

# Designing a Data Model with Power BI Desktop



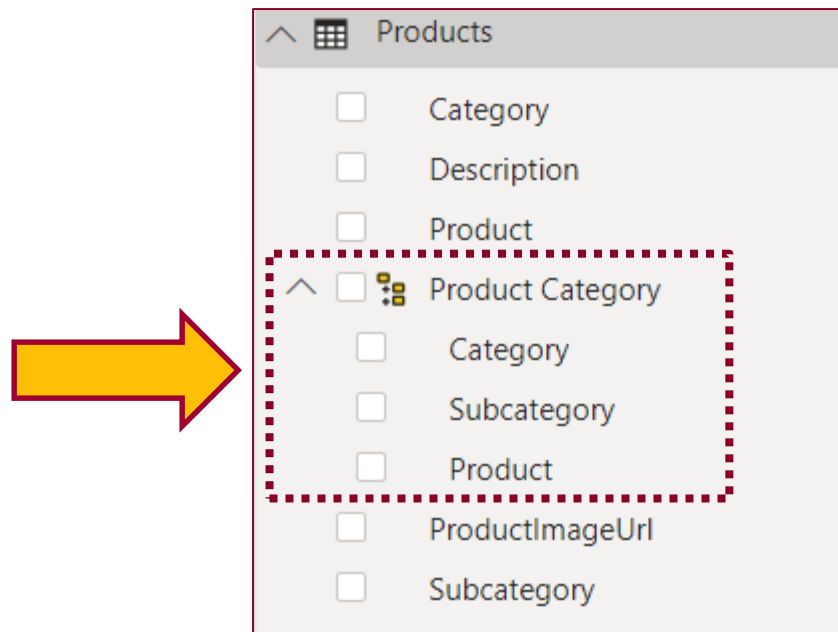
# Agenda

- 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



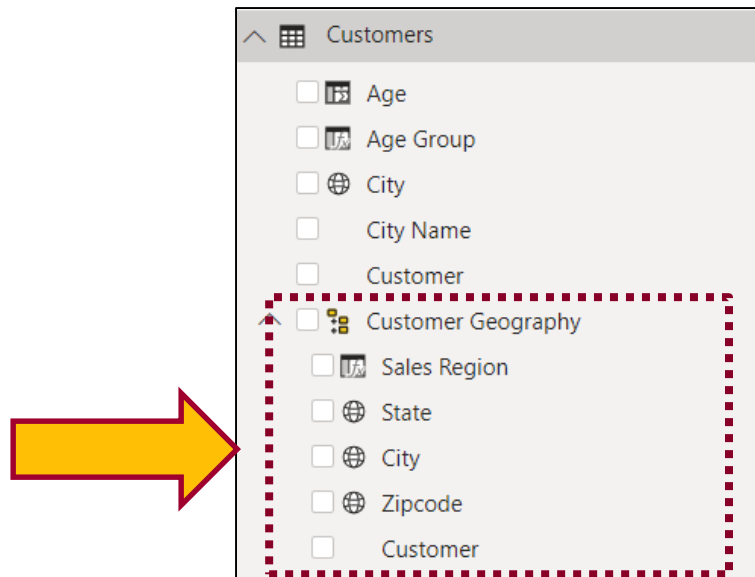
# Pulling Columns for Hierarchy into Single Table

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

1 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 | 3/7/1942  | Carlene Finch | One-time Customer | 75  | 65 and over | Western Region |

- Then create hierarchy in the table with all the columns



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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

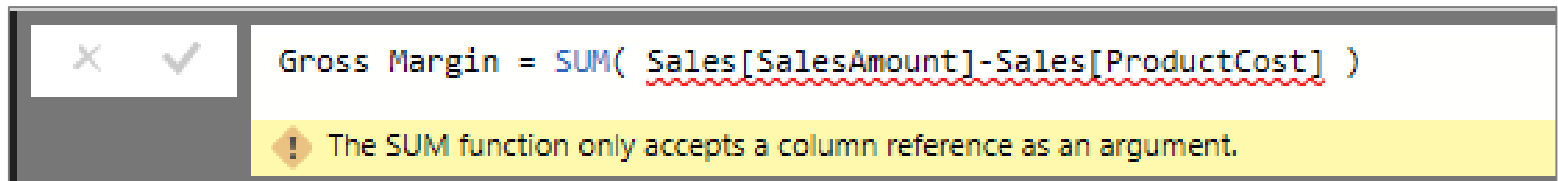
| ✕  | ✓                | City = [City Name] & ", " & [State] |            |                 |              |
|----|------------------|-------------------------------------|------------|-----------------|--------------|
|    | Age Group        | Sales Region                        | State Name | SalesRegionSort | 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 |

