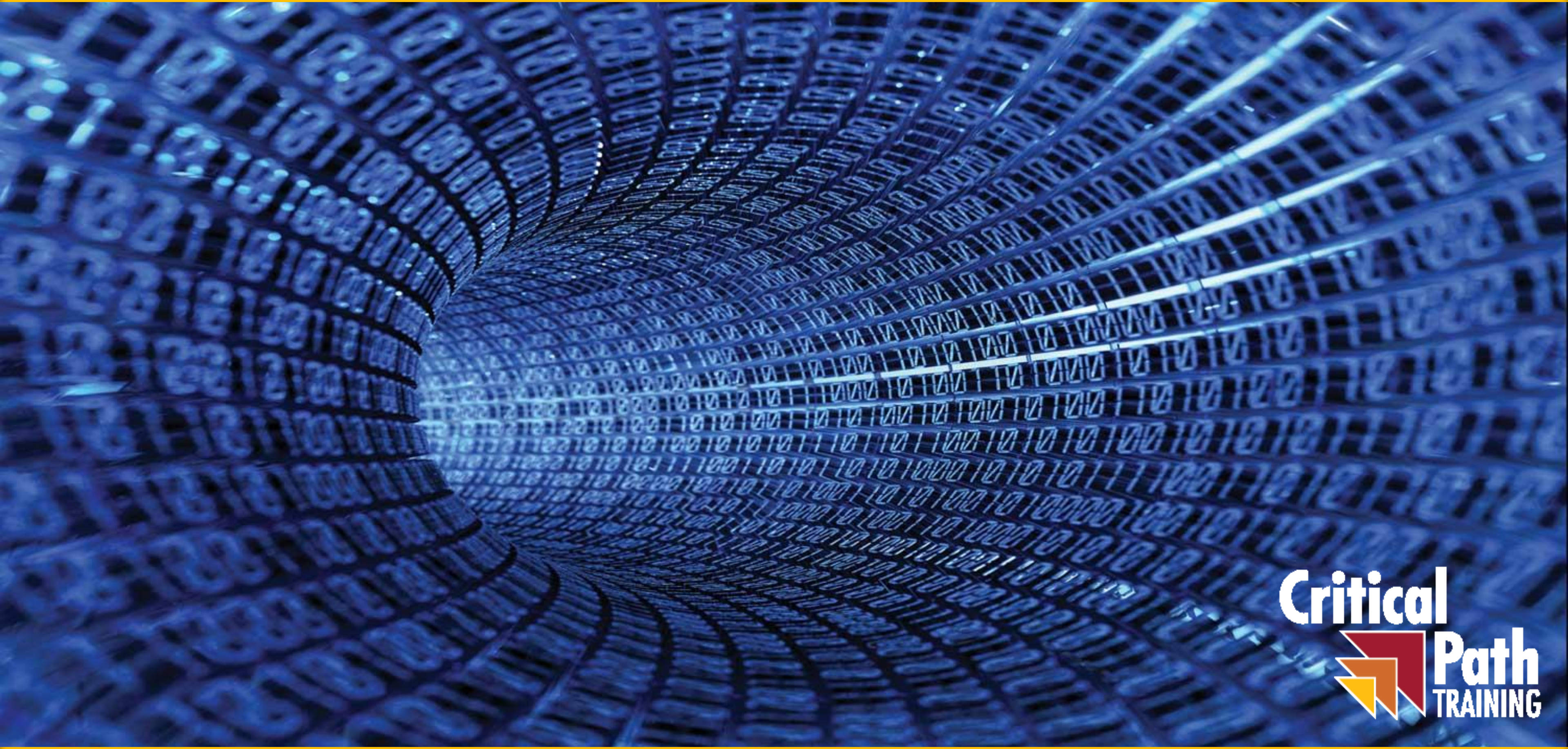
Writing Advanced DAX Expressions



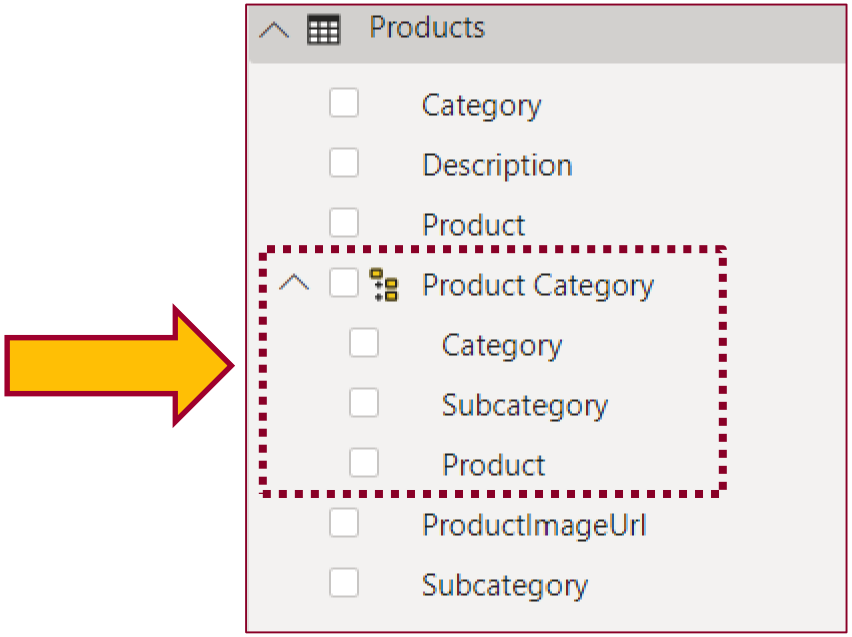
Critical Path TRAINING

Agenda

- Creating Dimensional Hierarchies
- Understanding Evaluation Context and Calculate
- Creating a Calendar Table
- Calling DAX Time Intelligence Functions
- Writing Contextually-aware DAX Expressions
- Calculating the Top 5 Products

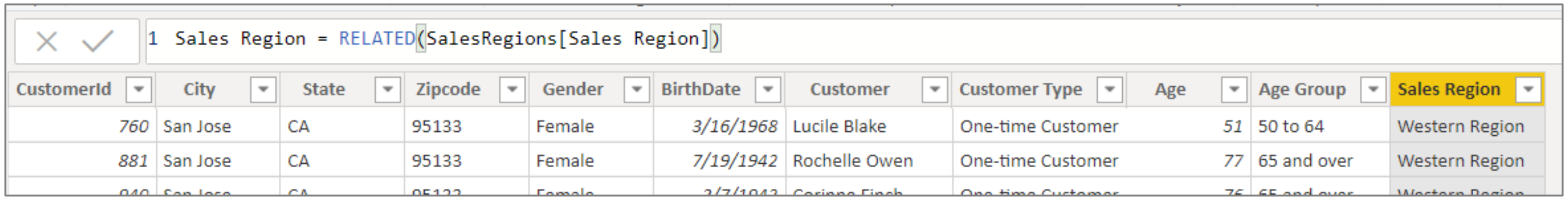
Dimensional Hierarchies

- Hierarchy created from two or more columns
  - All columns in hierarchy must be from the same table
  - Defines parent-child relationship between columns
  - Provides path to navigate through data
  - Provides path to drill down into greater level of detail



Pulling Columns for Hierarchy into Single Table

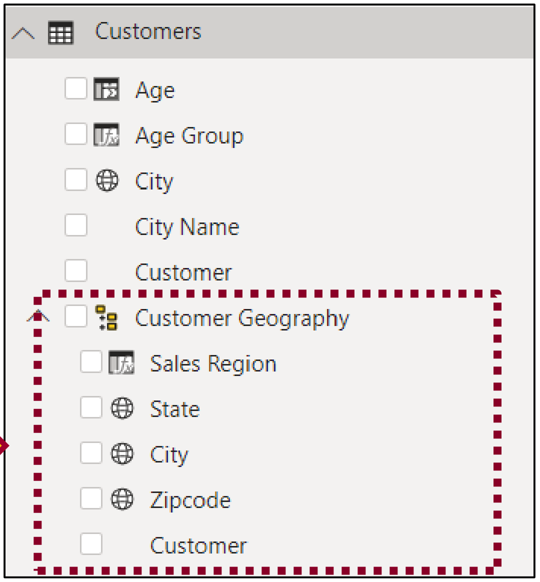
- Sometimes hierarchy columns are spread across tables
  - Use RELATED function from DAX to pull columns into single table



```
Sales Region = RELATED(SalesRegions[Sales Region])
```

CustomerId	City	State	Zipcode	Gender	BirthDate	Customer	Customer Type	Age	Age Group	Sales Region
760	San Jose	CA	95133	Female	3/16/1968	Lucile Blake	One-time Customer	51	50 to 64	Western Region
881	San Jose	CA	95133	Female	7/19/1942	Rochelle Owen	One-time Customer	77	65 and over	Western Region
940	San Jose	CA	95133	Female	3/7/1943	Corinne Finch	One-time Customer	76	65 and over	Western Region

