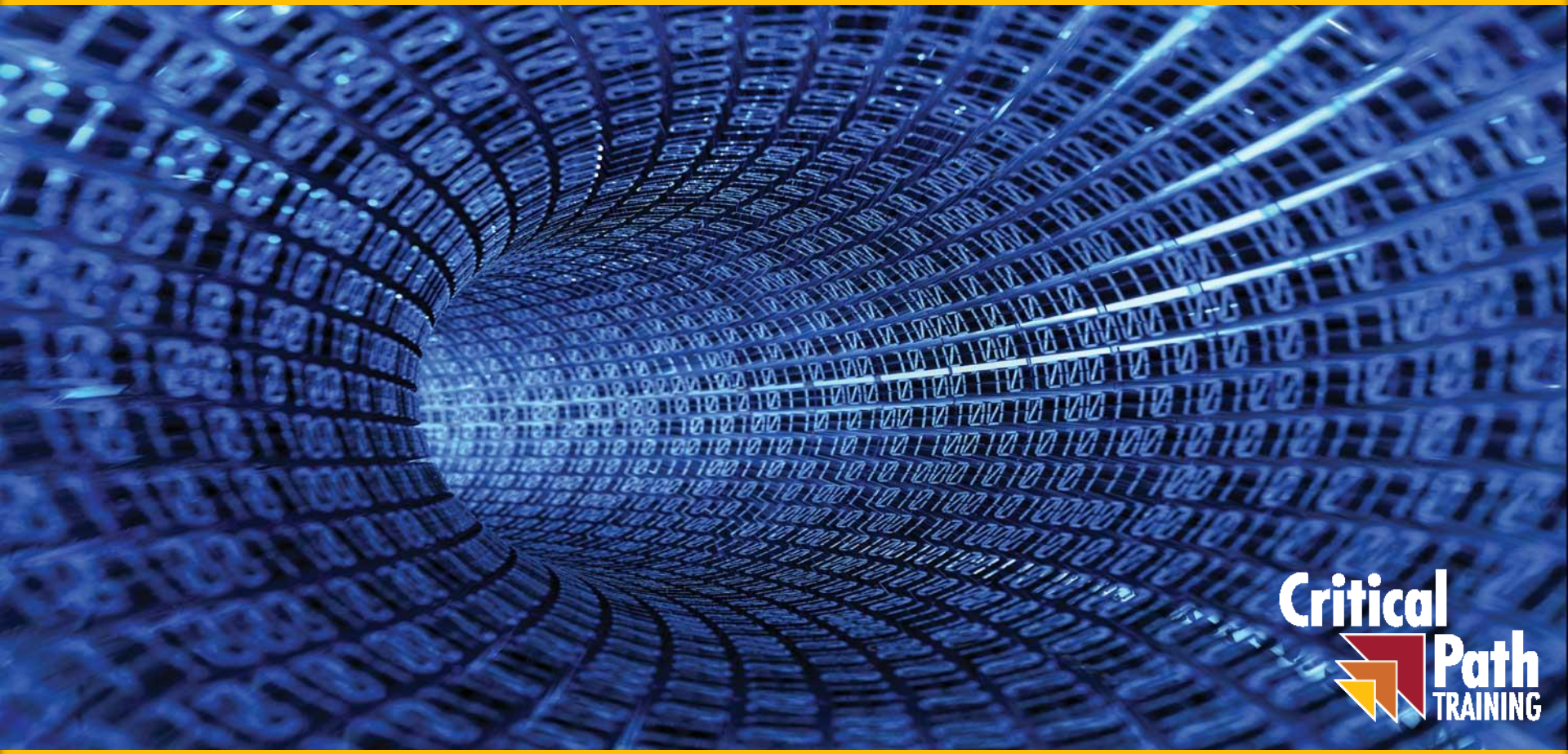
# Power BI Desktop Primer



# Agenda

- Power BI Desktop Overview
- Building Queries
- Designing Data Models
- Designing Reports

# Power BI Desktop Projects

- Design queries to create a dataset
  - Most datasets created using import model
  - Datasets can be created with DirectQuery and Live Connect
- Enrich the dataset using data modeling features
  - Add calculated columns, measures, hierarchies, etc
- Visualize insights from your dataset by creating reports
  - Build reports using visuals
- Publish projects to the Power BI Service
  - Your datasets & reports can be used in Power BI embedding

# Agenda

- ✓ Power BI Desktop Overview
- ➢ Building Queries
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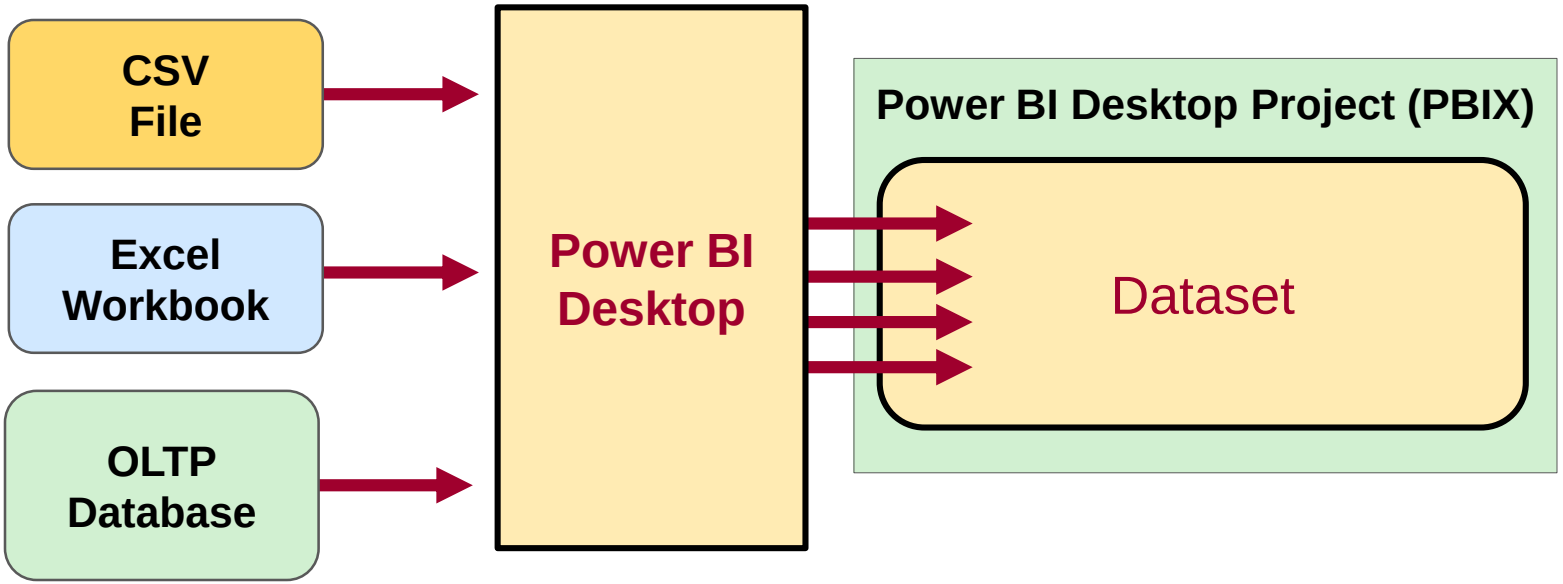
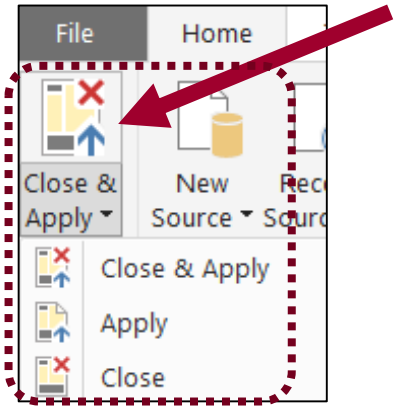
# Power BI Desktop is an ETL Tool

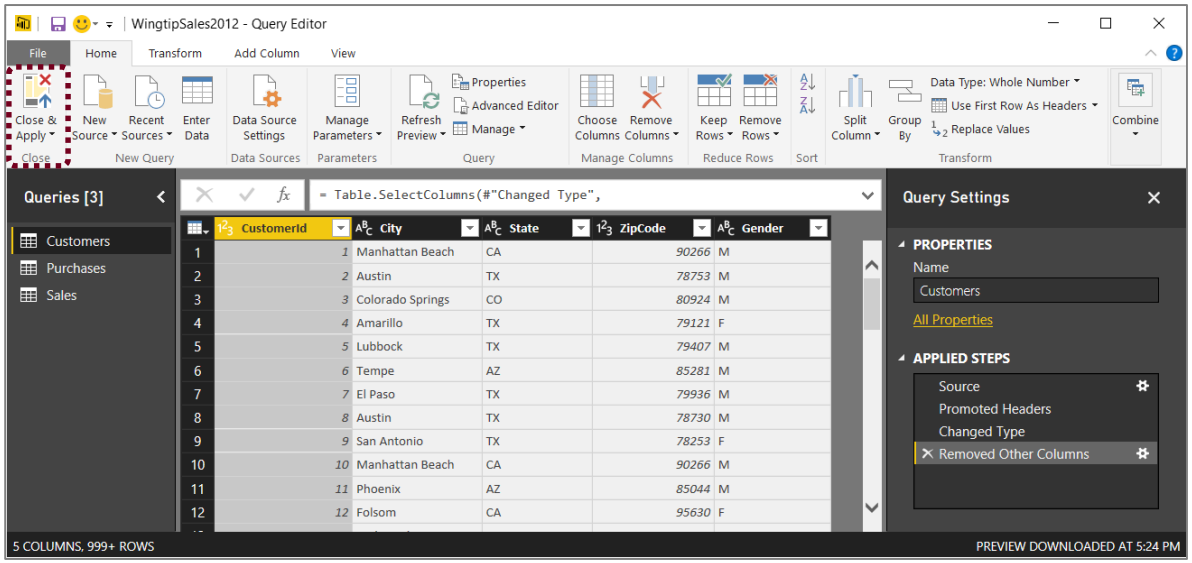
- ETL process is essential part of any BI Project
  - **Extract** the data from wherever it lives
  - **Transform** the shape of the data for better analysis
  - **Load** the data into dataset for analysis and reporting



