TechMentors

Helping you get the most out of technology

Microsoft Power BI Level 2

Student Manual

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Table of Contents

1. Visualizations 1
A. Visualizations tell stories 2
B. Which visualization should I use? 3
C. Which rating is on top? 6
D. Entering data to create custom sorts 10
E. Using Small multiples 14
F. Advanced Line Charts 16
G. Combination Charts 20
H. Matrix 24
I. Gauge 27
J. KPI 32
2. Additional Visualization Objects 38
A. Inserting a text box 39
B. Inserting a shape 44
C. Inserting an image 45
D. Adding bookmarks 46
E. Inserting a button 49
3. Interactive Tools 53
A. Spotlights 54
B. Edit Interactions 55
C. Filters and slicers affecting this visualization 57
D. Focus Mode 58
E. Show as a table 59
F. Export Data 60
G. Sorting 61
H. Drill down 62
4. Creation Tools 66
A. Page Size 67
B. Page View 68
C. Themes 69
D. Aligning and grouping objects 71
E. Lock Objects 73
F. Selection pane 74
G. Mobile layout 76

5. Data Modeling....77
A. Creating new tables....78
B. Understanding a star schema data model....80
C. Split a flat file into multiple tables....83
D. Create a star schema data model....88
E. Date tables....90
F. Create and edit a Hierarchy....106
6. DAX Calculations and Measures....112
A. What is DAX?....113
B. DAX Functions....115
C. DAX Operators....116
D. DAX Variables....117
E. Measures....118
7. Practice Lab....122
A. Import the data and create a star schema....123
B. Add Date table(s)....125
C. Create report pages....126
D. Use tools....127

1. Visualizations

Complete this unit and you'll be able to:

A. Explain why visualizations tell stories

B. Explain when to use which visualizations

C. Create a visualization that shows the top rating

D. Create a custom sort

E. Use the Small Multiples feature

F. Create an advanced line chart

G. Create a combination chart

H. Create a matrix visualization

I. Create a gauge visualization

J. Create a KPI visualization

A. Visualizations tell stories

In the Power BI Level 1 course you learned how to use Microsoft Power BI Desktop to create Power BI reports with multiple visualizations. As its name implies, visualizations help viewers visualize information. In other words, a good visualization can help tell a data-driven story that…

- Helps provide context, meaning, relevance and clarity.
- Helps presents cold hard facts with attractive media that captures and keeps an audience's attention with an experience that is both analytical and emotional.
- Helps a decision maker see the big picture.
- Helps observers learn what has occurred in an organization.
- Helps viewers gain insights.
- Helps a marketer highlight the value of their products and services.
- Helps a presenter influence stakeholders towards their position.

Ling Wong defines data storytelling as "the practice of blending hard data with human communication to craft an engaging narrative that's anchored by facts."[1] Linda's article, "Data-Driven Storytelling: 9 Techniques for Effective Visualization" is worth reading and can be found at https://www.gokantaloupe.com/blog/best-techniques-for-data-driven-storytelling.

[1] https://www.gokantaloupe.com/blog/best-techniques-for-data-driven-storytelling

B. Which visualization should I use?

The following is a summary of various visualizations, and their best use in telling the data-driven story.

Table 

Tables are useful for displaying multiple pieces of raw data (text, numbers, dates, etc.). They are like a spreadsheet because they show data in a series of rows and columns. Tables have column headers and total which can be turned on or off and formatted as desired.

Matrix 

A matrix visualization is useful for showing summary data. Like a table, it too shows raw data in rows and columns, but it also shows aggregated calculations. In appearance and function it is similar to a PivotTable in Excel.

Bar and column charts 

Bars and column charts are useful for displaying specific data across different categories in either a stacked or clustered format.

Line and area charts 

Line and area charts are most useful for displaying trends over time. They both usually display time on an X (horizontal) axis and values on a Y (vertical) axis. The line chart of course shows a line, and the area chart shows the line with shaded color in the area underneath the line.

Ribbon charts 

Ribbon charts are a special type of clustered column charts that are most useful for allowing viewers to easily spot trends in the data.

Pie charts, donut charts, and Treemaps 

Pie charts, donut charts and Treemaps are useful for displaying the quantitative relationship between various parts and their whole.

Pies and donut charts are best used when the number of pieces is 7 or less.

Combo charts 

Power BI provides two types of combo charts: 1) a **Line and Stacked Column chart** and 2) a **Line and Clustered Column chart**. These are useful for…

- Comparing multiple measures with different value ranges
- Seeing the correlation between two different measures
- Determining if a measure meets a target

Card visualization 

Card visualizations are useful for viewing a single data point (value) or a single total.

Multi-row card 

Multi-row card visuals are useful for showing multiple data points with each data point listed on a separate row.

Funnel 

Funnel visualizations are useful for displaying a linear sequential process or workflow with connected stages. For example, an email marketer can use a funnel chart to compare 1) the number of emails that were sent, 2) the number that were opened, 3) the number of readers who followed a hyperlink within the message, and 4) the number of readers who purchased a product or service from the website.

Funnels are best used when the process has at least four stages, and the number of items in the first stage is greater than the number of items in the final stage.

Gauge 

A gauge looks like a car's speedometer. It is useful for seeing progress toward a goal, or an actual value compared to a maximum value. When creating a gauge a best practice is to include the actual value, as well as the minimum, maximum, and target values.

Waterfall 

Waterfall charts are useful for…

- Showing a running total, and the impact each piece has on the grand total.
- Seeing changes over time or different divisions.
- Breaking down total revenue by the various products and services.
- Viewing an organization's beginning and ending headcount.
- Visualizing income and expenses and their impact on the total account balance

Scatter chart 

A scatter chart is useful for showing patterns in large sets of data without regard to time, and for plotting groups of numbers on both an X and Y axis. It is also useful for displaying anomalies or outliers in your data.

Maps 

Maps are useful for showing data that are specific to a geographical location (country, region, state, province, county, city, etc.)

Slicers 

Slicers are useful for viewing and editing filters.

Q&A 

Question and Answer visuals are useful for letting users ask questions, in natural language, and receive answers in the form of a visualization.

KPI 

KPI is an acronym for Key Performance Indicator. KPI visuals are useful for tracking progress toward a specific goal.

Further reading

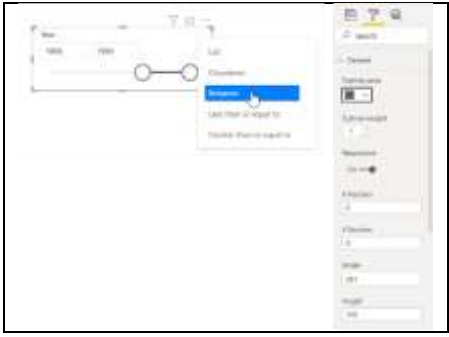
Microsoft provides an excellent overview of various visualizations at https://docs.microsoft.com/en-us/learn/modules/visuals-power-bi/3-effective-visualization.

C. Which rating is on top?

In this exercise assume you need to make a presentation regarding movies in America. You need to use the data to tell a story about Hollywood's preference for the various types of ratings. You want to know, and clearly demonstrate to others, if the percentage of movies per rating has changed in the last four decades of the 20th century.

1. Create a new Power BI report based on the **Movies.xlsx**, **Lots of Movies** sheet.

2. Create a slicer with the following properties:



Property	Setting
Field	Year
Type	Between
First	1968
Last	1990
General, Effects, Visual border	On
General, Properties, Position, Horizontal	0
General, Properties, Position, Vertical	0
General, Properties, Size, Width	281
General, Properties, Size, Height	100

3. Create a Stacked column chart with following parameters.

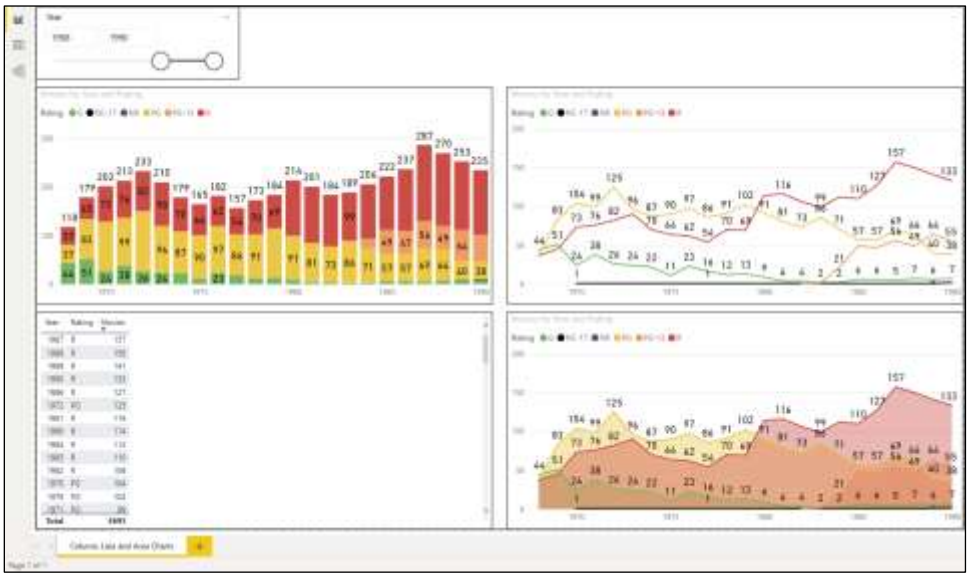
Property	Setting
X-Axis	Year
Y-Axis	Count of Titles
Y-Axis, Rename for this visual	Movies
Legend	Rating
General, Effects, Visual border	On
View, Theme	City Park
Visual, Columns, Colors, G	Green
Visual, Columns, Colors, PG	Yellow
Visual, Columns, Colors, PG-13	Orange
Visual, Columns, Colors, R	Red
Visual, Columns, Colors, NC-17	Black
Visual, Columns, Colors, NR	Blue
Data Labels	On
Data Labels, Values, Color	Black
Data Labels, Values, Font Size	12
Data Labels, Options, Label Density	100%
Total Labels	On
General, Properties, Position, Horizontal	0
General, Properties, Position, Vertical	110

4. Duplicate the chart, move it to the right, convert it to a line chart.

5. Duplicate the chart, move it below the column chart, convert it to a table.

6. Duplicate the chart, move it below the line chart, convert it to an area chart.

7. Name the page "**Column, Line and Area charts**".



8. Duplicate the page.

9. Delete the line chart, area chart, and table visualizations.

10. Stretch the column chart across to fit the width of the page.

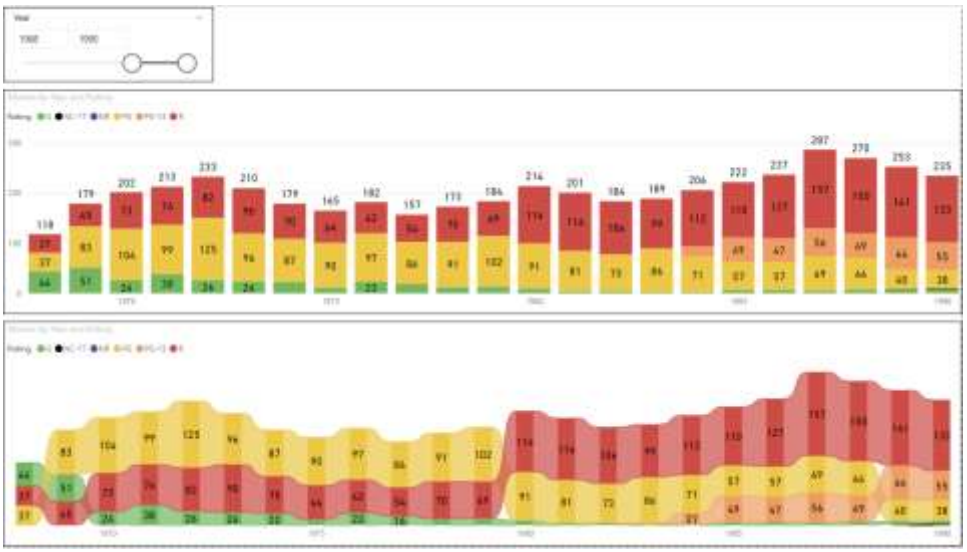
11. Duplicate the column chart and place it underneath the other one.

12. Change the new column chart into a ribbon chart.

13. Change the following properties of the ribbon chart.

Format Visual Property	Setting
Data Label, Values, Overflow text	On
Ribbons, Colors, Border	On

14. Rename the page "Column chart vs Ribbon chart".

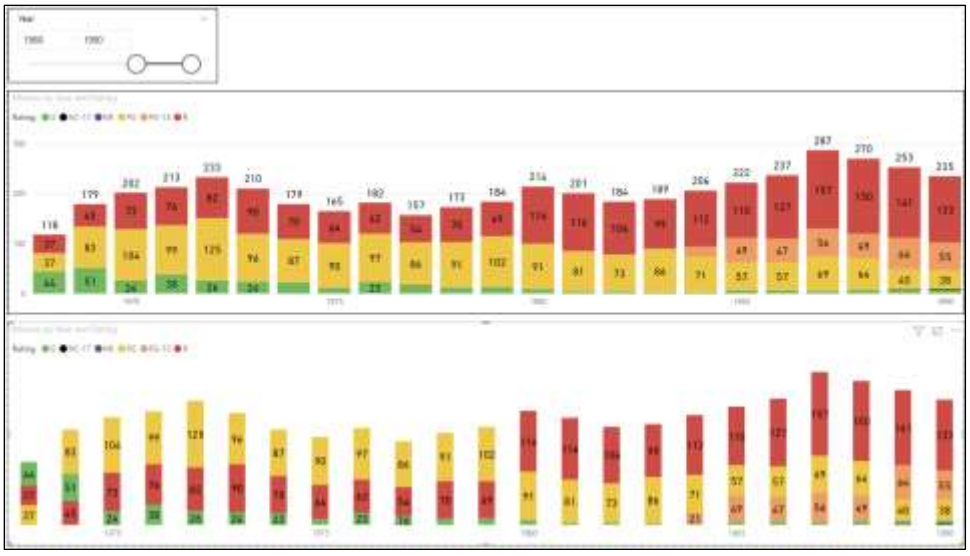


15. Duplicate the page.

16. Change the following settings for the ribbon chart.

Format Visual Property	Setting
Ribbons, Colors, Connector color	Off
Ribbons, Transparency	100
Ribbons, Border	Off

17. Rename the page as "Column chart vs Ribbon chart – no connector color".



18. Notice the following:
    - The ribbon chart now appears to be a clustered column chart.
    - In the column chart, the sequence of boxes is the same for each year. R is on top, then if they exist PG-13, PG, NR, NC-17, and finally G on the bottom.

- In the ribbon chart the sequence of boxes is **not** the same for each year. The rating with the most movies for the year is always on top.

19. Return to the second page and notice the following:
    - The ribbon chart on this page has the same sequence of boxes as the one on the third page.
    - Because the connector is not 100% transparent, it is easier to see when a rating jumps into first place.
        - In 1968 G was on top, and PG was on the bottom.
        - In 1969 PG took first place, while G and R took second and third place.
        - In 1970 R moved to second place.
        - Ten years later, in 1980, R took first place, and PG took second. G was almost 0.
        - The first year with PG-13 was 1984.
        - In 1989 PG-13 took second place.
    - The tool tip for each year displays the year, rating, and count.
    - The tool tip between each year displays the year, rating and count for both the previous and the following years, and it displays the change from one year to another.

20. Save your report as **Movies.pbix**.

Of all the charts you have just created, which one best helps tell the story of the movement of PG to first place in the 1970s and R to first place in the 1980s?

D. Entering data to create custom sorts

For all the charts you just created, you will notice the legend of ratings is in alphabetical order: G, NC-17, NR, PG, PG-13, R

You have decided it will help tell your story if the legend was a more familiar sort where G is first and NC-17 and NR are last. To do this you will create a new Sort Order table that will define your desired sort.

Create a custom sort table

1. From the ribbon, choose **Home**, **Data**, **Enter data**.

2. Double click Column1 and enter "Rating Code".

3. Click the + in column 2 and rename the column "Sort Order".

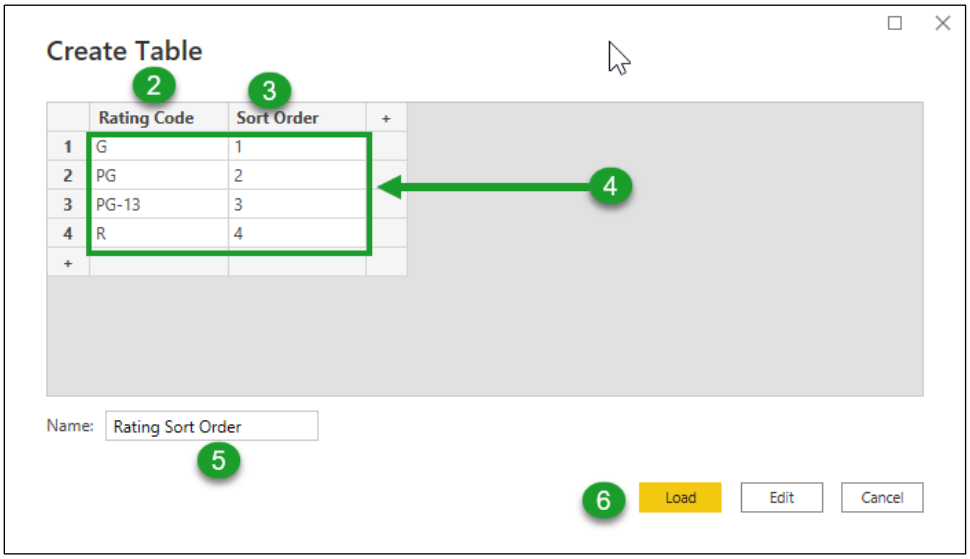
4. Enter the following values:

Rating Code	Sort Order
G	1
PG	2
PG-13	3
R	4

   Notice we did not include the NC-17 nor the NR rating. We will add them later.