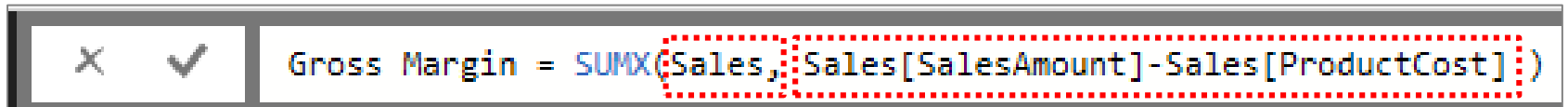


# Understanding Iterators Like SUMX

- 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



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



- 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                        |                |
|-------------------------------------|----------------|
| <input checked="" type="checkbox"/> | Western Region |
| <input type="checkbox"/>            | Central Region |
| <input type="checkbox"/>            | Eastern Region |

| Customer Type                       |                   |
|-------------------------------------|-------------------|
| <input type="checkbox"/>            | One-time Customer |
| <input checked="" type="checkbox"/> | 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] )  
    )  
)
```



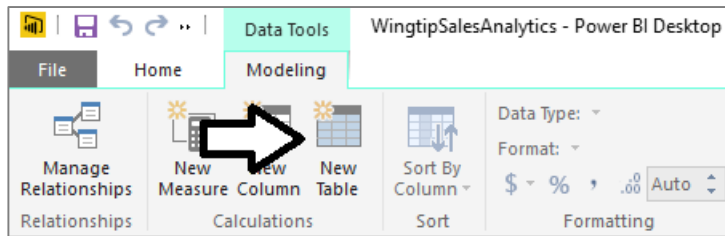
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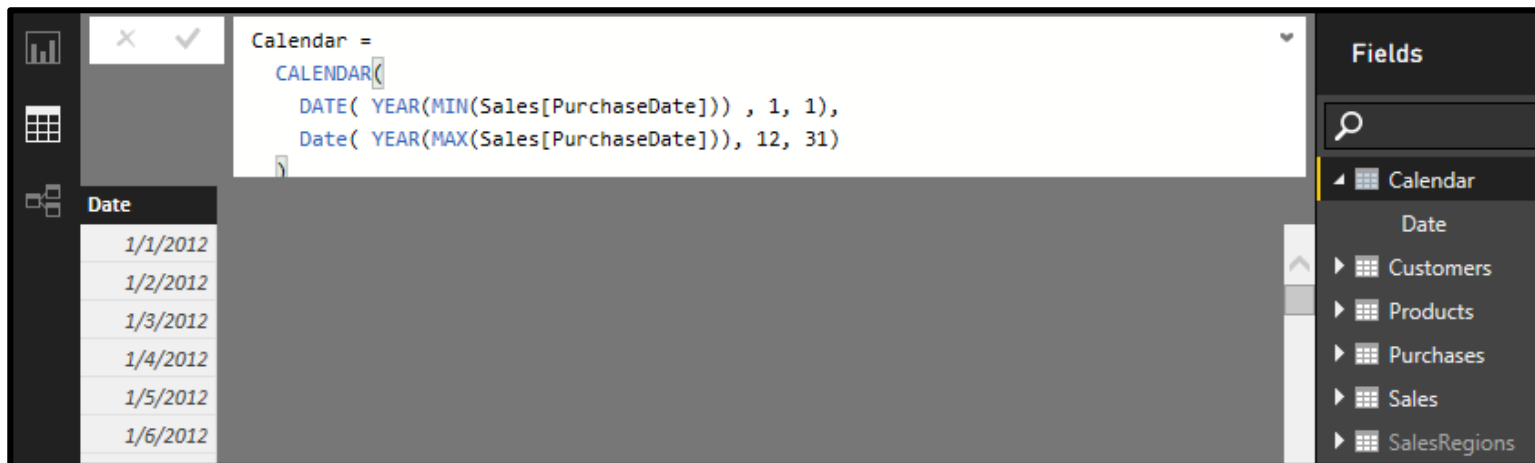


# Creating Calendar Table as Calculated Table

- Use **New Table** command in ribbon



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



# Adding Columns to Calendar Table

- Creating the **Year** column

| X ✓ Year = YEAR('Calendar'[Date]) |      |
|-----------------------------------|------|
| Date                              | Year |
| 1/1/2012                          | 2012 |
| 1/2/2012                          | 2012 |
