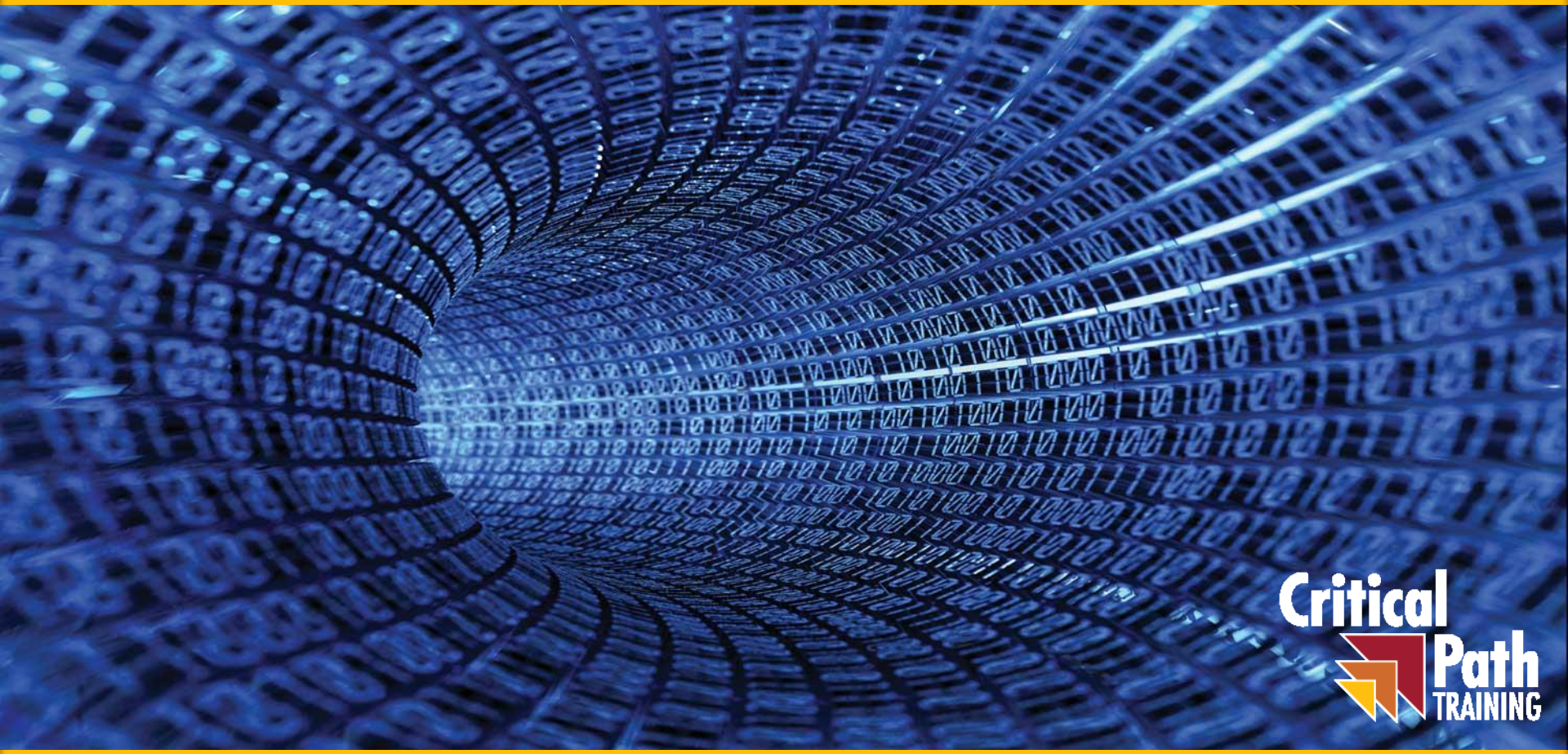
Power BI Desktop Primer



Agenda

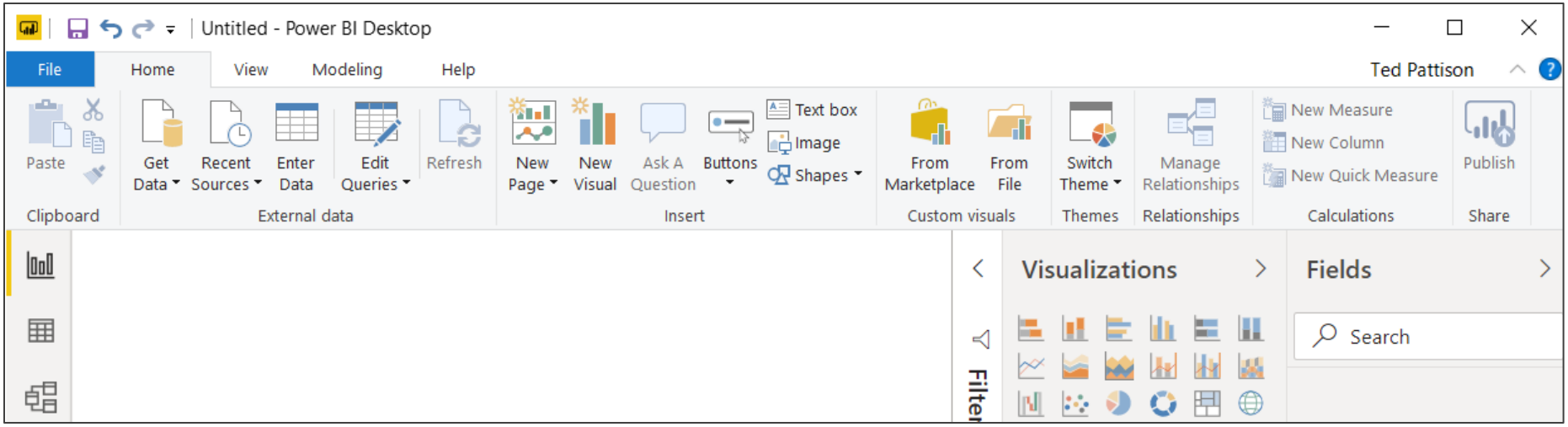
- Power BI Desktop Overview
- Building Queries
- Designing Data Models
- Designing Reports

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

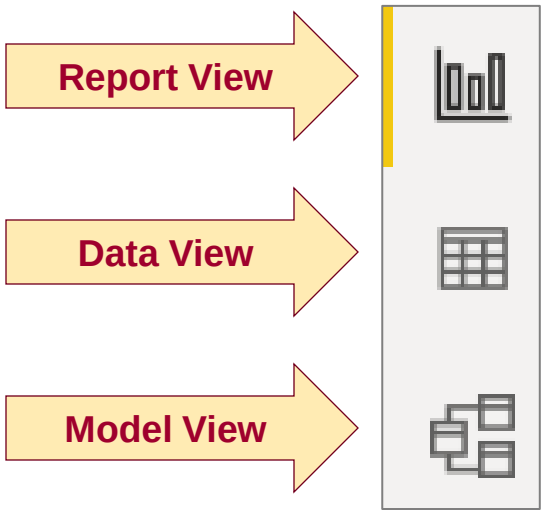
Working with Power BI Desktop

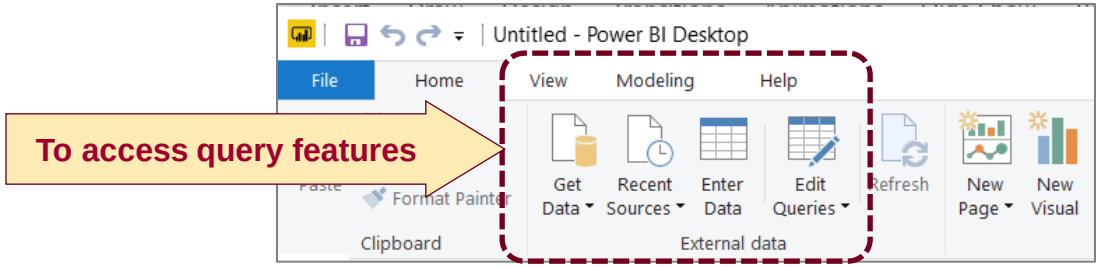
- Power BI Desktop is a Windows application
  - Work is saved and published in terms of PBIX projects
  - You can work on multiple projects at once
  - Each project runs in its own Power BI Desktop instance
  - Power BI Desktop can freeze up or act buggy
  - Quit & restart Power BI Desktop if it acts strangely



Getting Around in Power BI Desktop

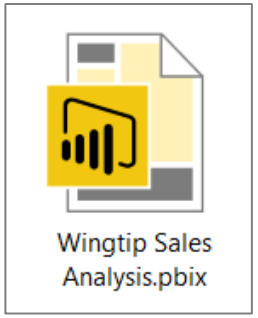
- What do you need to learn to use Power BI Desktop?
  - Query features for importing data
  - Designing data model & writing DAX expressions
  - Designing reports with Power BI Desktop report designer
- Navigating between view modes

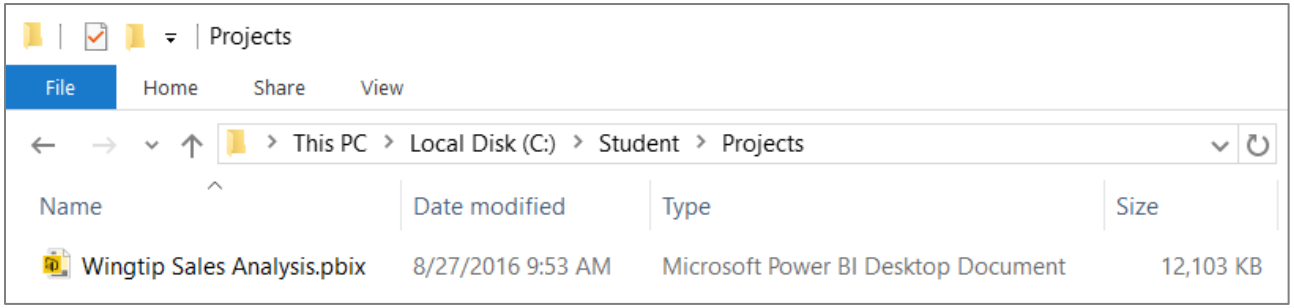




Projects and PBIX Files

- Power BI Desktop projects saved using PBIX files
  - PBIX file contains data source definitions
  - PBIX file contains query definitions
  - PBIX file contains data imported from queries
  - PBIX file contains exactly one data model definition
  - PBIX file contains exactly one report
  - PBIX file never contains data source credentials