# Query Editor Window

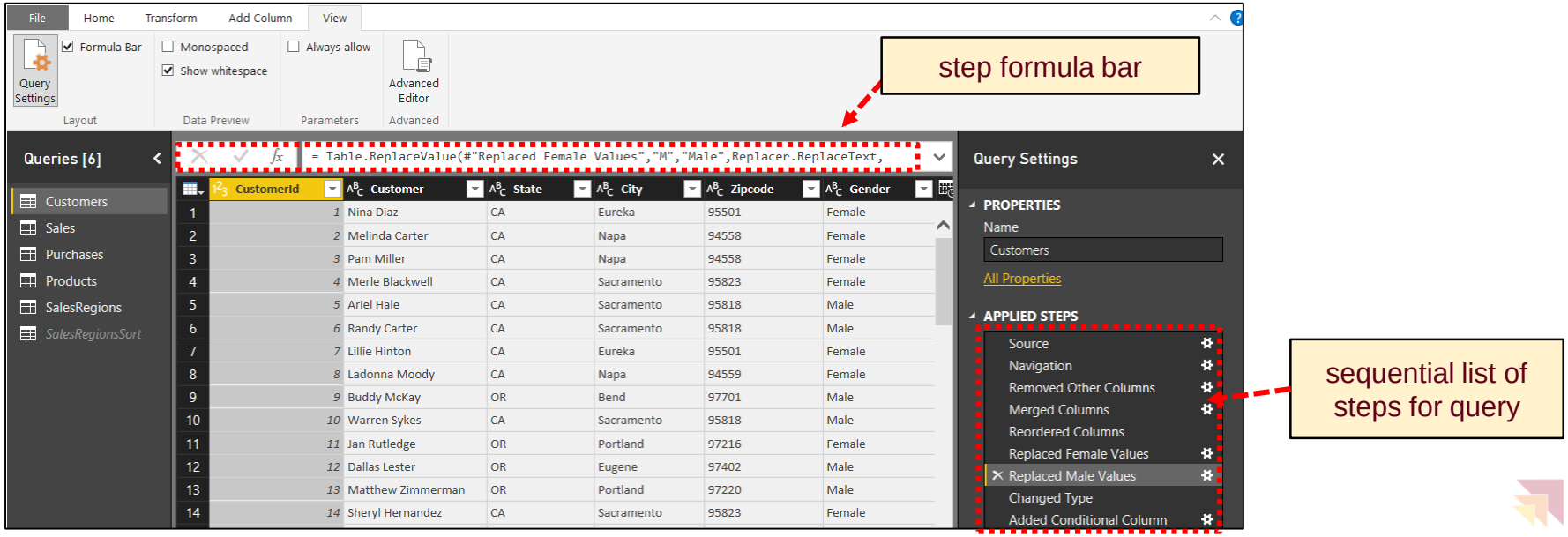
- Power BI Desktop provides separate Query Editor window
  - Provides powerful features for designing queries
  - Displays list of all queries in project on the left
  - Displays **Properties** and **Applied Steps** for selected query on right
  - Preview of table generated by query output shown in the middle
  - Query can be executed using **Apply** or **Close & Apply** command



# Query Steps

- A query is created as a sequence of steps
  - Each step is a parameterized operation on the data
  - Each step has formula which can be viewed/edited in formula bar
  - Query starts with Source step to extract data from a data source
  - Additional steps added to perform transform operations on data
  - You can replay query operations one by one by clicking on steps

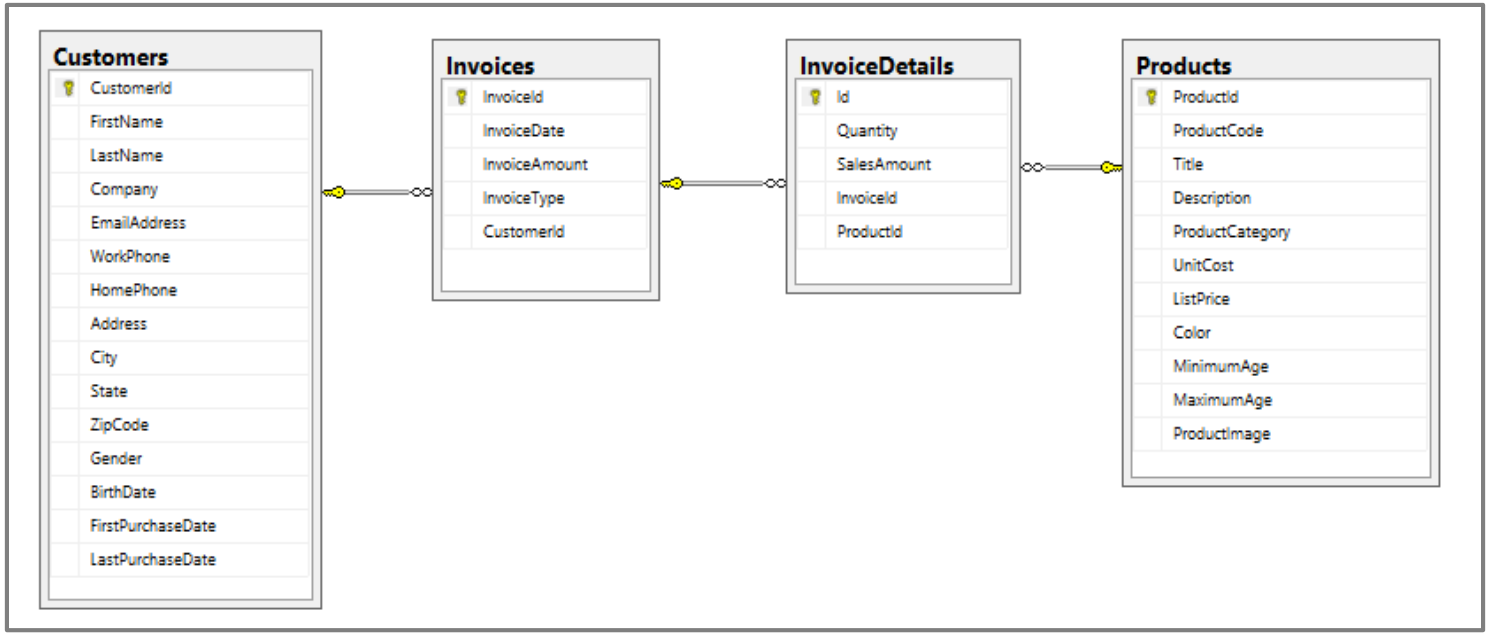


# Examples of Basic Power BI Desktop Steps

- Rename column
- Convert column type
- Trim and clean column values
- Replace column values
- Format column values
- Expanding related column
- Merging columns
- Splitting columns

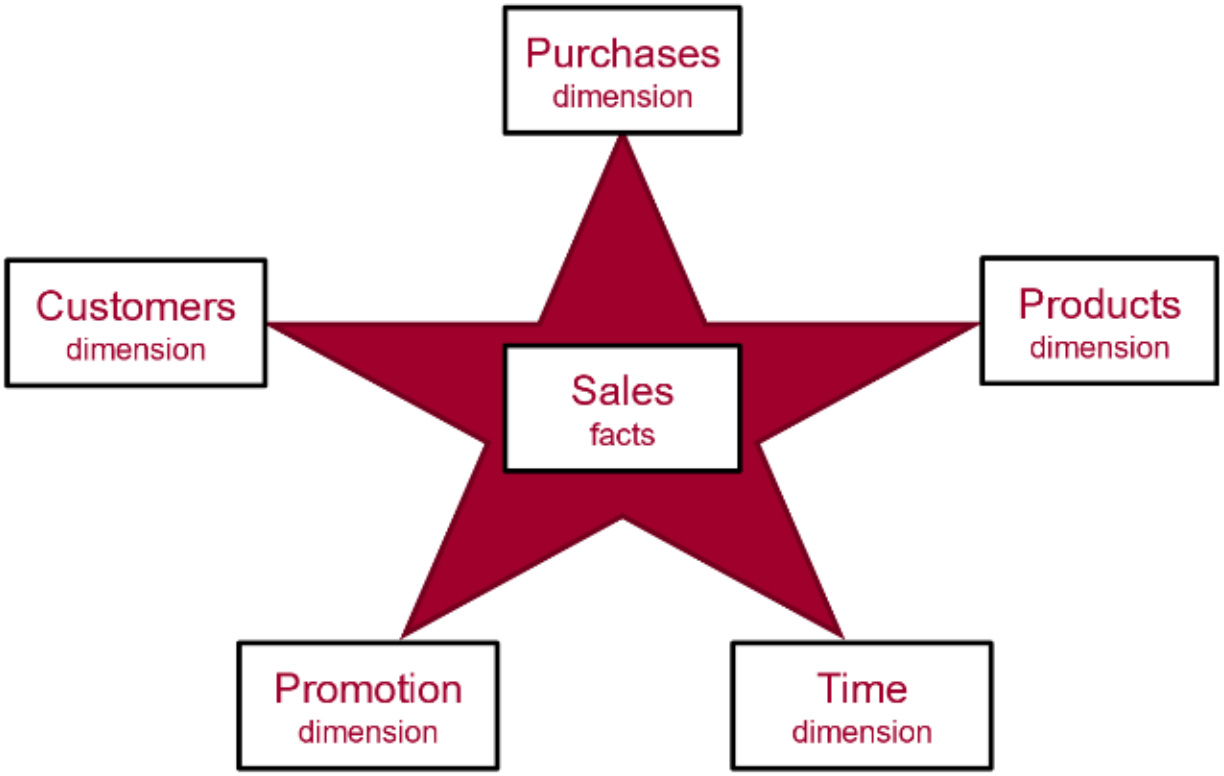
# Sample OLTP Database: WingtipSalesDB

- Online Transaction Processing (OLTP) System
  - Used for real-time data access and transaction-based data entry
  - Optimized for faster transactions (e.g. inserts, updates & deletes)
  - Tables normalized to reduce/eliminate redundancies
  - Table schemas can be hard for business users to understand



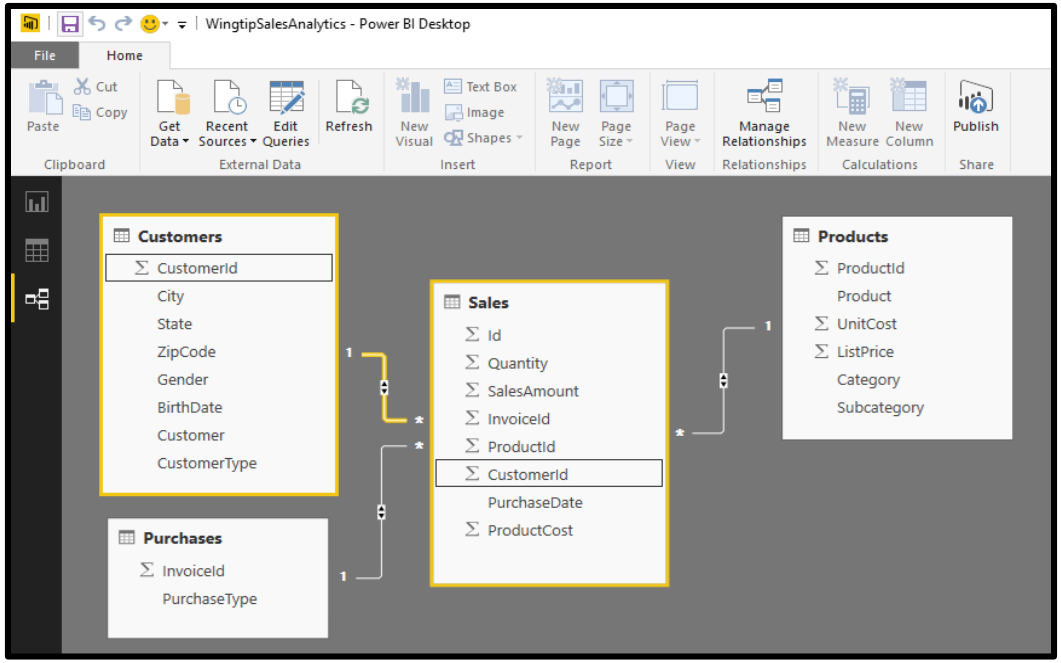
# Data Modeling using a Star Schema

- OLAP Modeling often based on Star Schema
  - Tables defined as fact tables or dimension tables
  - Fact tables related to dimension table using 1-to-many relationships