| 1/3/2012                          | 2012 |

- Creating the **Quarter** column

| X ✓ 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

| X ✓ 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

The screenshot shows the Power BI Desktop interface. In the 'Table' view, the 'Month' column is selected. The 'Sort By Column' dropdown menu is open, showing 'MonthSort' as the selected option. The 'MonthSort' column is highlighted in yellow in the table view. The table view shows the following data:

| Date     | Year | Month    | MonthSort |
|----------|------|----------|-----------|
| 1/1/2012 | 2012 | Jan 2012 | 2012-01   |
| 1/2/2012 | 2012 | Jan 2012 | 2012-01   |

Arrows indicate the flow from the 'Sort By Column' dropdown to the 'MonthSort' column in the table view.







# Integrating Calendar Table into Data Model

- Calendar table needs relationship to one or more tables



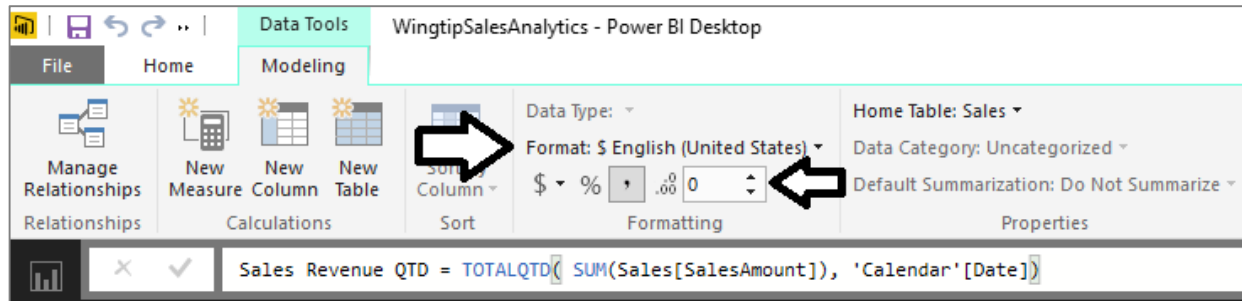
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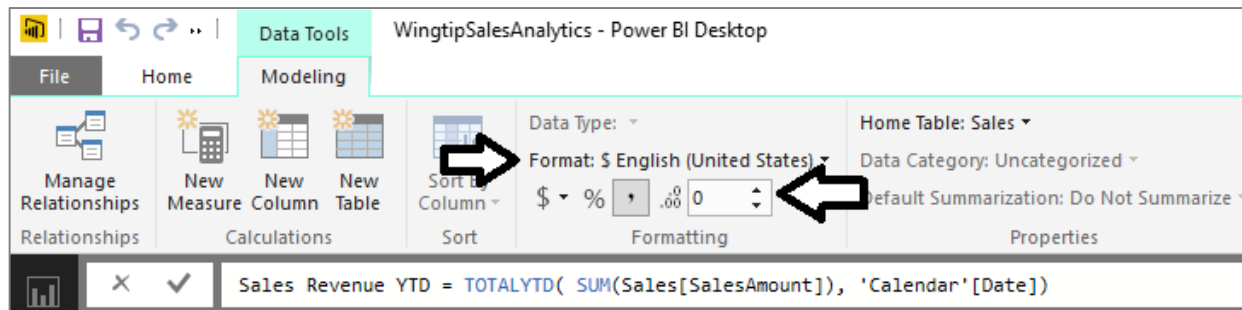


# Calculated Fields for QTD and YTD Sales

- TOTALQTD function calculates quarter-to-date totals

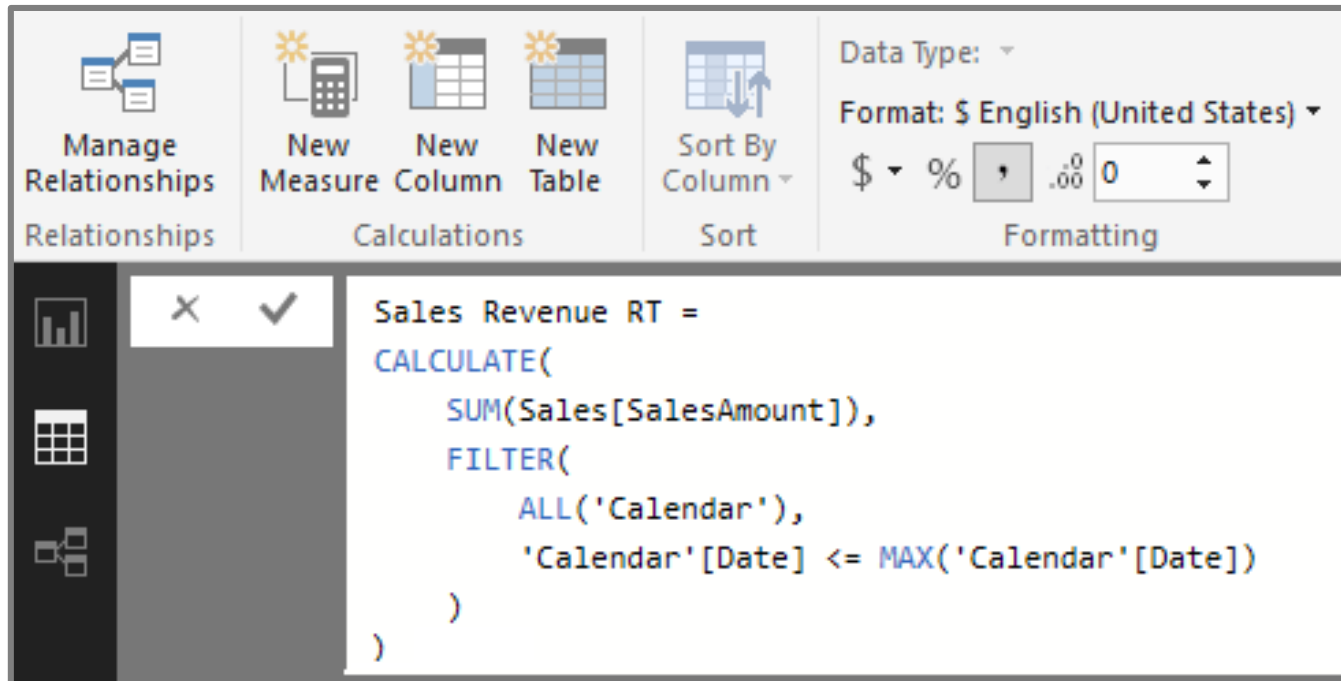


- TOTALYTD function calculates year-to-date totals



# Creating Running Total using CALCULATE

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



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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 %          |