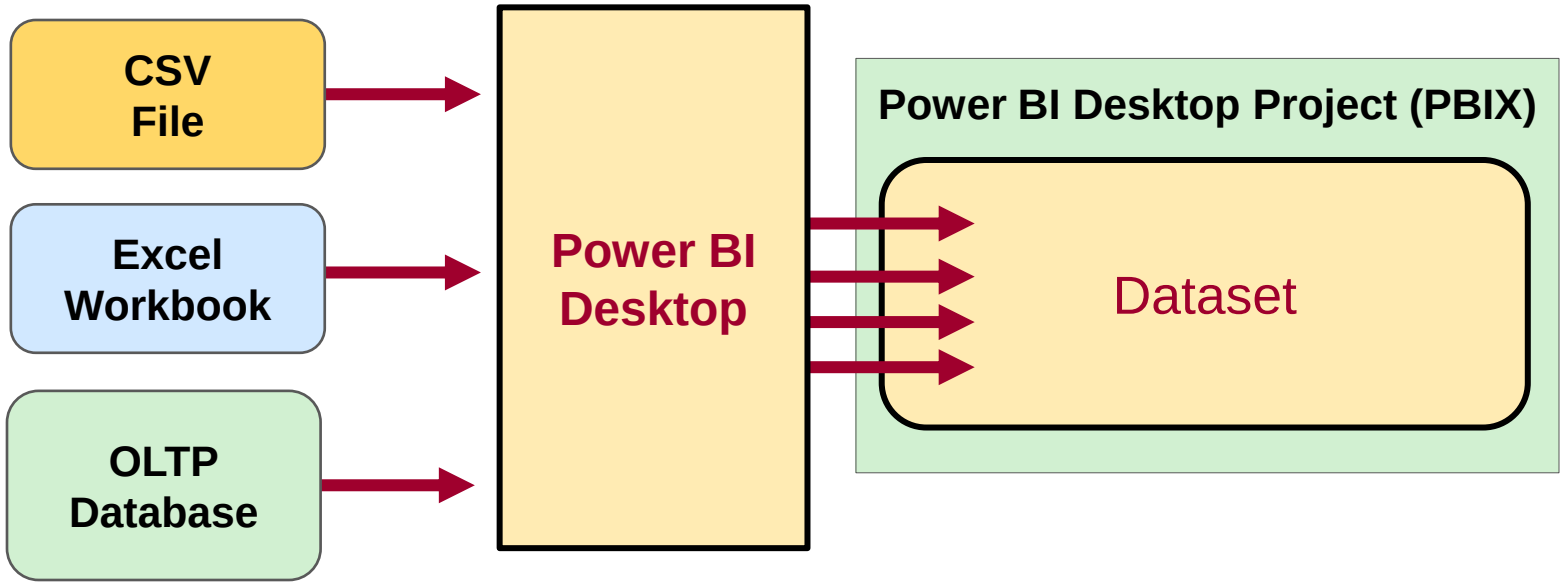


Agenda

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

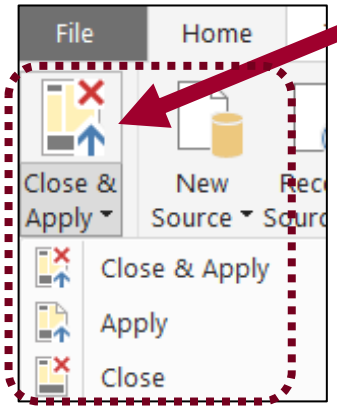
Power BI Desktop is an ETL Tool

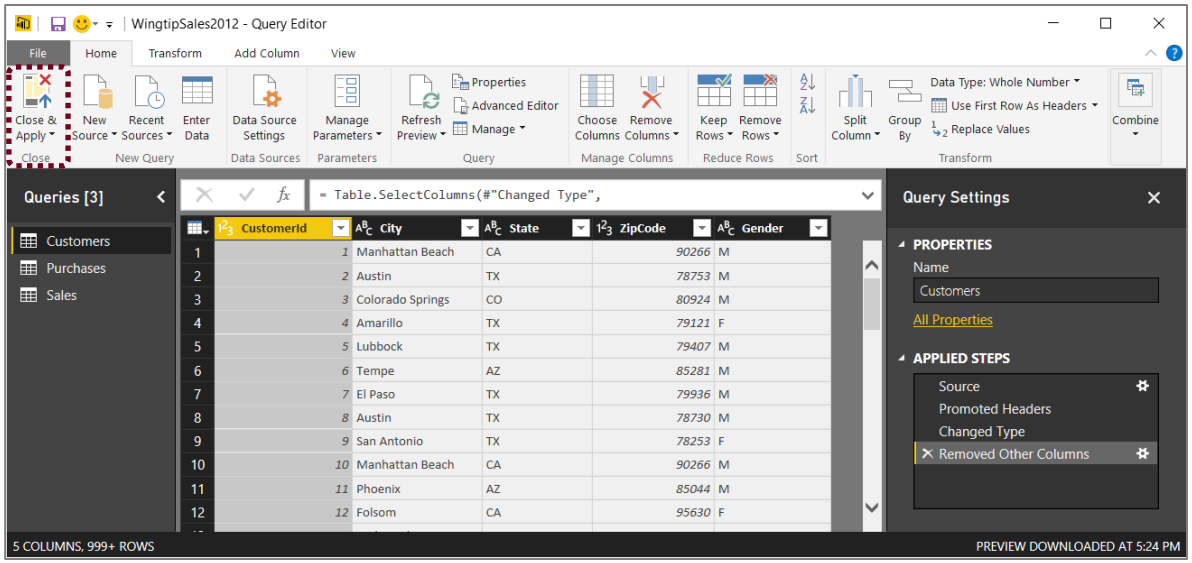
- ETL process is essential part of any BI Project
  - **Extract** the data from wherever it lives
  - **Transform** the shape of the data for better analysis
  - **Load** the data into dataset for analysis and reporting



Query Editor Window

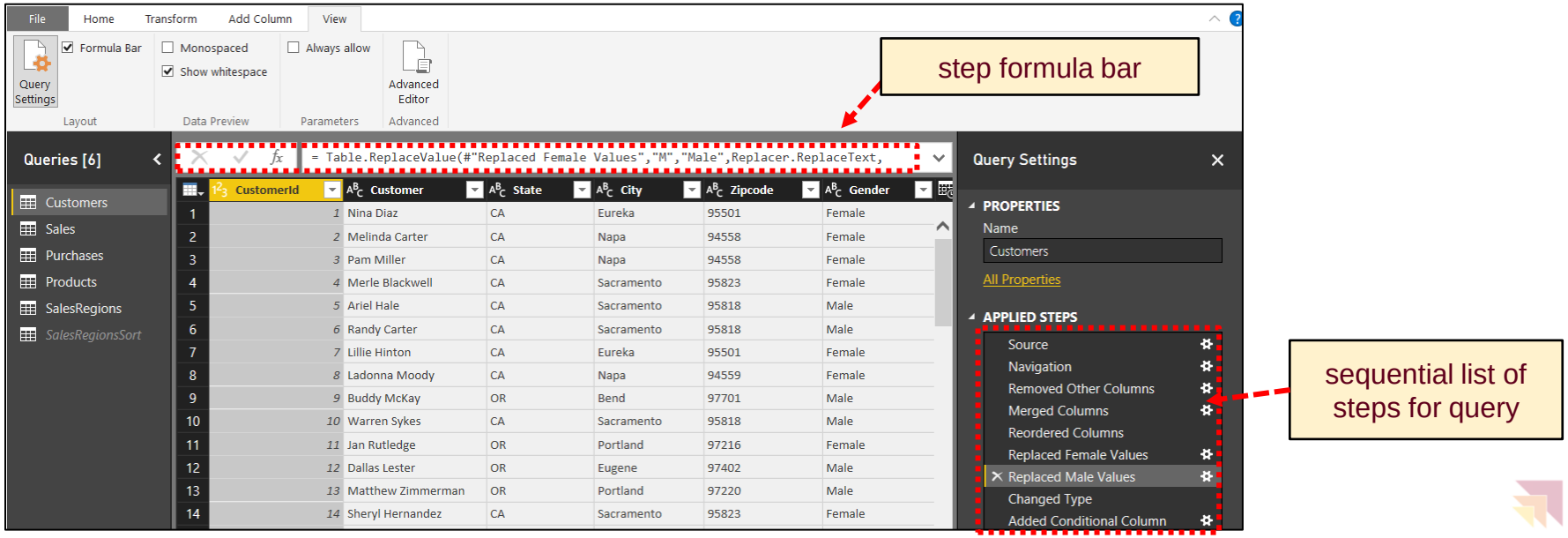
- Power BI Desktop provides separate Query Editor window
  - Provides powerful features for designing queries
  - Displays list of all queries in project on the left
  - Displays **Properties** and **Applied Steps** for selected query on right
  - Preview of table generated by query output shown in the 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