5. Change the name of the table to "Rating Sort Order".

6. Click **Load**.



Edit data in a custom table

The Rating Sort Order table has been created, but we did not include the NC-17 and the NR ratings in it. In this exercise we will use the query editor to add the additional rating.

1. Right click on the **Rating Sort Order** table and choose **Edit query**.

2. In the Power Query Editor choose the **Rating Sort Order** table.

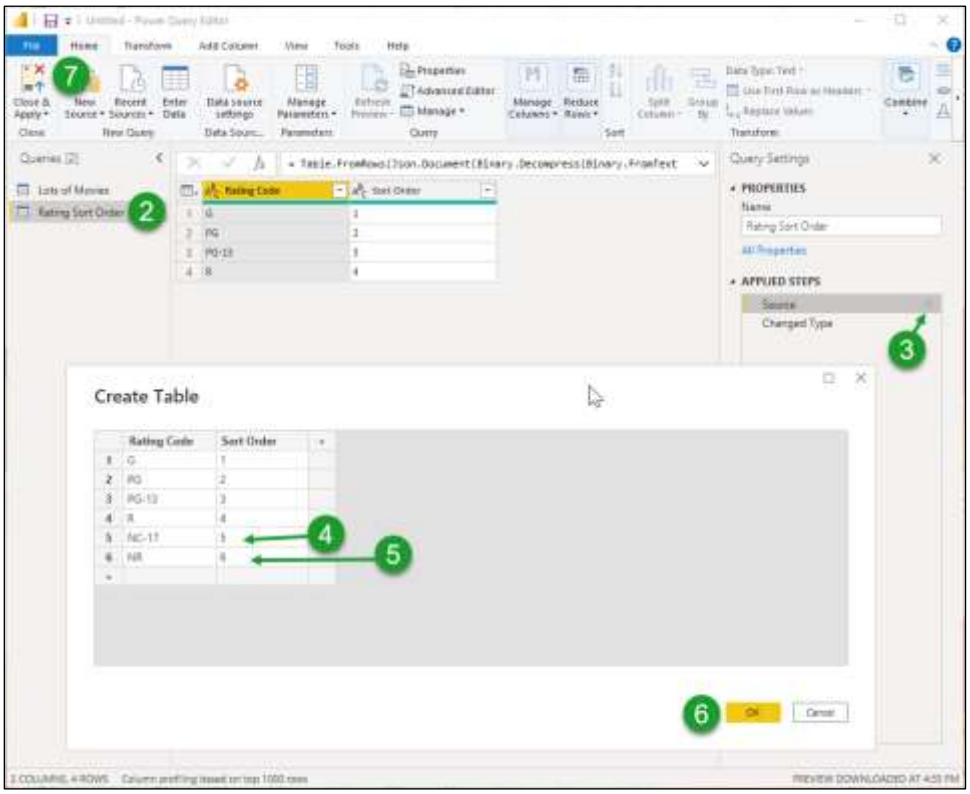
3. In the **Applied Steps** area, click the **gear icon** next to **source**.

4. In the rating column, click below R and enter **NC-17**.
   In the Sort Order column enter **5**.

5. In the rating column, click below NC-17 and enter **NR**.
   In the Sort Order column enter **6**.

6. Click the **OK** button.

7. On the ribbon select **Home**, **Close**, **Close & Apply**.



Update the data model with a new relationship

Now that the new **Rating Sort Order** table has been added, we need to update the data model to show there is a Many to One relationship between **Lots of Movies** and **Rating Sort Order**.

1. From the ribbon choose **Modeling**, **Relationships**, **Manage Relationships**.

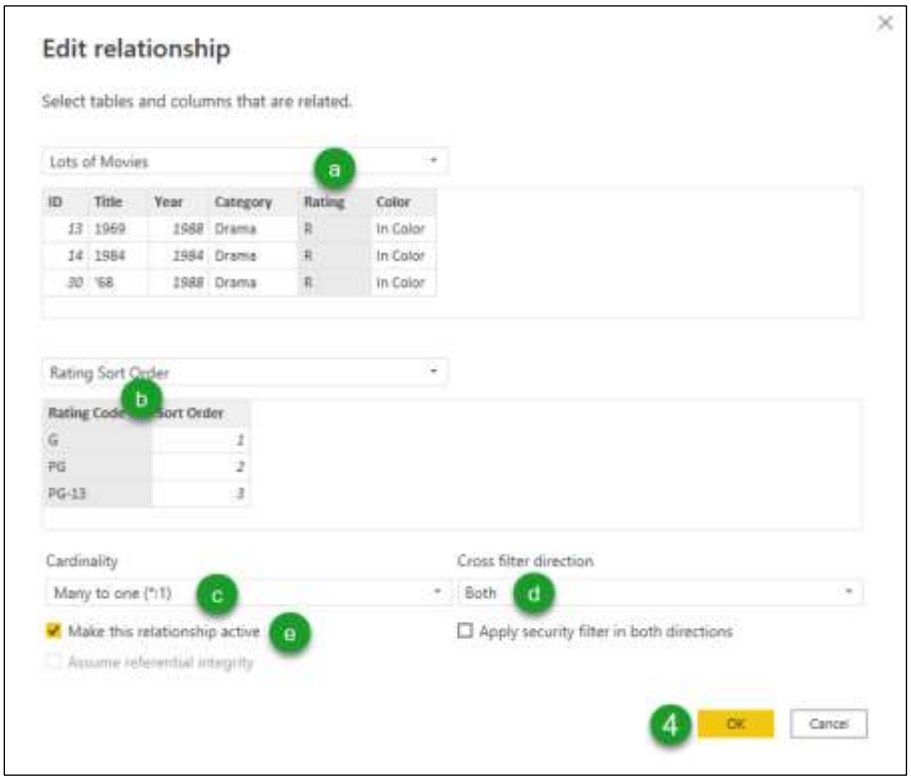
2. If the system is showing a relationship between Lots of Movies and Rating Sort Order, then click **Edit…**

   If the relationship for the two tables is not shown, click **New…**

3. As needed change the Edit relationship window to match the following:

   a) Select the **Lots of Movies**, **Rating** column.
   b) Select the **Rating Sort Order**, **Rating Code** column.
   c) Make sure the **Cardinality** is set to **Many to one (*:1)**.
   d) Make sure the **Cross filter direction** is set to **Both**.
   e) Make sure the Make this relationship active option.

4. Click **OK**.



5. Click **Close**.

Add a new Rating Custom Sort column to the Lots of Movie table

Power BI provides an option to override the default sort associated with a column. This feature is found in the ribbon's **Column tools** tab. When selected the designer can choose an alternate sort field. However, the alternate sort field must be from the same table. Therefore, in this exercise you will 1) create a new calculated column for the Lots of Movies table, and 2) use that calculated column to override the default sort.

1. Right click on the **Lots of Movie** table and select **New column**.

2. Enter the following formula:

```
Rating Custom Sort = Related('Rating Sort Order'[Sort Order])
```

   This is a DAX formula that works as follows:

   - The name of the field is prior to the equal sign.
   - The formula is after the equal sign.
   - The formula uses the **Related** function which can find information in another table. This is like Excel's VLookup function. However, the Related function is easier than VLookup because it can find related information via the data model.
   - The **Related** function takes one parameter, with two parts.
     - The first part is the name of the related table. Notice that the table is enclosed in single quotes because the table name includes spaces.
     - The second part refers to the desired field, enclosed between two square brackets. The square brackets are required, even if the field name has no spaces.
   - Notice Power BI uses color to help you write the formula.
     - The name of the new column is in black.
     - The function is in a light blue color.
     - The parameter, table name + field name, is in violet.

3. In the fields pane, select the **Lots of Movies**, **Rating** field.

4. From the ribbon, select **Column Tools**, **Sort**, **Sort by column**, and then choose **Rating Custom Sort**.

5. Notice that each chart's legend is now in the following order:
   G, PG, PG-13, R, NC-17, NR.

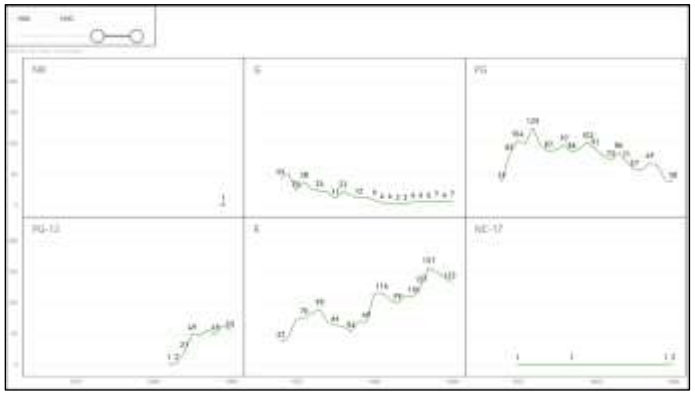
6. Save your report.

E. Using Small multiples

What are small multiples?

Small multiples, also known as trellising, is a feature that allows you to split a visual into multiple smaller versions of itself. Each version is then contained in a grid of multiple horizontal and vertical square.

Suppose for example that you wanted to show a separate line chart, per rating, of the number of movies made each year. You could do it the long way by creating one line chart for the G rated movies, and then duplicate it for each of the various ratings. Or you could save time by creating one line chart and then set the Small multiples well to Rating.



Create a line chart with small multiples

1. Duplicate the "**Column, Line and Area Charts**" page.
2. Rename the new page "**Line chart with small multiples**".
3. Delete all the visualizations except the slicer and the line chart.
4. Resize the line chart to fill most of the page.
5. Drag the **Rating** field from the Legend well to the Small multiples well.
6. Set the following formatting properties.

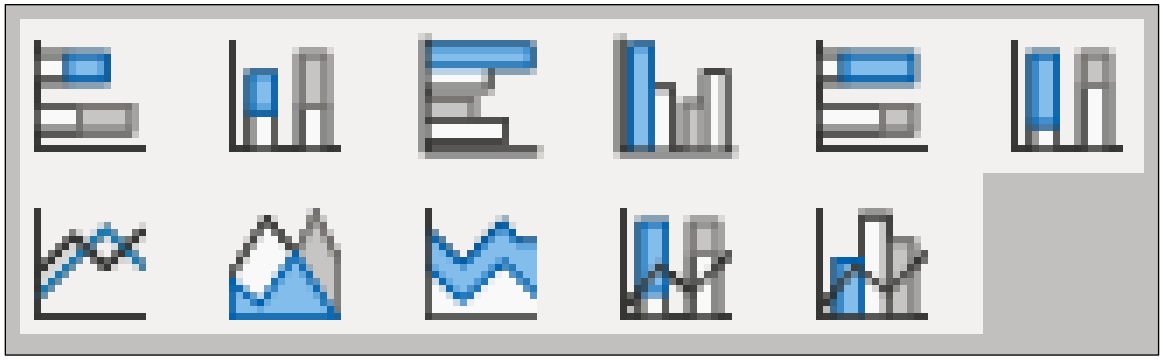
Visual Property	Setting
Small multiples, Title, Font	14 pt Bold
Small multiples, Layout, Rows	2
Small multiples, Layout, Columns	3
Small multiples, Border, Gridlines	Horizontal and vertical

7. Save your report.

Where visualizations support small multiples?

The following visualizations support small multiples:

Bar charts	Column charts	Line Charts	Area Charts
• Stacked bar chart • Clustered bar chart • 100% Stacked bar chart	• Stacked column chart • Clustered column chart • 100% Stacked column chart	• Line chart • Line and stacked column chart • Line and clustered column chart	• Area chart • Stacked Area chart

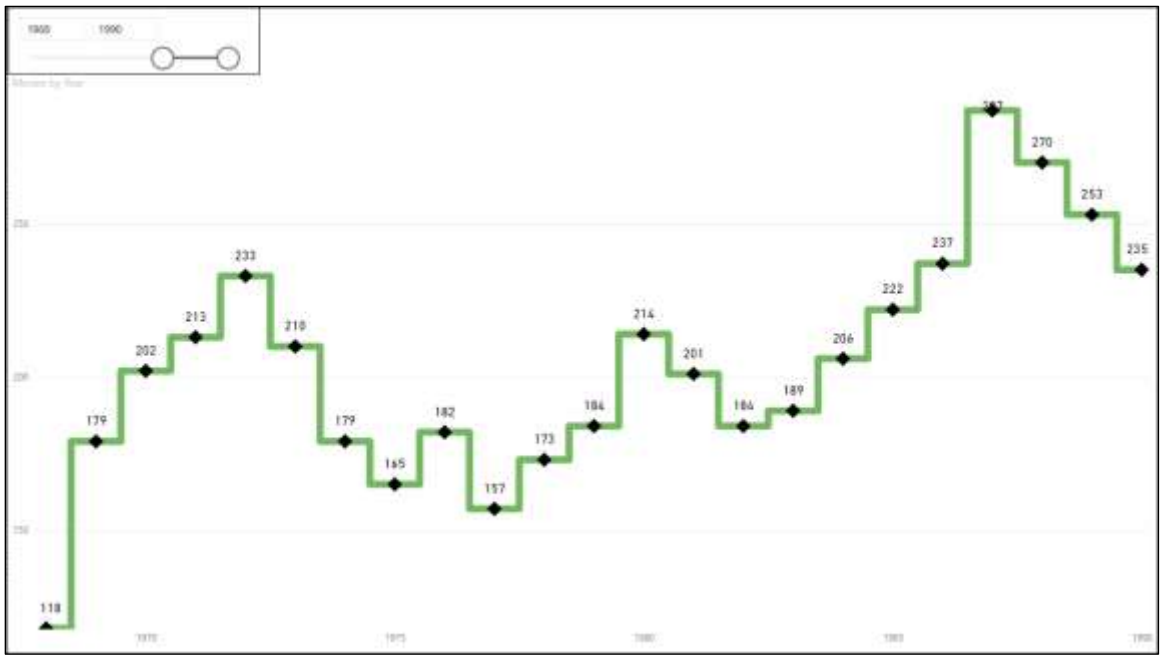


F. Advanced Line Charts

Line charts have many formatting options, including the following which we will cover in this exercise:

- Stroke width
- Line style
- Show marker: On or off
- Marker color
- Marker shape: bullet, square, diamond, triangle, and more
- Marker size
- Stepped: On or off

Formatting options



1. Duplicate the page from the previous exercise.

2. Rename the page as "**Formatted Line Charts**".

3. Remove the Rating from the Small multiples page.

4. Click the **Format** icon, and then expand the **Lines** area.

5. Change the **Shape**, **Line style** to **Dotted**, then **Dashed** and finally back to **Solid**.

   Notice the difference in the line.

6. Change the **Stroke width** to **8**.

   Notice the line is much thicker.

7. Change the **Stepped** option to **On**.

   Notice the diagonal lines have been replaced with stepped lines.