| 2014 | 2014-Q3 | Total    | \$2,224,114   | 253.81 %        |
|      |         | 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

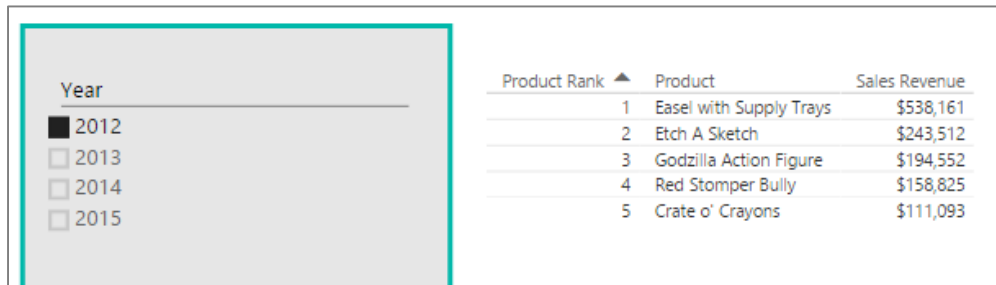
| Year | Quarter | Month        | Sales Revenue      | Sales Growth PM |
|------|---------|--------------|--------------------|-----------------|
| 2014 | 2014-Q1 | Jan 2014     | \$629,969          | -18.13 %        |
|      |         | Feb 2014     | \$609,637          | -3.23 %         |
|      |         | Mar 2014     | \$628,618          | 3.11 %          |
|      |         | <b>Total</b> | <b>\$1,868,225</b> |                 |
|      | 2014-Q2 | Apr 2014     | \$661,588          | 5.24 %          |
|      |         | May 2014     | \$748,193          | 13.09 %         |
|      |         | Jun 2014     | \$814,333          | 8.84 %          |
|      |         | <b>Total</b> | <b>\$2,224,114</b> |                 |
|      | 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



The screenshot shows a filter panel on the left with a 'Year' section containing checkboxes for 2012, 2013, 2014, and 2015. The 2012 checkbox is selected. To the right is a table with three columns: 'Product Rank' (with an upward arrow), 'Product', and 'Sales Revenue'.

| 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