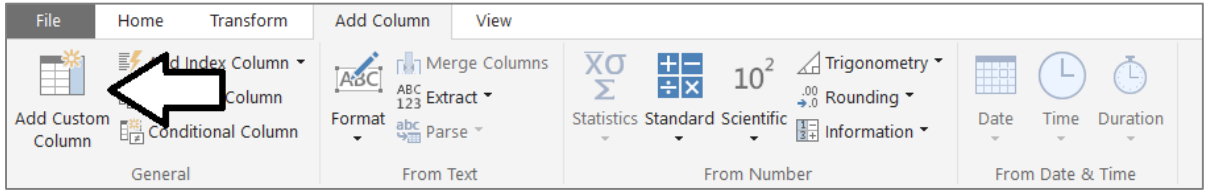
# Designing Queries to Build a Star Schema

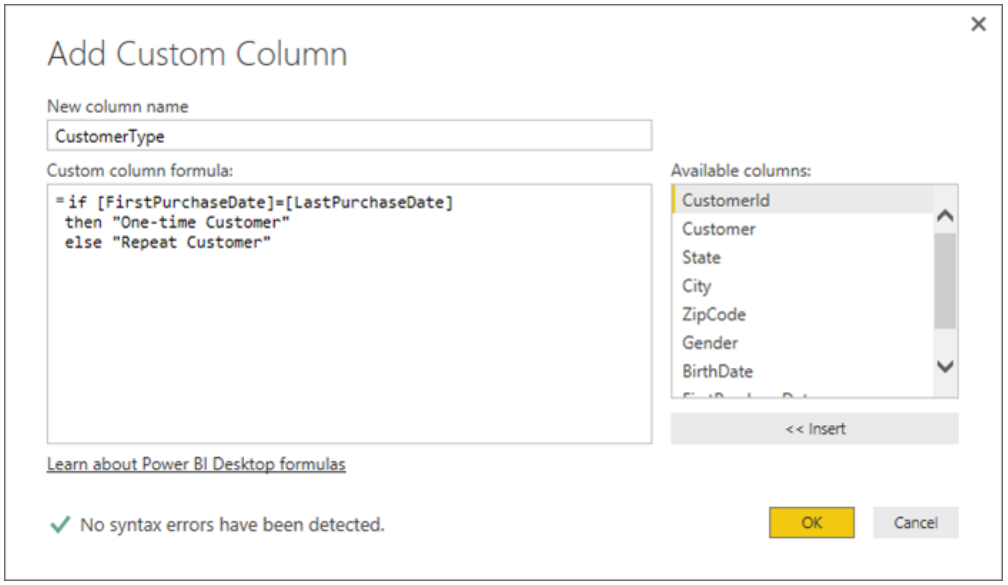
- Converts OLTP Data Model to OLAP Data Model
  - Sales table is modeled as a OLAP Fact Table
  - Other tables are modeled as OLAP Dimension tables
  - Requires pulling CustomerId column into Sales table
  - All dimension tables should be directly related to fact table



# Adding a Custom Column

- Custom column provide custom logic
  - Logic must be written in M programming language

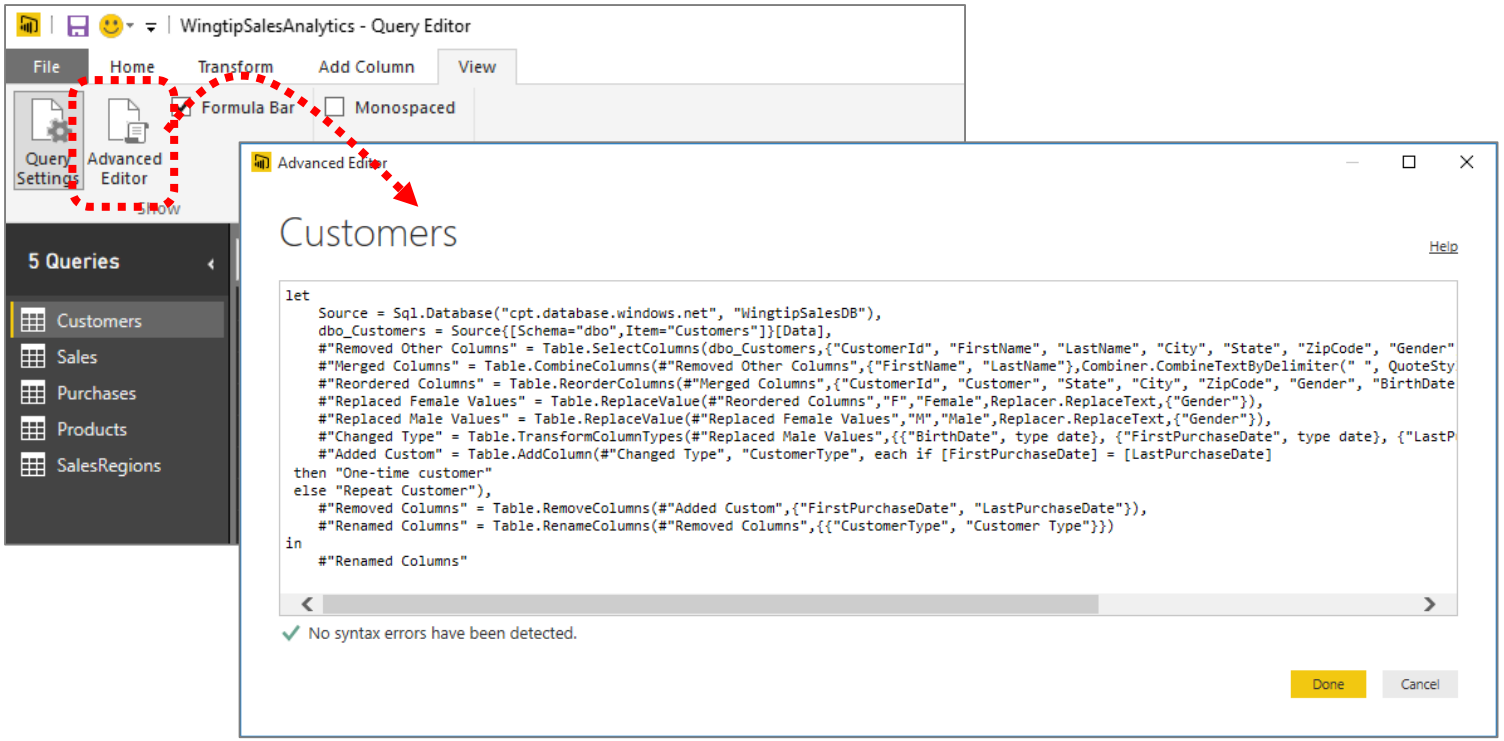



| FirstPurchaseDate | LastPurchaseDate | CustomerType |
|---|---|---|
| 1/28/2012 | 1/28/2012 | One-time Customer |
| 1/28/2012 | 1/28/2012 | One-time Customer |
| 1/28/2012 | 1/28/2012 | One-time Customer |
| 1/28/2012 | 1/28/2012 | One-time Customer |
| 1/28/2012 | 1/28/2012 | One-time Customer |
| 1/28/2012 | 1/28/2012 | One-time Customer |
| 1/29/2012 | 11/22/2015 | Repeat Customer |
| 1/29/2012 | 10/2/2015 | Repeat Customer |
| 1/29/2012 | 1/29/2012 | One-time Customer |
| 1/29/2012 | 5/6/2015 | Repeat Customer |
| 1/29/2012 | 1/29/2012 | One-time Customer |

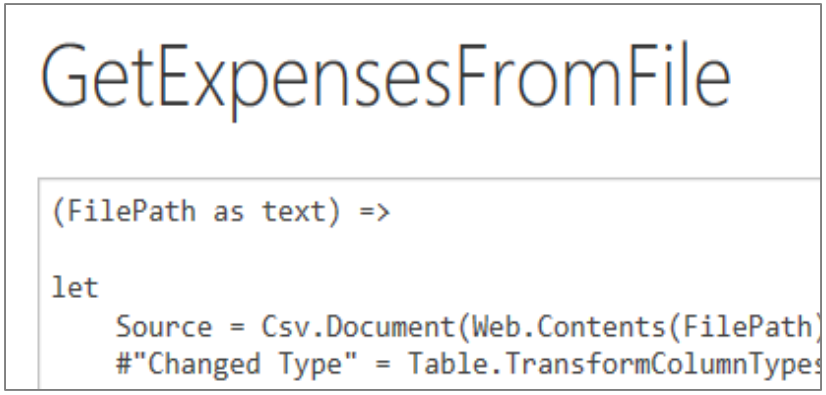
# Advanced Editor

- Power BI Desktop based on "M" functional language
  - Query in Power BI Desktop saved as set of M statements in code
  - Query Editor generates code in M behind the scenes
  - Advanced users can view & modify query code in Advanced Editor



# Understanding Function Queries

- Query can be converted into reusable function
  - Requires editing query M code in Advanced Editor
  - Function query can be defined to accept parameters




  - Function query can't be edited with visual designer

# Agenda

- ✓ Power BI Desktop Overview
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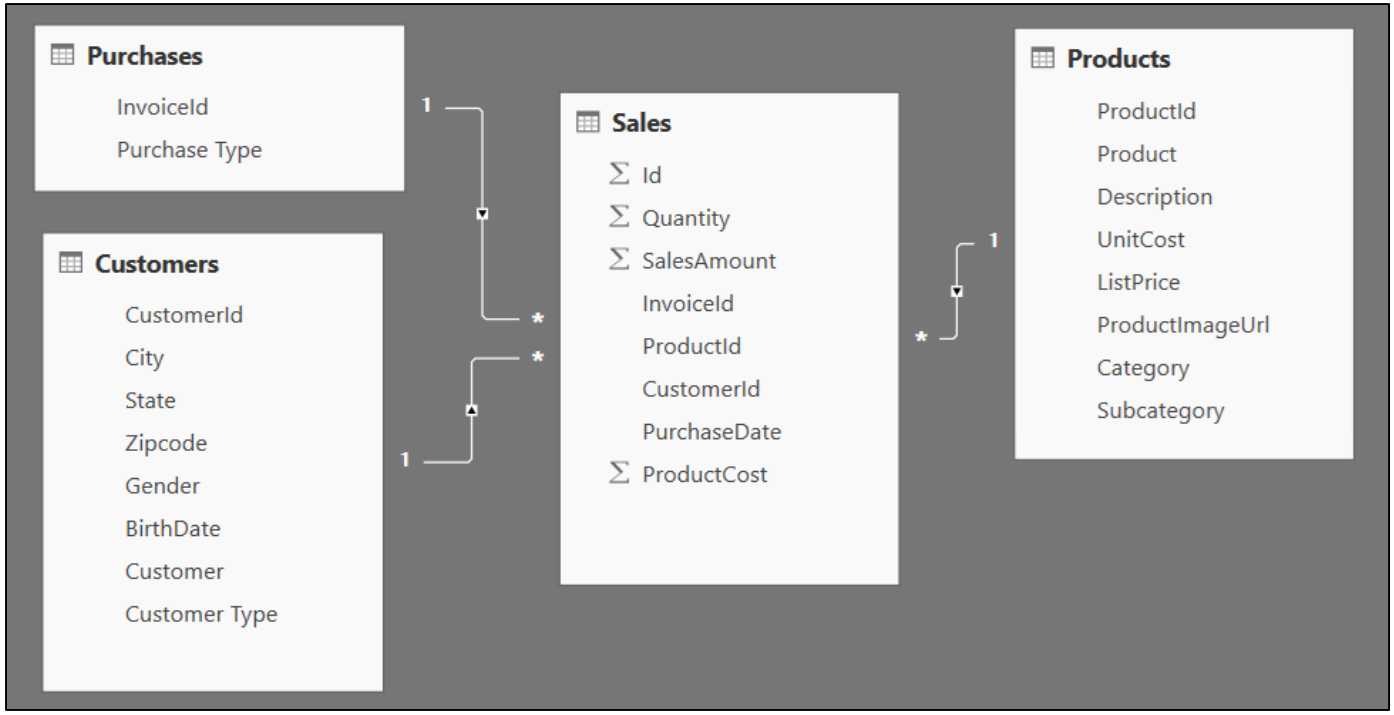
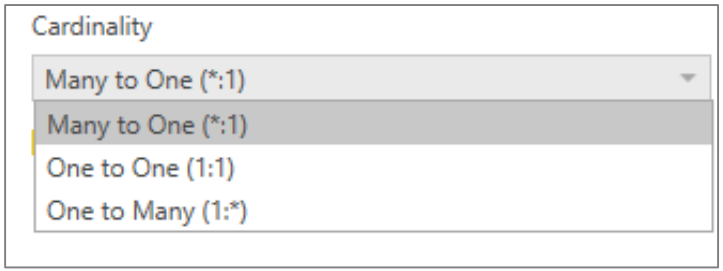
# Table Relationships