8. Collapse the **Lines** area and turn the **Markers** option to **On**.

9. Expand the **Markers** area and then expand the **Shape** area.

10. Change the **Marker color** to **black**.

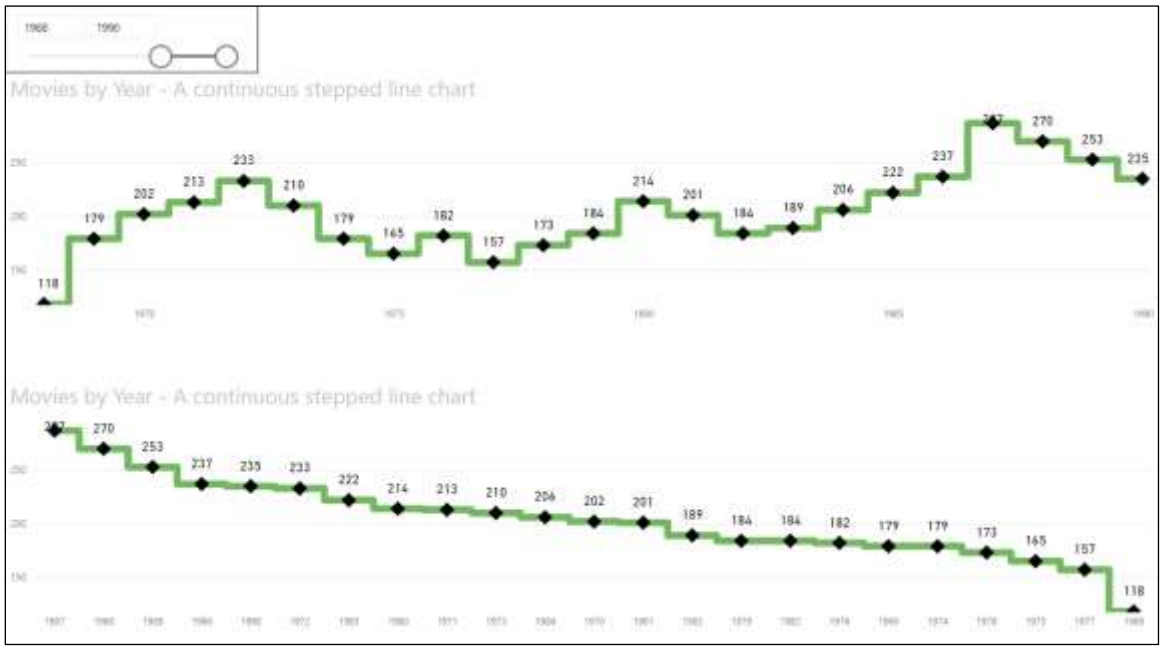
11. Change **Marker type** to a **square**, then **diamond**, and then to any shape of your choosing.

12. Change the **Marker size** to **10** and then to any size of your choosing.

13. Save your report.

Categorical Line Charts

Usually, a line chart has a continuous X axis that is based on time (years, months, dates, etc.). As you will see in this exercise a line chart can have a categorical X axis that is not continuous.



1. Change the Title of the chart to **Movies by Year – A continuous stepped line chart**.

2. Reduce the height of the line chart, so it only takes up half the page.

3. Duplicate the line chart and place the duplicate below the first.

4. Expand the **Format**, **Visual**, **X axis** section and change the **Type** option to **Categorical**.

   Notice the years on the X axis are no longer sequential from 1968 to 1990. Instead, the chart starts with the year that had the greatest number of movies, 1987. It then moves down to the year with the least number of movies, 1968.

5. Change the Title of the chart to **Movies by Year – A categorized stepped line chart**.

6. In the **X-Axis** well, **replace Year with Rating**.

7. Expand the **Format**, **Visual**, **X-axis** and notice the Type is gone.

   When the X axis is not numeric, the type cannot be continuous.

8. In the **Data**, **X-Axis** well, **replace Rating again with Year**.

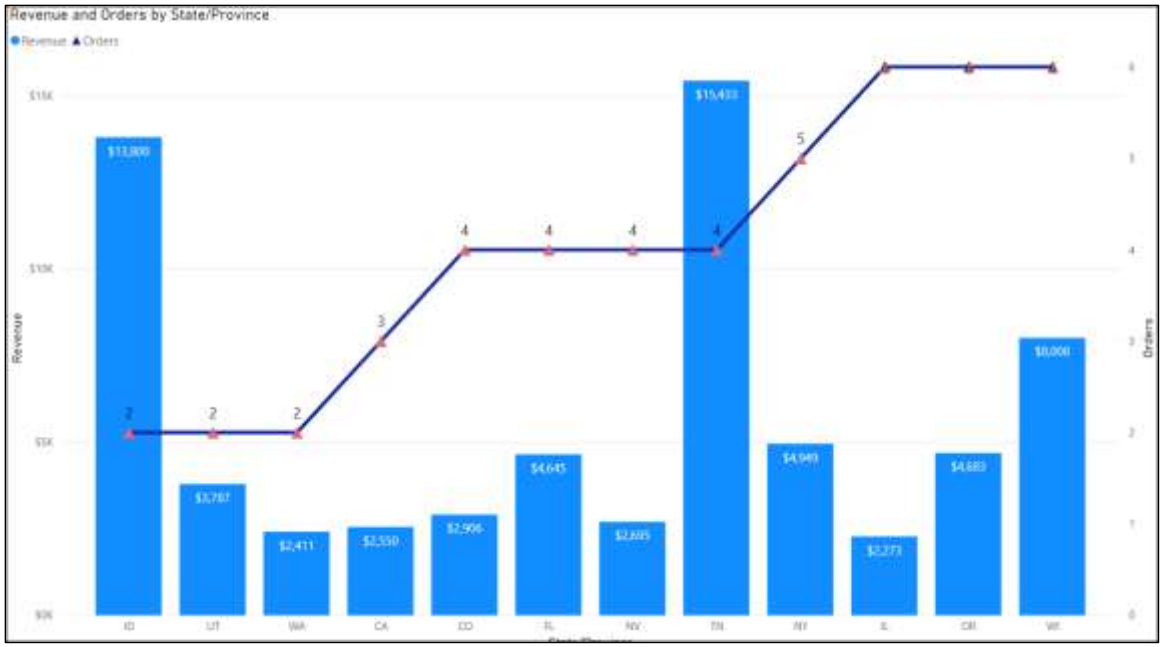
9. In the **Format**, **Visual**, **X-axis** area, change the **Type** back to **categorical**.

10. Save your report.

G. Combination Charts

Combination charts are useful when you need to compare two series that share the same X axis. The first series will be shown with a column chart, and the second series will show a line chart. The Y axis for both series is usually different.

For example, in this next exercise you want to determine if a correlation exists between total revenue and total number of orders for a food wholesaler named Northwind Traders.



1. Start a new Power BI report.

2. Get data from the **Northwind Traders.xlsx** file, and select the following tables:
   - Employees
   - Customers
   - Orders
   - Order Details
   - Products

3. Select **Modeling**, **Relationships**, **Manage Relationships**, and if necessary, create the following relationships:

   - Customers (ID) = Orders (Customer ID)
   - Employees (ID) = Orders (Employee ID)
   - Orders (Order ID) = Order_Details (Order ID)
   - Products (ID) = Order_Details (Product ID)

4. In the Order Details table, add a new calculated field with the following calculation.

```
Extended Price = [Quantity] * [Unit Price]
```

5. Add the Line and Stacked column chart visualization.

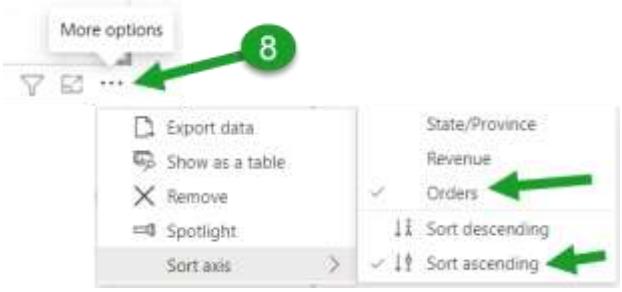
6. Set the following properties

Property	Setting
X-axis	'Customers' [State/Province]
Column y-axis	Sum of 'Order Details' [Extended Price]
Column y-axis - Rename for this visual	Revenue
Line y-axis	Count of 'Orders' [Order ID]
Line y-axis - Rename for this visual	Orders
Data Labels	On
Data Labels, Values, Display Units	None
Data Labels, Values, Value decimal places	0
Data Labels, Values, Font size	10 pt
Data Labels, Options, Orientation	Horizontal
Data Labels, Option, Position (column)	Inside End
Series Labels	On

7. Sort the visualization by Orders by doing the following:

   In the visualization, click the **More options ...** button and choose **Sort axis**, and select **Orders**.

   Again, click the **More options ...** button, choose **Sort axis**, and select **Sort ascending**.



8. In the **Data Labels** area, notice there is an **Apply settings to** area with a **Series** drop down that lets you pick either the Revenue or Orders series.

When you pick a series from the drop down, all the properties below the drop down will be relative to that series.

9. Using the table below set the set the following properties for each series.

Property	**Revenue** Setting	**Orders** Setting
Data labels	On	On
Data labels, Options, Position	Inside end	Above
Data labels, Values, Font size	10 pt	12 pt
Data labels, Values, Color	White	Black
Data labels, Values, Display units	None	None
Data labels, Values, Value decimal places	0	0
Data labels, Background	Off	Off

10. Expand the **Lines**, **Shapes** area, then set the following properties.

Property	Setting
Line style	Solid
Stroke width	4

11. Expand the **Markers** area, then set the following properties.

Property	Setting
Markers	On
Shape, Type	Triangle
Shape, Size	8
Colors	Red

12. Expand the **Secondary y-axis**, then set the following properties.

Property	Setting
Secondary y-axis	On
Range, Align zeros	On
Range, Minimum	0
Range, Maximum	Auto
Logarithmic scale	Off
Title	On

13. Save your report as **Northwind.pbix**.

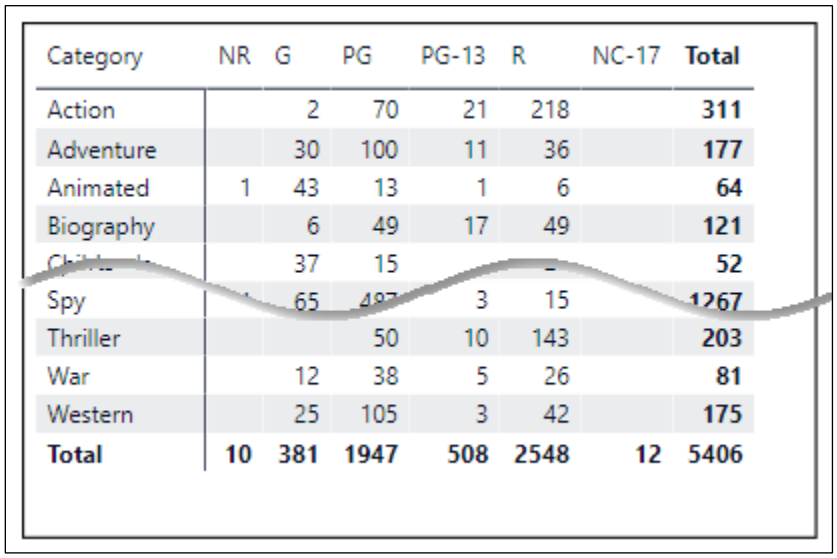
You should now have a combination chart that shows the sales revenue per state as a column chart and the number of orders per state as a line chart. Could you use this chart to convince management that there is no correlation between the number of orders and the earned revenue?

H. Matrix

As you know a table lets you view data in two dimensions (rows and columns). A matrix is similar to a table, but it supports a stepped layout, and it automatically summarizes or aggregates data.

Create a simple matrix

In this exercise you will create a matrix that answers the question "How many movies were made for each category and each rating.



Category	NR	G	PG	PG-13	R	NC-17	Total
Action		2	70	21	218		**311**
Adventure		30	100	11	36		**177**
Animated	1	43	13	1	6		**64**
Biography		6	49	17	49		**121**
[illegible]		37	15				**52**
Spy		65	[illegible]	3	15		**1267**
Thriller			50	10	143		**203**
War		12	38	5	26		**81**
Western		25	105	3	42		**175**
Total	**10**	**381**	**1947**	**508**	**2548**	**12**	**5406**

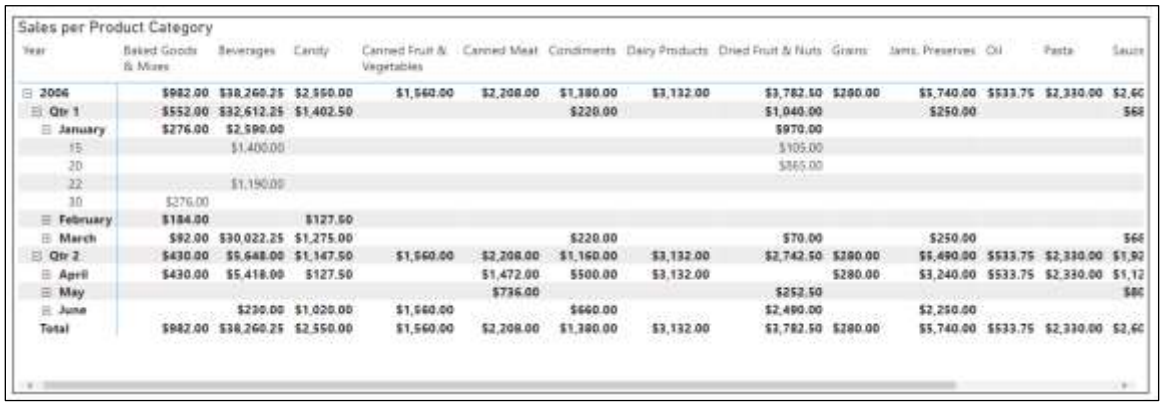
1. Open the **Movies.pbix** report from earlier.
2. Add a new page.
3. Rename the page as **Matrix**.
4. Set the following properties

Property	Setting
Rows	Category
Columns	Rating
Values	Count of Title

5. Add a border to the visualization.

Create a date oriented (hierarchical based) matrix

In this exercise you will create a date-based matrix for the Northwind company showing total sales per year, quarter, month and day per product category.



1. Open the **Northwind.pbix** report.

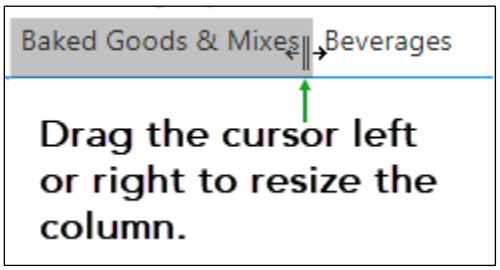
2. Create a new page.

3. Rename the page "Sales per Product Category"

4. Add a matrix visualization with the following properties.

Property	Setting
Rows	Orders, Order Date
Columns	Products, Category
Values	Sum of 'Order Details' [Extended Price]
Values Rename for this visual	Total Sales
Border	On
Title	On
Title text	Sales per Product Category

5. As desired, in the column heading row, resize the column by positioning the cursor to the right of the column, and then dragging to the left or right.



6. Click the buttons to the left of the year, quarter, etc. to drill down to the next level in the date hierarchy.

Practice

1. In the Northwind report create a new page with a matrix that shows **total revenue** (Order Details, Extended price) per **Sales rep** (Employees, Last Name) per **product category** (Products, Category).

   Rename the page "**Revenue per Sales Rep per Product Category**".

   Save the report.

2. In the Movies report create a new page named "**Movies per year**".

   Create a matrix visualization that counts the number of **movies** per **year** per **category**.

   Create a second matrix visualization that counts the number of **movies** per **year** per **rating**.

   Save the report.

I. Gauge

Create a table and four gauges

In this exercise you will create a report with four gauges, for the following sales performance for the North, East, Source, and West territories of ABC Distributors.

Territory	Actual	Goal
North	$2,548	$3,500
East	$3,506	$3,500
South	$1,908	$3,500
West	$4,371	$3,500

Your report will include both a table and a gauge. The table will show the data for each territory, plus a calculation showing the percent of goal achieved by each territory.

1. Create a new Power BI report.

2. Load data from the two sheets in the **ABC Distributors.xlsx** file.

3. Rename the page "**Actual vs Goal per Territory**".

4. Add a table visualization that shows, for the Actual vs Goal table, the **Territory**, **Actual**, and **Goal** fields.

5. Create a new column with the following formula.

```
Pct of Goal = DIVIDE( [Actual] , [Goal], 0)
```

   This formula uses the Divide function which divides the first argument by the second argument. This function also prevents Divide by Zero errors that will occur if the second argument is ever zero. The third argument tells the computer what to show instead of the Divide by Zero error.

6. Select the **Pct of Goal** field, and then using the ribbon's **Column tools** tab, change the format to a Percentage with two decimal places.

7. Add the **Pct of Goal** field to the table.

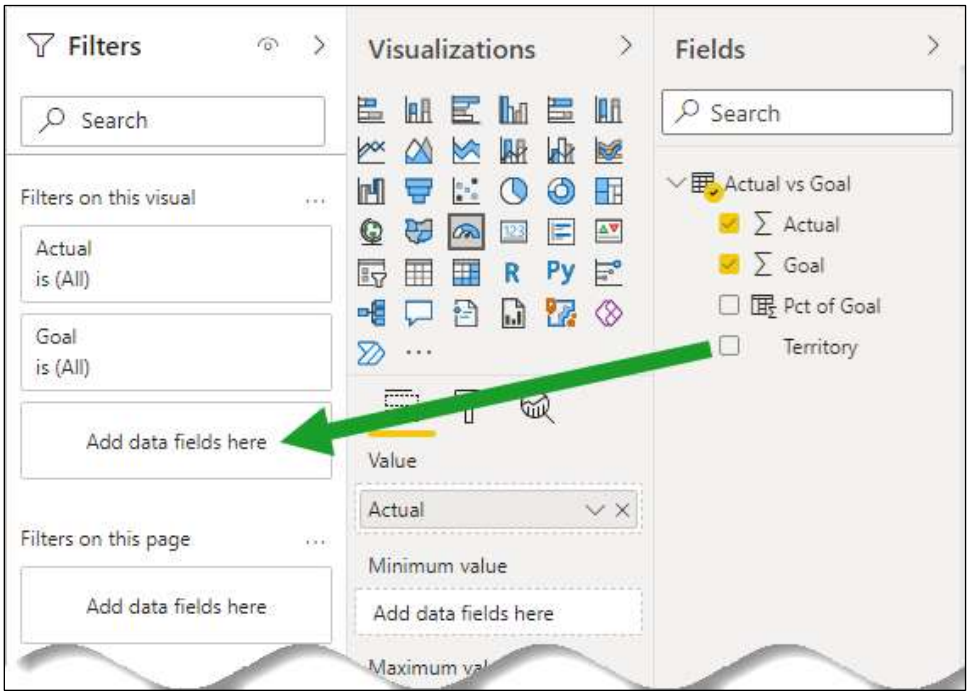
8. Add a Gauge visual with the following properties.