  - Then create hierarchy in the table with all the columns



Customers
- Age
- Age Group
- City
- City Name
- Customer
- Customer Geography
  - Sales Region
  - State
  - City
  - Zipcode
  - Customer

Agenda

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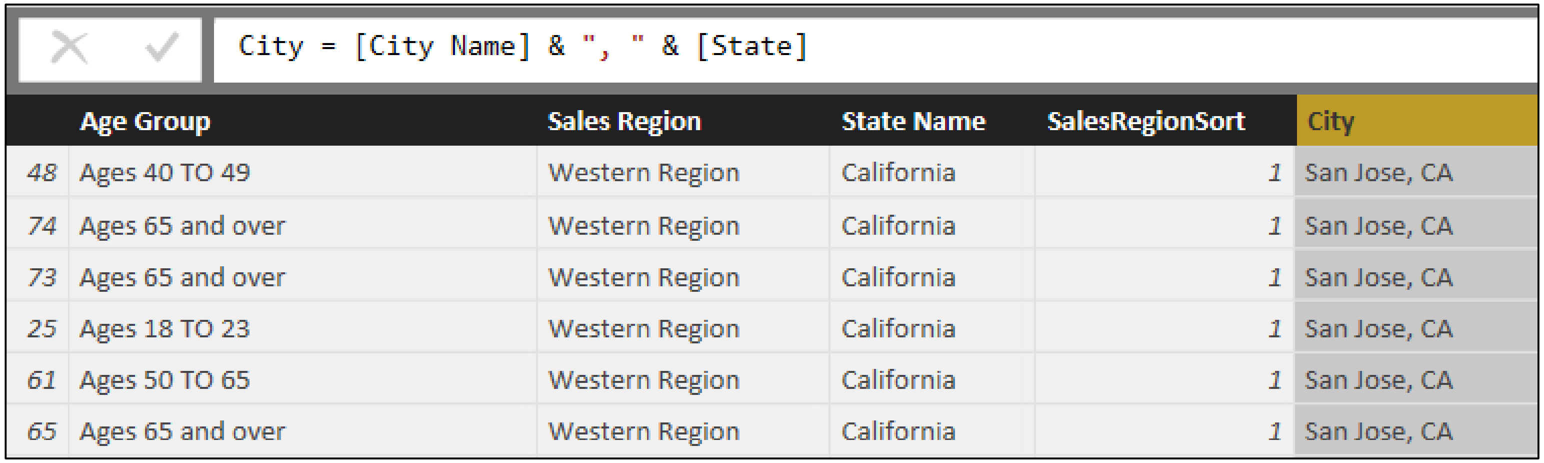
A Tale of Two Evaluation Contexts

- Row Context
  - Context includes all columns in iteration of current row
  - Used to evaluate DAX expression in calculated column
  - Only available in measures with iterator function (e.g. SUMX)

- Filter Context
  - Context includes filter(s) defining current set of rows
  - Used by default to evaluate DAX expressions in measures
  - Can be fully ignored or partially ignored using DAX code
  - Not used to evaluate DAX in calculated columns

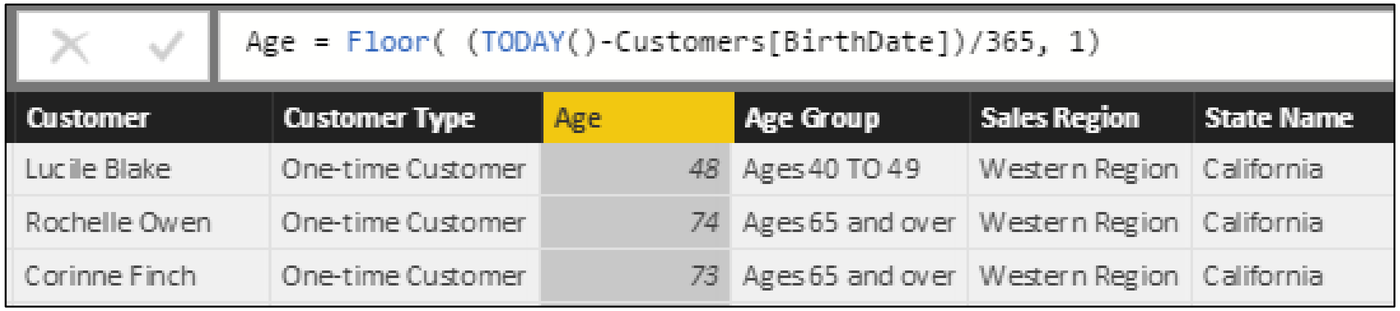
Understanding Row Context

- Row context used to evaluate calculated columns



```
City = [City Name] & ", " & [State]
```

	Age Group	Sales Region	State Name	SalesRegionSort	City
48	Ages 40 TO 49	Western Region	California	1	San Jose, CA
74	Ages 65 and over	Western Region	California	1	San Jose, CA
73	Ages 65 and over	Western Region	California	1	San Jose, CA
25	Ages 18 TO 23	Western Region	California	1	San Jose, CA
61	Ages 50 TO 65	Western Region	California	1	San Jose, CA
65	Ages 65 and over	Western Region	California	1	San Jose, CA

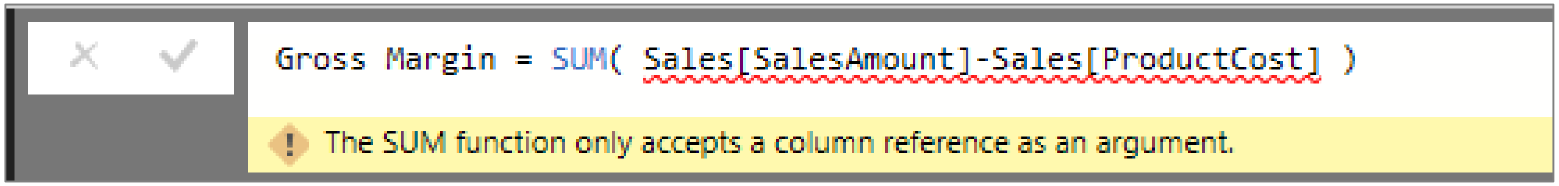


```
Age = Floor( (TODAY()-Customers[BirthDate])/365, 1)
```

Customer	Customer Type	Age	Age Group	Sales Region	State Name
Lucile Blake	One-time Customer	48	Ages 40 TO 49	Western Region	California
Rochelle Owen	One-time Customer	74	Ages 65 and over	Western Region	California
Corinne Finch	One-time Customer	73	Ages 65 and over	Western Region	California

Understanding Iterators Like SUMX

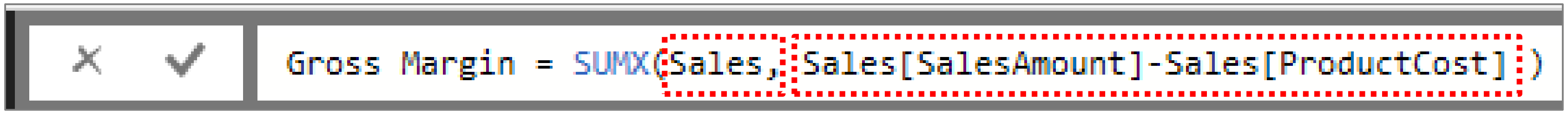
- Standard aggregation functions (e.g. SUM) have no row context
  - You can use SUM to sum values of a single column
  - You cannot use SUM to sum results of an expressions



```
Gross Margin = SUM( Sales[SalesAmount]-Sales[ProductCost] )
```

The SUM function only accepts a column reference as an argument.

