	1.38 %
Touring Tire	427	1.16 %
LL Road Tire	421	2.02 %
Fender Set - Mountain	378	1.82 %
ML Road Tire	297	1.72 %
ML Mountain Tire	266	1.94 %
HL Mountain Tire	206	3.40 %
Mountain-200 Silver, 46	199	1.51 %
Mountain-200 Black, 46	196	3.06 %
LL Mountain Tire	195	2.09 %
Mountain-200 Silver, 38	189	2.65 %
Bike Wash - Dissolver	187	2.38 %
Mountain-200 Black, 42	182	3.85 %
Mountain-200 Black, 38	180	3.33 %
Long-Sleeve Logo Jersey, M	161	4.35 %
HL Road Tire	158	5.06 %
Mountain-200 Silver, 42	156	1.28 %
Hydration Pack - 70 oz.	147	4.08 %
Long-Sleeve Logo Jersey, L	147	2.72 %
Long-Sleeve Logo Jersey, S	130	2.31 %
Total	**7,380**	**2.17 %**

For this particular value in the matrix, the **Total Orders** measure is calculated based on the following filter context: *Products[**ProductName**] = "**Touring Tire Tube**"*

- This allows the measure to return the total order quantity for each product specifically (or whatever the row and column labels dictate – *years, countries, product categories, customer names,* etc)

This Total is ***not*** calculated by summing the values above; it evaluates as its own measure, with **no filter context** (*since we aren't calculating orders for a specific product*)

HEY THIS IS IMPORTANT!

Each measure value in a report is ***like an island***, and calculates according to it's own filter context (*even Totals and Grand Totals*)

FILTER CONTEXT (EXAMPLES)

MEASURE: Total Revenue

FILTER CONTEXT:

- *Calendar[**Year**]* = 2016 *or* 2017
- *Customers[**Full Name**]* = Mr. Larry Munoz

MEASURE: Total Orders

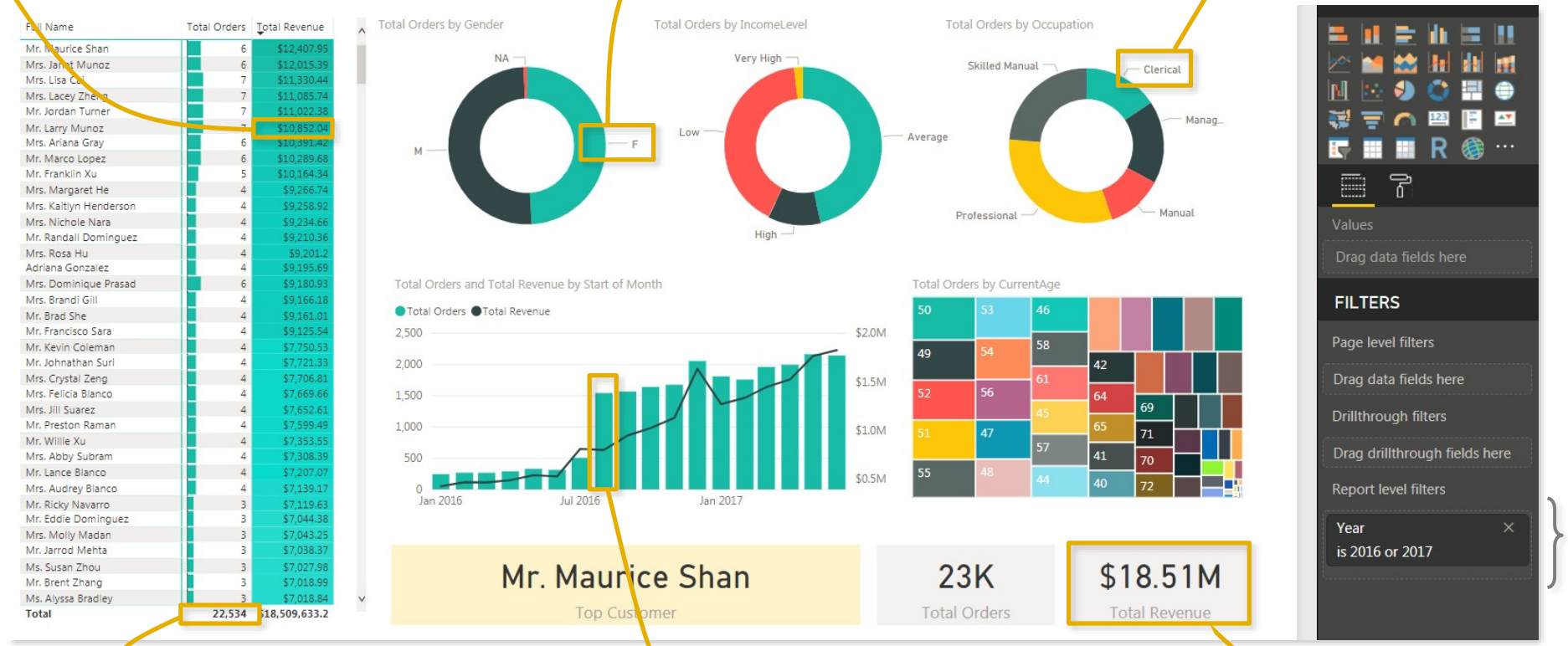
FILTER CONTEXT:

- *Calendar[**Year**]* = 2016 *or* 2017
- *Customers[**Gender**]* = F (Female)

MEASURE: Total Orders

FILTER CONTEXT:

- *Calendar[**Year**]* = 2016 *or* 2017
- *Customers[**Occupation**]* = Clerical



*This is **a page-level filter**, which impact **ALL** visuals on the report page*

MEASURE: Total Orders

FILTER CONTEXT:

- *Calendar[**Year**]* = 2016 *or* 2017

MEASURE: Total Orders

FILTER CONTEXT:

- *Calendar[**Year**]* = 2016 *or* 2017
- *Calendar[**Month**]* = August 2016

MEASURE: Total Revenue

FILTER CONTEXT:

- *Calendar[**Year**]* = 2016 *or* 2017

STEP-BY-STEP MEASURE CALCULATION

CategoryName	Total Returns
Accessories	1,115
Bikes	342
Clothing	267

How *exactly* is this measure calculated?

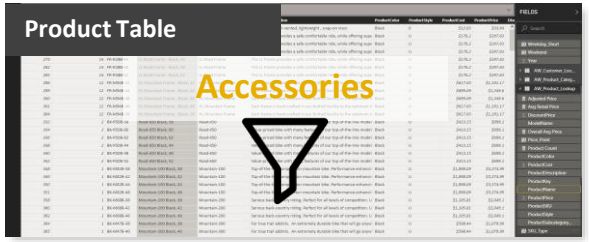
- **REMEMBER:** This all happens *instantly* behind the scenes, every time the filter context changes

STEP 1

Filter context is detected & applied

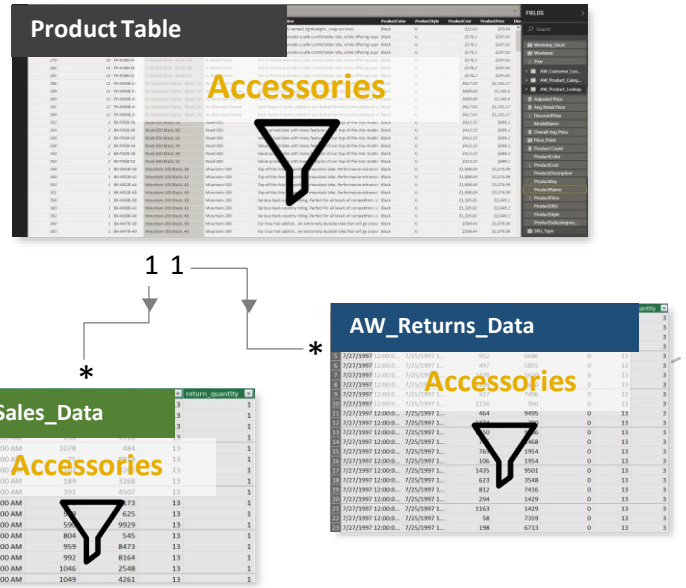
CategoryName	Total Returns
Accessories	1,115
Bikes	342
Clothing	267

Product[**CategoryName**] = "Accessories"



STEP 2

Filters flow "downstream" to all related tables



STEP 3

Measure formula evaluates against the filtered table

```
Total Returns = COUNTROWS(AW_Returns_Data)
```

*Count of rows in the **AW_Returns_Data** table, filtered down to only rows where the product category is "Accessories"* **= 1,115**

COMMON DAX FUNCTIONS

DAX SYNTAX

MEASURE NAME

- ***Note:*** *Measures are always surrounded in brackets (i.e.* ***[Total Quantity]****) when referenced in formulas, so spaces are OK*