- Tables in data model associated with relationships
  - Relationships based on single columns
  - Tabular model supports [1-to-1] and [1-to-many] relationships

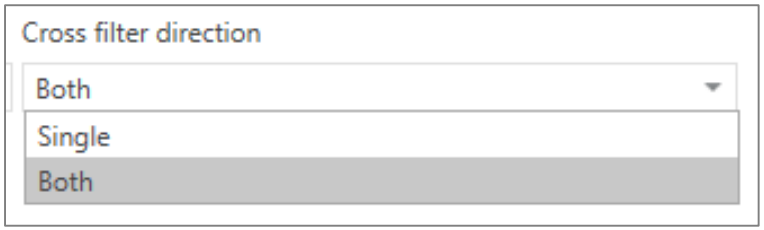


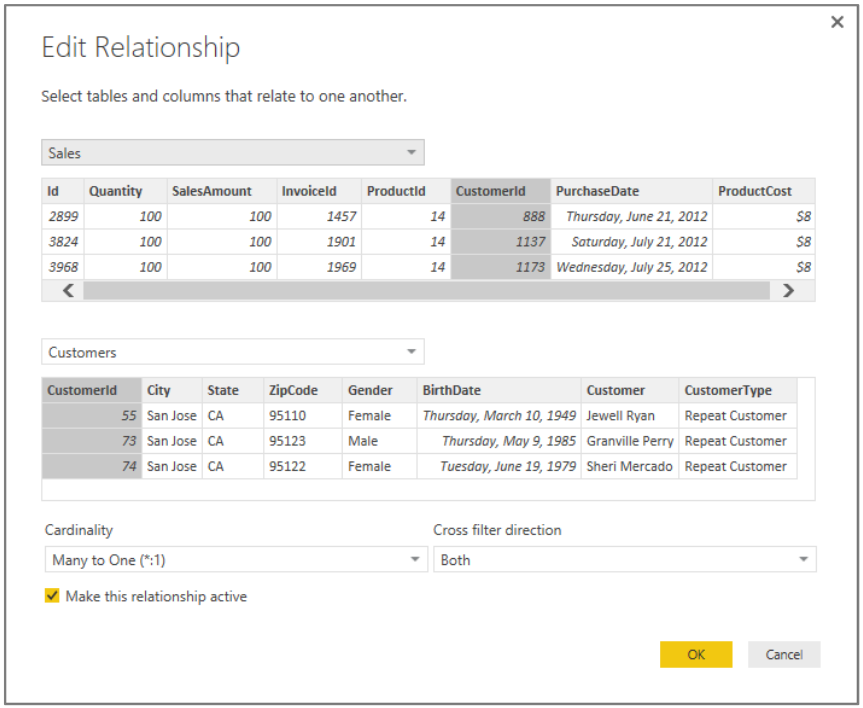
# Relationship Properties

- Cardinality



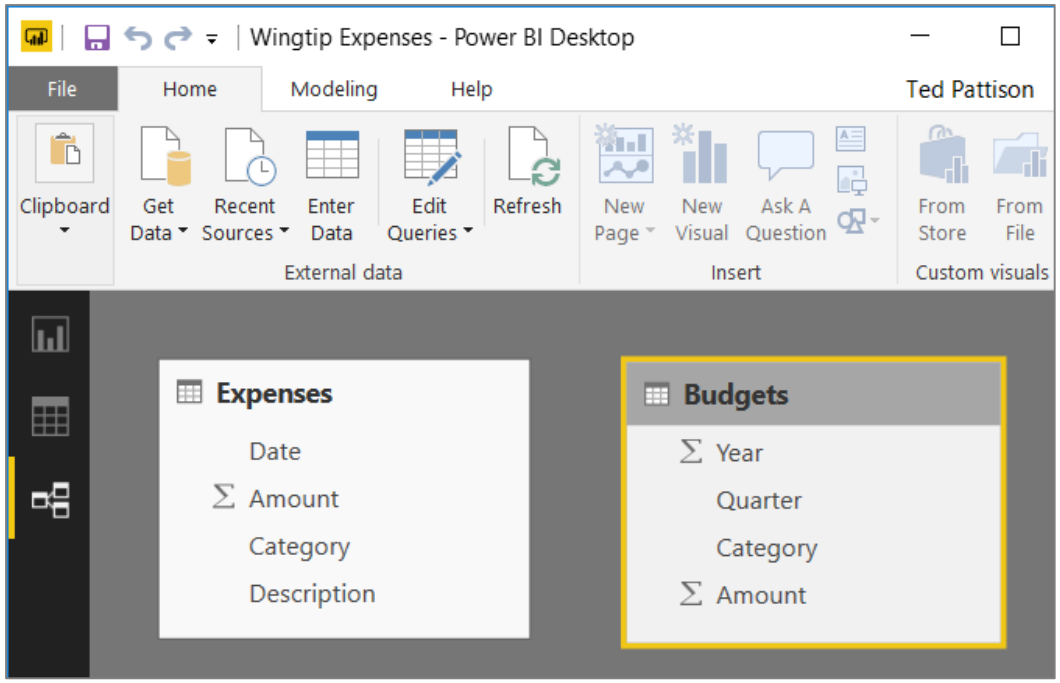

- Cross filter direction



# How Do You Create a Relationship Here?

- Two tables don't have fields to create relationship
  - The solution is to create two new calculated columns

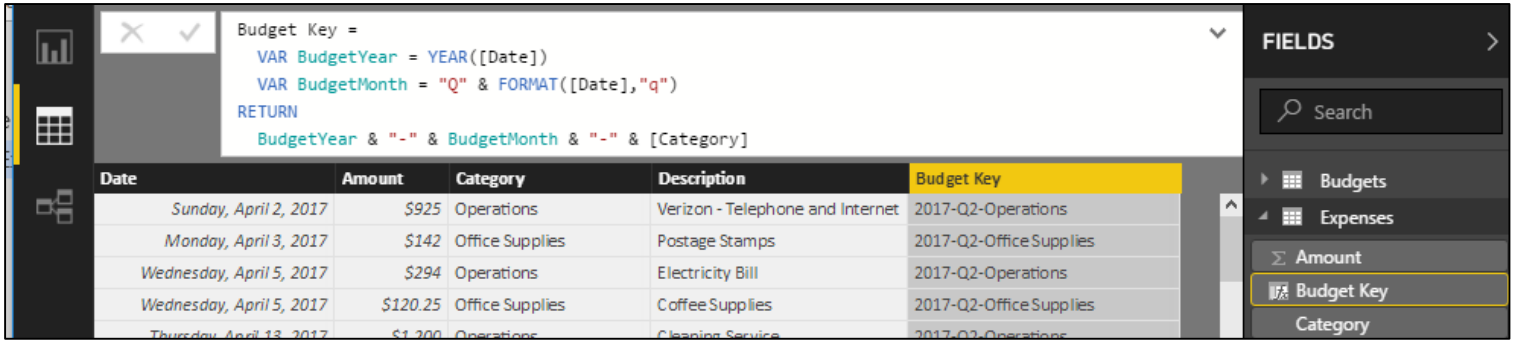


# Creating Composite Key Fields

- Create composite key column in Budgets

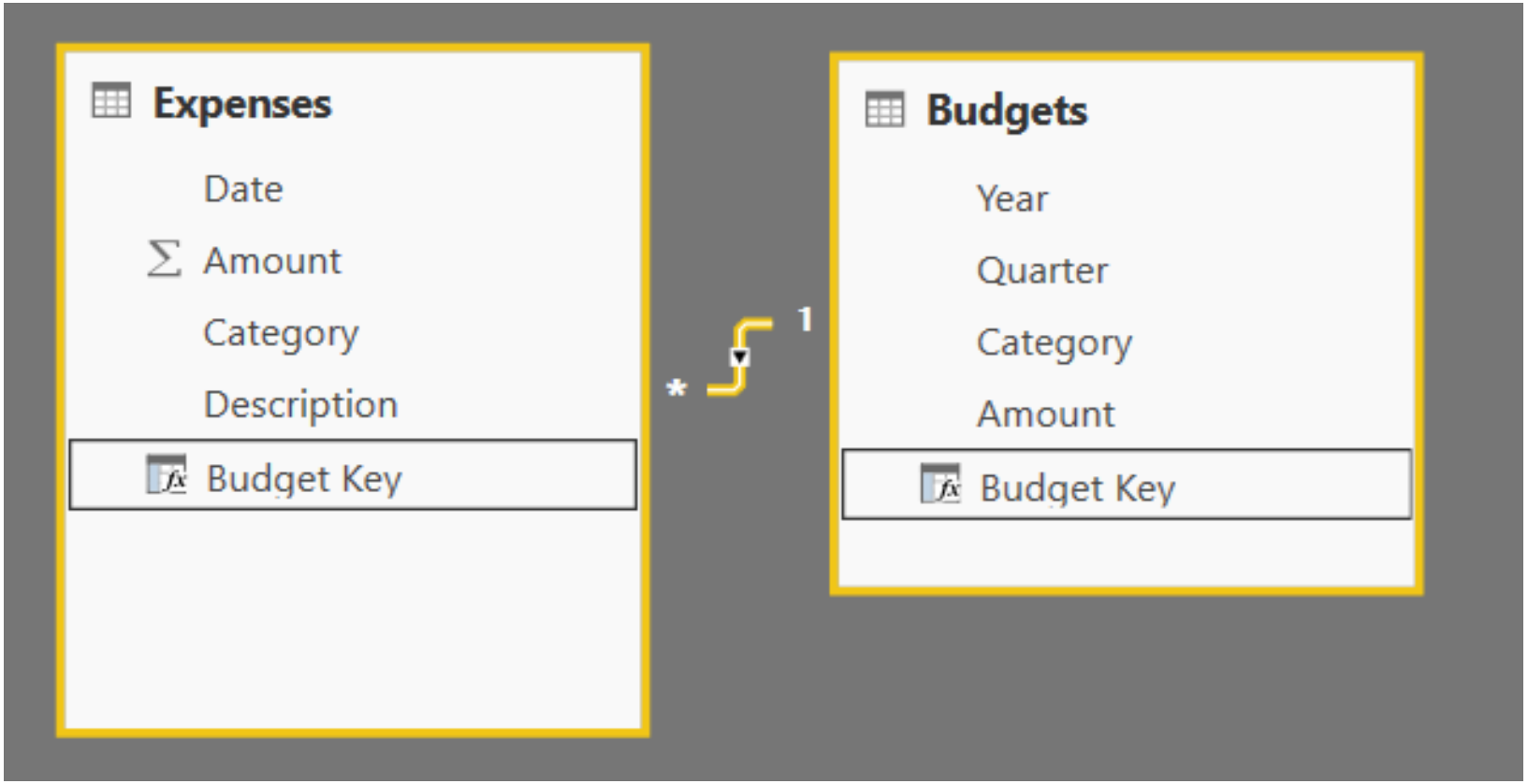

| Year | Quarter | Category | Amount | Budget Key |
|---|---|---|---|---|
| 2017 | Q1 | Marketing | $5,000 | 2017-Q1-Marketing |
| 2017 | Q1 | Office Supplies | $8,000 | 2017-Q1-Office Supplies |
| 2017 | Q1 | Operations | $8,000 | 2017-Q1-Operations |
| 2017 | Q1 | Research & Development | $5,000 | 2017-Q1-Research & Development |
| 2017 | Q2 | Marketing | $6,000 | 2017-Q2-Marketing |
| 2017 | Q2 | Office Supplies | $4,000 | 2017-Q2-Office Supplies |
| 2017 | Q2 | Operations | $7,000 | 2017-Q2-Operations |