- Iterator functions (e.g. SUMX) iterate through rows in target table

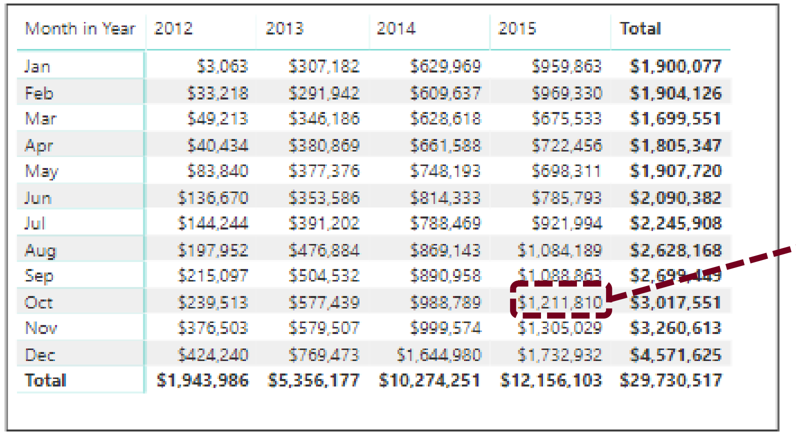


```
Gross Margin = SUMX(Sales, Sales[SalesAmount]-Sales[ProductCost] )
```

  - First argument accepts expressions that evaluates to table of rows
  - Second argument accepts expression that is evaluated for each row

Understanding Filter Context

- Visuals apply various filters in different evaluation contexts



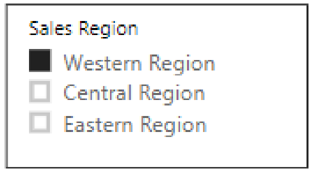
Month in Year	2012	2013	2014	2015	Total
Jan	$3,063	$307,182	$629,969	$959,863	**$1,900,077**
Feb	$33,218	$291,942	$609,637	$969,330	**$1,904,126**
Mar	$49,213	$346,186	$628,618	$675,533	**$1,699,551**
Apr	$40,434	$380,869	$661,588	$722,456	**$1,805,347**
May	$83,840	$377,376	$748,193	$698,311	**$1,907,720**
Jun	$136,670	$353,586	$814,333	$785,793	**$2,090,382**
Jul	$144,244	$391,202	$788,469	$921,994	**$2,245,908**
Aug	$197,952	$476,884	$869,143	$1,084,189	**$2,628,168**
Sep	$215,097	$504,532	$890,958	$1,088,863	**$2,699,449**
Oct	$239,513	$577,439	$988,789	$1,211,810	**$3,017,551**
Nov	$376,503	$579,507	$999,574	$1,305,029	**$3,260,613**
Dec	$424,240	$769,473	$1,644,980	$1,732,932	**$4,571,625**
Total	**$1,943,986**	**$5,356,177**	**$10,274,251**	**$12,156,103**	**$29,730,517**

Filters on this evaluation

[Year] = 2015

[Month in Year] = "October"

- Filter context also affected by slicers and other filters

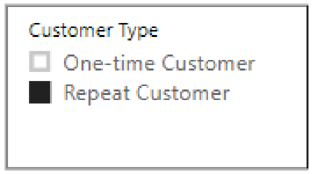


Sales Region

■ Western Region

☐ Central Region

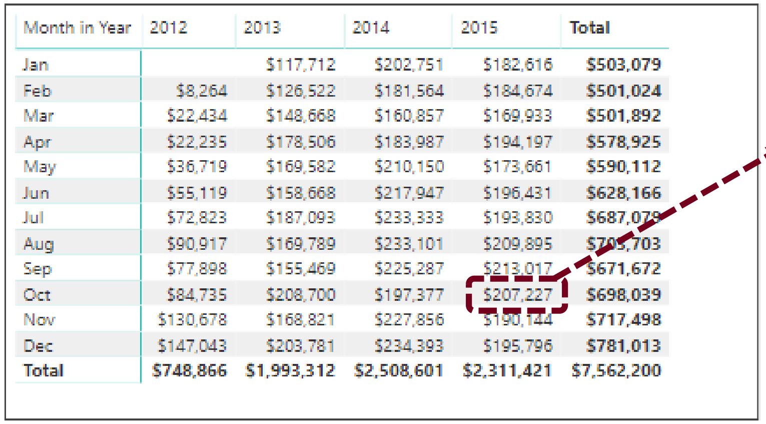
☐ Eastern Region



Customer Type

☐ One-time Customer

■ Repeat Customer



Month in Year	2012	2013	2014	2015	Total
Jan		$117,712	$202,751	$182,616	**$503,079**
Feb	$8,264	$126,522	$181,564	$184,674	**$501,024**
Mar	$22,434	$148,668	$160,857	$169,933	**$501,892**
Apr	$22,235	$178,506	$183,987	$194,197	**$578,925**
May	$36,719	$169,582	$210,150	$173,661	**$590,112**
Jun	$55,119	$158,668	$217,947	$196,431	**$628,166**
Jul	$72,823	$187,093	$233,333	$193,830	**$687,079**
Aug	$90,917	$169,789	$233,101	$209,895	**$703,703**
Sep	$77,898	$155,469	$225,287	$213,017	**$671,672**
Oct	$84,735	$208,700	$197,377	$207,227	**$698,039**
Nov	$130,678	$168,821	$227,856	$190,144	**$717,498**
Dec	$147,043	$203,781	$234,393	$195,796	**$781,013**
Total	**$748,866**	**$1,993,312**	**$2,508,601**	**$2,311,421**	**$7,562,200**

Filters on this evaluation

[Year] = 2015

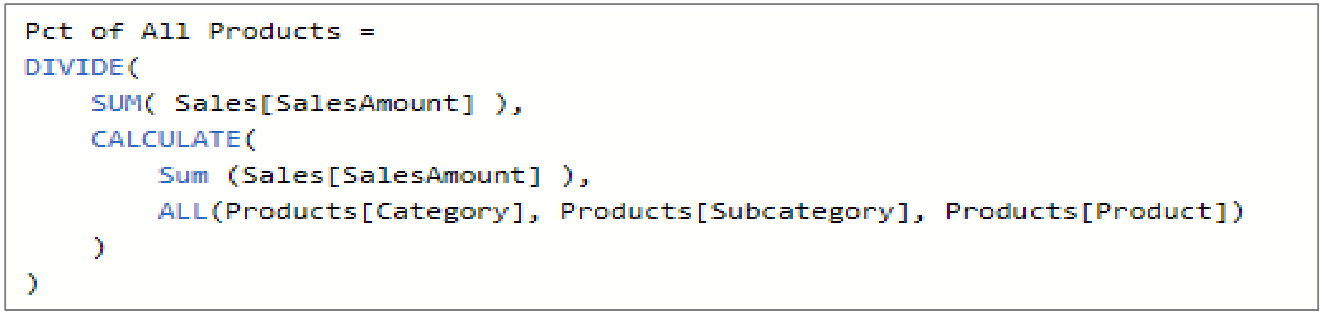
[Month in Year] = "October"

[Sales Region] = "Western Region"

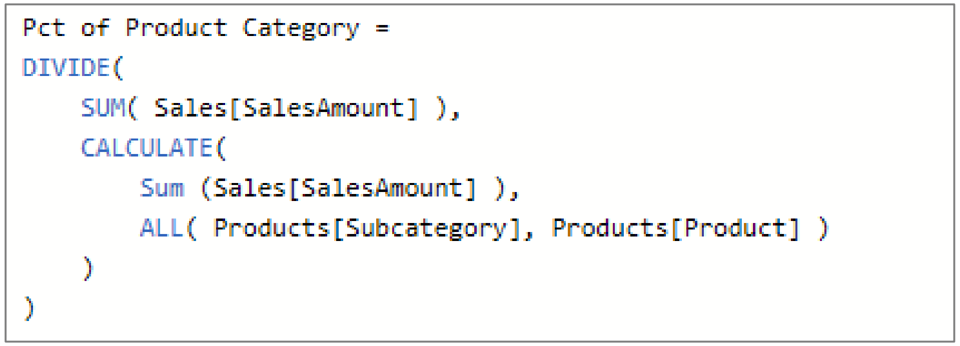
[Customer Type] = "Repeat Customer"

Using the CALCULATE Function

- CALCULATE function provides greatest amount of control
  - First argument defines expression to evaluate
  - Second argument defines table on which to evaluate expression
  - You can evaluate expressions with or without current filter context



```
Pct of All Products =
DIVIDE(
    SUM( Sales[SalesAmount] ),
    CALCULATE(
        Sum (Sales[SalesAmount] ),
        ALL(Products[Category], Products[Subcategory], Products[Product])
    )
)
```



```
Pct of Product Category =
DIVIDE(
    SUM( Sales[SalesAmount] ),
    CALCULATE(
        Sum (Sales[SalesAmount] ),
        ALL( Products[Subcategory], Products[Product] )
    )
)
```