Referenced **TABLE NAME**

Referenced **COLUMN NAME**

Total Quantity: =SUM(Transactions[quantity])

FUNCTION NAME

- Calculated columns don't always use functions, but measures do:
  - In a **Calculated Column**, **=Transactions[quantity]** returns the value from the quantity column in each row (*since it evaluates one row at a time*)
  - In a **Measure**, **=Transactions[quantity]** will return an ***error*** since Power BI doesn't know how to translate that as a single value (*you need some sort of aggregation*)

Note: *This is a* ***"fully qualified"*** *column, since it's preceeded by the table name -- table names with spaces must be surrounded by* ***single quotes****:*

- *Without a space:* ***Transactions****[quantity]*
- *With a space:* ***'Transactions Table'****[quantity]*

PRO TIP:

For ***column*** *references, use the fully qualified name (i.e.* ***Table[Column]****)*
For ***measure*** *references, just use the measure name (i.e.* ***[Measure]****)*

DAX OPERATORS

Arithmetic Operator	Meaning	Example
+	Addition	2 + 7
-	Subtraction	5 – 3
*	Multiplication	2 * 6
/	Division	4 / 2
^	Exponent	2 ^ 5

Comparison Operator	Meaning	Example
=	Equal to	[City]="Boston"
>	Greater than	[Quantity]>10
<	Less than	[Quantity]<10
>=	Greater than or equal to	[Unit_Price]>=2.5
<=	Less than or equal to	[Unit_Price]<=2.5
<>	Not equal to	[Country]<>"Mexico"

Pay attention to these!

Text/Logical Operator	Meaning	Example
&	Concatenates two values to produce one text string	[City] & " " & [State]
&&	Create an AND condition between two logical expressions	([State]="MA") && ([Quantity]>10)
|| (double pipe)	Create an OR condition between two logical expressions	([State]="MA") || ([State]="CT")
IN	Creates a logical OR condition based on a given list (using curly brackets)	'Store Lookup'[State] IN { "MA", "CT", "NY" }

Head to **www.msdn.microsoft.com for more information about DAX syntax, operators, troubleshooting, etc*

COMMON FUNCTION CATEGORIES

MATH & STATS Functions

*Basic **aggregation** functions as well as "**iterators**" evaluated at the row-level*

Common Examples:

- SUM
- AVERAGE
- MAX/MIN
- DIVIDE
- COUNT/COUNTA
- COUNTROWS
- DISTINCTCOUNT

Iterator Functions:

- SUMX
- AVERAGEX
- MAXX/MINX
- RANKX
- COUNTX

LOGICAL Functions

*Functions for returning information about values in a given **conditional expression***

Common Examples:

- IF
- IFERROR
- AND
- OR
- NOT
- SWITCH
- TRUE
- FALSE

TEXT Functions

*Functions to manipulate **text strings** or **control formats** for dates, times or numbers*

Common Examples:

- CONCATENATE
- FORMAT
- LEFT/MID/RIGHT
- UPPER/LOWER
- PROPER
- LEN
- SEARCH/FIND
- REPLACE
- REPT
- SUBSTITUTE
- TRIM
- UNICHAR

FILTER Functions

***Lookup** functions based on related tables and **filtering** functions for dynamic calculations*

Common Examples:

- CALCULATE
- FILTER
- ALL
- ALLEXCEPT
- RELATED
- RELATEDTABLE
- DISTINCT
- VALUES
- EARLIER/EARLIEST
- HASONEVALUE
- HASONEFILTER
- ISFILTERED
- USERELATIONSHIP

DATE & TIME Functions

*Basic **date and time** functions as well as advanced **time intelligence** operations*

Common Examples:

- DATEDIFF
- YEARFRAC
- YEAR/MONTH/DAY
- HOUR/MINUTE/SECOND
- TODAY/NOW
- WEEKDAY/WEEKNUM

Time Intelligence Functions:

- DATESYTD
- DATESQTD
- DATESMTD
- DATEADD
- DATESINPERIOD

****Note:** This is NOT a comprehensive list (does not include trigonometry functions, parent/child functions, information functions, or other less common functions)*