- Create composite key column in Expenses




| Date | Amount | Category | Description | Budget Key |
|---|---|---|---|---|
| Sunday, April 2, 2017 | $925 | Operations | Verizon - Telephone and Internet | 2017-Q2-Operations |
| Monday, April 3, 2017 | $142 | Office Supplies | Postage Stamps | 2017-Q2-Office Supplies |
| Wednesday, April 5, 2017 | $294 | Operations | Electricity Bill | 2017-Q2-Operations |
| Wednesday, April 5, 2017 | $120.25 | Office Supplies | Coffee Supplies | 2017-Q2-Office Supplies |
| Thursday, April 13, 2017 | $1,200 | Operations | Cleaning Service | 2017-Q2-Operations |

# Create Relationship Using Composite Keys



# Working with DAX

- DAX is the language used to create data models
  - DAX stands for "**D**ata **A**nalysis E**x**pression Language"
- DAX expressions are similar to Excel formulas
  - They always start with an equal sign (=)
  - DAX provides many built-in functions similar to Excel
- DAX Expressions are unlike Excel formulas…
  - DAX expressions cannot reference cells (e.g. A1 or C4)
  - Instead DAX expressions reference columns and tables

```
=SUM('Sales'[SalesAmount])
```

# Writing DAX Expressions

- Some DAX expressions are simple

```
Sales Revenue = Sum(Sales[SalesAmount])
```

- Some DAX expressions are far more complex

```
Sales Growth PM = IF(
  ( ISFILTERED(Calendar[Month]) && ISFILTERED(Calendar[Date]) = FALSE() ),
  DIVIDE(
    SUM(Sales[SalesAmount]) -
    CALCULATE(
      SUM(Sales[SalesAmount]),
      PREVIOUSMONTH(Calendar[Date])
    ),
    CALCULATE(
      SUM(Sales[SalesAmount]),
      PREVIOUSMONTH(Calendar[Date])
    )
  ),
  BLANK()
)
```

# Creating Variables in DAX Expressions

- Variables can be added at start of expression
  - Use **VAR** keyword once for each variable
  - Use **RETURN** keyword to return expression value

```
Budget Key =
  VAR BudgetYear = YEAR([Date])
  VAR BudgetMonth = "Q" & FORMAT([Date],"q")
RETURN
  BudgetYear & "-" & BudgetMonth & "-" & [Category]
```

# Calculated Columns vs Measures

- Calculated Columns (aka Columns)
  - Evaluated based on context of a single row
  - Evaluated when data is loaded into memory

```
Column1 = <DAX expression>
```

- Measures
  - Evaluated at query time based on current filter context
  - Commonly used for aggregations (e.g. SUM, AVG, etc.)
  - Used more frequently than calculated columns

```
Measure1 = <DAX expression>
```

# Calculated Column for Customer Age Group

1. Calculate customer age from birthdate

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

| CustomerId | City | State | ZipCode | Gender | BirthDate | Customer | CustomerType | Age |
|---|---|---|---|---|---|---|---|---|
| 55 | San Jose | CA | 95110 | Female | 3/10/49 | Jewell Ryan | Repeat Customer | 66 |
| 73 | San Jose | CA | 95123 | Male | 5/9/85 | Granville Perry | Repeat Customer | 30 |
| 74 | San Jose | CA | 95122 | Female | 6/19/79 | Sheri Mercado | Repeat Customer | 36 |
| 78 | San Jose | CA | 95110 | Male | 6/16/78 | Raleigh Olson | Repeat Customer | 37 |
| 136 | San Jose | CA | 95124 | Female | 1/2/45 | Carrie Foreman | Repeat Customer | 70 |
| 150 | San Jose | CA | 95134 | Female | 8/11/84 | Renee McMillan | Repeat Customer | 31 |

2. Calculate age groups using calculated column

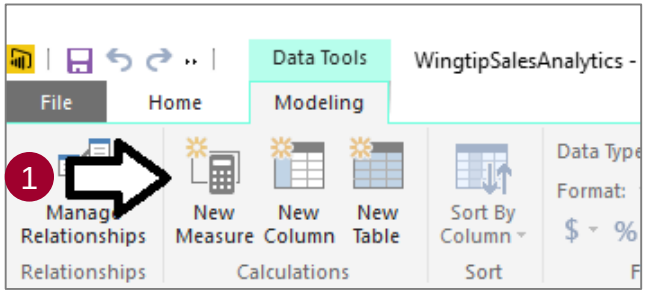
```
Age Group =
  SWITCH( TRUE(),
    [Age] >= 65, "Ages 65 and over",
    [Age] >= 50, "Ages 50 TO 65",
    [Age] >= 40, "Ages 40 TO 49",
    [Age] >= 30, "Ages 30 TO 39",
    [Age] >= 18, "Ages 18 TO 23",
    [Age] < 18, "Ages under 18"
)
```

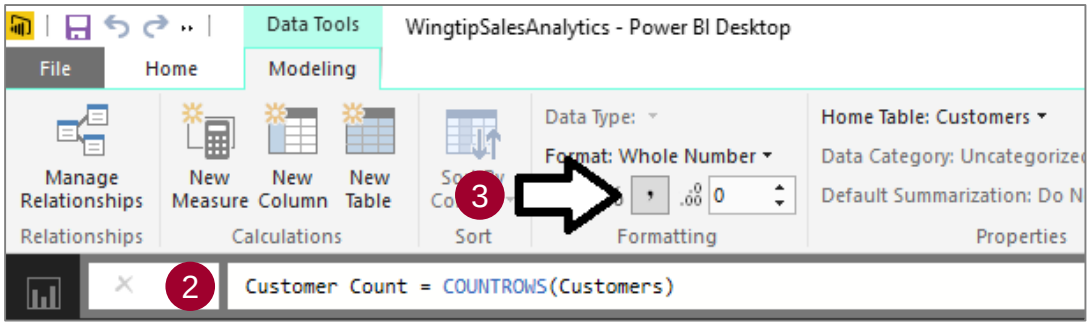
| CustomerId | City | State | ZipCode | Gender | BirthDate | Customer | CustomerType | Age | Age Group |
|---|---|---|---|---|---|---|---|---|---|
| 55 | San Jose | CA | 95110 | Female | 3/10/49 | Jewell Ryan | Repeat Customer | 66 | Ages 65 and over |
| 73 | San Jose | CA | 95123 | Male | 5/9/85 | Granville Perry | Repeat Customer | 30 | Ages 30 TO 39 |
| 74 | San Jose | CA | 95122 | Female | 6/19/79 | Sheri Mercado | Repeat Customer | 36 | Ages 30 TO 39 |
| 78 | San Jose | CA | 95110 | Male | 6/16/78 | Raleigh Olson | Repeat Customer | 37 | Ages 30 TO 39 |
| 136 | San Jose | CA | 95124 | Female | 1/2/45 | Carrie Foreman | Repeat Customer | 70 | Ages 65 and over |
| 150 | San Jose | CA | 95134 | Female | 8/11/84 | Renee McMillan | Repeat Customer | 31 | Ages 30 TO 39 |
| 178 | San Jose | CA | 95123 | Male | 9/7/89 | Wayne Gordon | Repeat Customer | 26 | Ages 18 TO 23 |
| 183 | San Jose | CA | 95110 | Female | 5/26/85 | Luella Vinson | Repeat Customer | 30 | Ages 30 TO 39 |
| 213 | San Jose | CA | 95123 | Male | 8/13/78 | Rosario Knight | Repeat Customer | 37 | Ages 30 TO 39 |

# Creating Measures

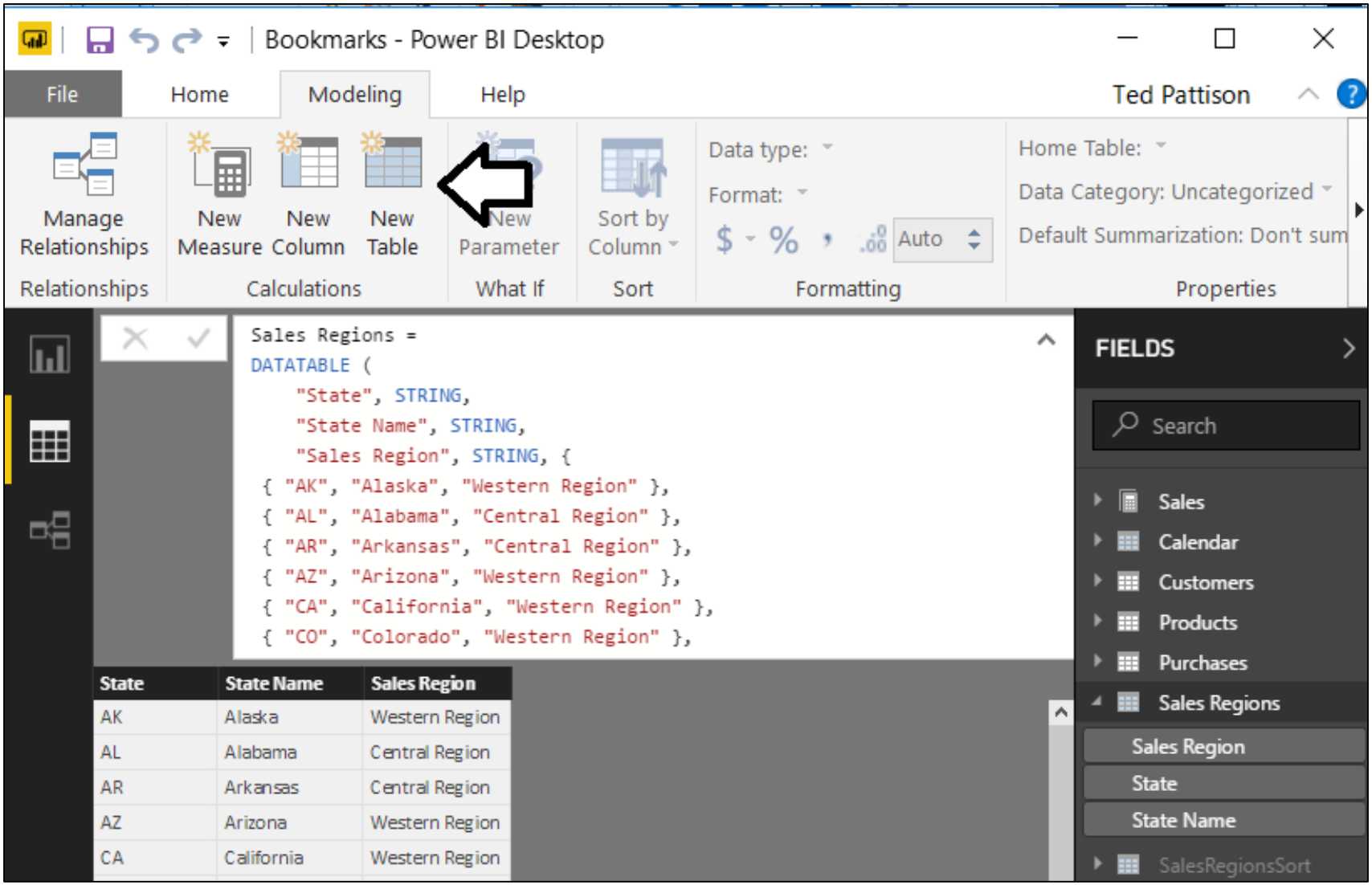
- Measures have advantage over calculated columns
  - They are evaluated based on the current evaluation context