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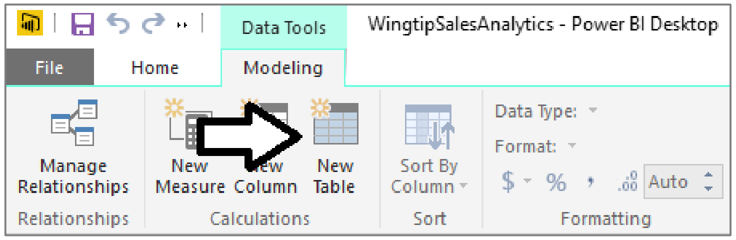
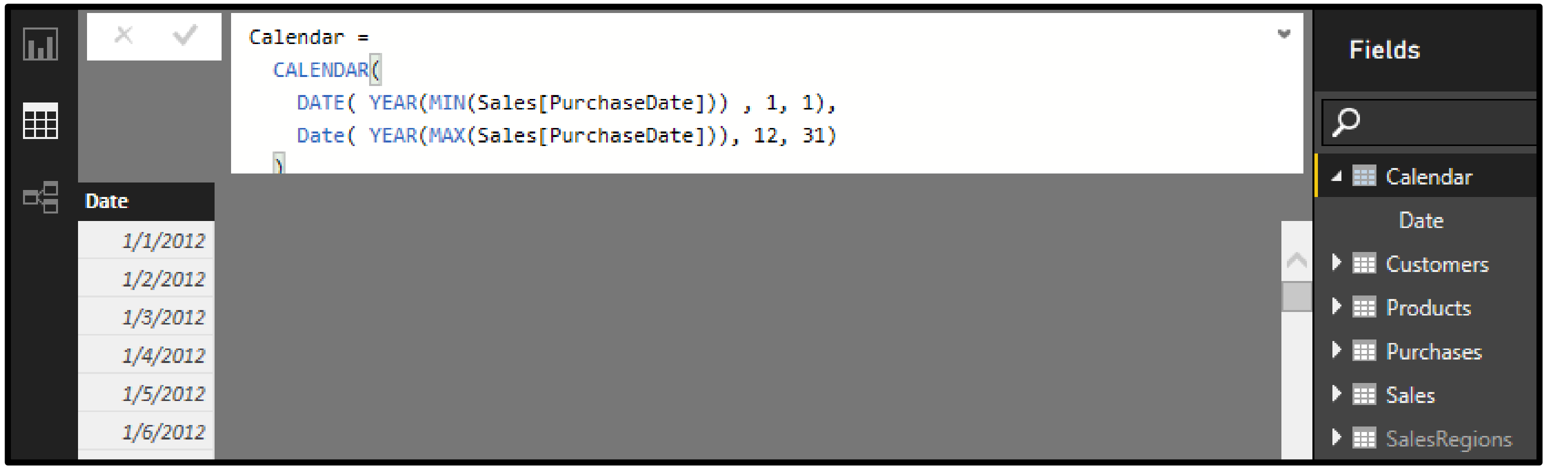
Creating Calendar Table as Calculated Table

- Use **New Table** command in ribbon



- Create calendar table using DAX **CALENDAR** function

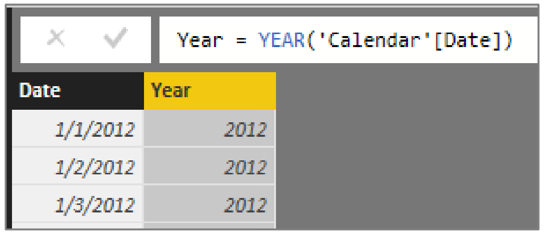


```
Calendar =
  CALENDAR(
    DATE( YEAR(MIN(Sales[PurchaseDate])) , 1, 1),
    Date( YEAR(MAX(Sales[PurchaseDate])), 12, 31)
  )
```

Date
1/1/2012
1/2/2012
1/3/2012
1/4/2012
1/5/2012
1/6/2012

Adding Columns to Calendar Table

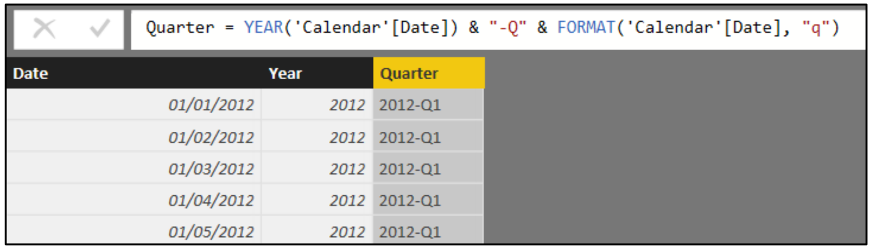
- Creating the **Year** column



```
Year = YEAR('Calendar'[Date])
```

Date	Year
1/1/2012	2012
1/2/2012	2012
1/3/2012	2012

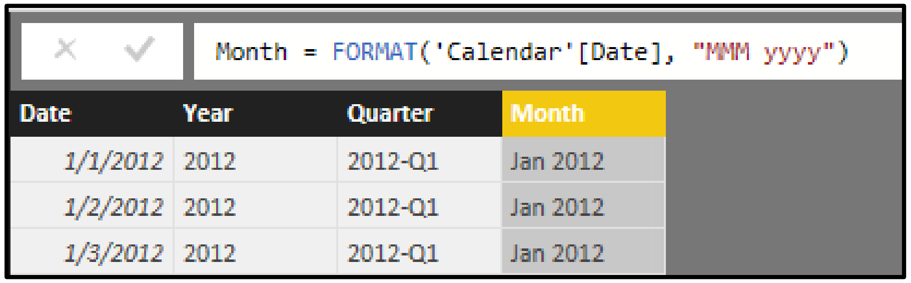
- Creating the **Quarter** column



```
Quarter = YEAR('Calendar'[Date]) & "-Q" & FORMAT('Calendar'[Date], "q")
```

Date	Year	Quarter
01/01/2012	2012	2012-Q1
01/02/2012	2012	2012-Q1
01/03/2012	2012	2012-Q1
01/04/2012	2012	2012-Q1
01/05/2012	2012	2012-Q1

- Creating the **Month** column



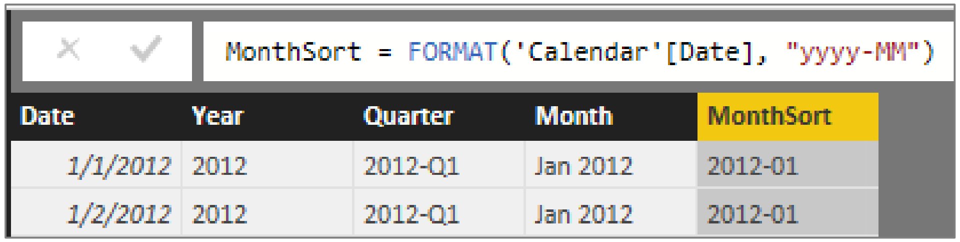
```
Month = FORMAT('Calendar'[Date], "MMM yyyy")
```

Date	Year	Quarter	Month
1/1/2012	2012	2012-Q1	Jan 2012
1/2/2012	2012	2012-Q1	Jan 2012
1/3/2012	2012	2012-Q1	Jan 2012

Configuring Sort Columns

- Month column will not sort in desired fashion by default
  - For example, April will sort before January, February and March

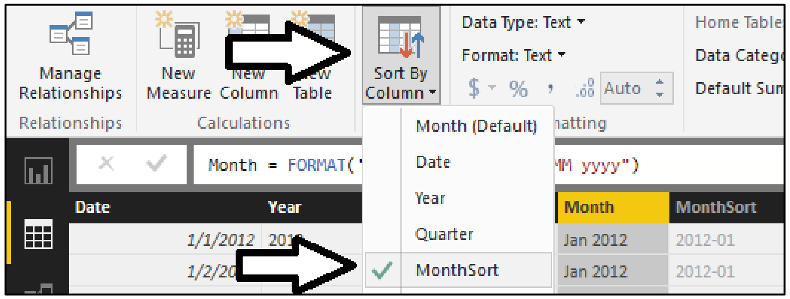
- Creating a sort column for the **Month** column
  - **MonthSort** sorts alphabetically & chronologically at same time



```
MonthSort = FORMAT('Calendar'[Date], "yyyy-MM")
```

Date	Year	Quarter	Month	MonthSort
1/1/2012	2012	2012-Q1	Jan 2012	2012-01
1/2/2012	2012	2012-Q1	Jan 2012	2012-01

  - Configure **Month** column with **MonthSort** as sort column

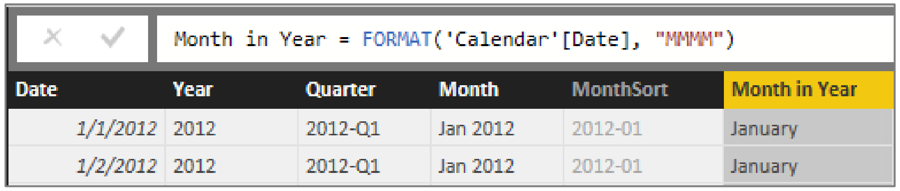


```
Month = FORMAT('
MM yyyy")
```

Date	Year	Month	MonthSort
1/1/2012	201	Jan 2012	2012-01
1/2/20		Jan 2012	2012-01

Columns for Month in Year and Day in week

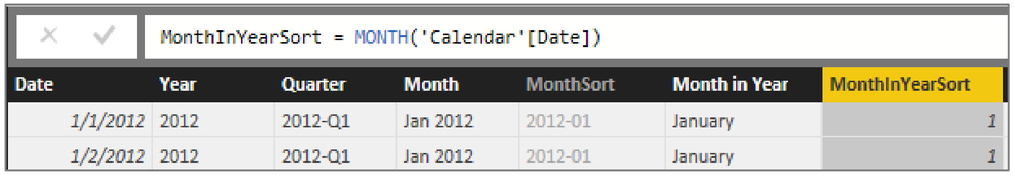
- Creating the **Month in Year** column



```
Month in Year = FORMAT('Calendar'[Date], "MMMM")
```