Property	Setting
Value	Actual
Target Value	Goal

Notice the Gauge is using the sum of all territories.

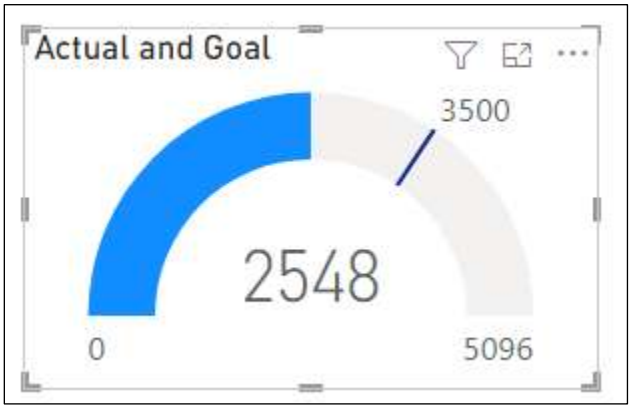
Notice that unfortunately the Gauge does not have a Small multiples option. Instead, we will have to create four separate gauges each with a different filter.

9. Drag the Territory field to the Add data fields here section of the Filters on this visual.



10. In the filter select **North**.

11. Notice the following:



- The gauge now shows the actual value, 2548, for the North territory in both the blue shaded curve and in the center of the visual.
- The gauge shows the goal with a line and its value of 3500.
- Because we did not include a Maximum value, the gauge sets the maximum as double the actual value.

12. Set the following properties for the gauge.

Property	Setting
Gauge axis, Max	5000
Border	On

13. Expand the Title section.

14. Click the conditional formatting button,  , next to Title text.

15. In the dialog box, click the drop down for the **Based on field** option, and choose **Territory**.

16. In the Summarization box choose **First**.

17. Click **OK**.

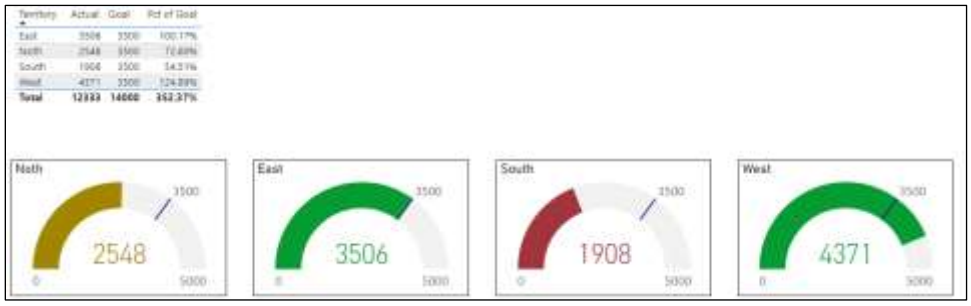
18. Duplicate the visual and place the duplicate on the right.

19. Then, in the fields pane, change the Territory filter to East.

20. Repeat the process for South and West.

21. Compare your screen with the image at the beginning of this exercise.

Changing gauge colors



You will now change the colors of the gauge based on the territory's percent of goal as shown below.

Percent of Goal	Color	Apply to
< 60%	Red	South
< 100%	Yellow	North
>100%	Green	East and West

1. Select the **North**'s visualization.

2. Expand the **Format**, **Visual**, **Colors** section and click the ***fx*** next to the fill color, and choose the settings shown below and in the image on the next page.

   Change the **Format style** to **Rules**.
   Change the "**What field should we base this on**" to "**Sum of Pct of Goal**."
   Keep the **Summarization** on **Sum**.

   Create the following rules:
   - >= 0 and < 0.6 then Red
   - >= 0.6 and < 1 then Yellow
   - >= 1 and < 2 then Green.

3. Expand the **callout value**, click the *fx* for the **color** and enter the same rules as in step 2.

4. Consult the table above and repeat the process for the other three gauges.

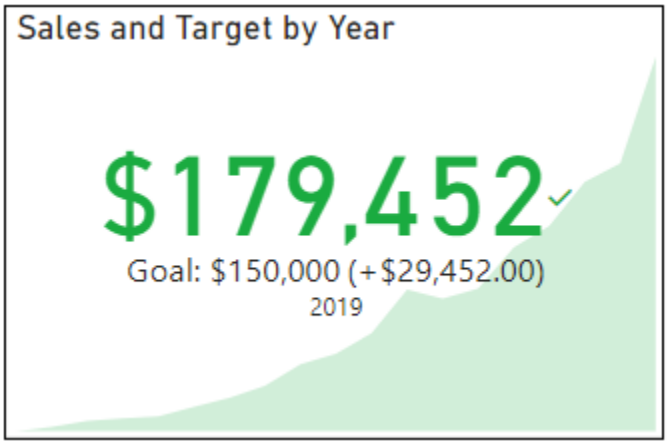
J. KPI

In this exercise you will create a KPI (key performance indicator) for the Annual Sales table of the ABC Distributors company. In a year when sales exceed the target the KPI will display green text, and red text when the sales fall short.

You will also add a table. The table will show the year, sales, target and the difference between the sales and target. You will make a negative difference appear in red by apply conditional formatting, and positive difference will appear in green.

Finally, you will add a slicer so you can pick a range of years and have the KPI visual show an area chart for the selected years.

Create the KPI



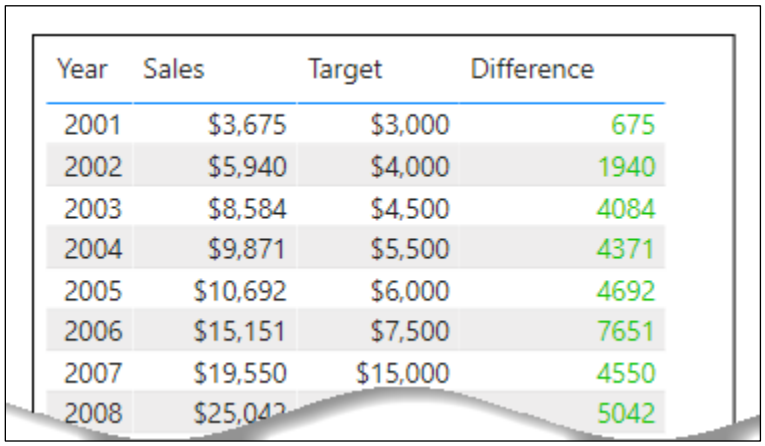
1. Add a new page to the ABC Distributors report.
2. Name the page "**Sales vs Target**".
3. In the fields pane, select the '**Annual Sales**' [**Sales**] field. Then, on the **Column tools** tab, set the **field type** to **Whole number** and the **Format** to **Currency** with **0 decimal places**.
4. Repeat step 3 for the '**Annual Sales**' [**Target**] field.
5. Add a KPI to the report.
6. Expand the Annual Sales table

7. Set the following properties:

Property	Setting
Value	Sales
Trend axis	Year
Target	Target
Indicator, Display units	None
Trend axis	On

Property	Setting
Goal, Goal	On
Goal, Label	Value
Trend axis, Direction	High is good
Date	On
Border	On

Create the table

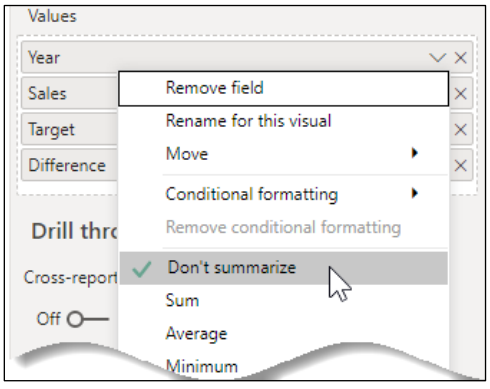


Year	Sales	Target	Difference
2001	$3,675	$3,000	675
2002	$5,940	$4,000	1940
2003	$8,584	$4,500	4084
2004	$9,871	$5,500	4371
2005	$10,692	$6,000	4692
2006	$15,151	$7,500	7651
2007	$19,550	$15,000	4550
2008	$25,042		5042

1. **Add a table visualization** to the page.

2. Add the **Year**, **Sales**, and **Target** fields to the table.

3. In the **Values** well, expand the **Year** field, and choose **Don't summarize**.



4. In the fields pane, add a new column to the **Annual Sales** table with the following calculation.

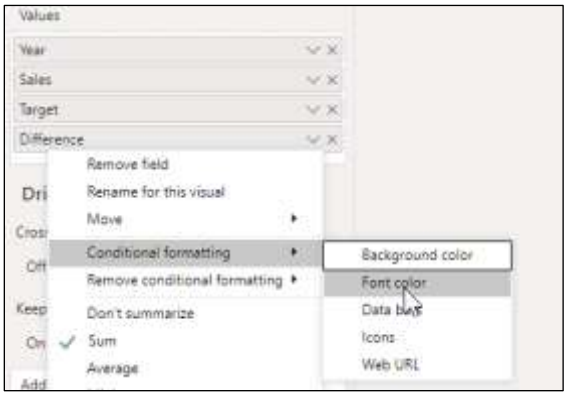
```
Difference = [Sales] - [Target]
```

5. In the fields pane, select the **Difference** column, and then on the ribbon's **Column tools** tab set the format to **Currency** with **0 decimal** places.

6. **Add** the **Difference** column to the table visualization.

7. In the Columns well rename the fields to **Sales**, **Target** and **Difference**.

8. In the Columns well expand the **Difference** value, choose **Conditional formatting**, and then choose **Font color**.



9. From the Format drop down choose **Rules**.

10. In the If value… line, set the following options:

Option	Rule 1 Setting	Rule 2 Setting
If value, Drop down	>=	>=
If value, Value	0	-1000000 (-one million)
If value, Percent or Number	Number	Number
and, Drop down	<	<
and, Value	1000000 *(one million)*	0
and, Percent or Number	Number	Number
then Color	Green	Red

11. Click **OK**.

12. Compare your table with the screen shot below.

Year	Sales	Target	Difference
2001	$3,675	$3,000	$675
2002	$5,940	$4,000	$1,940
2003	$8,584	$4,500	$4,084
2004	$9,871	$5,500	$4,371
2005	$10,692	$6,000	$4,692
2006	$15,151	$7,500	$7,651
2007	$19,550	$15,000	$4,550
2008	$25,042	$20,000	$5,042
2009	$35,308	$35,000	$308
2010	$40,217	$45,000	($4,783)
2011	$49,725	$60,000	($10,275)
2012	$70,115	$75,000	($4,885)
2013	$65,862	$80,000	($14,138)
2014	$70,675	$85,000	($14,325)
2015	$89,834	$90,000	($166)
2016	$100,072	$100,000	$72
2017	$120,695	$110,000	$10,695
2018	$129,485	$120,000	$9,485
2019	$179,452	$150,000	$29,452
Total	**$1,049,945**	**$1,015,500**	**$34,445**

Add the year slicer

1. Add a slicer to the page.

2. Add the Year field to the slicer.

3. If necessary, change the slicer type to **between**

Test the report

1. Using the table below, set the slicer to the years shown, and notice the results.

Years	KPI shows
2001 to 2019	• The text displayed is for the last year of the slicer's date range. • The text is in green because 2019 had a positive difference. • The area chart represents the Sales from 2001 to 2019. • The chart is also green because 2019 exceeded the target.
2010 to 2015	• The text displayed is for the last year of the slicer's date range. • The text is in red because 2015 had a negative difference. • The area chart represents the Sales from 2010 to 2015. • The chart is also red because 2014 did not meet the target.

2. Reset the slicer to 2001 to 2019.

3. In the table click on the year 2011.

   Notice the KPI is in red because 2011 had a negative difference.

   Notice the KPI does not show a trend (area chart) because only one year was selected.

4. Control-click on 2016.

   Notice the KPI is in green because the last year 2016 had a positive difference.

   Notice the KPI show a trend (area chart) for the two selected years.

5. Experiment selecting data from the table and/or slicer and see the results in the KPI.

6. Save your report as **ABC Distributors**.

Power KPI and Power KPI Matrix

Power KPI and Power KPI Matrix are two additional visuals from Microsoft that you can add from AppSource

2. Additional Visualization Objects

Complete this unit and you'll be able to:

A. Insert a text box

B. Insert a shape

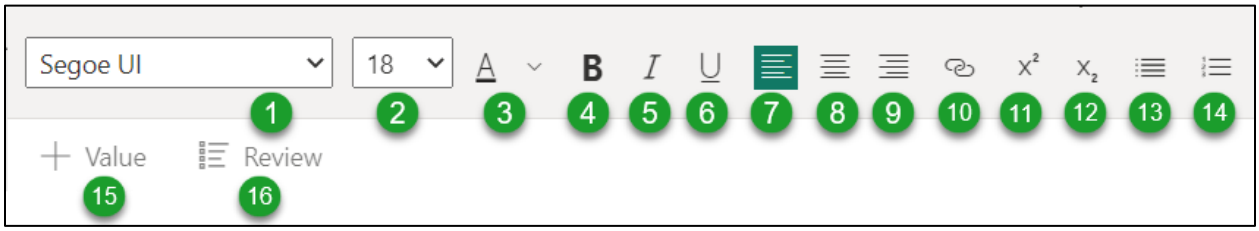
C. Insert an image

D. Create a bookmark

E. Insert a button

A. Inserting a text box

Like many other programs Microsoft Power BI allows you to insert text via a text box. That text can be formatted using the text box toolbar.

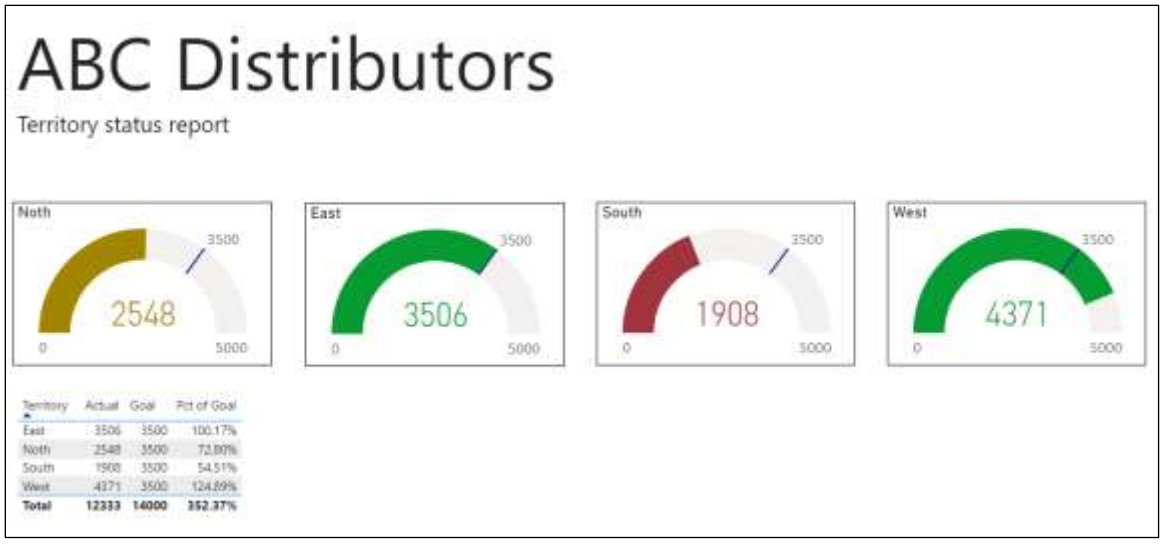


Using the toolbar, you can:

1. Change the **font**.
2. Change the **font size**.
3. Change the **font color**.
4. **Bold** the text.
5. **Italicize** the text.
6. **Underline** the text.
7. **Left justify** the text.
8. **Center justify** the text.
9. **Right justify** the text.
10. Turn the text into a **hyperlink**.
11. **Superscript** the text.
12. **Subscript** the text.
13. Make the text part of a **Bulleted list**.
14. Make the text part of a **Numbered list**.
15. Make the text dynamic by inserting a variable value.
16. Review and edit previously created variable values.

Exercise: Create a text box

In this exercise you will add a simple text box to our report.



1. If necessary, open the **ABC Distributors** report you created earlier.

2. On the first page, Actual vs Goal per Territory, move the table below the first gauge.

3. From the ribbon select **Home**, **Insert**, **Text box**.

   Notice a new text box is placed on the page, and the text box tool bar is also displayed.