- Creating a measure with Power BI Desktop
  1. Click New Measure button
  2. Give measure a name and write DAX expressions
  3. Configure formatting



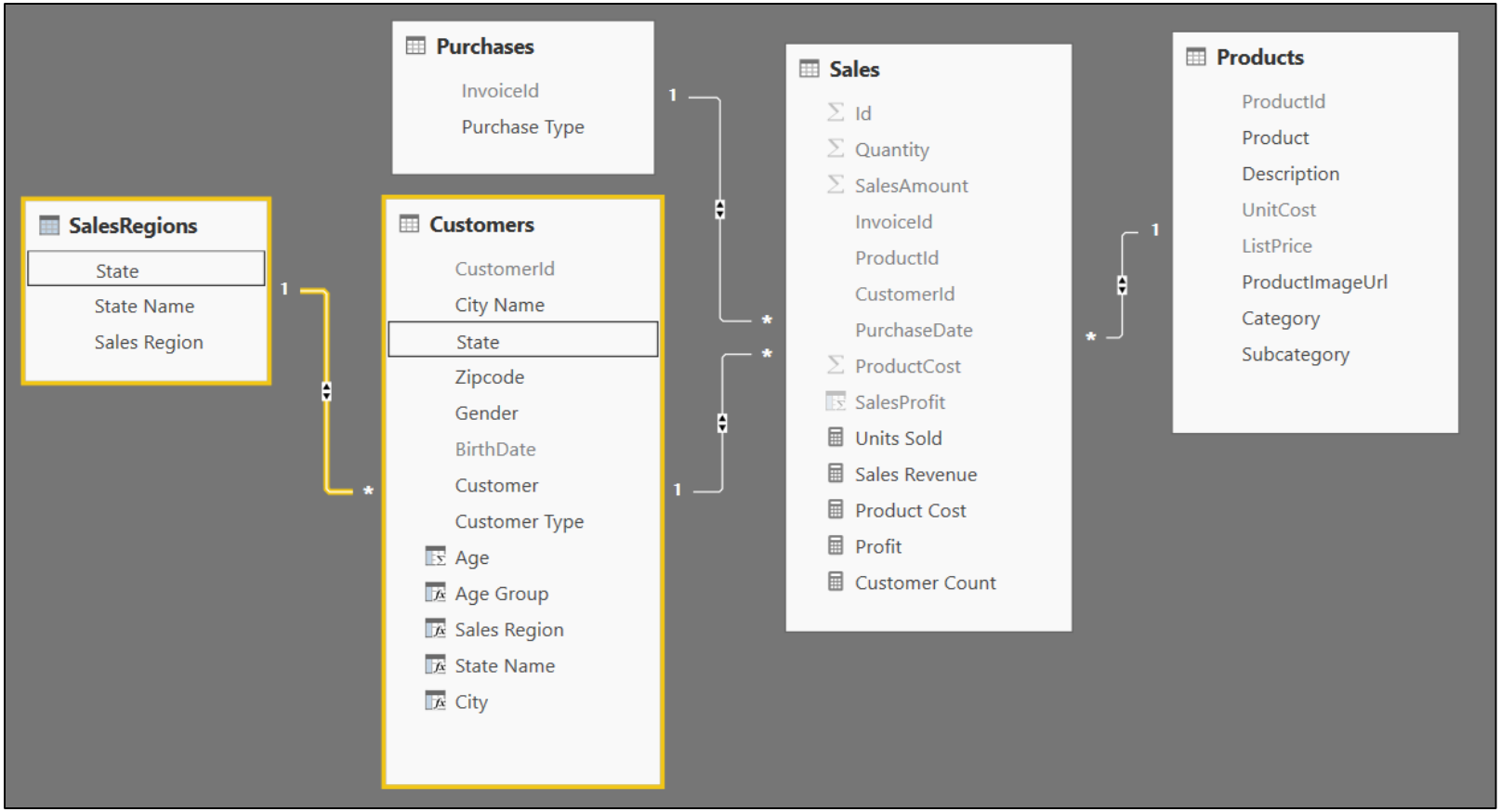



# Creating Tables Dynamically using DAX



# Integrating the Lookup Table into the Data Model

- Lookup table must be integrated into data model
  - Accomplished by creating relationship to one or more tables



# The RELATED Function

- RELATED function performs cross-table lookup
  - Effectively replaces older VLOOKUP function
  - Used in many-side table to look up value from one-side
  - Used to pull data from lookup table into primary table

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

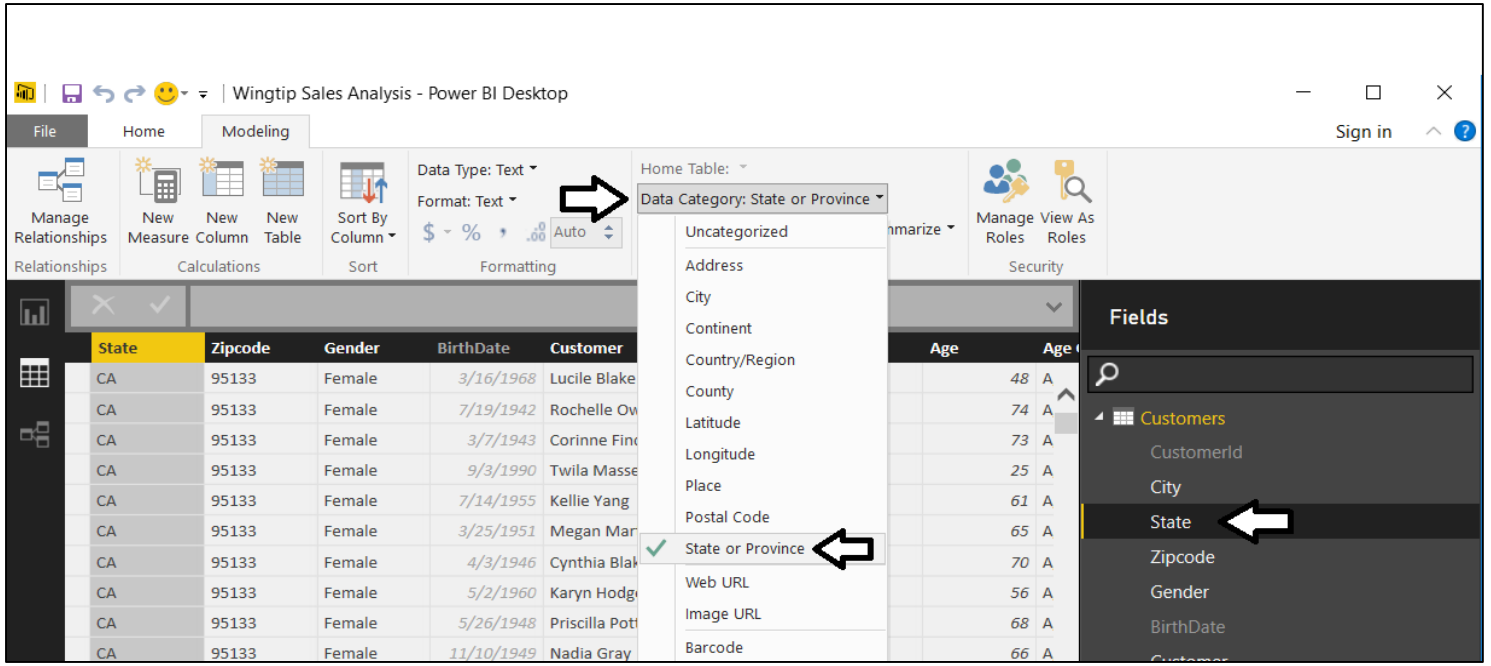
| CustomerId | City | State | ZipCode | Gender | BirthDate | Customer | CustomerType | Age | Age Group | Sales Region |
|---|---|---|---|---|---|---|---|---|---|---|
| 55 | San Jose | CA | 95110 | Female | 3/10/49 | Jewell Ryan | Repeat Customer | 66 | Ages 65 and over | Western Region |
| 73 | San Jose | CA | 95123 | Male | 5/9/85 | Granville Perry | Repeat Customer | 30 | Ages 30 TO 39 | Western Region |
| 74 | San Jose | CA | 95122 | Female | 6/19/79 | Sheri Mercado | Repeat Customer | 36 | Ages 30 TO 39 | Western Region |
| 78 | San Jose | CA | 95110 | Male | 6/16/78 | Raleigh Olson | Repeat Customer | 37 | Ages 30 TO 39 | Western Region |
| 136 | San Jose | CA | 95124 | Female | 1/2/45 | Carrie Foreman | Repeat Customer | 70 | Ages 65 and over | Western Region |
| 150 | San Jose | CA | 95134 | Female | 8/11/84 | Renee McMillan | Repeat Customer | 31 | Ages 30 TO 39 | Western Region |

```
State Name = RELATED(SalesRegions[StateFullName])
```

| State | ZipCode | Gender | BirthDate | Customer | CustomerType | Age | Age Group | Sales Region | State Name |
|---|---|---|---|---|---|---|---|---|---|
| CA | 95110 | Female | 3/10/49 | Jewell Ryan | Repeat Customer | 66 | Ages 65 and over | Western Region | California |
| CA | 95123 | Male | 5/9/85 | Granville Perry | Repeat Customer | 30 | Ages 30 TO 39 | Western Region | California |
| CA | 95122 | Female | 6/19/79 | Sheri Mercado | Repeat Customer | 36 | Ages 30 TO 39 | Western Region | California |
| CA | 95110 | Male | 6/16/78 | Raleigh Olson | Repeat Customer | 37 | Ages 30 TO 39 | Western Region | California |
| CA | 95124 | Female | 1/2/45 | Carrie Foreman | Repeat Customer | 70 | Ages 65 and over | Western Region | California |
| CA | 95134 | Female | 8/11/84 | Renee McMillan | Repeat Customer | 31 | Ages 30 TO 39 | Western Region | California |

# Geographic Field Metadata

- Fields in data model have metadata properties
  - Metadata used by visuals and reporting tools
  - Used as hints to Bing Mapping service