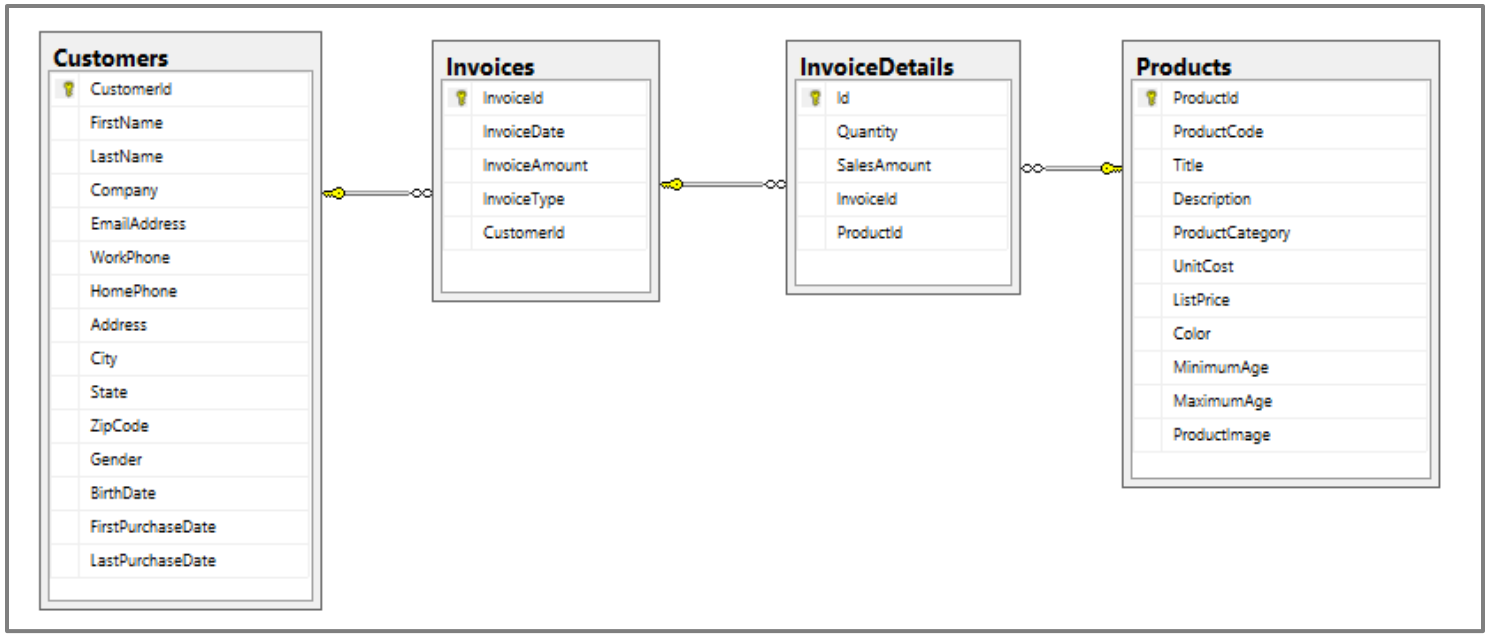


Examples of Basic Power BI Desktop Steps

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

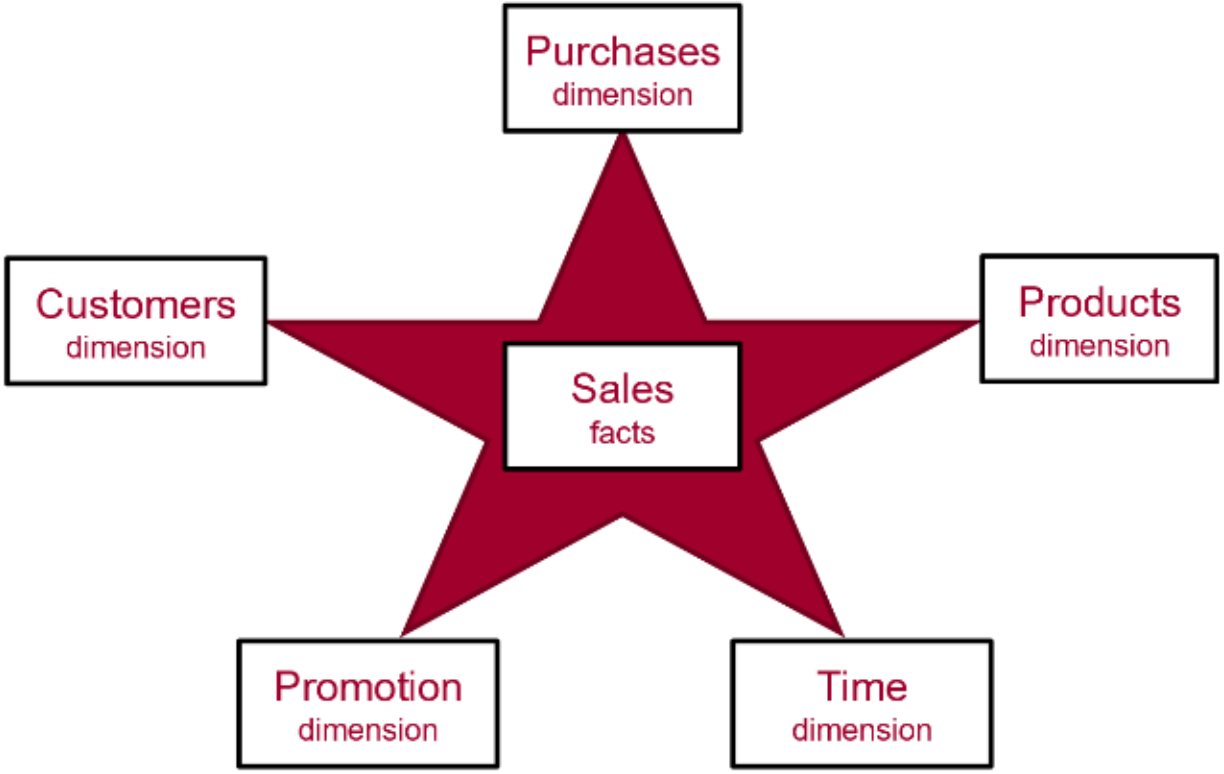
Sample OLTP Database: WingtipSalesDB

- 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



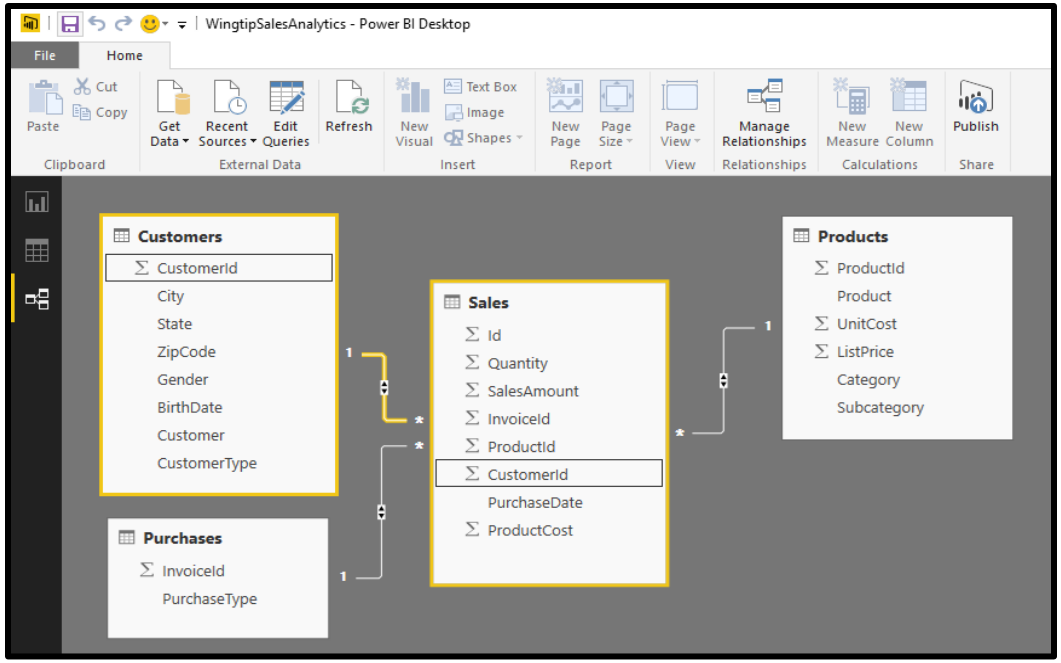
Data Modeling using a Star Schema

- 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



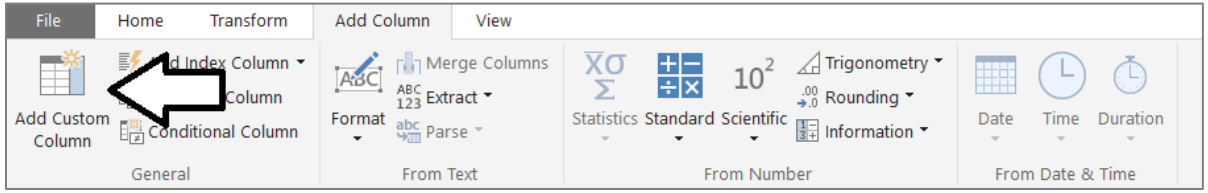
Designing Queries to Build a Star Schema

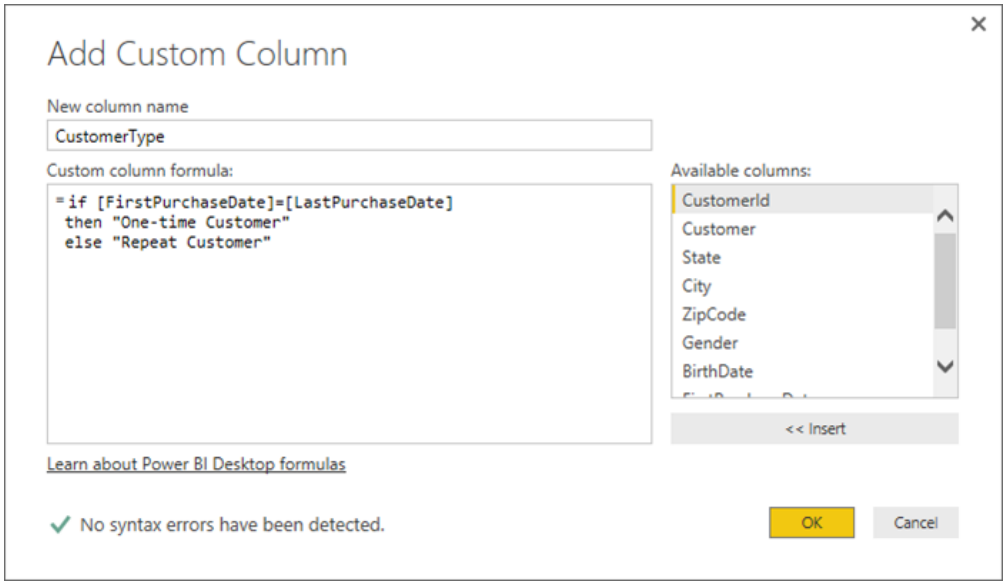
- Converts OLTP Data Model to OLAP Data Model
  - Sales table is modeled as a OLAP Fact Table
  - Other tables are modeled as OLAP Dimension tables
  - Requires pulling CustomerId column into Sales table
  - All dimension tables should be directly related to fact table