BASIC DATE & TIME FUNCTIONS

DAY/MONTH/ YEAR()	*Returns the day of the month (1-31), month of the year (1-12), or year of a given date*	=**DAY/MONTH/YEAR**(Date)
HOUR/MINUTE/ SECOND()	*Returns the hour (0-23), minute (0-59), or second (0-59) of a given datetime value*	=**HOUR/MINUTE/SECOND**(Datetime)
TODAY/NOW()	*Returns the current date or exact time*	=**TODAY/NOW**()
WEEKDAY/ WEEKNUM()	*Returns a weekday number from 1 (Sunday) to 7 (Saturday), or the week # of the year*	=**WEEKDAY/WEEKNUM**(Date, *[ReturnType]*)
EOMONTH()	*Returns the date of the last day of the month, +/- a specified number of months*	=**EOMONTH**(StartDate, Months)
DATEDIFF()	*Returns the difference between two dates, based on a selected interval*	=**DATEDIFF**(Date1, Date2, Interval)

BASIC LOGICAL FUNCTIONS (IF/AND/OR)

IF()	*Checks if a given condition is met, and returns one value if the condition is TRUE, and another if the condition is FALSE*	=**IF**(LogicalTest, ResultIfTrue, *[ResultIfFalse]*)
IFERROR()	*Evaluates an expression and returns a specified value if the expression returns an error, otherwise returns the expression itself*	=**IFERROR**(Value, ValueIfError)
AND()	*Checks whether both arguments are TRUE, and returns TRUE if both arguments are TRUE, otherwise returns FALSE*	=**AND**(Logical1, Logical2)
OR()	*Checks whether one of the arguments is TRUE to return TRUE, and returns FALSE if both arguments are FALSE*	=**OR**(Logical1, Logical2)

Note: *Use the **&&** and **||** operators if you want to include more than two conditions!*

TEXT FUNCTIONS

LEN()	*Returns the number of characters in a string*	=**LEN**(Text)
CONCATENATE()	*Joins two text strings into one*	=**CONCATENATE**(Text1, Text2)
LEFT/MID/ RIGHT()	*Returns a number of characters from the start/middle/end of a text string*	=**LEFT/RIGHT**(Text, *[NumChars]*) =**MID**(Text, StartPosition, NumChars)
UPPER/LOWER/ PROPER()	*Converts letters in a string to upper/lower/proper case*	=**UPPER/LOWER/PROPER**(Text)
SUBSTITUTE()	*Replaces an instance of existing text with new text in a string*	=**SUBSTITUTE**(Text, OldText, NewText, *[InstanceNumber]*)
SEARCH()	*Returns the position where a specified string or character is found, reading left to right*	=**SEARCH**(FindText, WithinText, *[StartPosition], [NotFoundValue]*)

Note: *Use the* ***&*** *operator as a shortcut, or to combine more than two strings!*

RELATED

RELATED() *Returns related values in each row of a table based on relationships with other tables*

=**RELATED**(ColumnName)

The column that contains the values you want to retrieve

Examples:

- *Product_Lookup[ProductName]*
- *Territory_Lookup[Country]*

HEY THIS IS IMPORTANT!

RELATED works almost *exactly* like a **VLOOKUP** function – it uses the relationship between tables (*defined by primary and foreign keys*) to pull values from one table into a new column of another

Since this function requires row context, it can only be used as a **calculated column** or as part of an **iterator function** that cycles through all rows in a table (*FILTER, SUMX, MAXX, etc*)

PRO TIP:

Avoid using RELATED to create redundant calculated columns unless you absolutely need them, since those extra columns increase file size; instead, use RELATED within a measure like FILTER or SUMX

BASIC MATH & STATS FUNCTIONS

SUM()	*Evaluates the sum of a column*	=**SUM**(ColumnName)
AVERAGE()	*Returns the average (arithmetic mean) of all the numbers in a column*	=**AVERAGE**(ColumnName)
MAX()	*Returns the largest value in a column or between two scalar expressions*	=**MAX**(ColumnName) *or* =**MAX**(Scalar1, *[Scalar2]*)
MIN()	*Returns the smallest value in a column or between two scalar expressions*	=**MIN**(ColumnName) *or* =**MIN**(Scalar1, *[Scalar2]*)
DIVIDE()	*Performs division and returns the alternate result (or blank) if div/0*	=**DIVIDE**(Numerator, Denominator, *[AlternateResult]*)

COUNT, COUNTA, DISTINCTCOUNT & COUNTROWS

COUNT()	*Counts the number of cells in a column that contain numbers*	=COUNT(ColumnName)
COUNTA()	*Counts the number of non-empty cells in a column (numerical and non-numerical)*	=COUNTA(ColumnName)
DISTINCTCOUNT()	*Counts the number of distinct or unique values in a column*	=DISTINCTCOUNT(ColumnName)
COUNTROWS()	*Counts the number of rows in the specified table, or a table defined by an expression*	=COUNTROWS(Table)