Date	Year	Quarter	Month	MonthSort	Month in Year
1/1/2012	2012	2012-Q1	Jan 2012	2012-01	January
1/2/2012	2012	2012-Q1	Jan 2012	2012-01	January

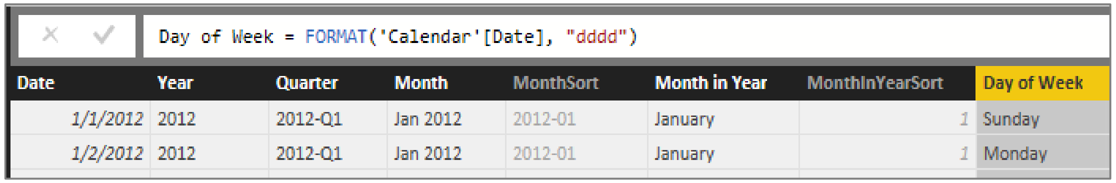
- Creating the **MonthInYearSort** column



```
MonthInYearSort = MONTH('Calendar'[Date])
```

Date	Year	Quarter	Month	MonthSort	Month in Year	MonthInYearSort
1/1/2012	2012	2012-Q1	Jan 2012	2012-01	January	1
1/2/2012	2012	2012-Q1	Jan 2012	2012-01	January	1

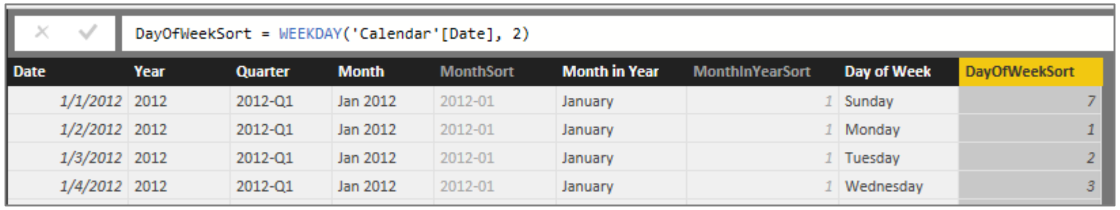
- Creating the **Day of Week** column



```
Day of Week = FORMAT('Calendar'[Date], "dddd")
```

Date	Year	Quarter	Month	MonthSort	Month in Year	MonthInYearSort	Day of Week
1/1/2012	2012	2012-Q1	Jan 2012	2012-01	January	1	Sunday
1/2/2012	2012	2012-Q1	Jan 2012	2012-01	January	1	Monday

- Creating the **DayOfWeekSort** column

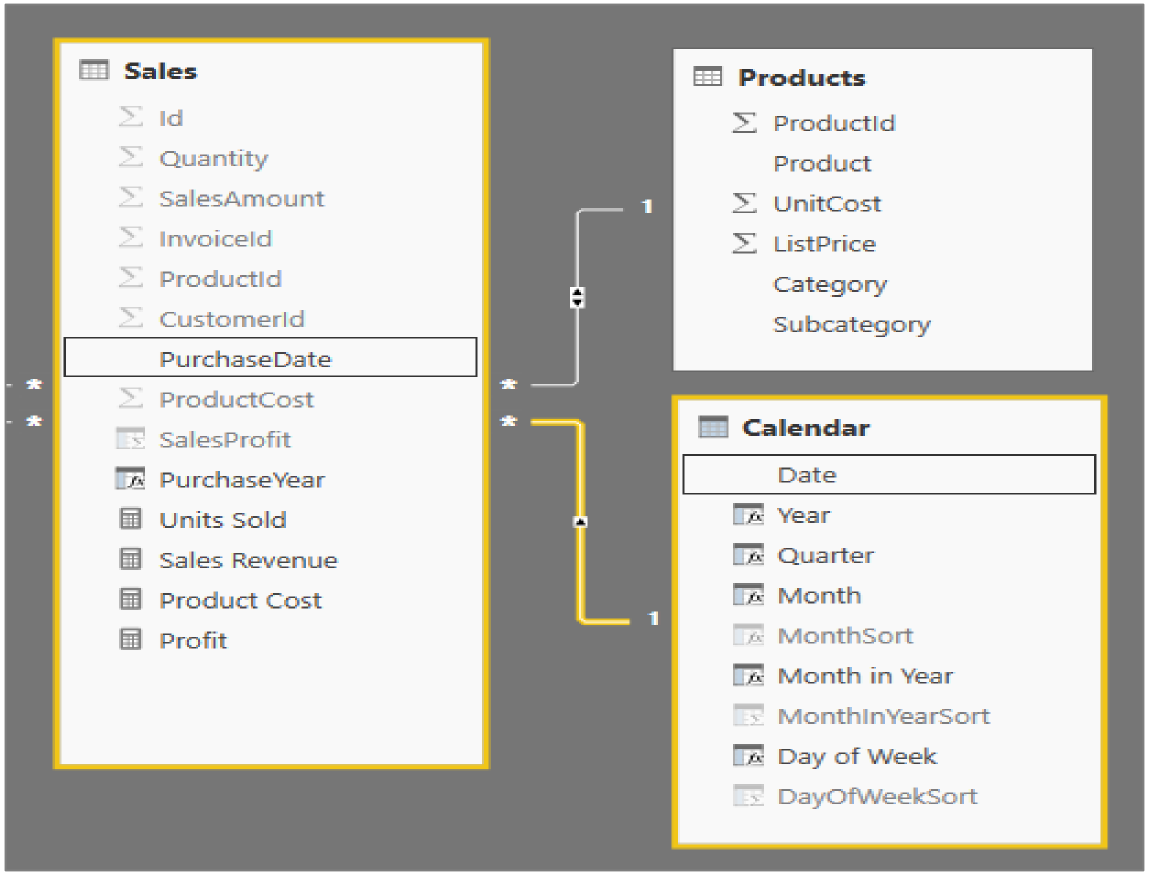


```
DayOfWeekSort = WEEKDAY('Calendar'[Date], 2)
```

Date	Year	Quarter	Month	MonthSort	Month in Year	MonthInYearSort	Day of Week	DayOfWeekSort
1/1/2012	2012	2012-Q1	Jan 2012	2012-01	January	1	Sunday	7
1/2/2012	2012	2012-Q1	Jan 2012	2012-01	January	1	Monday	1
1/3/2012	2012	2012-Q1	Jan 2012	2012-01	January	1	Tuesday	2
1/4/2012	2012	2012-Q1	Jan 2012	2012-01	January	1	Wednesday	3

Integrating Calendar Table into Data Model

- Calendar table needs relationship to one or more tables



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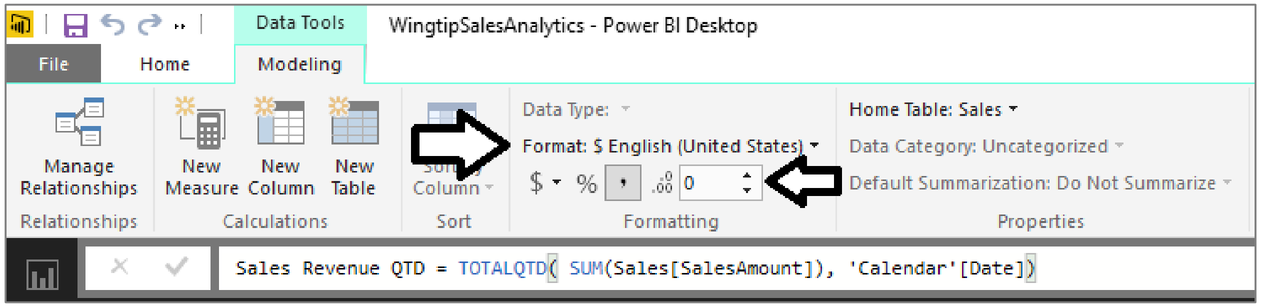
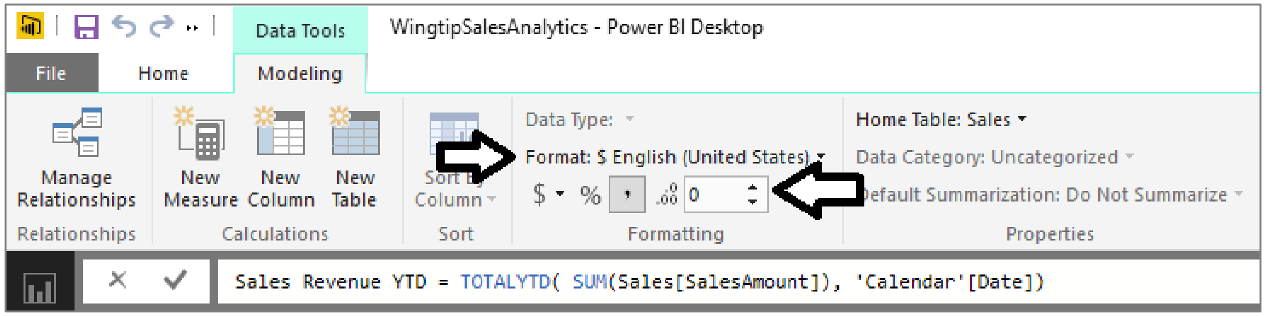
Calculated Fields for QTD and YTD Sales