Adding a Custom Column

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

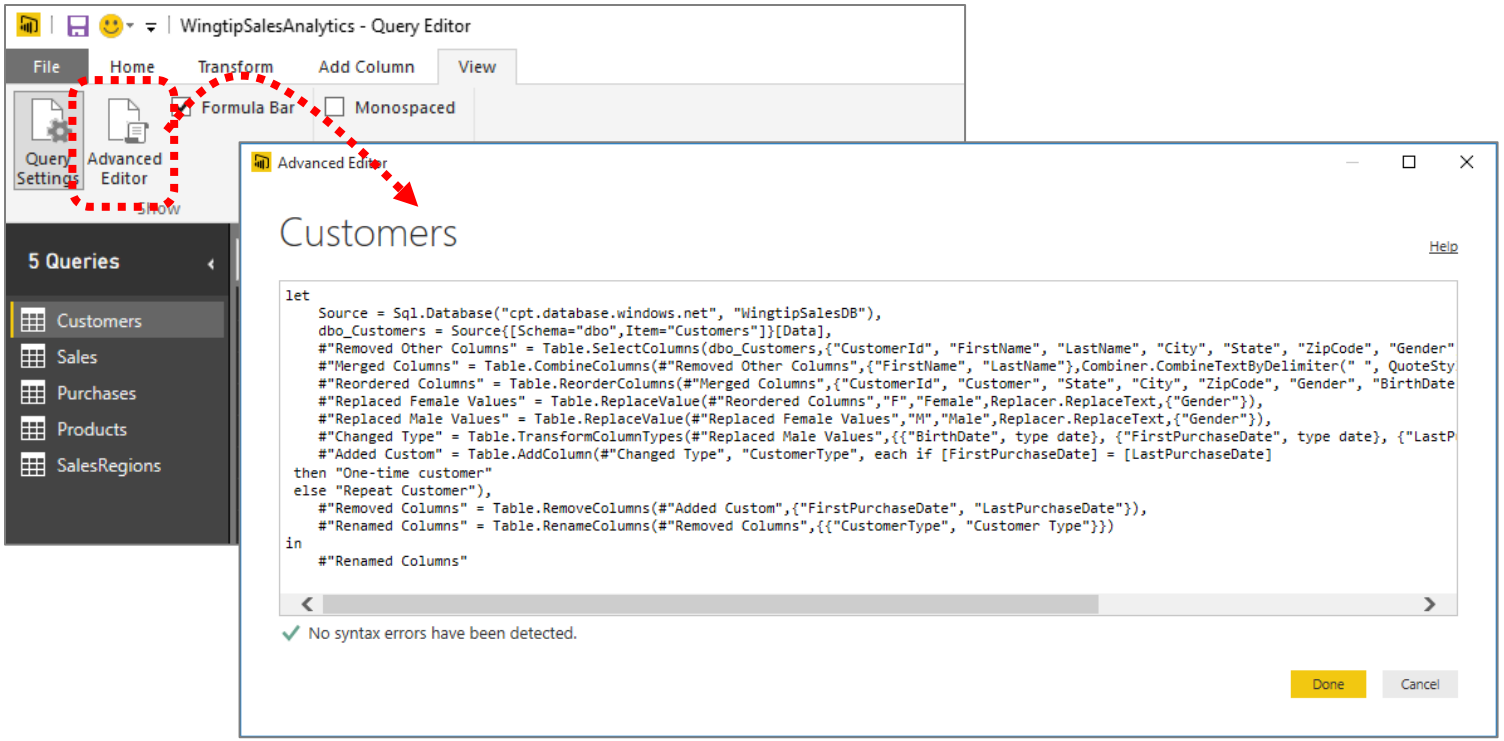




FirstPurchaseDate	LastPurchaseDate	CustomerType
1/28/2012	1/28/2012	One-time Customer
1/28/2012	1/28/2012	One-time Customer
1/28/2012	1/28/2012	One-time Customer
1/28/2012	1/28/2012	One-time Customer
1/28/2012	1/28/2012	One-time Customer
1/28/2012	1/28/2012	One-time Customer
1/29/2012	11/22/2015	Repeat 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

GetExpensesFromFile

```
(FilePath as text) =>

let
    Source = Csv.Document(Web.Contents(FilePath)
    #"Changed Type" = Table.TransformColumnTypes
```

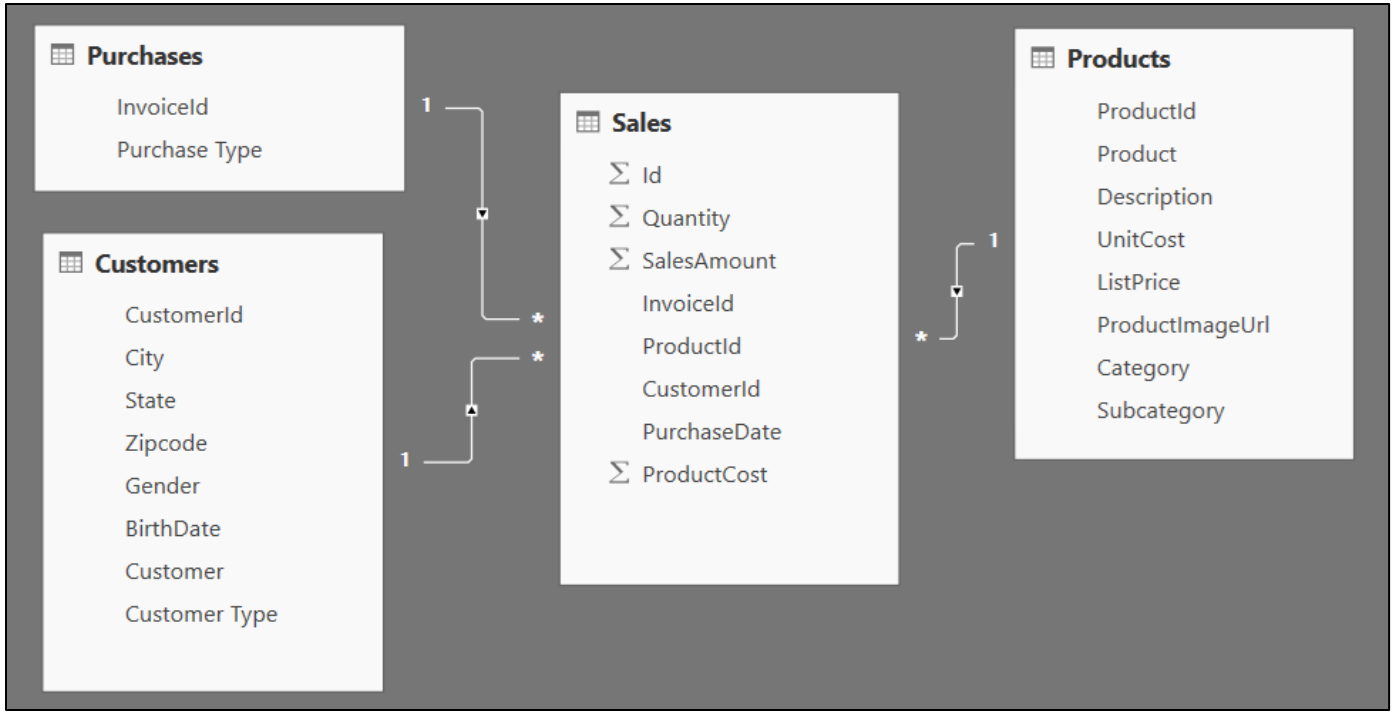
  - Function query can't be edited with visual designer