4. Resize the text box to fit the width of the page.

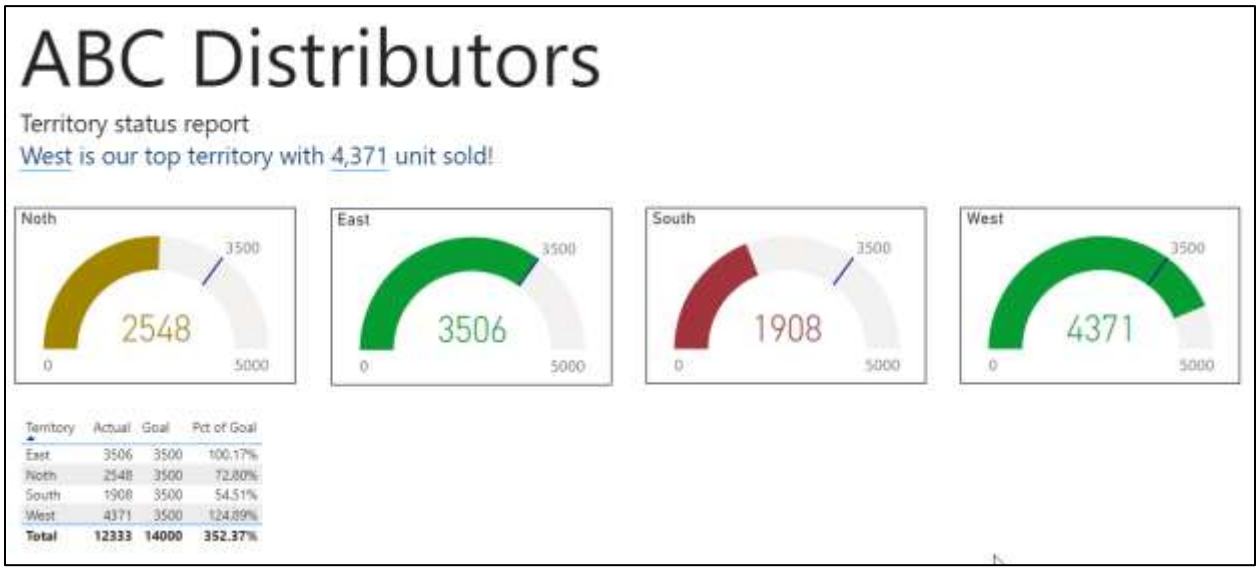
5. Change the **font size** to **60.**

6. In the text box type `ABC Distributors` then press enter.

7. Set the **font size** to **18** and type `Territory status report`.

Exercise: Add a dynamic text box

In this exercise you will add a line announcing the top territory. You will then create a calculation for the top actual amount, and then create another calculation for the name of the territory with the top actual amount. Finally, you will add these two calculations into the text box.



1. In the text box, add another return, and then type the following:

   ```
   X is our top territory with y units sold.
   ```

2. Create our first measure by selecting from the ribbon **Home**, **Calculations**, **New Measure**.

   A later chapter will cover measures in great detail. Until then, think of a **New Measure** as an aggregate calculation that is applied to a whole table, as opposed to a New Column which is a calculation that is applied to each row of a table.

3. Enter the following formula and press enter.

   ```
   Top Territory Actual = Max('Actual vs Goal'[Actual])
   ```

   This calculation uses the Max function to find the largest value for the selected column for the selected table.

4. Create our second calculation by again selecting from the ribbon **Home**, **Calculations**, **New Measure**.

5. Enter the following formula and press enter.

```
Top Territory Name = LOOKUPVALUE(
       'Actual vs Goal'[Territory],
       'Actual vs Goal'[Actual],
       [Top Territory Actual])
```

6. Click inside the text box, then highlight the x at the beginning of the third line.

7. Click the [**+ value**] button in the text box tool bar.

   Notice a blue box is inserted before the x.

8. Enter the following:

Property	Setting
How would you calculate this value	top territory name
Name your value	Top Territory Name

9. Click **Save**.

10. Delete the x.

11. Inside the text box, highlight the y in the third line.

12. Click the [**+ value**] button in the text box tool bar.

    Notice a blue box is inserted before the y.

13. Enter the following:

Property	Setting
How would you calculate this value	top territory actual
Name your value	Top Territory Actual Value

14. Click **Save**.

15. Delete the `y`.

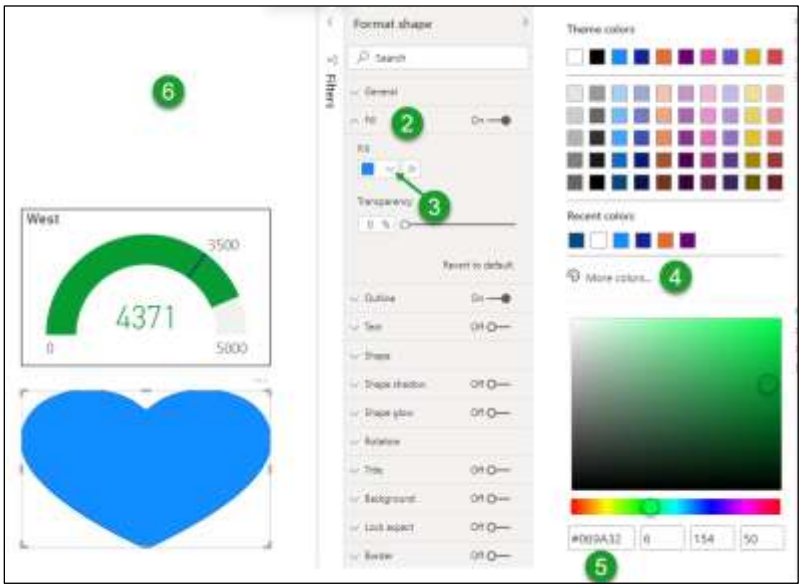
16. Save your report.

B. Inserting a shape

Like many other programs Microsoft Power BI allows you to insert shapes. In this exercise you will insert a green heart inside the west's gauge to show they are the top territory.

1. From the ribbon select **Insert**, **Elements**, **Shapes**, and then select the **heart**.

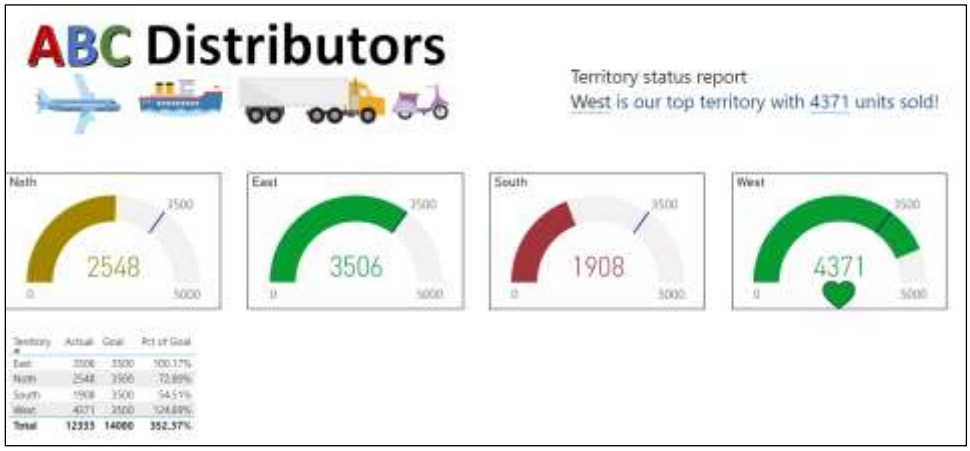
   A large blue heart is added to the page.



2. In the **Format** pane, expand the **Style**, **Fill** section.
3. Click the **Fill** color drop down.
4. Click **More colors…** option.
5. Enter #069A32 in the hexadecimal box.
6. Click back on the chart.
7. Using the shape's corner size handles, shrink the heart.
8. Position the heart inside the west's gauge.
9. In the **Format** pane, expand the **Style**,**Border** section.
10. Change the **Outline color** to **black**.

C. Inserting an image

Microsoft Power BI allows you to insert images. In this exercise you will insert a logo for ABC Distributors.



1. Be sure you have the ABC Distributors report open on the first page.
2. Edit the text box to remove the first line.
3. Move the text box to the right side of the page.
4. From the ribbon select **Insert**, **Elements**, **Image**.
5. Select the **ABC Distributors Logo.png** file from the exercise folder and click **Open**.
6. Drag and resize the image to position it in the top left corner of the page.

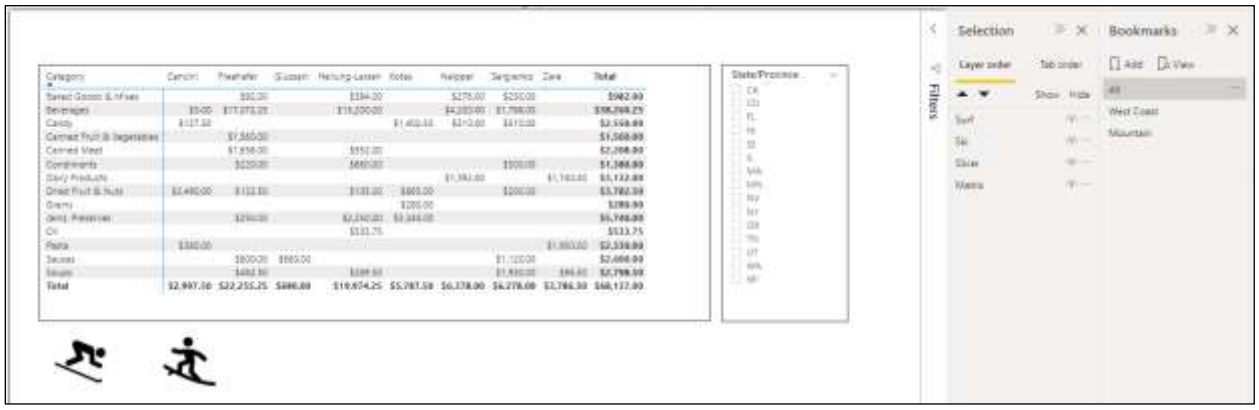
D. Adding bookmarks

In a physical book, a bookmark keeps track of the page number where you last read.
In your web browser a bookmark keeps track of webpages you were viewing.
In Power BI, bookmarks keep track of the current configurations of a report page, so you can easily return to this view later. The saved configurations include:

- The page you are viewing
- Filters
- Slicers
- Sort order
- Visibility of specific objects via the selection pane

In this exercise you will create some bookmarks for the third page of the Northwind report. To demonstrate the features of the bookmarks, you will add a slicer for the State/Providence field, and two images: a skier and a surfer. You will then setup three bookmarks:

- The first will be named **All** and will show data for all states. It will also show both images.
- The second will be named **West Coast** and will only show data for WA, OR, and CA. It will also show the surf image.
- The third will be named **Mountain** and will only show data for CO, ID, and UT. It will also show the ski image.



Add the slicer

1. Open the **Northwind** report you created earlier, and go to the third page, "**Revenue per Sales Rep per Product Category**".
2. Add a **slicer** to the right side of the page for the **Customers**, **State/Province** field.

Add the images

1. From the ribbon select **View**, **Show panes**, **Selection**.
2. From the exercise folder, add the **Ski.png** image below the matrix.
3. In the selection pane, double click the image and rename it "Ski".
4. From the exercise folder, add the **Surf.png** image to the right side of the ski image.
5. In the selection pane, double click the image and rename it "**Surf**".

Add the bookmarks

1. From the ribbon select **View**, **Show panes**, **Bookmarks**.
2. In the bookmarks pane, click **Add**.

   Notice Bookmark 1 is added.
3. **Right click** on the bookmark, choose **Rename**, and enter the name "**All**".
4. In the slicer, select **CA**, **OR**, and **WA**.
5. In the selection pane, click the **eyeball** next to **Ski** to hide it.
6. Add a new bookmark and change its name to "**West Coast**".
7. Click on the **All** bookmark.

   Notice the page returns to showing all data, and both images.
8. Click on the **West Coast** bookmark.

   Notice the page again shows West Coast data, and the surf image is displayed.

9. Practice: Create a bookmark named "**Mountain**". It should have the slicer set to **CO**, **ID**, and **UT** and should display the Ski image.

10. Go to a different page in the report.

11. Click on any of the three bookmarks.

    The screen should automatically move to the third page, show the appropriate images, and set the slicer to the appropriate filter.

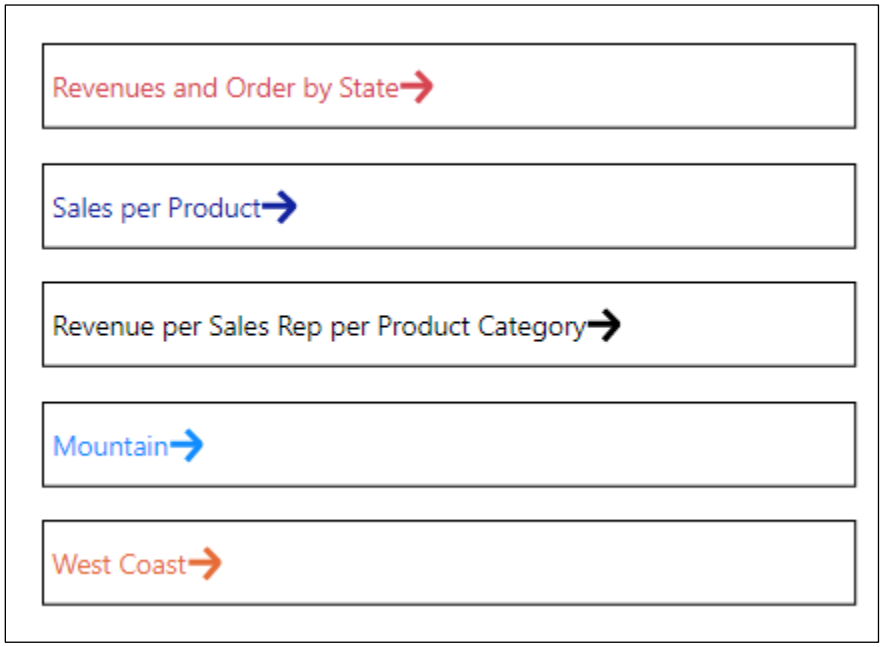
E. Inserting a button

Buttons are similar to text boxes, shapes and images, but with one major advantage; buttons have actions that make them interactive. These actions can make your report behave like an app where users can easily interact with the content.

Below is a list of the actions you can assign to a button:

- **Back** – Like a back button in a browser, a button with the back action will return to the previous view.
- **Bookmark** – Performs the action associated with a designated bookmark.
- **Drill through** – Moves the user to a drillthrough page with data that is filtered per a specification, all without the use of a bookmark.
- **Page navigation** – Moves the user to a specified page in the report.
- **Q&A** – Opens a window where users can type in questions that will cause Power BI's artificial intelligence to answer the question with a visualization.
- **Web URL** – Opens a web page in a new browser window.

Adding Buttons



In this exercise you will create a new "Home" page to your report, and add the following buttons to it:

Button Type	Button Text	Action Type	Results
Right Arrow	Revenues and Order by State	Page Navigation	Moves to the Revenue and Order by State page
Right Arrow	Sales per Product	Page Navigation	Moves to the Sales per Product page
Right Arrow	Revenue per Sales Rep per Product Category	Bookmark	Applies the All bookmark to let users view all the data on the Sales Rep per Product Category page
Right Arrow	Mountain	Bookmark	Applies the Mountain bookmark
Right Arrow	West Coast	Bookmark	Applies the West Coast bookmark

1. Add a new page to the report.
2. Move the new page to page 1.
3. Rename the new page "**Home**".
4. From the ribbon select **Insert**, **Elements**, **Buttons**, and then choose the **Right Arrow** button.

5. Apply the following properties in the Format button area.

Property	Setting
Action	On
Action, Type	Page Navigation
Action, Destination	Revenues and Order by State
Style, Text	On
Style, Text, Text	Revenues and Order by State
Style, Text, Color	Red
Style, Text, Vertical Alignment	Middle
Style, Text, Horizontal Alignment	Left
Style, Icon	On
Style, Icon, Icon placement	Right of text
Style, Icon, Line color	Red
Style, Border	On
General, Properties, Width	400

6. Duplicate the button (copy and paste) and place the new button below the first. Then change the properties as shown below.

Property	Setting
Action, Destination	Sales per Product
Style, Text, Text	Sales per Product
Style, Text, Color	Dark Blue
Style, Icon, Line color	Dark Blue

7. Duplicate the button again and place the new button below the second. Then change the properties as shown below.

Property	Setting
Action, Type	Bookmark
Action, Bookmark	All
Style, Text, Text	Revenue per Sales Rep per Product Category
Style, Text, Color	Black
Style, Icon, Line color	Black

8. Duplicate the **Revenue per Sales Rep per Product Category** button and place the new button below the third. Then change the properties as shown below.