- TOTALQTD function calculates quarter-to-date totals



```
Sales Revenue QTD = TOTALQTD( SUM(Sales[SalesAmount]), 'Calendar'[Date])
```

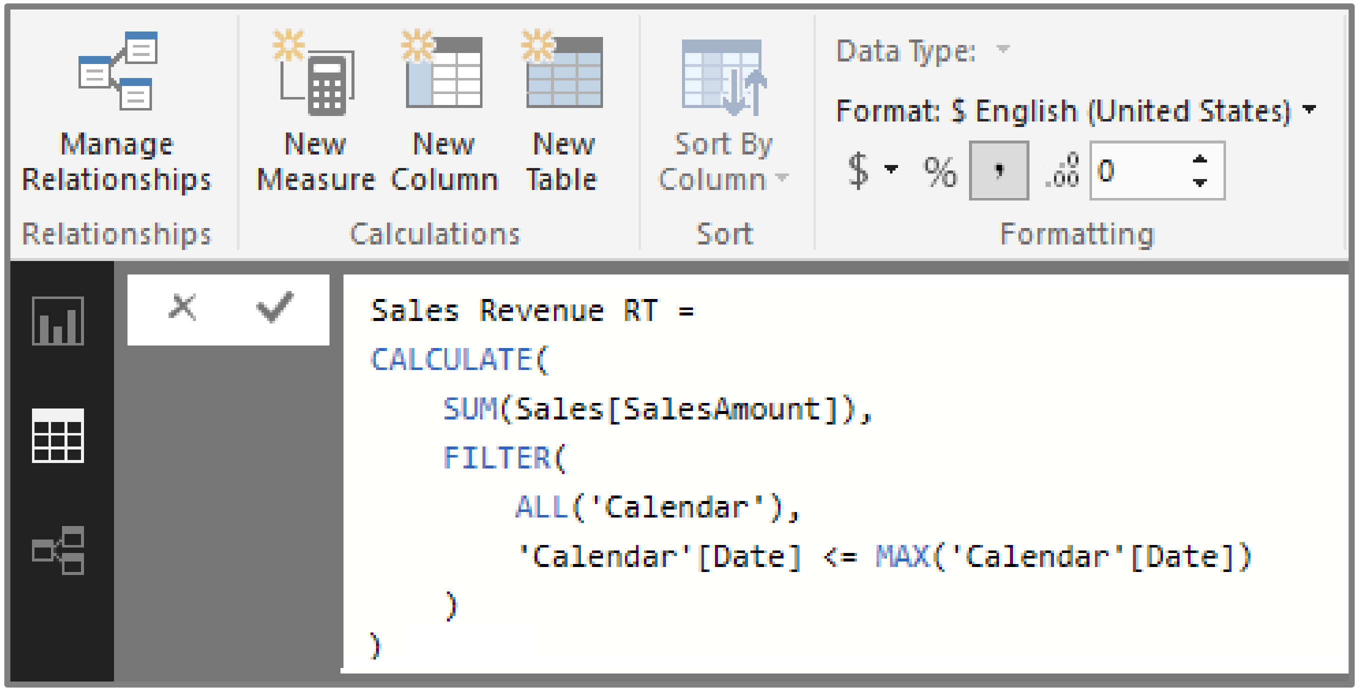
- TOTALYTD function calculates year-to-date totals



```
Sales Revenue YTD = TOTALYTD( SUM(Sales[SalesAmount]), 'Calendar'[Date])
```

Creating Running Total using CALCULATE

- Calculate a running total of sales revenue across years
  - This must be done using **CALCULATE** function



```
Sales Revenue RT =
CALCULATE(
    SUM(Sales[SalesAmount]),
    FILTER(
        ALL('Calendar'),
        'Calendar'[Date] <= MAX('Calendar'[Date])
    )
)
```

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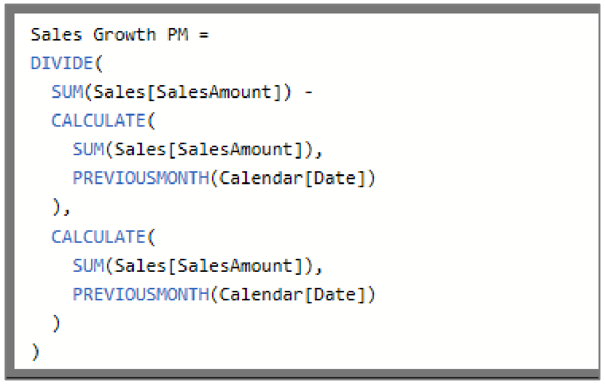
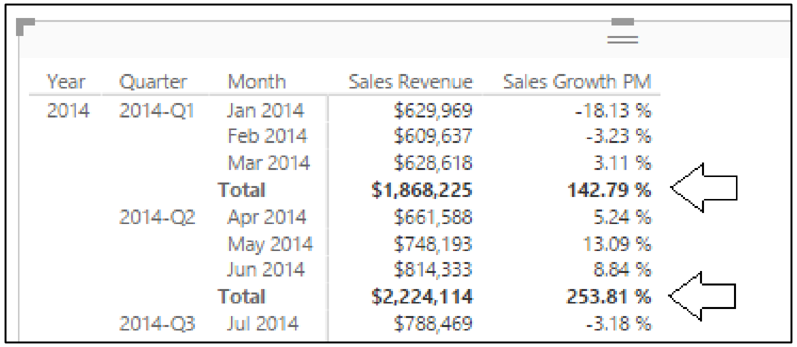
Sales Growth PM Measure - First Attempt

- Create a measure named Sales Growth PM



```
Sales Growth PM =
DIVIDE(
  SUM(Sales[SalesAmount]) -
  CALCULATE(
    SUM(Sales[SalesAmount]),
    PREVIOUSMONTH(Calendar[Date])
  ),
  CALCULATE(
    SUM(Sales[SalesAmount]),
    PREVIOUSMONTH(Calendar[Date])
  )
)
```

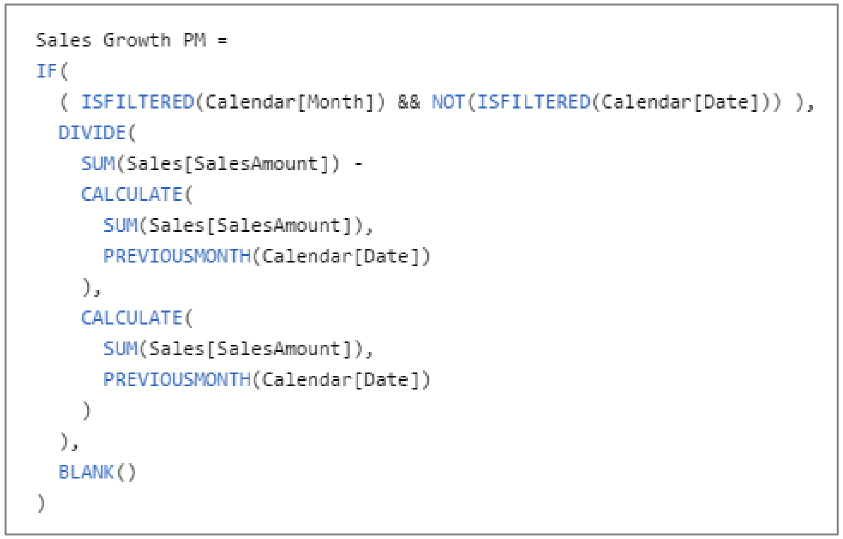
- Use measure in matrix evaluating month and quarter
  - Measure returns correct value when filtered by Month
  - Measure returns large, erroneous value when filtered by Quarter



Year	Quarter	Month	Sales Revenue	Sales Growth PM
2014	2014-Q1	Jan 2014	$629,969	-18.13 %
		Feb 2014	$609,637	-3.23 %
		Mar 2014	$628,618	3.11 %
		Total	**$1,868,225**	**142.79 %**
	2014-Q2	Apr 2014	$661,588	5.24 %
		May 2014	$748,193	13.09 %
		Jun 2014	$814,333	8.84 %
		Total	**$2,224,114**	**253.81 %**
	2014-Q3	Jul 2014	$788,469	-3.18 %