Agenda

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

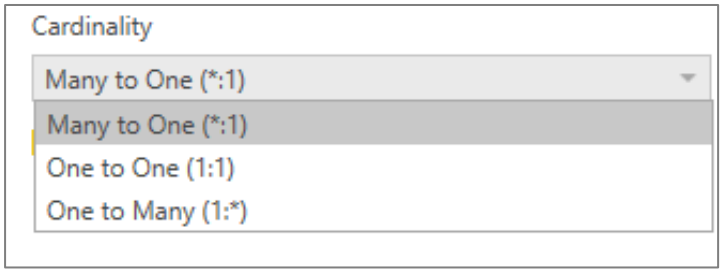
Table Relationships

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

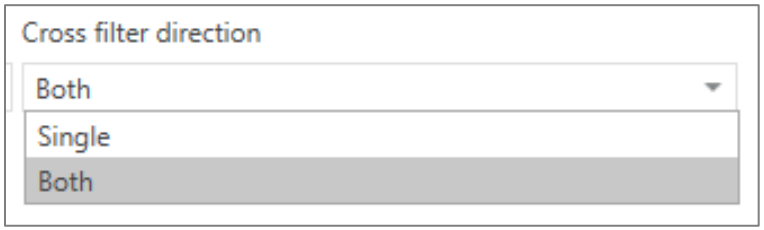


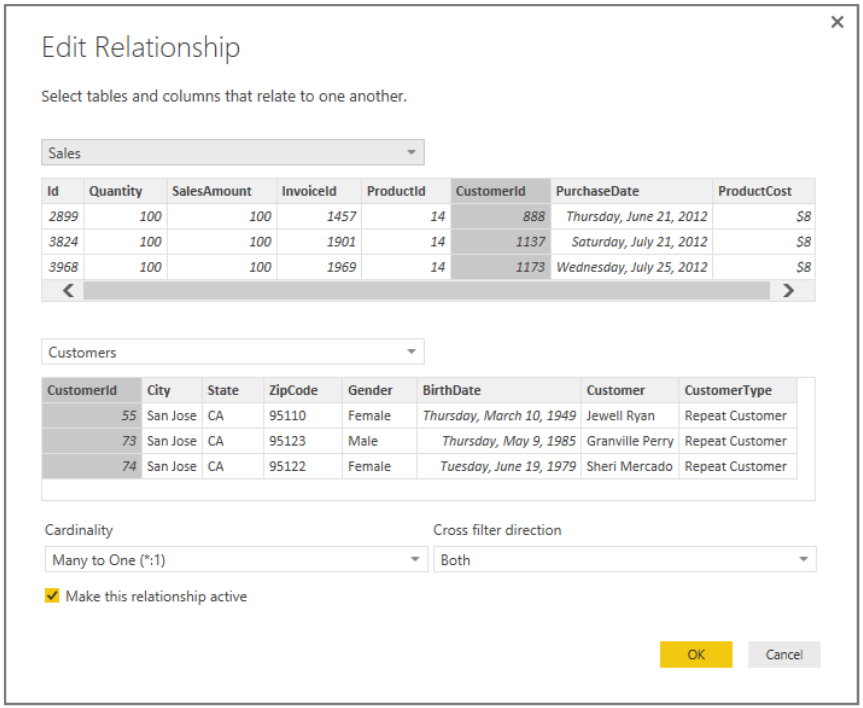
Relationship Properties

- Cardinality



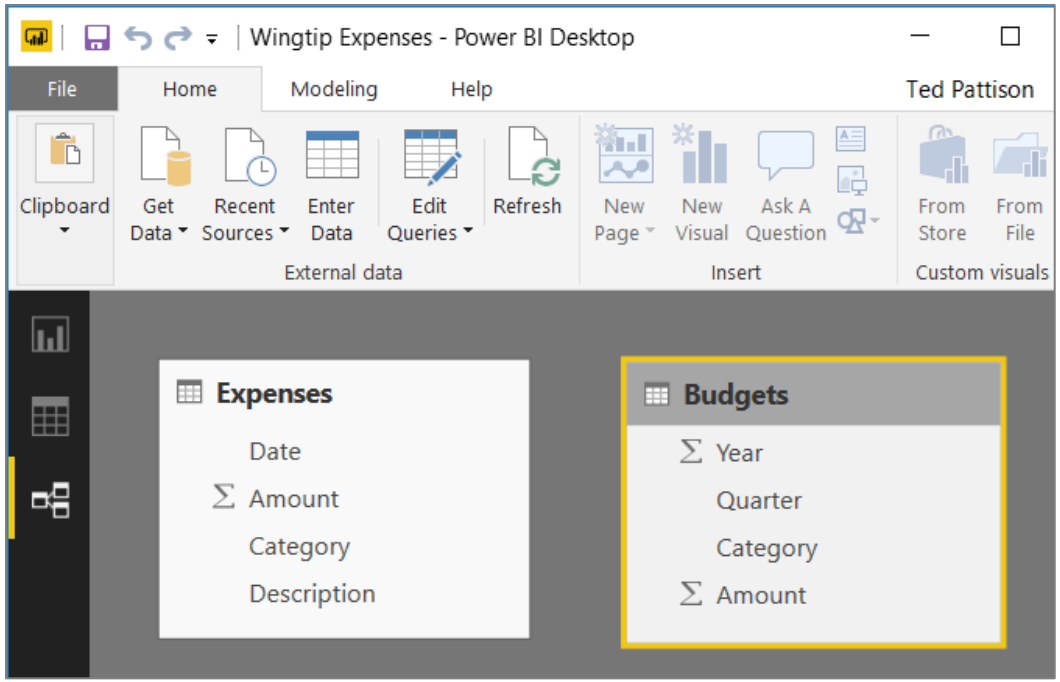
- Cross filter direction





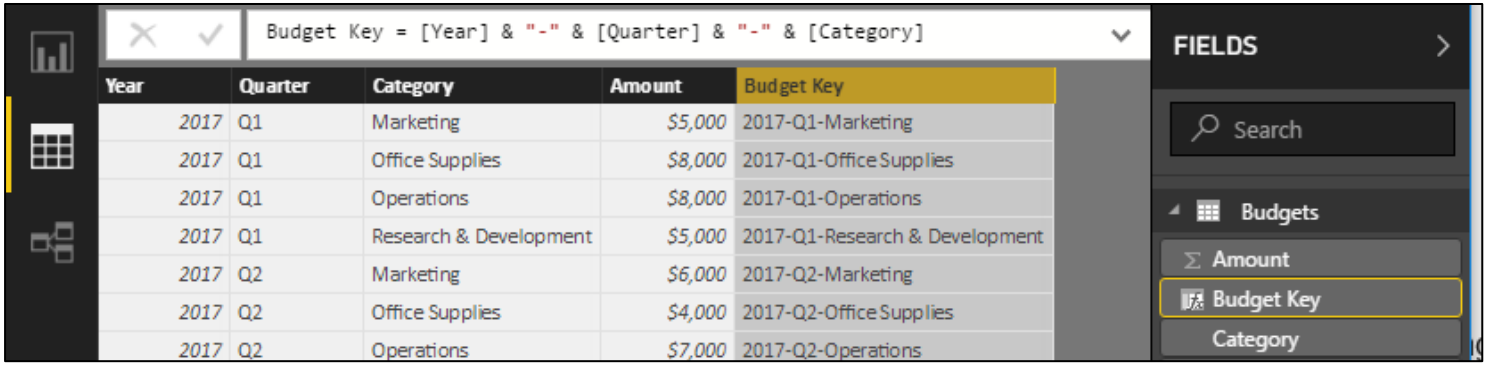
How Do You Create a Relationship Here?

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



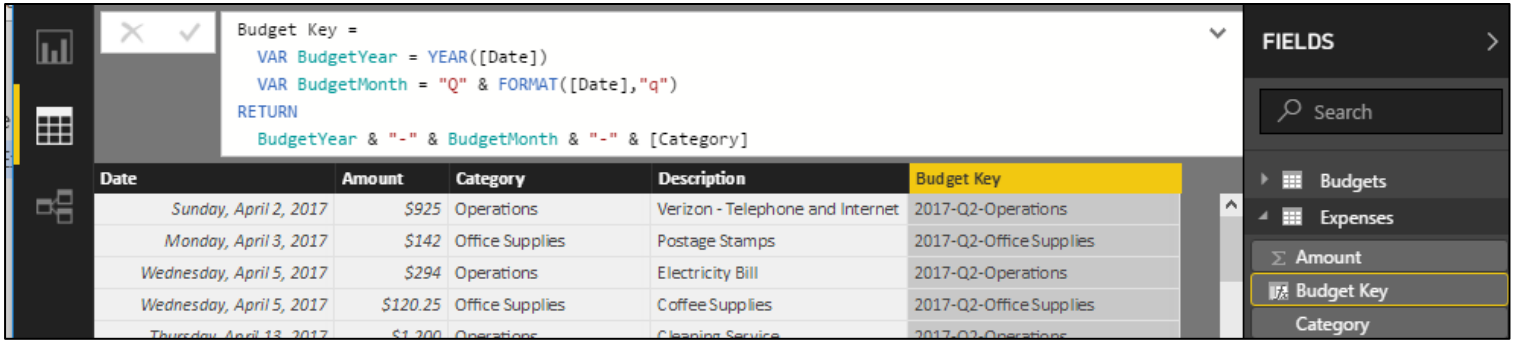
Creating Composite Key Fields

- Create composite key column in Budgets



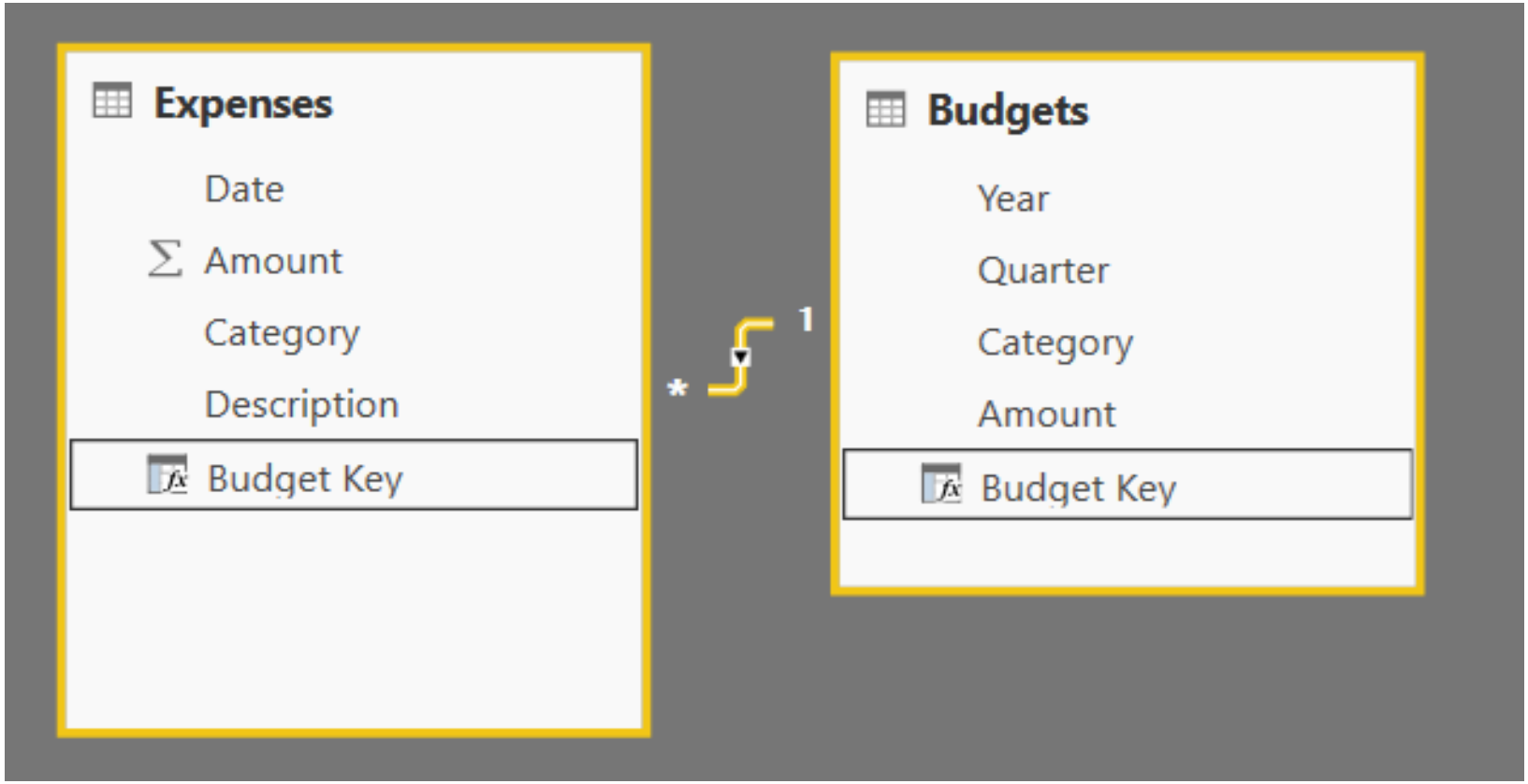
Year	Quarter	Category	Amount	Budget Key
2017	Q1	Marketing	$5,000	2017-Q1-Marketing
2017	Q1	Office Supplies	$8,000	2017-Q1-Office Supplies
2017	Q1	Operations	$8,000	2017-Q1-Operations
2017	Q1	Research & Development	$5,000	2017-Q1-Research & Development
2017	Q2	Marketing	$6,000	2017-Q2-Marketing
2017	Q2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