Property	Setting
Action, Type	Bookmark
Action, Bookmark	Mountain
Style, Text, Text	Mountain
Style, Text, Color	Blue
Style, Icon, Line color	Blue

9. Duplicate the **Mountain** button and place the new button below the third. Then change the properties as shown below.

Property	Setting
Action, Type	Bookmark
Action, Bookmark	West Coast
Style, Text, Text	West Coast
Style, Text, Color	Orange
Style, Icon, Line color	Orange

10. Test each button by Ctrl Clicking on it.

11. As time permits play with other properties.

12. Save the report.

3. Interactive Tools

Complete this unit and you'll be able to:

A. Spotlight a visualization

B. Edit interactions

C. Determine which filters and slicers are affecting a visualization

D. Turn on Focus Mode

E. Use the Show as a Table feature

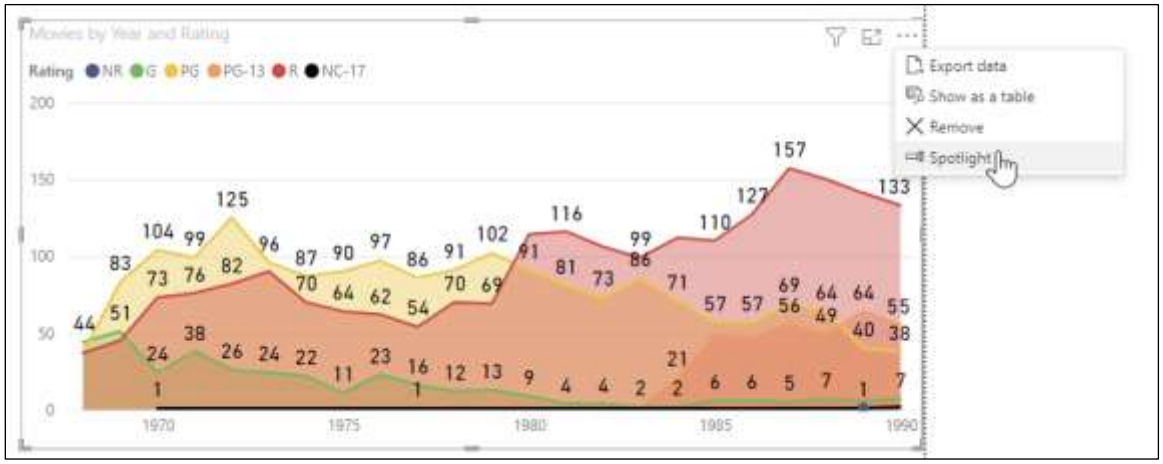
F. Export data from a visualization

G. Sort a visualization

H. Apply drill downs

A. Spotlights

In the theater when a director wants the audience to focus on the hero and heroine, , all the lights on the stage are dimmed and a spotlight is focused on the heroic couple. Spotlights in Power BI can also be used to draw viewers attention to a specific visual. In this exercise you will use the spotlight feature in the movies report.



1. **Open** the **Movies** report and select the first page, "Column Lines and Area Charts."

2. Click on the chart in the bottom right corner.

3. Click the **More Options** (three dots in the top right corner) of the visualization.

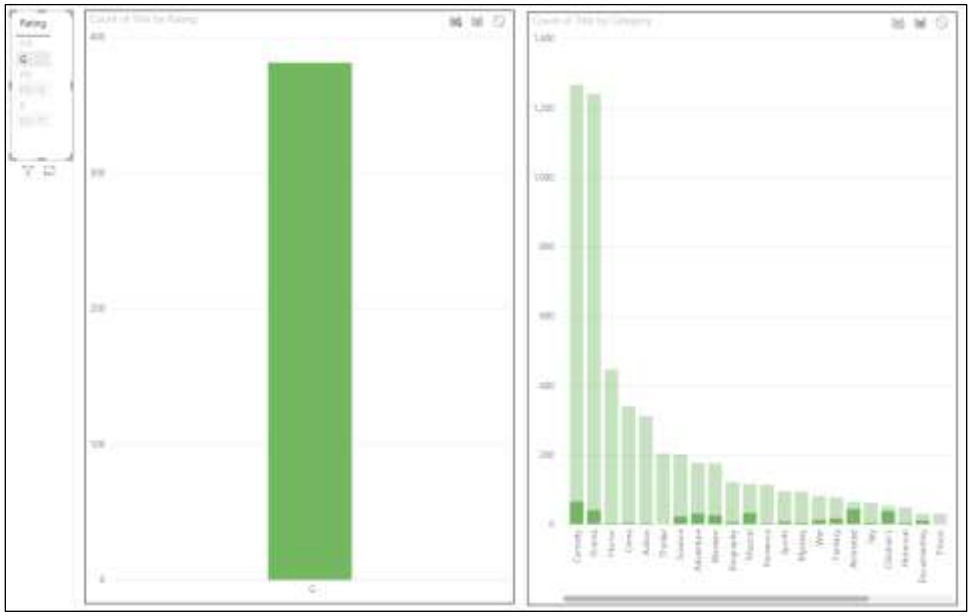
4. Choose **Spotlight**.

5. Notice the other charts are dimmed, thus attracting viewers to the one chart.

   Note: The spotlight is only temporary. Once you click somewhere else, the spotlight is removed.

B. Edit Interactions

As a designer of Power BI reports, you can control the interactions between various visualizations. Specifically, you can decide if a visualization should allow another to filter it, highlight it, or have no effect on it. This is done through the Edit Interactions feature on the ribbon's Format menu.



1. Add a new page to the Movies report. Name the page **2 Column Charts**.

2. Add a table for the list of ratings.

3. Create a column chart with the following properties:

Property	Setting
X-axis	Rating
Y-axis	Count of Title

4. Create a second column chart with the following properties:

Property	Setting
X-axis	Category
Y-axis	Count of Title

5. Select the table visualization.

6. From the ribbon select **Format**, **Interactions**, **Edit Interactions** to turn on the Edit interactions mode.

   Notice the column charts now display three icons that control the interactions between the table visualization and the other visualization.

Icon	Name	Meaning
	Filter	Data in this visualization can be filtered by the table visualization.
	Highlight	Data in this visualization can be highlighted by the table visualization.
	None	This visualization will not be affected by a selection in the table visualization.

   These three icons are like three radio buttons, so when you click one icon ON for a chart, you have simultaneously set the other two icons OFF.

7. For the Rating column chart click the filter icon  .

8. For the Category column chart click the highlight icon  .

9. From the ribbon select **Format**, **Interactions**, **Edit Interactions** to turn off the Edit interactions mode.

10. In the Rating table click G.

    Notice that the rating chart only displays the G rated bar. Notice the Category chart highlights the portion of the bars that represent the G rated movies.

11. In the Rating table click G.

    Notice both charts return to normal.

12. Experiment with other selections in the rating table and see the results.

13. Save the report.

C. Filters and slicers affecting this visualization

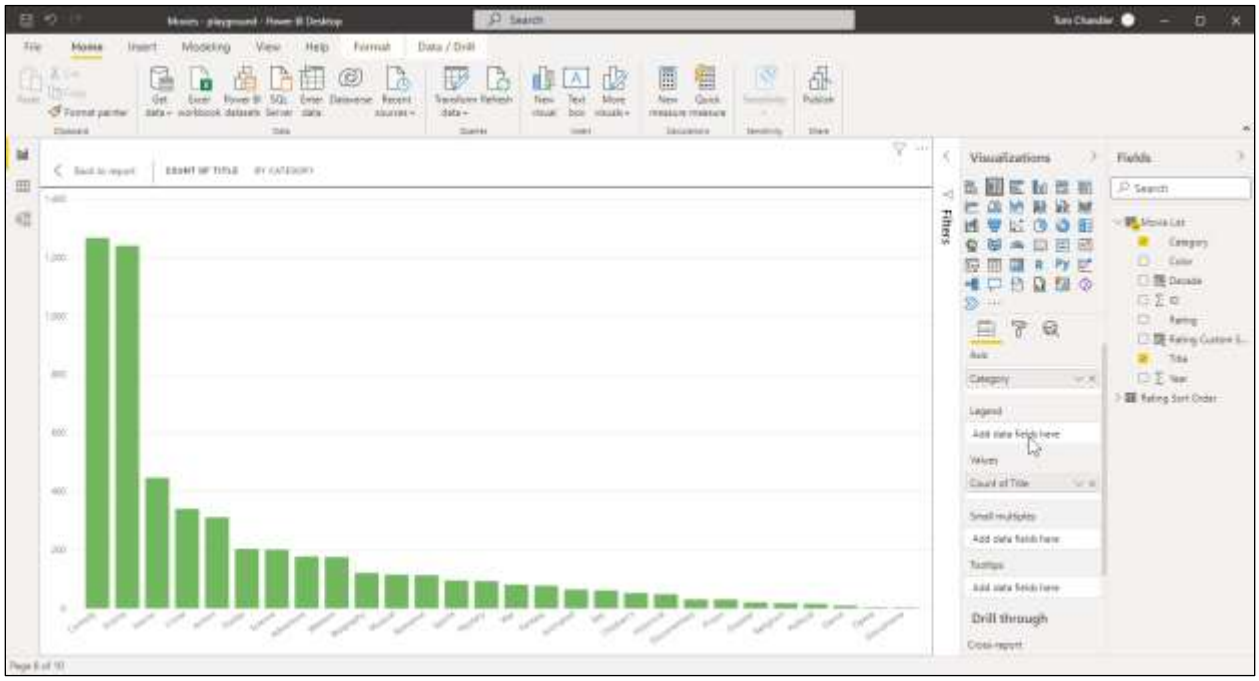
Sometimes you need to know which slicers and other objects are affecting a visualization. The **Filters and slicers affecting this visualization** tool can provide this information. In this exercise you will add a slicer to the page and then use the **Filters and slicers affecting this visualization** tool.

1. Add a **slicer** based on the **Category** field.
2. In the slicer select **Comedy**.
3. In the Rating table click **PG**.
4. In the rating column chart hover the mouse over the funnel that appears in either the top or bottom right corner of the chart.

   Notice a tip window appears explaining that this chart is filtered by the Comedy Category and only includes the PG ratings.
5. **Clear** the slicer.
6. Reselect PG in the rating table, thus enabling all the ratings.
7. Save your report.

D. Focus Mode

The Power BI focus mode allows you to zoom in and focus on a visualization.



1. Hover the mouse over the Category column chart.

2. Click the focus mode icon .

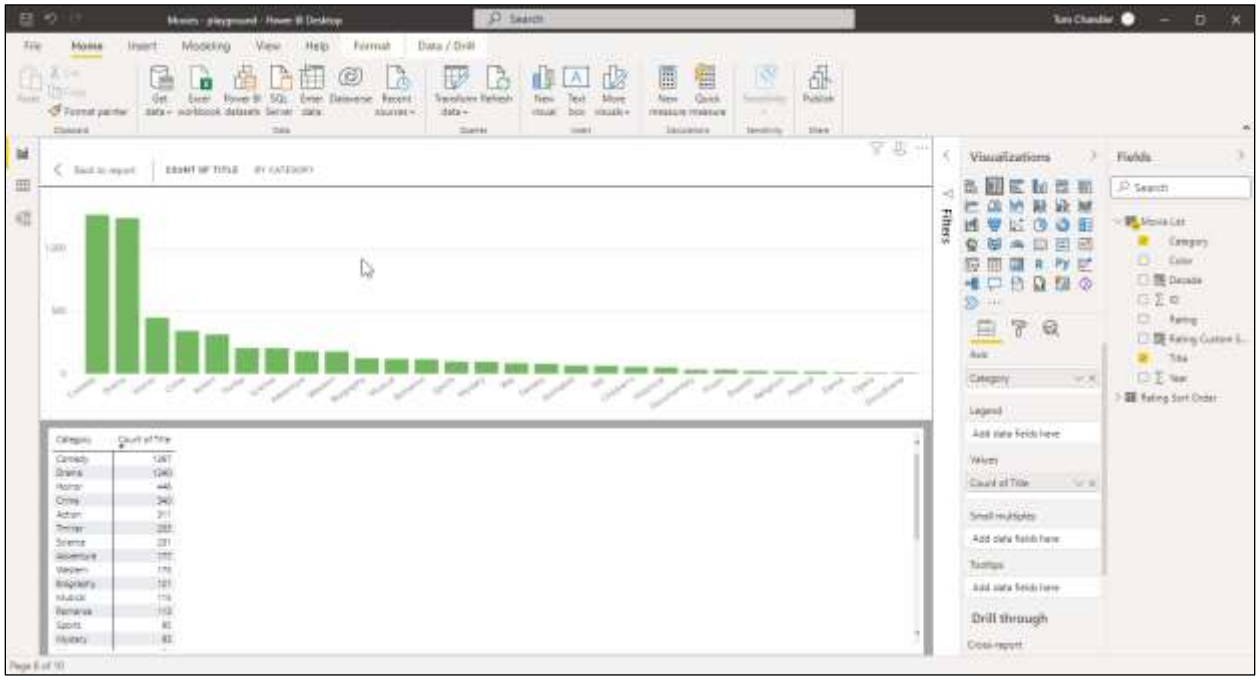
   Notice the screen now zooms in on, and only shows, the Category column chart; all other charts are temporarily hidden.

   Notice the Filters, Visualizations, and Fields panes are still visible. While in Focus mode you can still modify the visualization as needed.

3. In the top left corner click the **Back to report** button to exit focus mode.

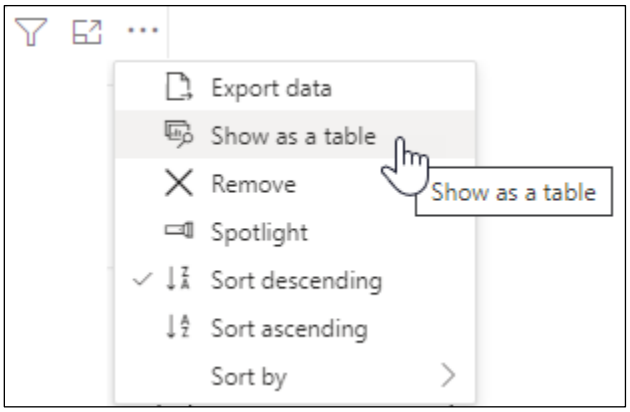
E. Show as a table

The Show as a table feature is like focus mode, but it also shows you the data in a table.



1. Again, hover the mouse over the Category column chart.

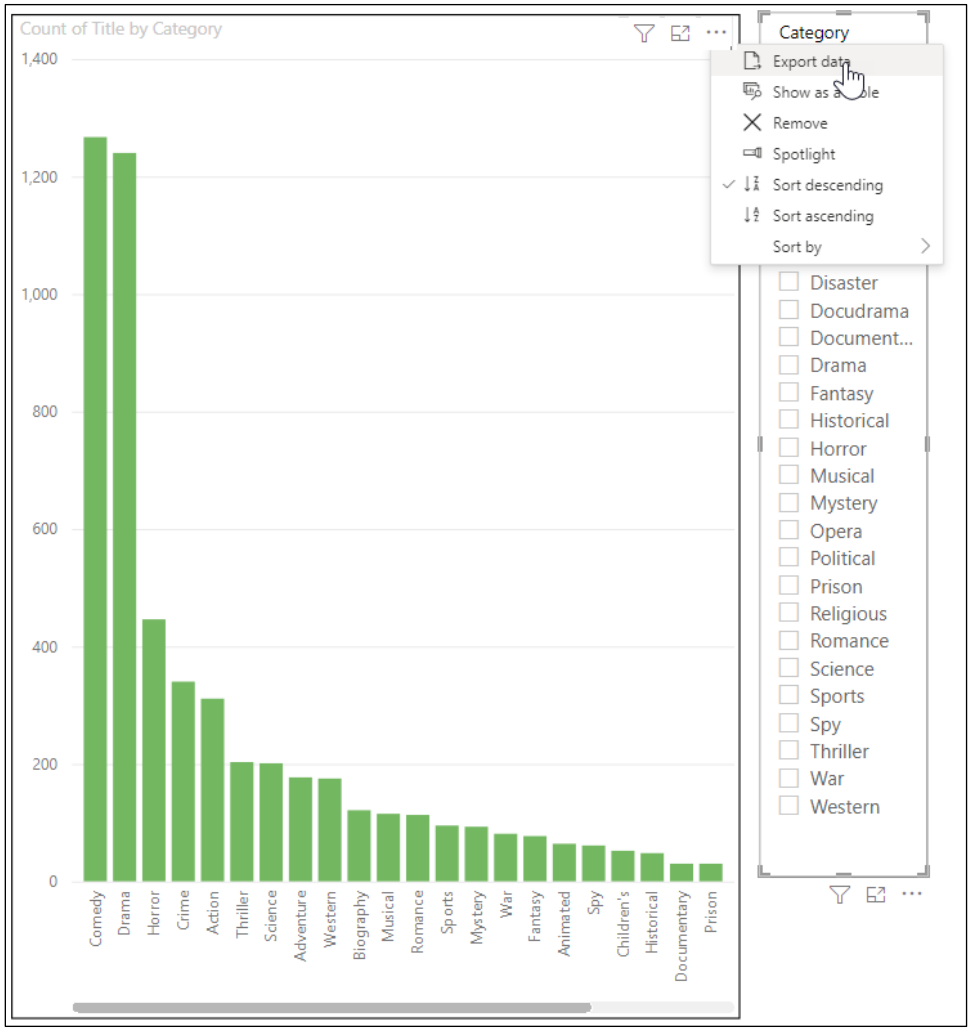
2. In the top or bottom right corner click the three dots, then click the **Show as a table** option.