# Eliminate Geographic Ambiguity

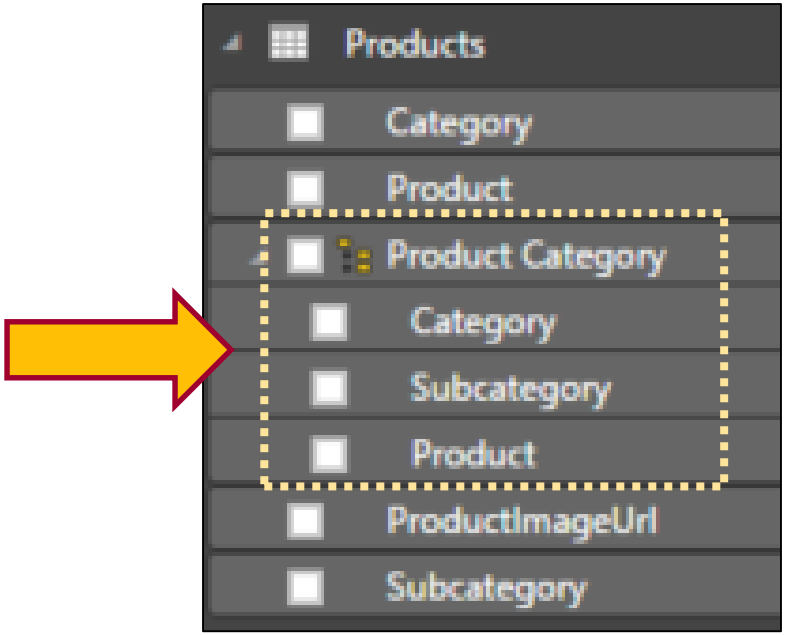
- City name alone is ambiguous
  - "Athens" defaults to Greece not Georgia
  - Concatenate city name with state to disambiguate

```
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 |

# 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



# 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 Filter Context

- Visuals apply various filters in different evaluation contexts

| Month in Year | 2012 | 2013 | 2014 | 2015 | Total |
|---|---|---|---|---|---|
| January | $6,306 | $164,334 | $385,275 | $512,822 | $1,068,737 |
| February | $48,815 | $126,501 | $358,244 | $597,684 | $1,131,244 |
| March | $53,958 | $243,676 | $381,309 | $532,123 | $1,211,067 |
| April | $52,601 | $300,872 | $381,157 | $602,751 | $1,337,381 |
| May | $61,756 | $334,948 | $438,261 | $647,276 | $1,482,241 |
| June | $76,756 | $321,715 | $378,749 | $608,448 | $1,385,668 |
| July | $104,408 | $287,800 | $359,744 | $620,316 | $1,372,268 |
| August | $111,167 | $298,483 | $457,312 | $678,499 | $1,545,461 |
| September | $110,716 | $376,207 | $505,332 | $613,974 | $1,606,229 |
| October | $145,999 | $362,943 | $602,448 | $620,735 | $1,732,125 |
| November | $156,751 | $340,228 | $545,572 | $590,220 | $1,632,770 |
| December | $147,593 | $331,526 | $581,977 | $686,814 | $1,747,910 |
| **Total** | **$1,076,826** | **$3,489,234** | **$5,375,379** | **$7,311,660** | **$17,253,100** |

**Filters on this evaluation**

[Year] = 2015

[Month in Year] = "October"

- Filter context also affected by slicers and other filters

Sales Region

- Select All
- Central Region
- Eastern Region
- Western Region

Customer Type

- One-time customer
- Repeat Customer

| Month in Year | 2012 | 2013 | 2014 | 2015 | Total |
|---|---|---|---|---|---|
| January | $425 | $50,169 | $61,295 | $76,614 | $188,503 |
| February | $13,891 | $40,133 | $63,670 | $101,542 | $219,236 |
| March | $19,121 | $58,411 | $73,839 | $84,180 | $235,551 |
| April | $19,128 | $53,711 | $67,919 | $91,762 | $232,520 |
| May | $22,939 | $64,259 | $78,668 | $109,689 | $275,555 |
| June | $29,082 | $50,564 | $73,504 | $88,047 | $241,197 |
| July | $34,809 | $62,971 | $69,053 | $80,749 | $247,582 |
| August | $36,096 | $61,217 | $76,009 | $94,719 | $268,041 |
| September | $39,415 | $68,653 | $82,697 | $94,805 | $285,570 |
| October | $51,994 | $69,122 | $99,344 | $84,177 | $304,637 |
| November | $47,020 | $52,548 | $85,924 | $74,611 | $260,102 |
| December | $50,580 | $66,260 | $102,088 | $94,877 | $313,804 |
| **Total** | **$364,500** | **$698,018** | **$934,009** | **$1,075,771** | **$3,072,298** |

**Filters on this evaluation**

[Year] = 2015

[Month in Year] = "October"

[Sales Region] = "Western Region"

[Customer Type] = "Repeat Customer"

# Using the CALCULATE Function

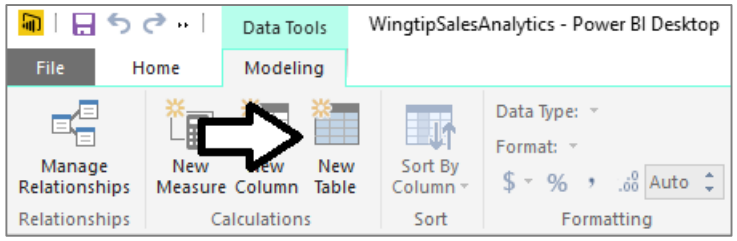
- CALCULATE function provides greatest amount of control
  - First argument defines expression to evaluate
  - Second argument defines table on which to evaluate expression
  - You can evaluate expressions with or without current filter context

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

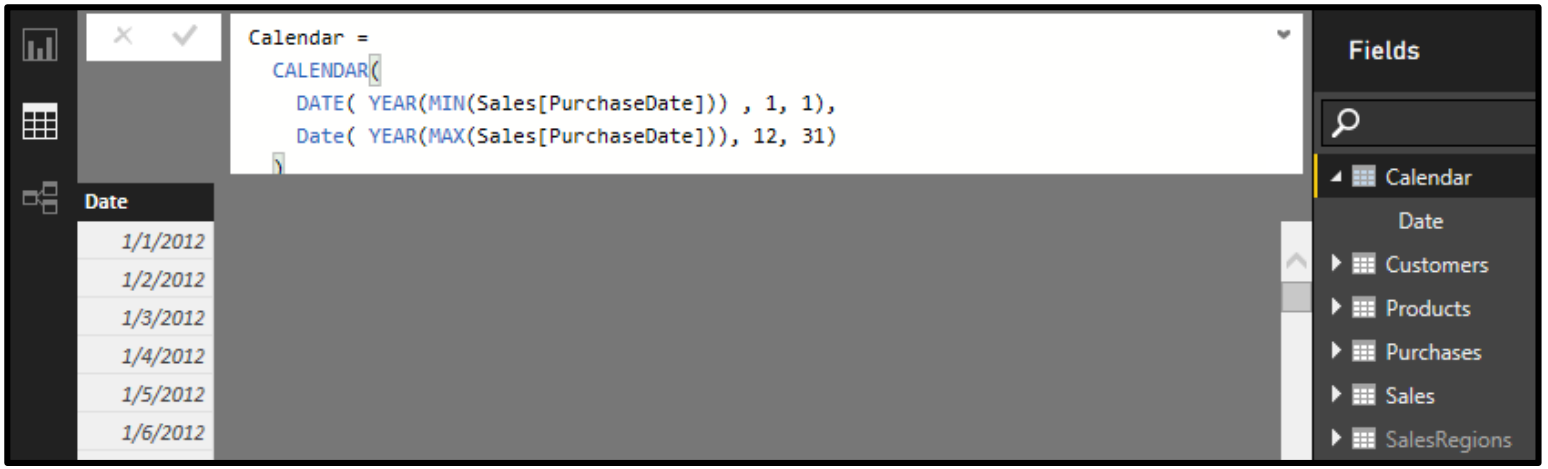
```
Pct of Product Category =
DIVIDE(
    SUM( Sales[SalesAmount] ),
    CALCULATE(
        Sum (Sales[SalesAmount] ),
        ALL( Products[Subcategory], Products[Product] )
    )
)
```

# 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

```
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

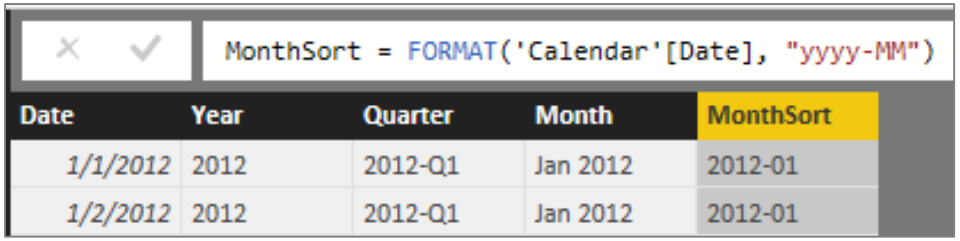
```
Month = FORMAT('Calendar'[Date], "MMM yyyy")
```