The screenshot shows a filter panel on the left with two sections: 'Year' with checkboxes for 2012, 2013, 2014, and 2015, and 'Category' with checkboxes for Action Figures, Arts and Crafts, and Remote Control Vehicles. The 'Action Figures' checkbox is selected. To the right is a table with three columns: 'Product Rank' (with an upward arrow), 'Product', and 'Sales Revenue'.

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

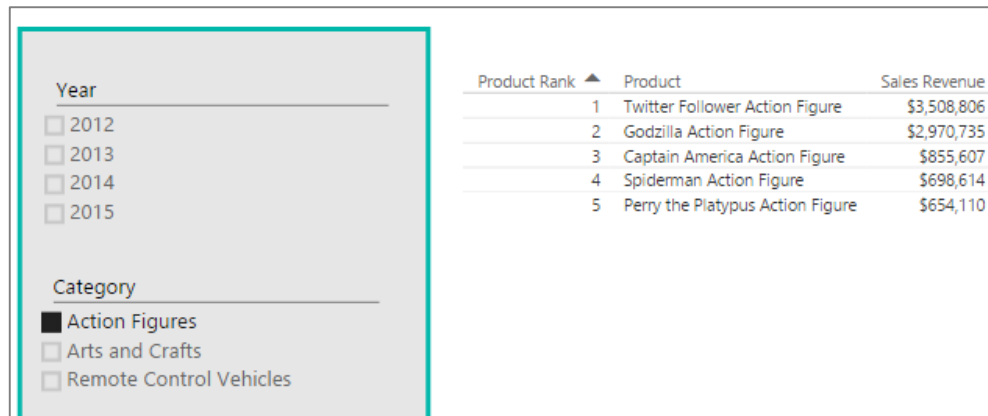


# Writing Context Aware DAX Code

- 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



| 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     |



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# 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 to...

Show items when the value:

is less than or equal to ▼

5

☒ And ☐ Or








▼

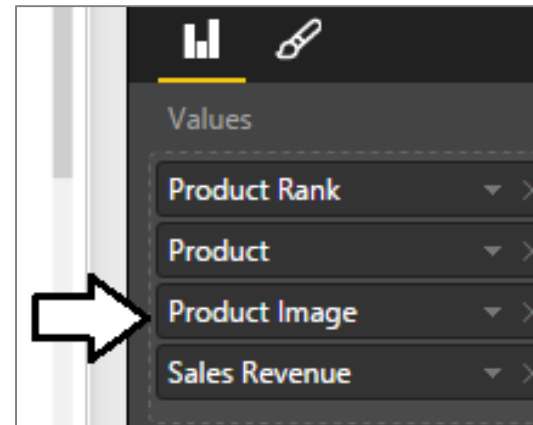
Apply filter



# 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     |

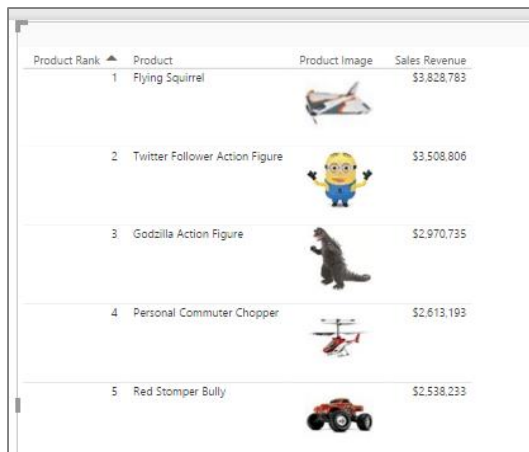


# Getting It Right






- 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



A screenshot of a Power BI table visual displaying a ranked list of products. The table has four columns: 'Product Rank' (with a sort arrow), 'Product', 'Product Image', and 'Sales Revenue'. The data is sorted by rank, showing the top five products. Each row includes a small image of the product.

| 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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