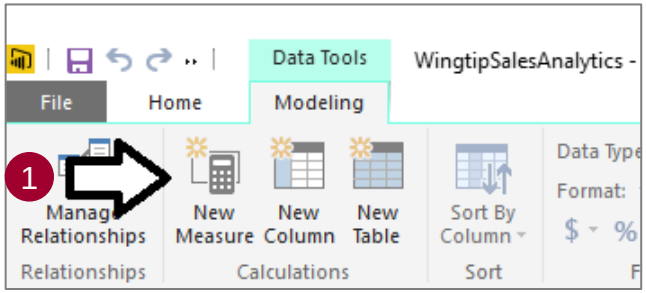
```
Age Group =
  SWITCH( TRUE(),
    [Age] >= 65, "Ages 65 and over",
    [Age] >= 50, "Ages 50 TO 65",
    [Age] >= 40, "Ages 40 TO 49",
    [Age] >= 30, "Ages 30 TO 39",
    [Age] >= 18, "Ages 18 TO 23",
    [Age] < 18, "Ages under 18"
  )
```

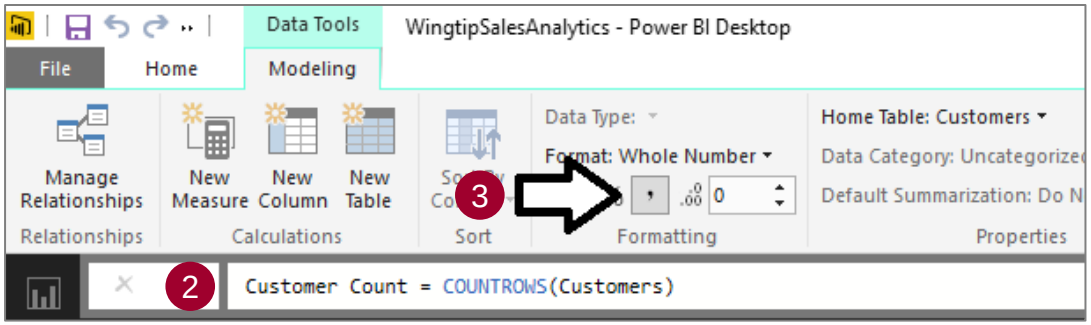
CustomerId	City	State	ZipCode	Gender	BirthDate	Customer	CustomerType	Age	Age Group
55	San Jose	CA	95110	Female	3/10/49	Jewell Ryan	Repeat Customer	66	Ages 65 and over
73	San Jose	CA	95123	Male	5/9/85	Granville Perry	Repeat Customer	30	Ages 30 TO 39
74	San Jose	CA	95122	Female	6/19/79	Sheri Mercado	Repeat 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

Bookmarks - Power BI Desktop

File | Home | Modeling | Help | Ted Pattison

Manage Relationships | New Measure | New Column | New Table | New Parameter | Sort by Column | Data type: | Format: | Auto | Home Table: | Data Category: Uncategorized | Default Summarization: Don't sum

Relationships | Calculations | What If | Sort | Formatting | Properties

```
Sales Regions =
DATATABLE (
    "State", STRING,
    "State Name", STRING,
    "Sales Region", STRING, {
 { "AK", "Alaska", "Western Region" },
 { "AL", "Alabama", "Central Region" },
 { "AR", "Arkansas", "Central Region" },
 { "AZ", "Arizona", "Western Region" },
 { "CA", "California", "Western Region" },
 { "CO", "Colorado", "Western Region" },
```

State	State Name	Sales Region
AK	Alaska	Western Region
AL	Alabama	Central Region
AR	Arkansas	Central Region
AZ	Arizona	Western Region
CA	California	Western Region

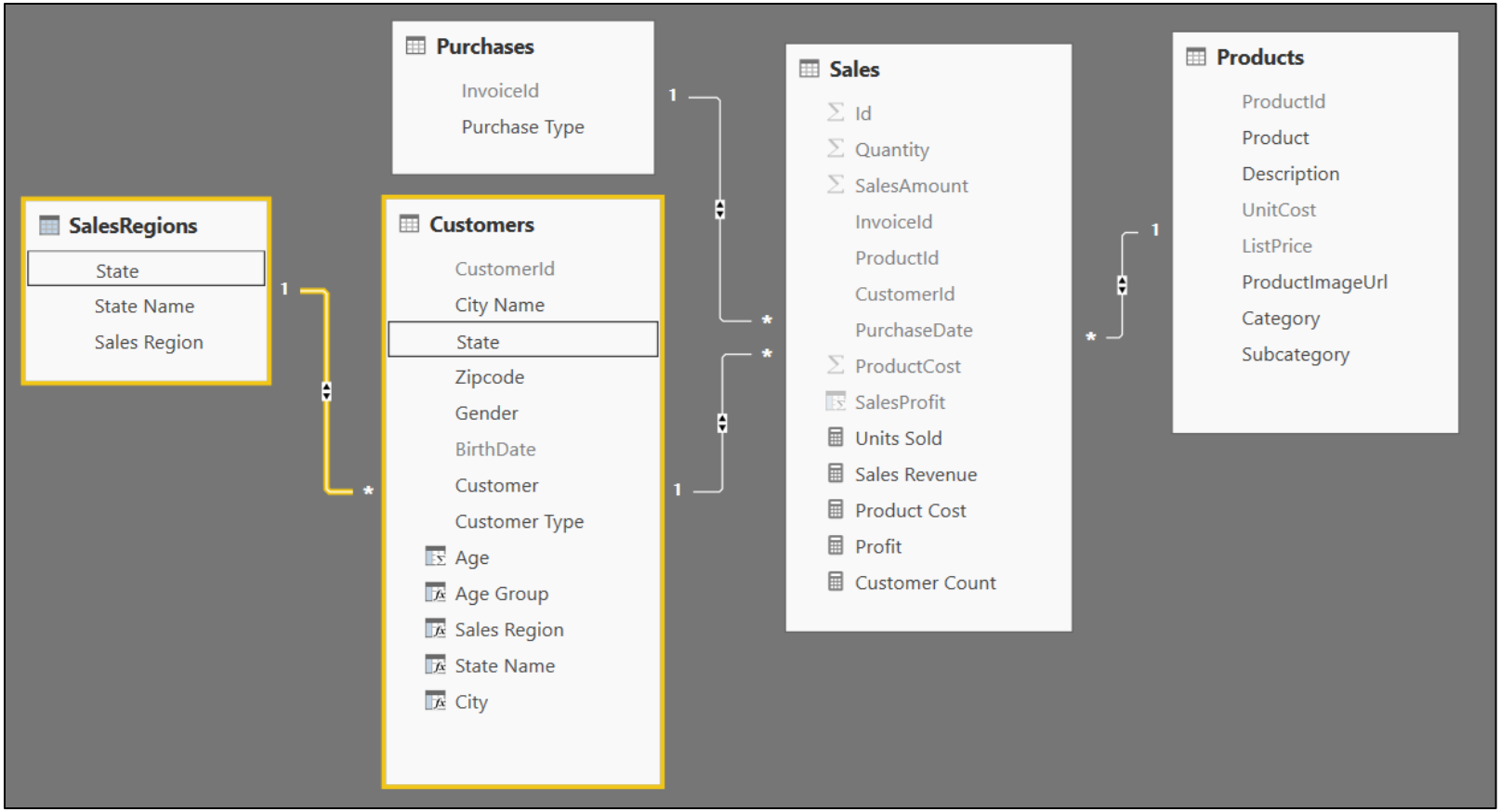
FIELDS

Search

- Sales
- Calendar
- Customers
- Products
- Purchases
- Sales Regions
  - Sales Region
  - State
  - State Name
- SalesRegionsSort