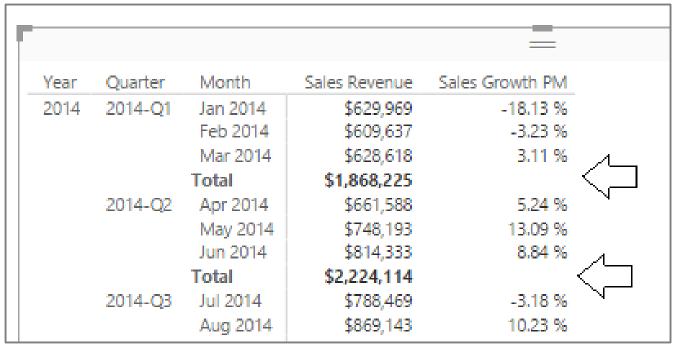
Using the ISFILTERED Function

- ISFILTERED function used to determine when perform evaluation



```
Sales Growth PM =
IF(
  ( ISFILTERED(Calendar[Month]) && NOT(ISFILTERED(Calendar[Date])) ),
  DIVIDE(
    SUM(Sales[SalesAmount]) -
    CALCULATE(
      SUM(Sales[SalesAmount]),
      PREVIOUSMONTH(Calendar[Date])
    ),
    CALCULATE(
      SUM(Sales[SalesAmount]),
      PREVIOUSMONTH(Calendar[Date])
    )
  ),
  BLANK()
)
```

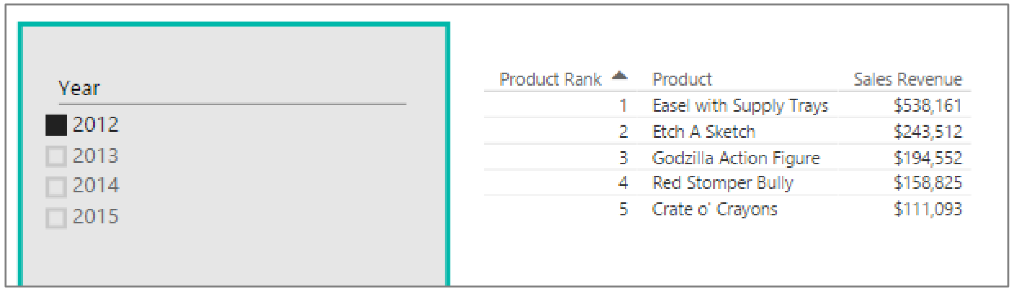
- Expression returns Blank value when evaluation context is invalid



Year	Quarter	Month	Sales Revenue	Sales Growth PM
2014	2014-Q1	Jan 2014	$629,969	-18.13 %
		Feb 2014	$609,637	-3.23 %
		Mar 2014	$628,618	3.11 %
		Total	**$1,868,225**	
	2014-Q2	Apr 2014	$661,588	5.24 %
		May 2014	$748,193	13.09 %
		Jun 2014	$814,333	8.84 %
		Total	**$2,224,114**	
	2014-Q3	Jul 2014	$788,469	-3.18 %
		Aug 2014	$869,143	10.23 %

Problems with the Filter Context

- RANKX function is affected by filter context
  - Sometimes you get the results you are expecting

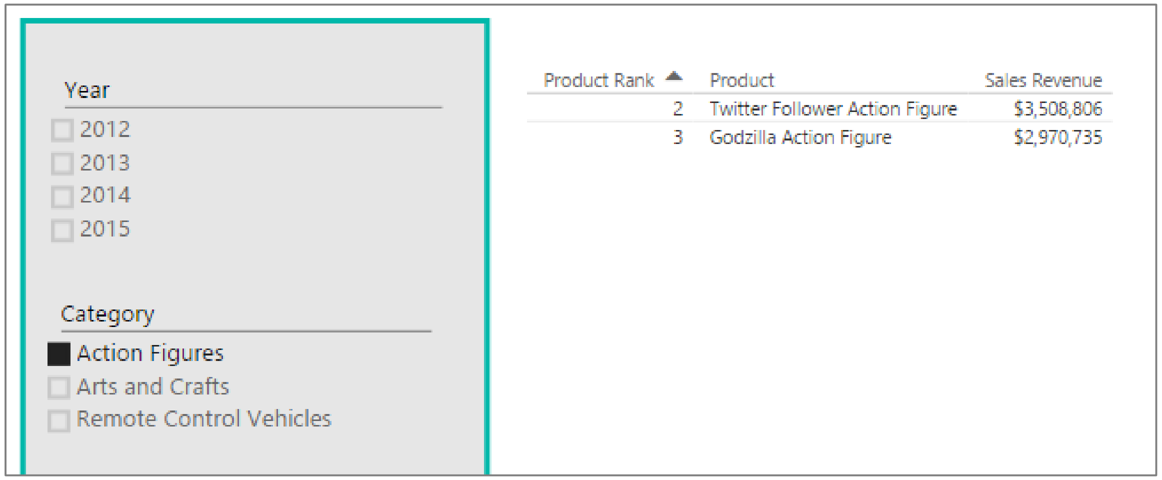


Year

- ■ 2012
- ☐ 2013
- ☐ 2014
- ☐ 2015

Product Rank	Product	Sales Revenue
1	Easel with Supply Trays	$538,161
2	Etch A Sketch	$243,512
3	Godzilla Action Figure	$194,552
4	Red Stomper Bully	$158,825
5	Crate o' Crayons	$111,093

  - Sometimes you might get unexpected results



Year

- ☐ 2012
- ☐ 2013
- ☐ 2014
- ☐ 2015

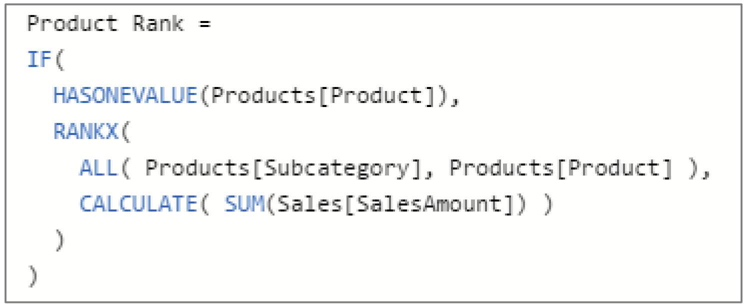
Category

- ■ Action Figures
- ☐ Arts and Crafts
- ☐ Remote Control Vehicles

Product Rank	Product	Sales Revenue
2	Twitter Follower Action Figure	$3,508,806
3	Godzilla Action Figure	$2,970,735

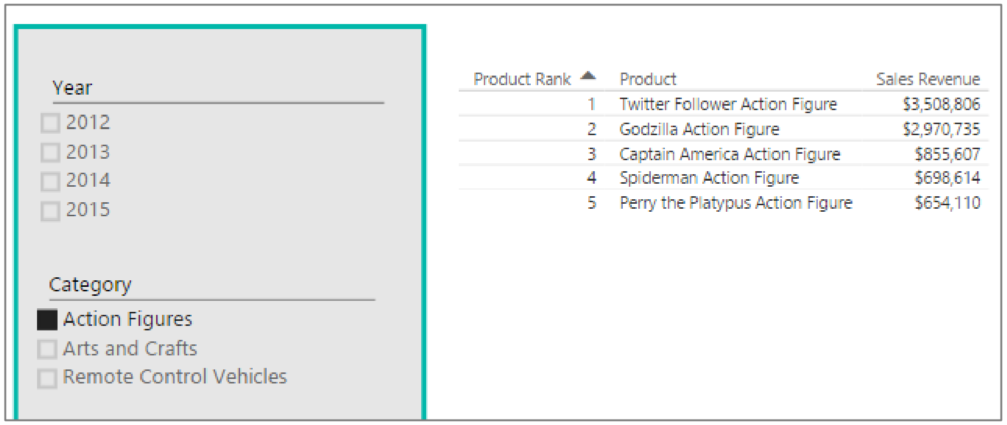
Writing Context Aware DAX Code

- When using RANKX…
  - It's recommended to call **HASONEVALUE** function
  - When calling ALL function, pass one or more columns



```
Product Rank =
IF(
  HASONEVALUE(Products[Product]),
  RANKX(
    ALL( Products[Subcategory], Products[Product] ),
    CALCULATE( SUM(Sales[SalesAmount]) )
  )
)
```

  - Ranking function now evaluates product ranking for specific Category



Year
- ☐ 2012
- ☐ 2013
- ☐ 2014
- ☐ 2015

Category
- ■ Action Figures
- ☐ Arts and Crafts
- ☐ Remote Control Vehicles

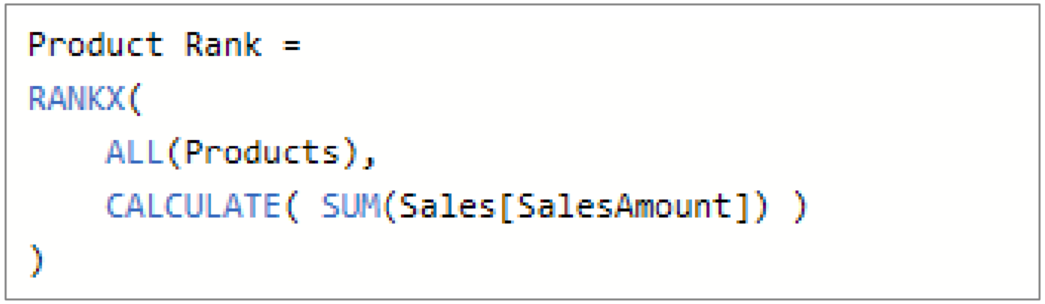
Product Rank	Product	Sales Revenue
1	Twitter Follower Action Figure	$3,508,806
2	Godzilla Action Figure	$2,970,735
3	Captain America Action Figure	$855,607
4	Spiderman Action Figure	$698,614
5	Perry the Platypus Action Figure	$654,110