| 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 |

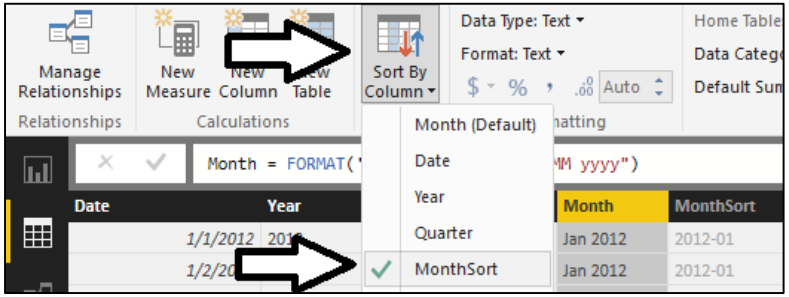
# Configuring Sort Columns

- 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

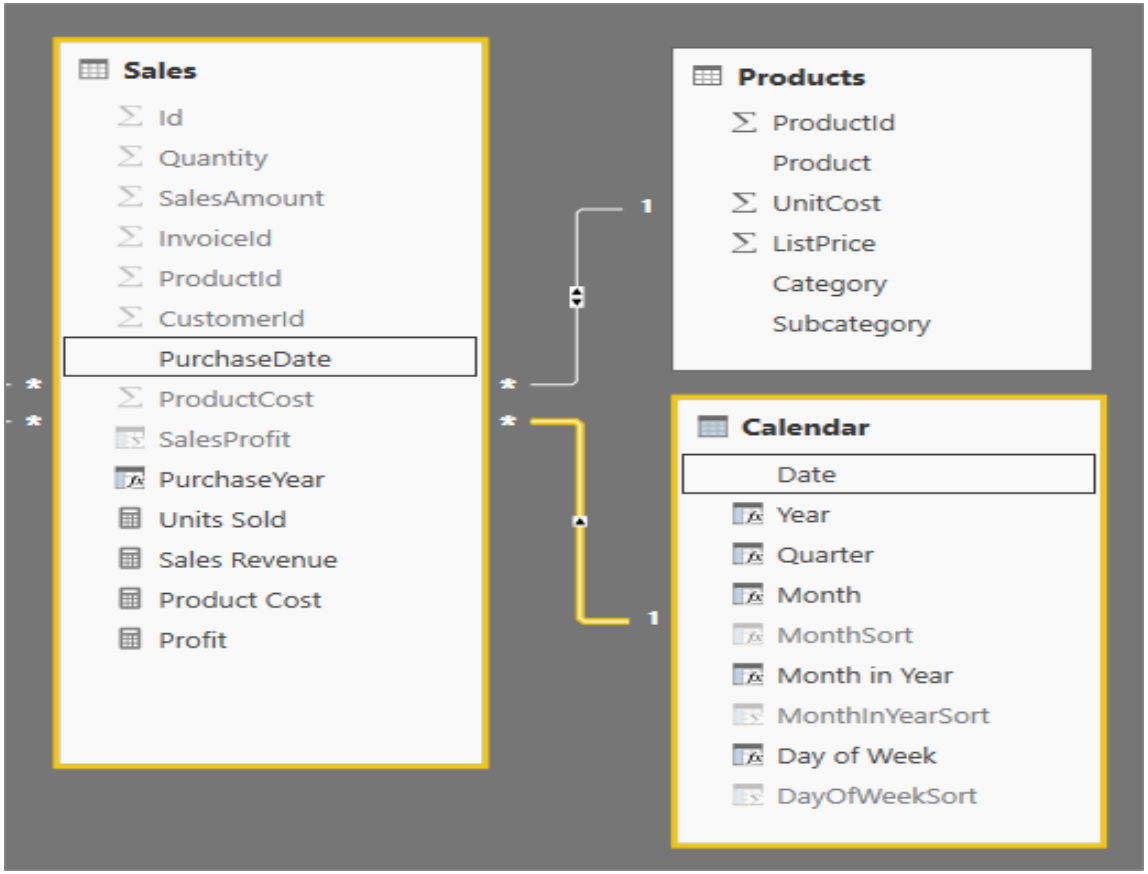



  - Configure **Month** column with **MonthSort** as sort column



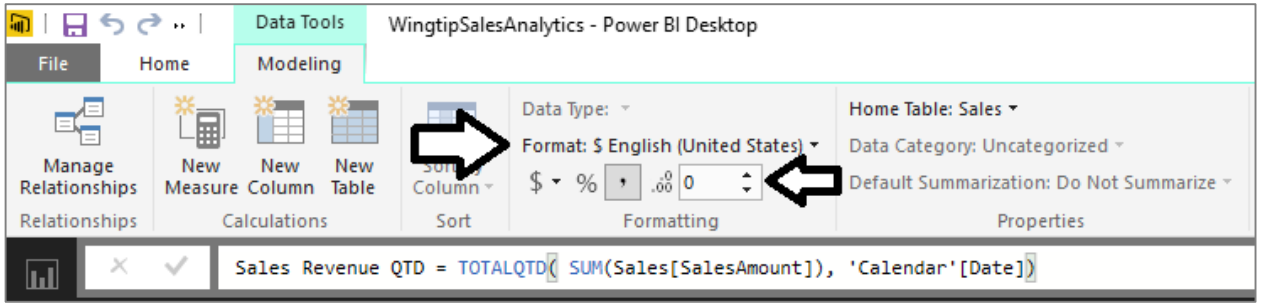
# Integrating Calendar Table into Data Model

- Calendar table needs relationship to one or more tables

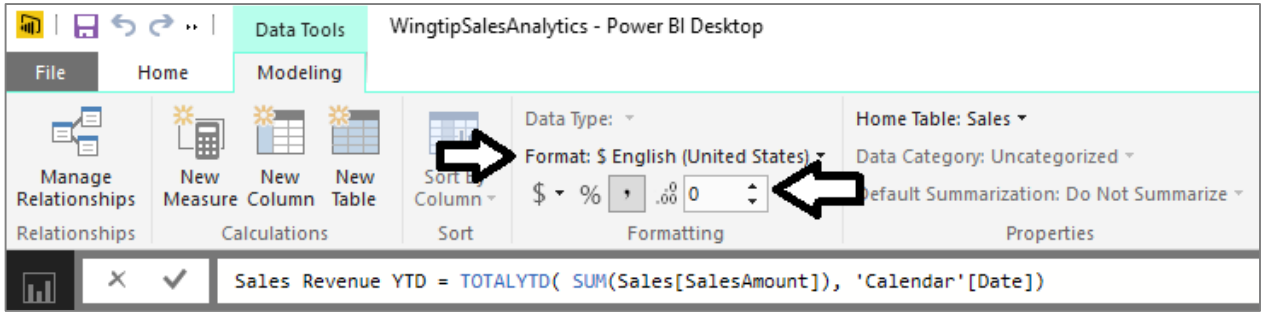


# Calculated Fields for QTD and YTD Sales

- TOTALQTD function calculates quarter-to-date totals

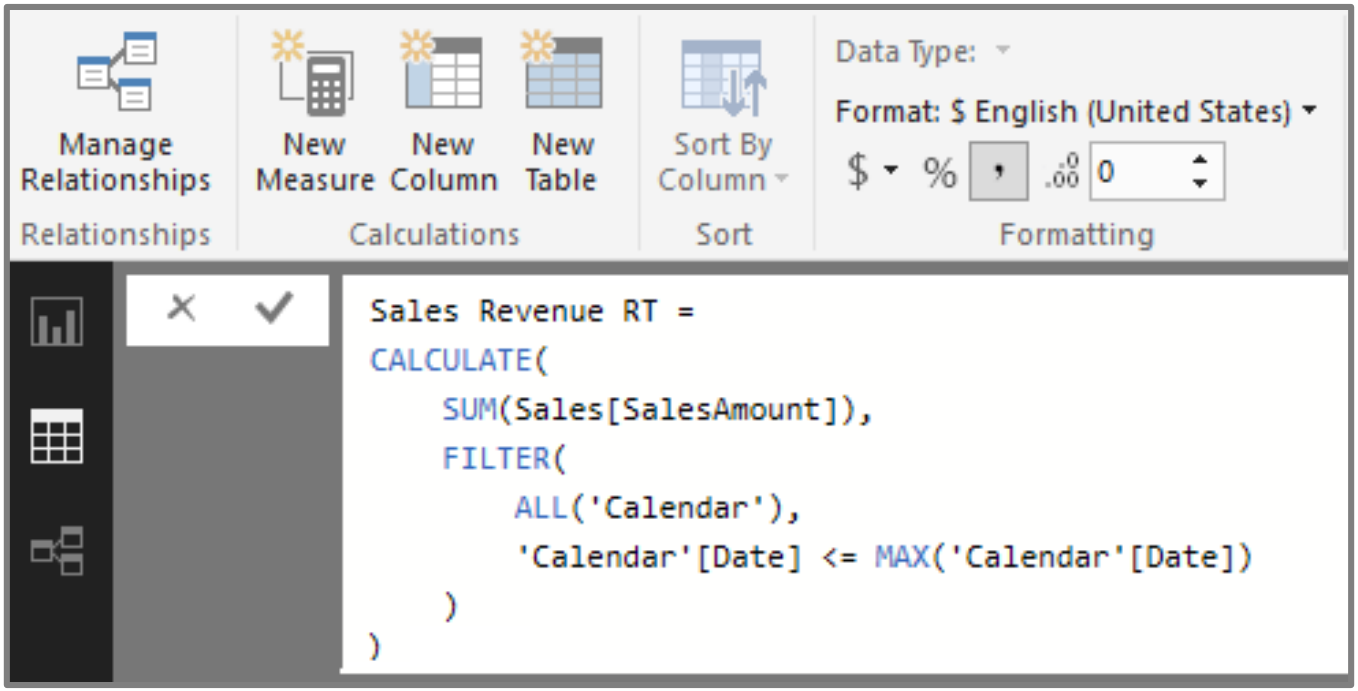



- TOTALYTD function calculates year-to-date totals



# Creating Running Total using CALCULATE

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



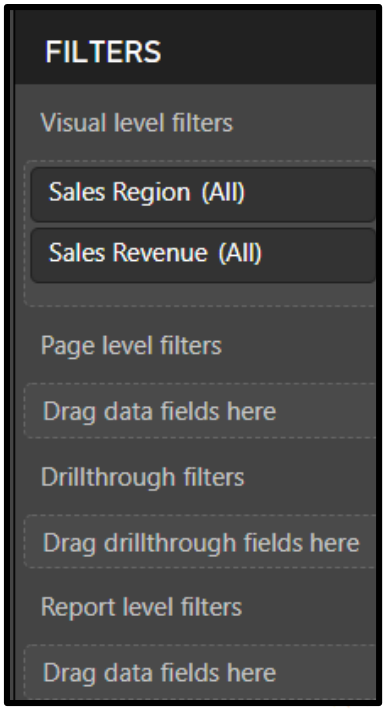
# Agenda

- ✓ Power BI Desktop Overview
- ✓ Building Queries
- ✓ Designing Data Models
- ➢ Designing Reports

# Creating Reports

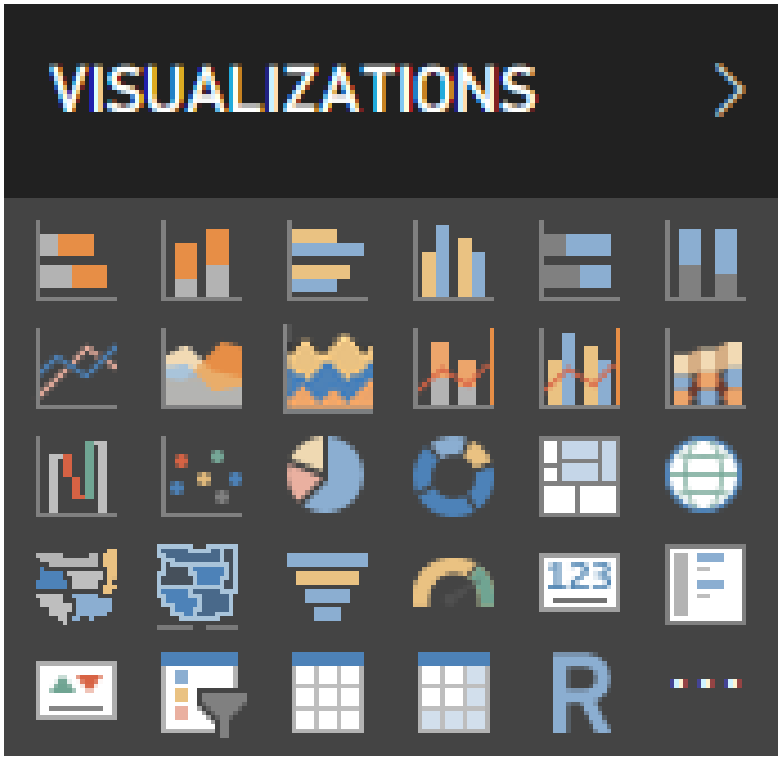
- Power BI Desktop project contains one report
  - Report within project can contain multiple pages
  - Report pages contains visuals

- Reports can be created using filters
  - You can add visual level filters
  - You can add page level filters
  - You can add drillthrough filters
  - You can add report level filters



# Built-in Visualization Types

- Table and Matrix
- Bar charts and Column charts
- Pie charts and Doughnut chart
- Line chart and Area chart
- Scatter chart and Combo charts
- Card and Multi-row Card
- Treemap
- Ribbon chart
- Waterfall chart
- Funnel chart
- Gauge
- Map and Filled Map
- Slicer
- R script visual
- Shape map (in preview)



# Designing Reports with Interactive Filtering

- Slicers
  - Provide report consumers with intuitive filtering
- Visual Highlighting
  - Filtering applied when user clicks on a visual data element
- Drilldown Mode
  - Allows report consumer to drill into field hierarchy
    *e.g. Sales Region > State > City > Zipcode*
- Drillthrough Pages
  - Allows report consumer to navigate to drillthrough page

# Summary

- ✓ Power BI Desktop Overview
- ✓ Building Queries
- ✓ Designing Data Models
- ✓ Designing Reports