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])
```

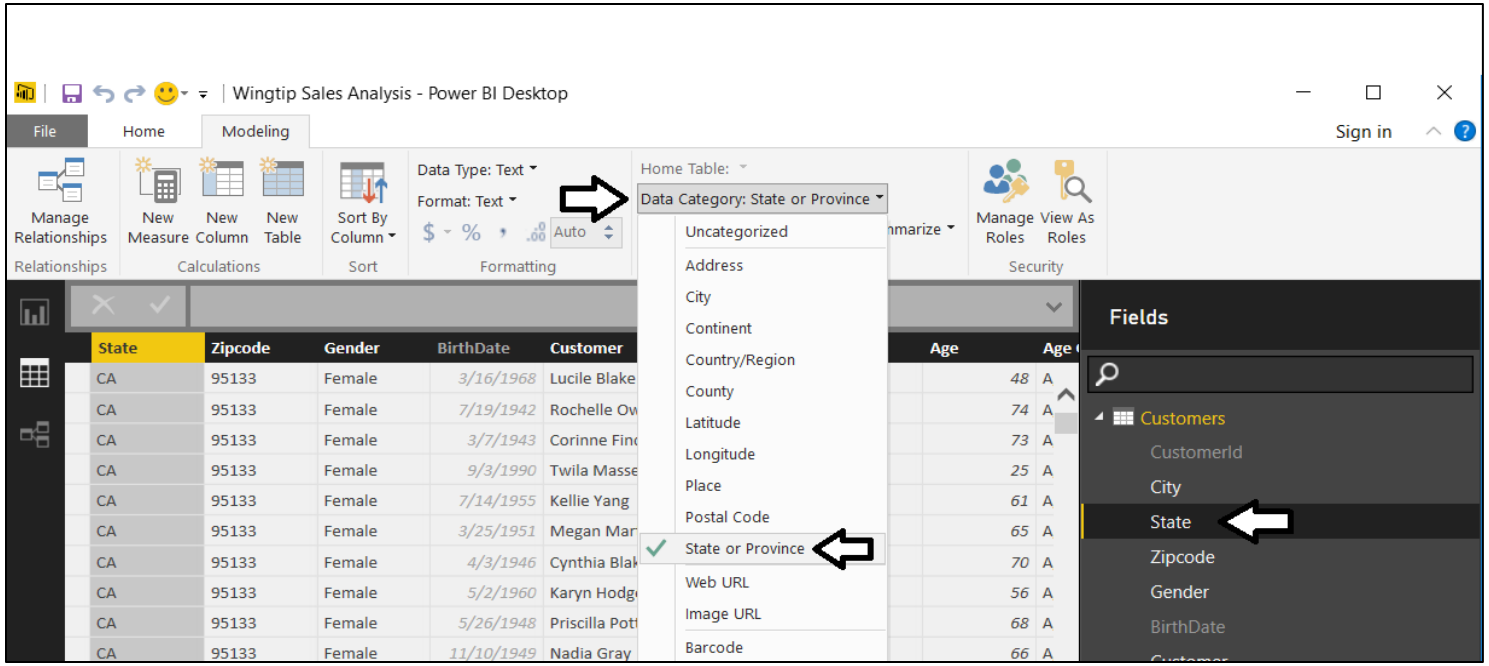
CustomerId	City	State	ZipCode	Gender	BirthDate	Customer	CustomerType	Age	Age Group	Sales Region
55	San Jose	CA	95110	Female	3/10/49	Jewell Ryan	Repeat Customer	66	Ages 65 and over	Western Region
73	San Jose	CA	95123	Male	5/9/85	Granville Perry	Repeat Customer	30	Ages 30 TO 39	Western Region
74	San Jose	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

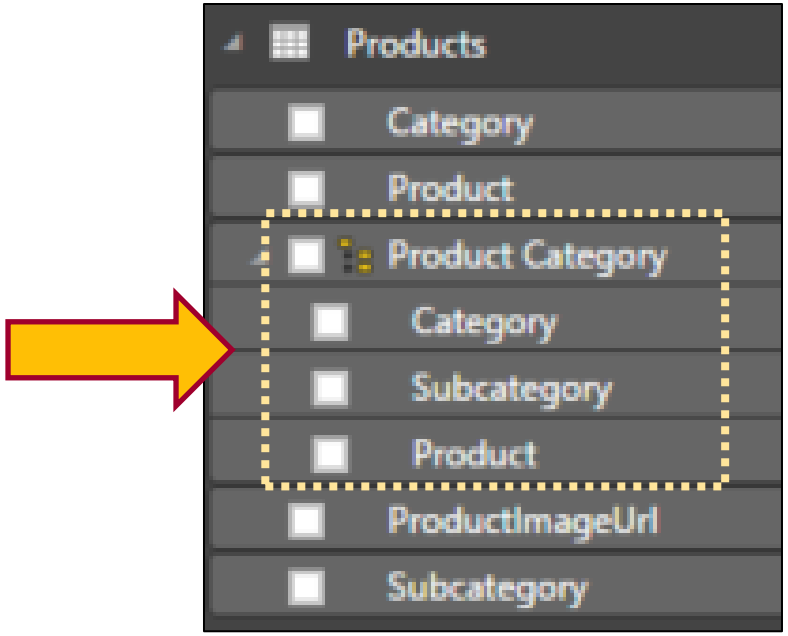
- City name alone is ambiguous
  - "Athens" defaults to Greece not Georgia
  - Concatenate city name with state to disambiguate

```
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

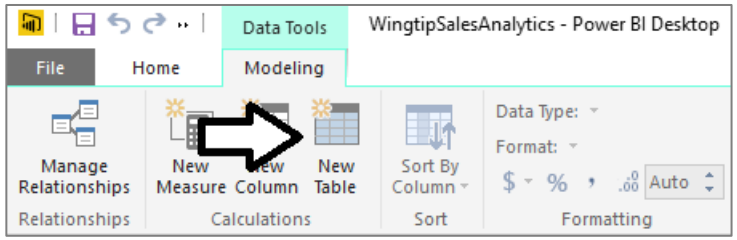
- CALCULATE function provides greatest amount of control
  - First argument defines expression to evaluate
  - Second argument defines table on which to evaluate expression
  - You can evaluate expressions with or without current filter context

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

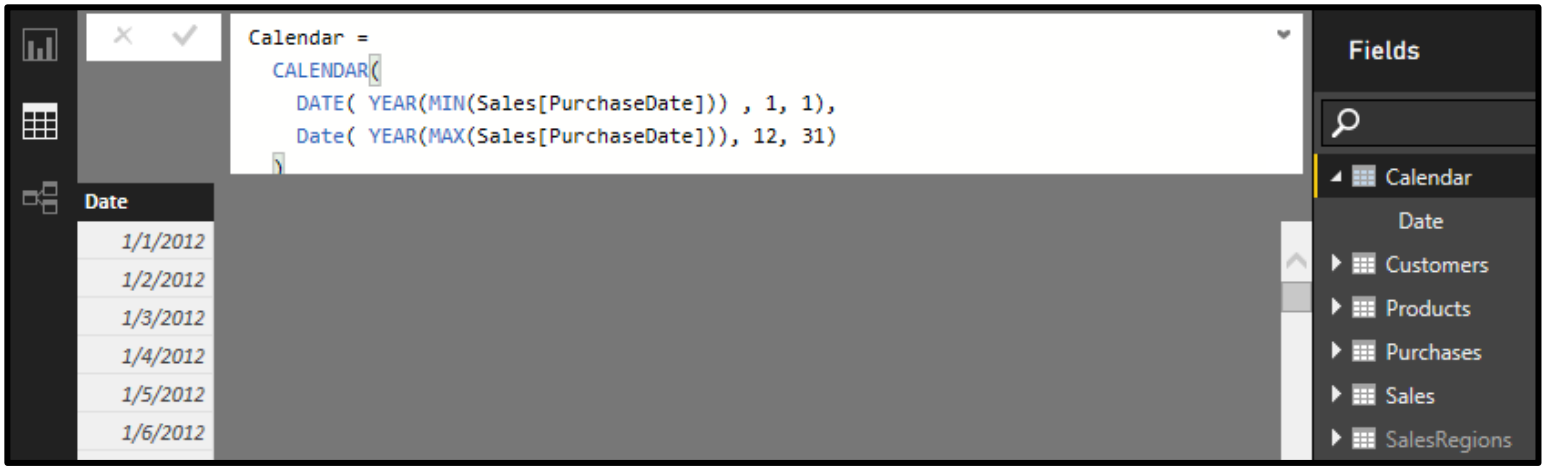
```
Pct of Product Category =
DIVIDE(
    SUM( Sales[SalesAmount] ),
    CALCULATE(
        Sum (Sales[SalesAmount] ),
        ALL( Products[Subcategory], Products[Product] )
    )
)
```

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

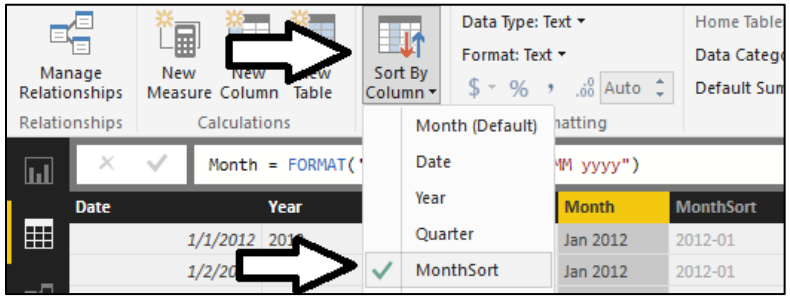
- Month column will not sort in desired fashion by default
  - For example, April will sort before January, February and March

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

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

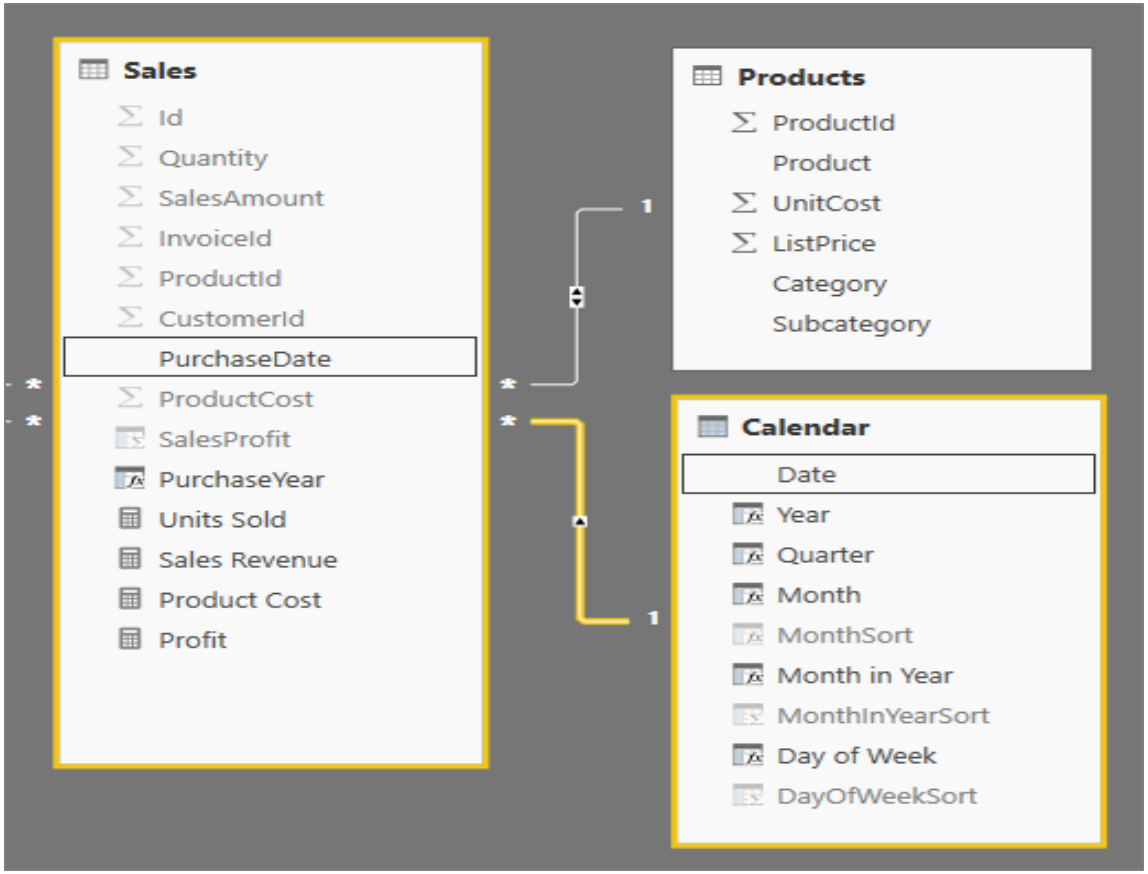
Date	Year	Quarter	Month	MonthSort
1/1/2012	2012	2012-Q1	Jan 2012	2012-01
1/2/2012	2012	2012-Q1	Jan 2012	2012-01