3. Click the **Back to report** button to exit the Show as a table feature.

F. Export Data

Power BI gives you the ability to export the summary data from which a visualization is made. This is the same data that appears when you use the Show as a table feature. The data will be saved as a CSV file which can then be opened in Excel and many other programs.



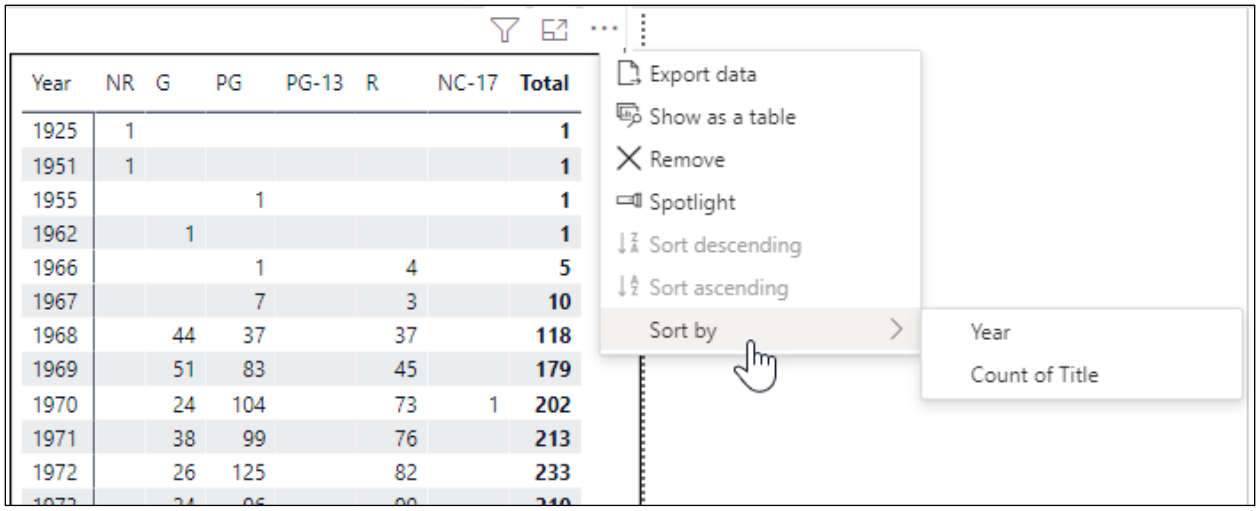
1. Again, hover the mouse over the Category column chart.

2. In the top or bottom right corner, click the three dots, then click **Export data**.

3. When prompted **choose a folder**, and **enter a filename**, then click **Save**.

G. Sorting

Depending on the visualization and its data, Power BI gives you options for how the data should be sorted. In this exercise you will experiment with sorting a visualization on the Movies per year page.



1. Move to the **Movies per year** page you created earlier.

2. Hover the mouse over the top or bottom right corner, click the **three dots**, and choose **Sort by**.

   Here you can see the fields from which this report can be sorted.

3. Choose the **count of title** field.

   Notice, the report now sorts the results by the **total column.**

4. Again, hover the mouse over the top right corner, click the **three dots**, and choose **Sort Ascending**.

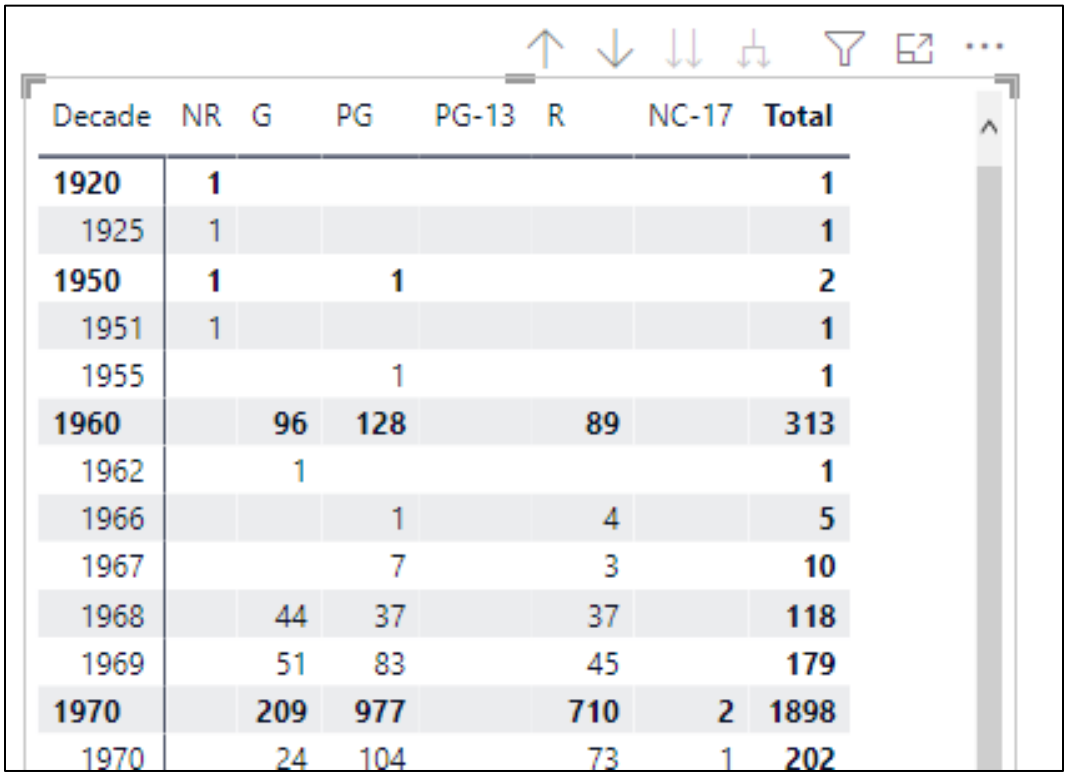
   The report now displays the records with the least number of total movies first.

5. Practice: Sort the visualization by year in descending order.

H. Drill down

Power BI gives you the ability to create a report with a high-level of detail, and then "drill down" to see a lower-level details.

In this exercise you will create a new column named decade. It will be based on the year the movie was made. You will then create a matrix report based on the decade and then see how to drill down to see the report per year.



Decade	NR	G	PG	PG-13	R	NC-17	Total
1920	**1**						**1**
1925	1						**1**
1950	**1**		**1**				**2**
1951	1						**1**
1955			1				**1**
1960		**96**	**128**		**89**		**313**
1962		1					**1**
1966			1		4		**5**
1967			7		3		**10**
1968		44	37		37		**118**
1969		51	83		45		**179**
1970		**209**	**977**		**710**	**2**	**1898**
1970		24	104		73	1	**202**

Create a calculated Decade field

1. From the ribbon select **Modeling**, **Calculations**, **New Column**.

2. Enter the following formula:

```
Decade = INT([Year]/10) * 10
```

Create a matrix visualization

1. Add a new page to the report named "Movies by decade".

2. Add a matrix visualization with the following properties.

Property	Setting
Rows	Decade Year
Columns	Rating
Values	Count of Title

3. Resize the matrix so it takes up most of the page.

4. Notice the bottom of the visualization includes these hierarchical icons.

Icon	Name
	Drill up
	Drill down
	Go to the next level in the hierarchy
	Expand all down one level in the hierarchy

5. Double click 1960.

   Notice nothing happens.

6. Click the drill down button  .

   This turns on the ability to drill down. Notice the icon has changed to  .

7. Double click 1960.

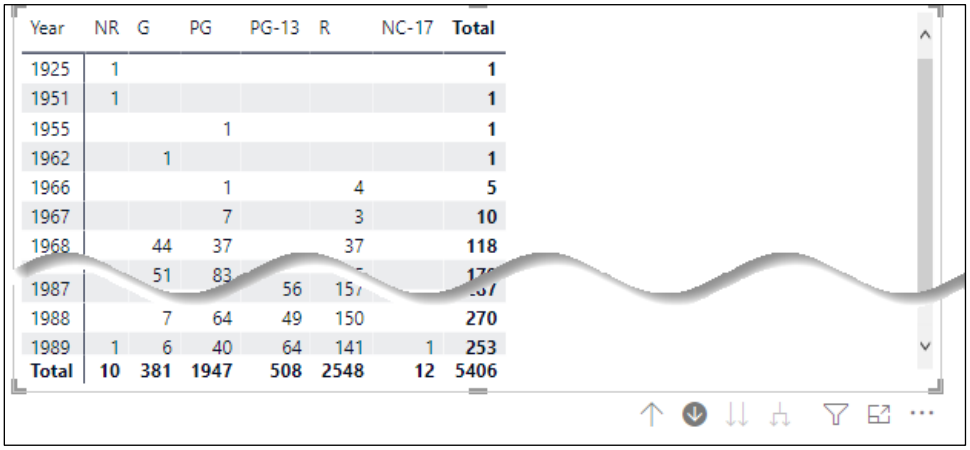
   Notice the screen now displays the 1960 decade with details for each year that has a data.

Decade	G	PG	R	Total
1960	**96**	**128**	**89**	**313**
1962	1			**1**
1966		1	4	**5**
1967		7	3	**10**
1968	44	37	37	**118**
1969	51	83	45	**179**
Total	**96**	**128**	**89**	**313**

8. Click the drill up icon to return to the decade only report.

9. Click the **Go to the next level in the hierarchy** button.

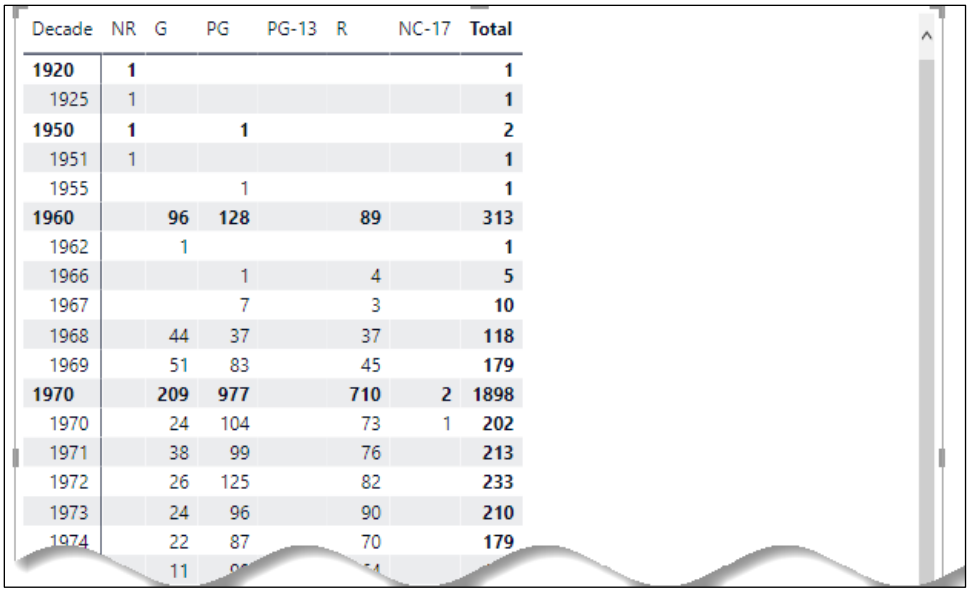
   Notice the screen now displays the report by year instead of decade.



10. Click the drill up icon to return to the decade report.

11. Click the **Expand all down one level in the hierarchy** button.

Notice the report displays both decade and year data.



Decade	NR	G	PG	PG-13	R	NC-17	Total
1920	**1**						**1**
1925	1						**1**
1950	**1**		**1**				**2**
1951	1						**1**
1955			1				**1**
1960		**96**	**128**		**89**		**313**
1962		1					**1**
1966			1		4		**5**
1967			7		3		**10**
1968		44	37		37		**118**
1969		51	83		45		**179**
1970		**209**	**977**		**710**	**2**	**1898**
1970		24	104		73	1	**202**
1971		38	99		76		**213**
1972		26	125		82		**233**
1973		24	96		90		**210**
1974		22	87		70		**179**
		11					

12. Click the drill up icon to return to the decade only report.

13. Save your report.

4. Creation Tools

Complete this unit and you'll be able to:

A. Change the size of a page

B. Change the page view

C. Switch to a mobile layout

D. Apply themes

E. Easily align objects

F. Lock objects

G. Use the selection pane

A. Page Size

By default, Power BI assumes you are using a wide monitor with a 16:9 aspect ratio. If necessary you can change the page size as follows:

1. Open your report.
2. Click outside a visualization so your cursor is on the page.
3. From the visualizations pane, click the format properties button.
4. Expand the **Canvas settings** section.
5. Click the type drop down and select the desired page size.

   Notice the drop down includes multiple options which are explained below:

Option	Width x Height in Pixels	Comments
4:3	920 x 720	This was the original standard size used by televisions in the 1940s.
16:9	1280 x 720	To compete with televisions, movie theaters used this wider screen size. Today's wide screen monitors are 1280 x 720 or 1920 x 1080, both of which use the 16:9 aspect ratio. Most computers today use this standard. It is therefore the default in Power BI.
Letter	816 x 1056	Sized for standard 8 ½" x 11" paper.
Tooltip	320 x 240	Size for a popup tooltip box.
Custom	*Your choice*	Unlike the other settings, custom lets you enter the height and width settings.

B. Page View

Page size and page view are different. By analogy, page size and page view are somewhat like Microsoft Word's paper size and zoom. If you want to change your page view (zoom) do the following:

1. From the ribbon select **View**, **Scale to fit**, **Page View**, then select one of the following options:

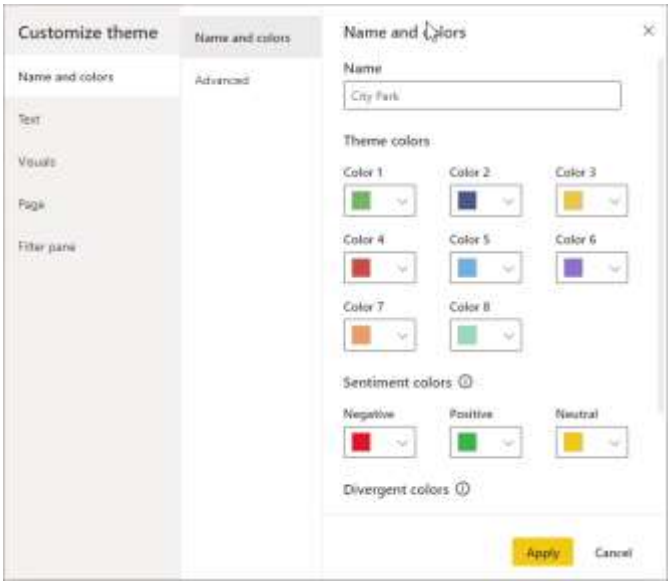
Option	Result
Fit to page	Zoom is changed so the whole page (width and height) fits in the application window.
Fit to width	Zoom is changed so the width fits in the application window. You may have to scroll down to see the rest of the page.
Actual Size	Zoom is changed to 100% so, no matter the size of the application window, the image will be the same size. If you have a small application window then you will most likely need to scroll in order to see the rest of the image. In a large application window scrolling may not be needed.

C. Themes

You can quickly change colors by applying a report theme. The ribbon's **View** menu lets you pick one of many prebuilt themes.

To select a theme, click the drop down and choose the desired theme.

By selecting **Customize current theme** you can change the colors of the current theme.



After you apply your changes, you can save your theme to a JSON file using the **Save current theme** option.

The **Browse for theme** option allows you to open a JSON file that has the theme you or someone else created.

The **Theme gallery** option will open a webpage where Microsoft has multiple themes that you can preview and download.

If you would like to learn more about JSON files and creating a theme, click the **How to create a theme** option. It will take you to a detailed Microsoft web page about using and creating themes.