Agenda

- ✓ Creating Dimensional Hierarchies
- ✓ Understanding Evaluation Context and Calculate
- ✓ Creating a Calendar Table
- ✓ Calling DAX Time Intelligence Functions
- ✓ Writing Contextually-aware DAX Expressions
- ➢ Calculating the Top 5 Products

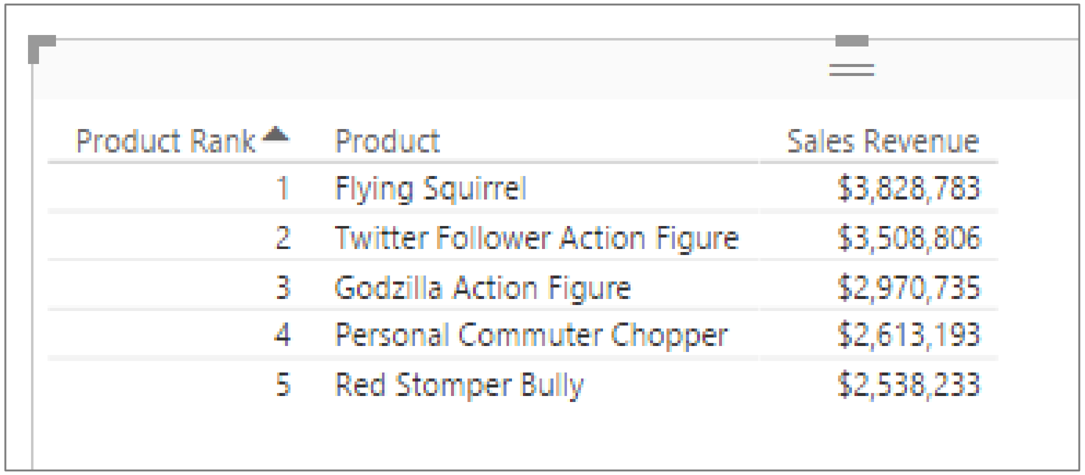
Ranking Products By Sales using RANKX

- DAX provides RANKX function for ranking
  - Can be used to track top 5 products by sales revenue

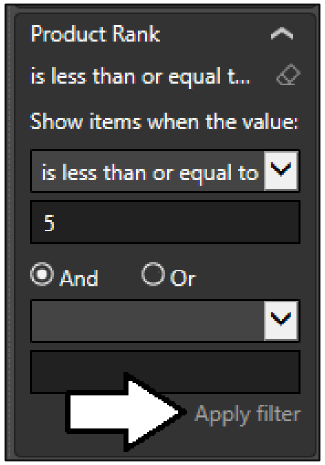


```
Product Rank =
RANKX(
    ALL(Products),
    CALCULATE( SUM(Sales[SalesAmount]) )
)
```

  - You can sort and filter on output of RANKX function



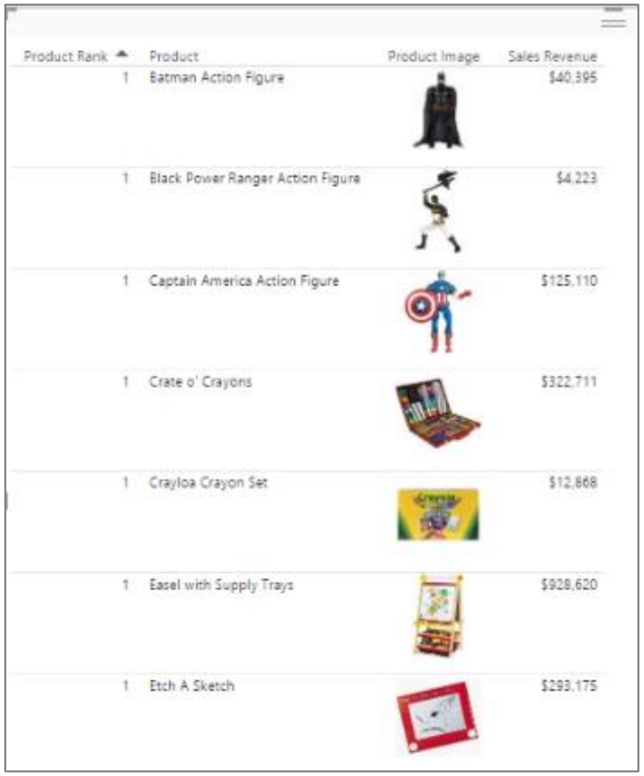
Product Rank	Product	Sales Revenue
1	Flying Squirrel	$3,828,783
2	Twitter Follower Action Figure	$3,508,806
3	Godzilla Action Figure	$2,970,735
4	Personal Commuter Chopper	$2,613,193
5	Red Stomper Bully	$2,538,233



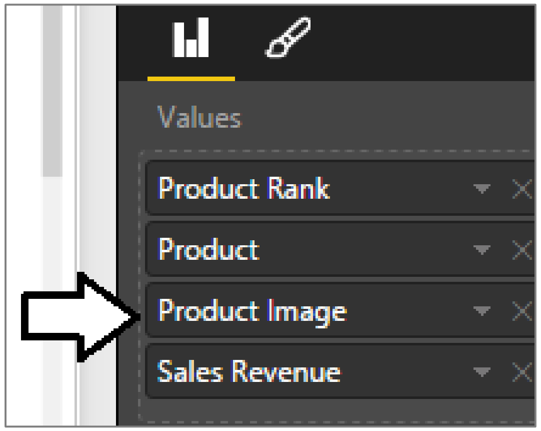
Product Rank
is less than or equal t...
Show items when the value:
is less than or equal to
5
[✓ And] Or
Apply filter

More Ranking Evaluation Problems

- Adding new column to table creates new problem
  - Ranking run separately for each separate Product Image
  - Every product has unique Product Image and is given rank of 1



Product Rank	Product	Product Image	Sales Revenue
1	Batman Action Figure		$40,395
1	Black Power Ranger Action Figure		$4,223
1	Captain America Action Figure		$125,110
1	Crate o' Crayons		$322,711
1	Crayloa Crayon Set		$12,868
1	Easel with Supply Trays		$928,620
1	Etch A Sketch		$293,175

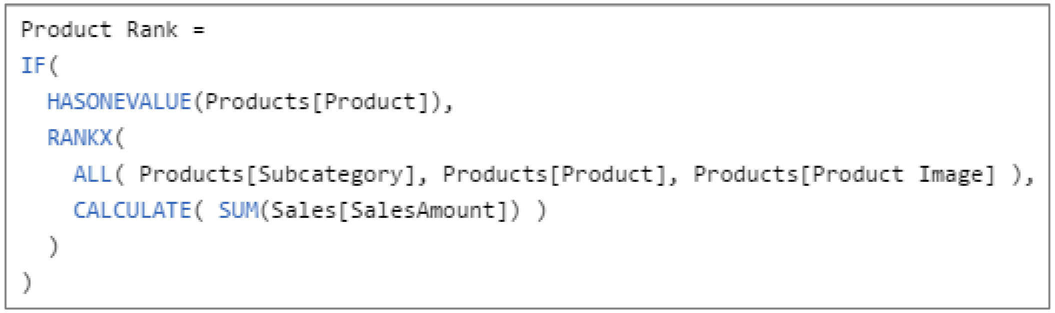


Values

- Product Rank
- Product
- Product Image
- Sales Revenue

Getting It Right

- Call to RANKX must be modified again
  - You must specify which columns to factor into ranking



```
Product Rank =
IF(
  HASONEVALUE(Products[Product]),
  RANKX(
    ALL( Products[Subcategory], Products[Product], Products[Product Image] ),
    CALCULATE( SUM(Sales[SalesAmount]) )
  )
)
```

  - Context-aware DAX code corrects problems with visual

Product Rank	Product	Product Image	Sales Revenue
1	Flying Squirrel		$3,828,783
2	Twitter Follower Action Figure		$3,508,806
3	Godzilla Action Figure		$2,970,735
4	Personal Commuter Chopper		$2,613,193
5	Red Stomper Bully		$2,538,233

Summary

- ✓ Creating Dimensional Hierarchies
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