CALCULATE

CALCULATE() — *Evaluates a given expression or formula under a set of defined filters*

=**CALCULATE**(Expression, *[Filter1], [Filter2],…*)

Name of an existing measure, or a DAX formula for a valid measure

Examples:

- *[Total Orders]*
- *SUM(Returns_Data[ReturnQuantity])*

*List of simple Boolean (True/False) filter expressions (**note:** these require simple, fixed values; you cannot create filters based on measures)*

Examples:

- *Territory_Lookup[Country] = **"USA"***
- *Calendar[Year] > **1998***

PRO TIP:

*CALCULATE works just like **SUMIF** or **COUNTIF** in Excel, except it can evaluate measures based on ANY sort of calculation (not just a sum, count, etc); it may help to think of it like **"CALCULATEIF"***

CALCULATE (EXAMPLE)

```
Bike Returns = CALCULATE([Total Returns], Products[CategoryName] = "Bikes")
```

CategoryName	Total Returns	Bike Returns
Accessories	1,115	342
Bikes	342	342
Clothing	267	342
Components		342
Total	**1,724**	**342**

Here we've defined a new measure named "**Bike Returns**", which evaluates the "**Total Returns**" measure when the *CategoryName* in the **Products** table equals "**Bikes**"

*Wait, why do we see the **same repeating values** when we view a matrix with different categories on rows?*

*Shouldn't these cells have different filter contexts for **Accessories**, **Clothing**, **Components**, etc?*

HEY THIS IS IMPORTANT!

CALCULATE ***modifies*** and ***overrules*** any competing filter context!

In this example, the "Clothing" row has filter context of CategoryName = "**Clothing**" (*defined by the row label*) ***and*** CategoryName= "**Bikes**" (*defined by the CALCULATE function*)

Both cannot be true at the same time, so the "**Clothing**" filter is overwritten and the "**Bikes**" filter (from CALCULATE) takes priority

CALCULATE **CHANGES** THE FILTER CONTEXT

CALCULATE

Filters modified by CALCULATE

[**CategoryName**] = **"Bikes"**

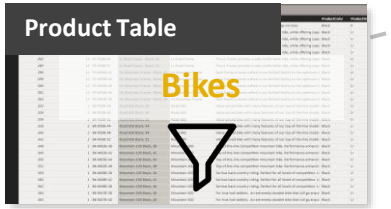
If the measure being evaluated contains a **CALCULATE** function, filter context is *overwritten* between **Step 1** & **Step 2**

STEP 1

Filter context is detected & applied

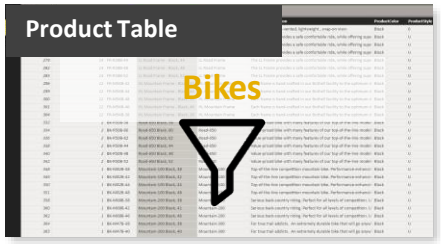
CategoryName	Total Returns	Bike Returns
Accessories	1,115	342
Bikes	342	342
Clothing	267	342
Components		342
Total	**1,724**	**342**

Products[**CategoryName**] = **"Accessories"**



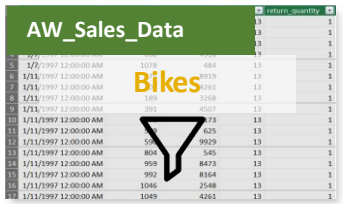
STEP 2

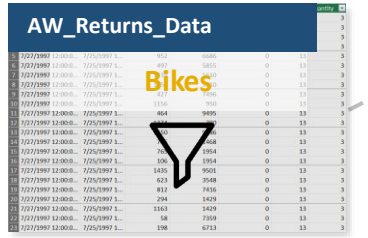
Filters flow "downstream" to all related tables



1 1

* *





STEP 3

Measure formula evaluates against the filtered table

```
Total Returns = COUNTROWS(AW_Returns_Data)
```

*Count of rows in the **AW_Returns_Data** table, filtered down to only rows where the product category is "**Bikes**"* = **342**

ALL

ALL() *Returns all rows in a table, or all values in a column, ignoring any filters that have been applied*

=**ALL**(Table *or* ColumnName, *[ColumnName1], [ColumnName2],…*)

The table or column that you want to clear filters on

Examples:

- *Transactions*
- *Products[ProductCategory]*

List of columns that you want to clear filters on (optional)

Notes:

- *If your first parameter is a table, you can't specify additional columns*
- *All columns must include the table name, and come from the same table*

Examples:

- *Customer_Lookup[CustomerCity], Customer_Lookup[CustomerCountry]*
- *Products[ProductName]*

PRO TIP:

*Instead of adding filter context, ALL **removes it**. This is often used when you need unfiltered values that won't react to changes in filter context (i.e. **% of Total**, where the denominator needs to remain fixed)*

FILTER

FILTER() *Returns a table that represents a subset of another table or expression*

=**FILTER**(Table, FilterExpression)

Table to be filtered

Examples:

- *Territory_Lookup*
- *Customer_Lookup*

A Boolean (True/False) filter expression to be evaluated for each row of the table

Examples:

- *Territory_Lookup[Country] = **"USA"***
- *Calendar[Year] = **1998***
- *Products[Price] > **[Overall Avg Price]***

HEY THIS IS IMPORTANT!

FILTER is used to add new filter context, and can handle ***more complex filter expressions*** than CALCULATE (*by referencing measures, for example*)

Since FILTER returns an entire table, it's almost always used as an *input* to other functions, like CALCULATE or SUMX

PRO TIP:

Since FILTER iterates through each row in a table, it can be slow and processor-intensive; don't use FILTER if a CALCULATE function will accomplish the same thing

ITERATOR ("X") FUNCTIONS

Iterator (or "**X**") **functions** allow you to loop through the same calculation or expression on *each row of a table*, and then apply some sort of aggregation to the results (*SUM*, *MAX*, etc)

=**SUMX**(Table, Expression)

*Aggregation to apply to calculated rows**

Examples:

- *SUMX*
- *COUNTX*
- *AVERAGEX*
- *RANKX*
- *MAXX/MINX*

Table in which the expression will be evaluated

Examples:

- *Sales*
- *FILTER(Sales, RELATED(Products[Category])="Clothing")*

Expression to be evaluated for each row of the given table

Examples:

- *[Total Orders]*
- *Sales[RetailPrice] * Sales[Quantity]*

PRO TIP:

*Imagine the function **adding a temporary new column** to the table, calculating the value in each row (based on the expression) and then applying the aggregation to that new column (like SUMPRODUCT)*

In this example we're looking at **SUMX, but other "X" functions follow a similar syntax*

TIME INTELLIGENCE FORMULAS

Time Intelligence functions allow you to easily calculate common time comparisons:

Performance To-Date

```
=CALCULATE(Measure, DATESYTD(Calendar[Date]))
```

Use **DATESQTD** *for Quarters or* **DATESMTD** *for Months*

Previous Period

```
=CALCULATE(Measure, DATEADD(Calendar[Date], -1, MONTH))
```

*Select an interval (***DAY***,* **MONTH***,* **QUARTER***, or* **YEAR***) and the # of intervals to compare (i.e. previous month, rolling 10-day)*

Running Total

```
=CALCULATE(Measure,
        DATESINPERIOD(Calendar[Date], MAX(Calendar[Date]), -10, DAY))
```

PRO TIP:

To calculate a ***moving average****, use the running total calculation above and divide by the number of intervals*

BEST PRACTICES: CALCULATED COLUMNS & MEASURES

Don’t use a calculated column when a measure will do the trick

- *Only use calculated columns to “stamp” static, fixed values to each row in a table*
- *Use measures when aggregation is necessary, or to create dynamic values in a report*

Write measures for even the simplest calculations *(i.e. Sum of Sales)*

- *Once you create a measure it can be used anywhere in the report and as an input to other, more complex calculations (no implicit measures!)*

Break measures down into simple, component parts

- *DAX is a difficult language to master; focus on practicing and understanding simple components at first, then assemble them into more advanced formulas*

Reference columns with the table name, and measures alone

- *Using “fully qualified” column references (preceeded by the table name) helps make formulas more readable and intuitive, and differentiates them from measure references*

BEST PRACTICES: SPEED & PERFORMANCE

Eliminate redundant columns; keep data tables narrow

- *Data tables should ideally only contain only quantitative values and foreign keys; any extra descriptive columns can usually live in a related lookup table*

Imported columns are better than calculated columns

- *When possible, create calculated columns at the source (i.e. in your raw database) or within the Query Editor; this is more efficient than processing those calculations in the Data Model*

Minimize iterator functions (FILTER, SUMX, etc.)

- *Functions that cycle through each row in a table are "expensive", meaning that they take time and consume processing power*