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



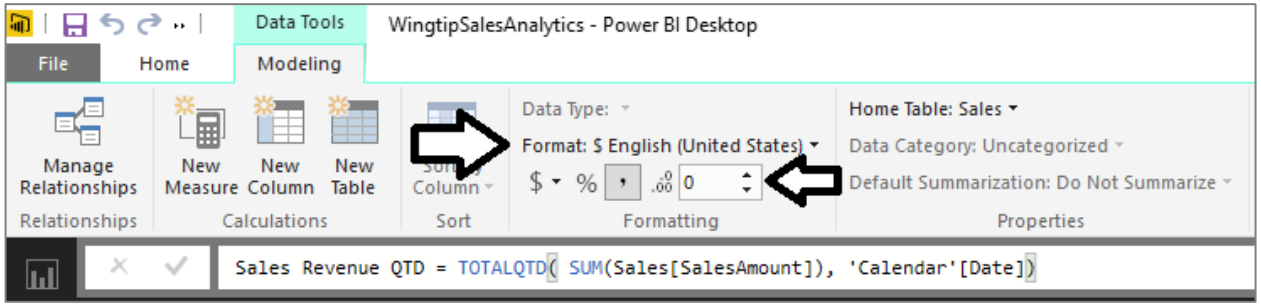
Integrating Calendar Table into Data Model

- Calendar table needs relationship to one or more tables

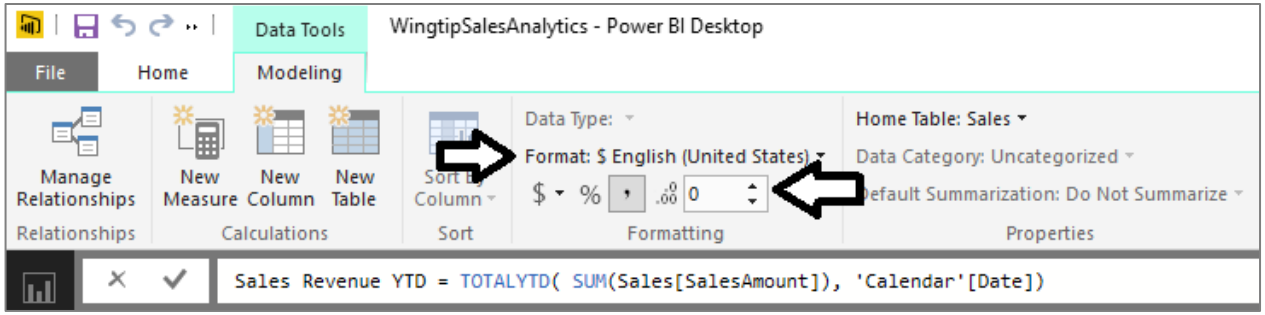


Calculated Fields for QTD and YTD Sales

- TOTALQTD function calculates quarter-to-date totals

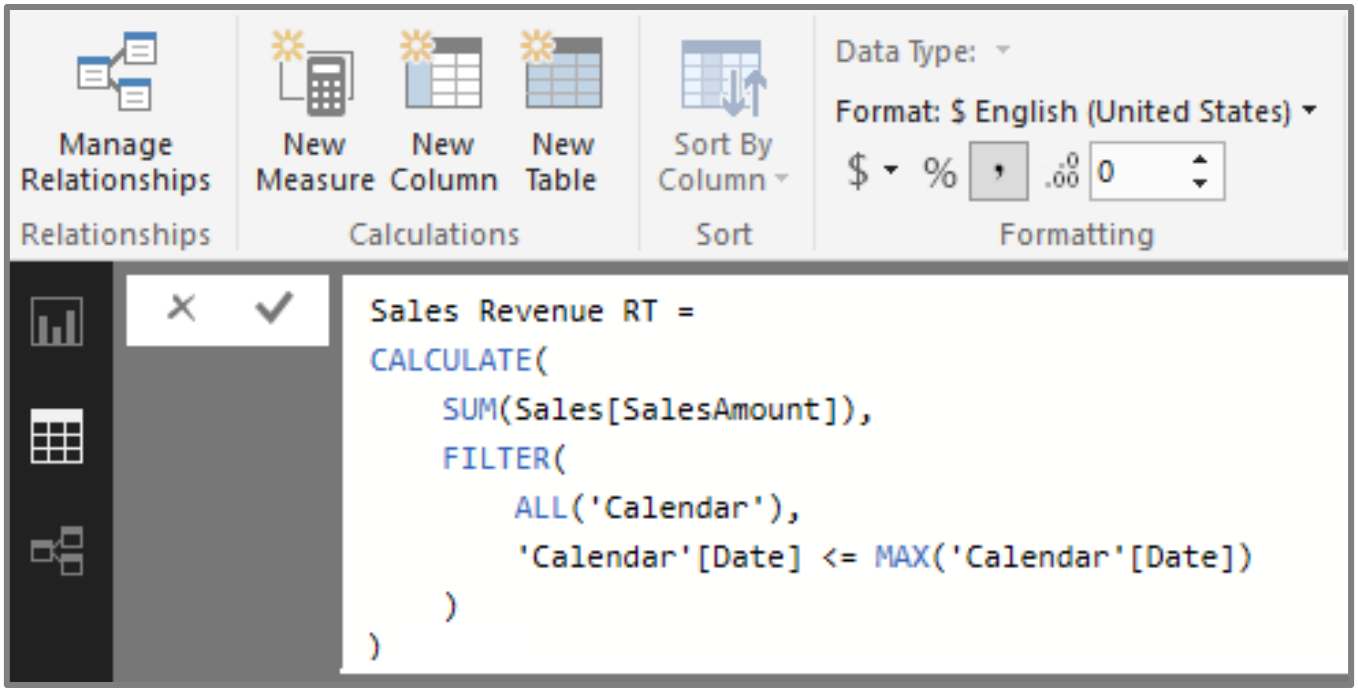


- TOTALYTD function calculates year-to-date totals



Creating Running Total using CALCULATE

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



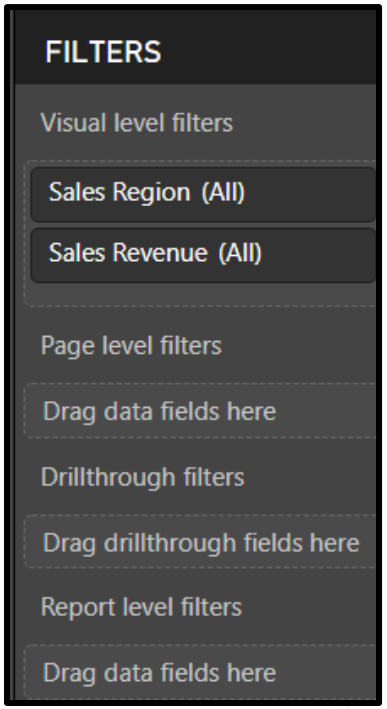
Agenda

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

Creating Reports

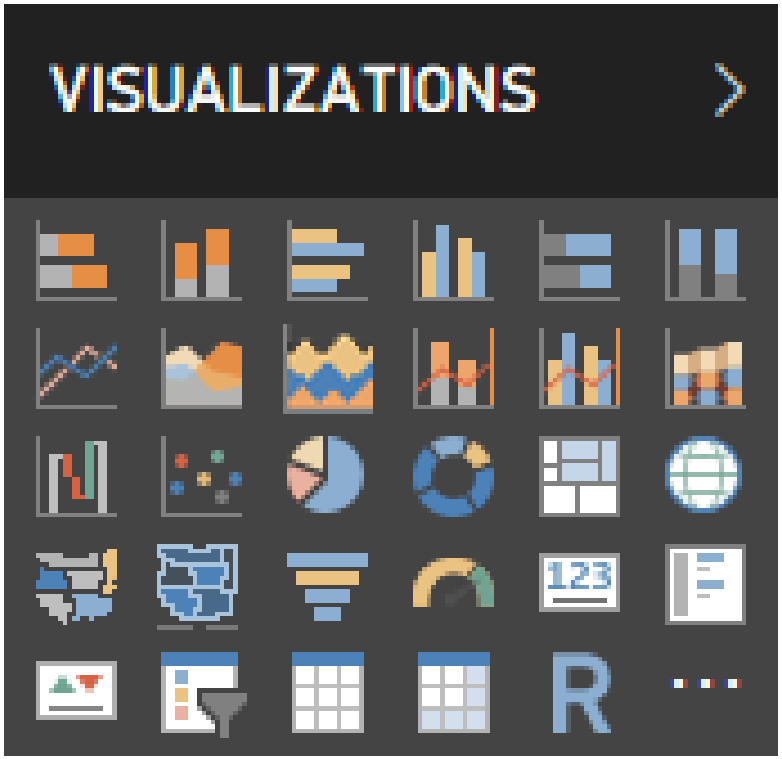
- Power BI Desktop project contains one report
  - Report within project can contain multiple pages
  - Report pages contains visuals

- 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