D. Aligning and grouping objects

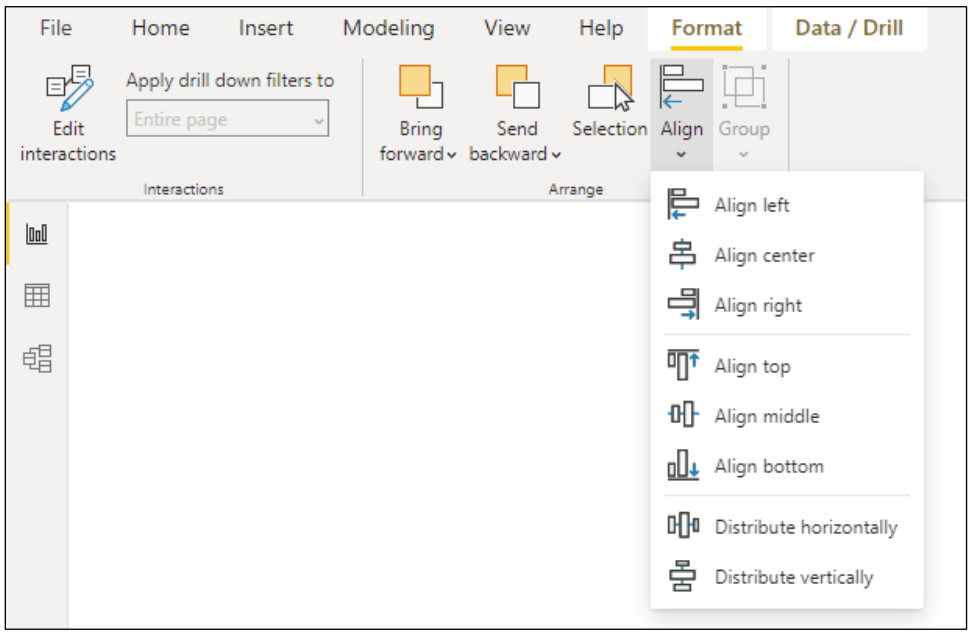
The ribbon's **View** menu and the ribbon's **Format** menu includes options that can help you align objects on your screen:

View menu

The **View, Gridlines** option will display gridlines that help you visually align your objects on the screen.

The **View, Snap to Grid** option can help you align objects on the page because, when checked each object you move on the screen will have to line up with the dots of the grid. The snapping even take place if you choose to not show the gridlines.

Format Menu



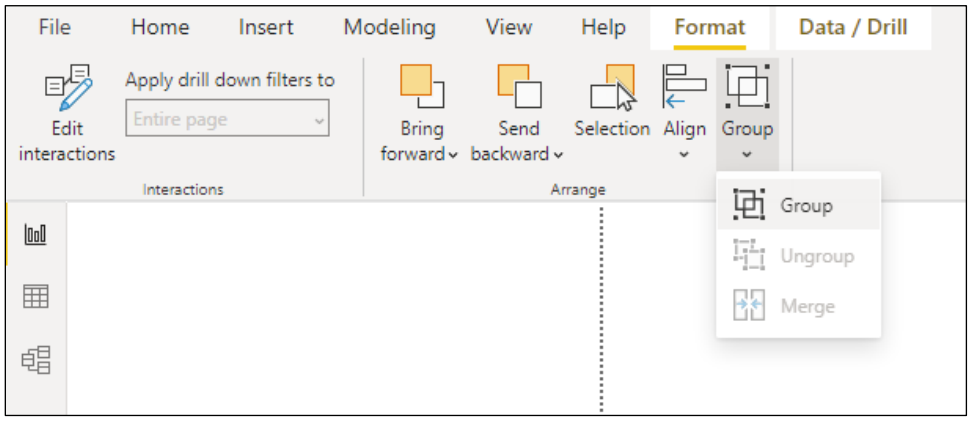
The format menu is displayed when one or more objects are selected.

When one object is selected, then the **Format, Align** button will let you align objects on the left, center, right, top, middle, or bottom or the page.

When multiple objects are selected, then the **Format, Align** button will let you align objects relative to each other.

When multiple objects are selected, the **Format, Align** button also lets you distribute the objects evenly on either the horizontal or vertical axis.

Grouping objects



You can use the **Format** menu's **Group** button to **Group** multiple objects together so they will act as one object. If you need to ungroup previously grouped objects, you can do so with **Format**, **Group**, **Ungroup**.

E. Lock Objects

Once you have placed an object right where you want it, you may want to lock it in place so it cannot be moved. This can be done with the ribbon's **View**, **Lock objects** check box. Once locked, the objects can be modified via the format pane, but they cannot be moved with the mouse.

F. Selection pane

The selection pane is a pane that displays the various objects (visuals, shapes, text boxes, etc.) that belong to a page. With the selection pane you can hide or show each object, change layer order (i.e. move one object in front of another), and change tab order.

View the selection pane

To view the selection pane, from the ribbon choose **View**, **Show pages**, **Selection**.

Hide an object

1. Select the object you wish to hide.
2. In the selection pane, click the eyeball next to the object.

Unhide an object

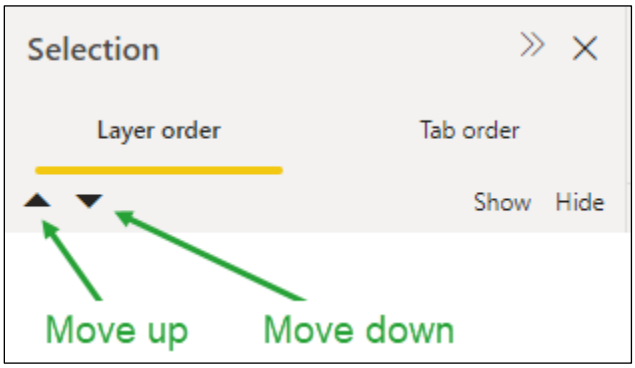
1. In the selection pane, find the object you wish to unhide.
2. In the selection pane, click the eyeball next to the object.

Change layer order

Power BI offers two methods for changing layer order.

Change layer order with the selection pane

1. Select the desired object.
2. In the selection pane, click the black up arrow to move it toward the top of the list, or click the black down arrow to move it toward the bottom of the list.



Change layer with the format menu

1. Select the desired object.

2. Select one of the following the ribbon's Format menu:

Menu option	Menu path	Result
Bring forward	Format, Bring Forward, Bring Forward	Moves the object in front of another
Bring to front	Format, Bring Forward, Bring to front	Moves the object in front of all other objects
Send backward	Format, Send backward, Send backward	Moves the object behind another
Send to back	Format, Send backward, Send to back	Moves the object behind all other objects

Change tab order

When viewing a page in the Power BI service, many viewers prefer to use the keyboard's tab key to move from one visual to another. The default tab order is defined by the order in which you placed the objects on the page. Using the selection pane, you can change the tab order.

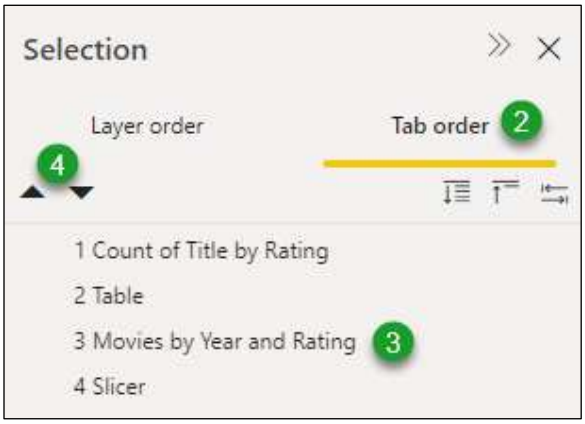
1. Display the selection pane (from the ribbon choose **View**, **Show pages**, **Selection**).

2. Click the Tab order link at the top of the selection pane.

   Notice each object is listed with a number to its left.

3. Select the desired object.

4. Click the black up or down arrow to promote or demote the object's tab order.



G. Mobile layout

You can quickly convert a desktop / browser-based Power BI report into a set of mobile-friendly visualizations using the Mobile layout view. This view allows you to drag and drop visualizations from your report page onto the image of a mobile phone. From there you can resize and reposition the visuals as desired.

1. Open your Power BI report.
2. From the ribbon select **View**, **Mobile**, **Mobile layout**.

   The screen will show you the image of a mobile phone, and a pane named Page visuals.
3. Select a visual from the pane and drag it onto the image of the mobile phone.
4. Click inside the added visual and move it to the desired location.
5. As needed, resize the visual using the size handles.
6. As needed, scroll up or down using the scroll bar on the right side of the mobile phone's image.
7. Repeat steps 3 through 6 for each visual.
8. From the ribbon select **View**, **Mobile**, **Mobile layout** to return to your regular report view.

5. Data Modeling

Complete this unit and you'll be able to:

A. Create new tables

B. Understand the star schema model

C. Split a flat file into multiple tables

D. Create and use a date table

E. Create and edit a hierarchy

A. Creating new tables

Sometimes your data model needs a new table to provide functionality and/or to improve performance. We saw an example of this when we created a Rating Sort Order table in a previous exercise.

Before creating the table, you should first do the following:

- Determine which fields you will need in your new table.
- Determine which field will be the primary key.
- Determine the data type (whole number, decimal number, Date, Time, Text, True/false, etc.) each field will need.
- Determine if you will manually enter the records or if the computer can generate the data for you.

Two methods for creating new tables are presented below: one with Excel and the other with Power BI.

Manually creating a table within Excel

To manually create a table within Excel, do the following:

A. Open a new Excel workbook.

B. Enter appropriate column headings in row 1.

C. Enter data below column headings.

D. Be sure your data is "well formed" by doing the following:

- Make sure the data is contiguous; in other words there should be no blank rows and no blank columns in your data).
- Make sure the data in each column is consistent. For example, a number column should have only numeric values, and a date column should only have date values. Furthermore, the formatting should be consistent. For example, do not have January 31, 2018, 28-Mar-2017, and 12/15/19 in the date column. Instead pick one date format and stick with it.
- Make sure the purpose of each column is consistent. For example, a phone number column should only have phone numbers and a first name column should only have first names (not first and middle names).

E. Rename the sheet to the desired table name.

F. Save the Excel file.

G. Import the Excel sheet into Power BI.

H. Relate the table to the other tables as needed.

Manually creating a table within Power BI

To manually create a table within Power BI, do the following:

A. From the ribbon, choose **Home**, **Data**, **Enter data**.

B. Double click the column heading and enter the field name.

C. Click the + to add a new column.

D. Repeat step 2 and 3 for each field.

E. Enter your data in the rows below the column headings.

F. Change the name of the table.

G. Click **Load**.

H. Switch to the data view.

I. Select each field in the new table, and on the ribbon's **Column tools** tab, verify the **Data type** and **formatting options** are correct.

J. On the ribbon's **Column tools** tab click Manage relationships and, as taught in the Power BI Level 1 course, create or edit relationships as needed. Be sure each relationship has the correct **Cardinality** and **Cross filter direction**.

B. Understanding a star schema data model

What is star schema?

Star schema is a data modeling approach that is used by many relational data warehouses. This schema / plan places a "fact" table in the center of the data model, and then has various "dimension" tables surrounding it – thus making the data model look like a star.

What is a dimension table?

Dimensions tables contain information about people, places, or things. For example, an employee table is a dimension table about people. The product table is a dimension table because it is about the things a company sells, and the order table is another dimension table that contains information about the orders of those products.

Each dimensions table contains one primary key field / column, and multiple attribute columns.

The **primary key** column is usually a number. In this dimension table, the primary key field is always unique; it is never duplicated in this table. The primary key field can also never be blank. Many databases use an auto-number field as their primary key. For example, the primary key in an employee table will be the employee number field. When a new employee is hired, they are assigned the next available employee number.

The **attribute** columns share attributes about the person, place, or thing. For example, the employee table will include attribute columns for first name, last name, department, and start date. Similarly, a product table will include attribute columns for product name, suggested retail price, product description, color, size, etc.

In Power BI, the dimension tables are usually used for grouping and filtering data.

What is a fact table?

Fact tables usually contain the transactions, events, enrollments, or sales. It is usually the table that contains the information you want to summarize with an aggregate (sum, average, maximum, minimum, etc.).

Why should I use a Star schema?

Setting up your data model with multiple tables in a Star schema will:

- Provide organization and usability:
  Having your fields in multiple categorical tables is like organizing your files with folders. In contrast, using only one large table is like putting all your files in the same folder. It becomes a big mess and makes it difficult to find things.

- Make formulas easier:
  Formulas become much more complex when all the fields are stuck in the same table. However, when the fields are organized in a logical Star schema the formulas are easier to write, read, and comprehend.

- Improve performance:
  The computer's performance in calculating formulas and apply filters is significantly improved when the data is organized into a logical Star schema.

- Faster refresh:
  If you have tens or hundreds of millions of records, you will notice a report with a logical Star schema will refresh significantly fast than a similarly sized database that has all the data in one table.

Additional resources

If you would like to learn more about the benefits of a star schema, check out these resources:

- Understand star schema and the import for Power BI – Microsoft document https://docs.microsoft.com/en-us/power-bi/guidance/star-schema
- Why Power BI loves a Star schema – Guy in a Cube YouTube video https://www.youtube.com/watch?v=vZndrBBPiQc

C. Split a flat file into multiple tables

Depending on your data source, you may need to split your tables into multiple tables before you can create a star schema data model. The following steps are needed.

Steps for splitting a flat table into multiple tables:
A. Examine your source data
B. Determine which columns are not needed
C. Determine the name of the fact table and the various dimension tables
D. Determine which fields belong in which table
E. Split the flat file's data into the fact and dimension tables
F. Add any additional tables
G. Relate the dimension tables to the fact table

In this exercise, you will create a new Power BI report for Adventure Works, which has provided you with a flat file that includes Internet Sales, Product, Promotion, Customer, Currency, Sales Territory, and Geography information all in one large spreadsheet. You will split the flat file into multiple tables. Then, in the next exercise you will create a star schema data model.

Examine the data

In this exercise you will do the first four steps of examine the data, determining which columns are not needed, picking names for your tables, and assigning the fields to the various tables. All of this will occur without using Power BI.

1. Examine your data source.

   Open the **AdventureWorks1000.xlsx** file in Excel. Here you notice the following:

   - There is data in columns A through BX (76 columns total).
   - Row 1 has column headings.
   - Rows 2 through 1001 contain data values.
   - Many of the column headings include the word "key".
   - To make this exercise easier, some columns are shaded blue, others in green, gold, etc. Also, some column headings are in red text. The purpose of these colors will be explained below.

2. Determine which columns are not needed.

   Based on the needs of the various visualizations, you would decide which columns are not needed. In this exercise, this has been done for you. The columns with a red column heading will need to be deleted. Although you could delete them here, instead you will delete them in Power BI.

3. Determine the name of the fact table and the various dimension tables, and determine which fields belong in which table.

   After examining the data, you notice the following:

   - The blue columns are attributes of a sale made over the internet.
   - The light orange columns are attributes of the products that are being sold.
   - The orange columns are attributes of various promotional discounts.
   - The light-green columns are attributes of a customer.
   - The light-purple columns are attributes of the various types of currencies used by the customers.
   - The light-yellow columns are attributes of the sales territory.
   - The aqua-colored columns are attributes of a geographical location.

   You therefore determine you will need the following tables:
   - Internet Sales – a fact table
   - Product – a dimension table
   - Promotion – a dimension table
   - Customer – a dimension table
   - Currency – a dimension table
   - Sales Territory – a dimension table
   - Geography – a dimension table

   Note: Remember, the colors in the spreadsheet were added to make the exercise go faster. Outside the classroom the columns will not be colored and therefore you will have to analyze the data to figure out the proper table groupings.

Split the flat file's data

1. Start a new Power BI report.

2. From the ribbon choose **Data**, **Excel workbook**, and then select the **AdventureWorks1000.xlsx** file.

3. Select the check box for **Internet Sales**, and click **Transform Data**.

   The Power BI Query Editor will open with your one table.

4. Rename the **Internet Sales** query to **Original Data**.

Remove unwanted columns

5. From the ribbon choose **Home**, **Manage Columns**, **Choose Columns**, **Choose Columns**, then uncheck the following columns, and click **OK**.

   - RevisionNumber
   - CarrierTrackingNumber
   - CustomerPONumber
   - SpanishProductName
   - SpanishPromotionType
   - SpanishPromotionCategory
   - SpanishEducation
   - SpanishOccupation
   - DateFirstPurchase
   - StateProvinceCode
   - CountryRegionCode
   - SpanishCountryRegionName

Create a new Internet Sales table

6. Duplicate the Original Data query and rename the copy as **Internet Sales**.

7. Select all Internet Sales columns, which are the columns from **Product Key** through **Ship Date**, then from the ribbon choose **Home**, **Manage Columns**, **Remove Columns**, **Remove Other Columns.**

Create the other tables
If time is short skip steps 8 through 12.

8. Do the following steps for each query as shown in the list below:

Query Name	First column	Last column	Rows
Product	ProductKey_1	EnglishDescription	25
Promotion	PromotionKey_2	MaxQty	1
Customer	CustomerKey_3	Phone	1000
Currency	CurrencyKey_4	CurrencyName	6
Sales Territory	SalesTerritoryKey_5	SalesTerritoryGroup	7
Geography	GeographyKey_6	PostalCode	245

A. **Duplicate** the **Original Data** query.

B. Rename it to the query name shown above.

C. Select the first column for the target query by selecting from the ribbon **Home**, **Manage Columns**, **Choose Columns**, **Go to Column**, and then picking the desired column name and clicking **OK**.

D. Select from the first to the last column by pressing **shift** and the **right arrow** on the keyboard until you are on the last column.

E. From the ribbon choose **Home**, **Manage Columns**, **Remove Columns**, **Remove Other Columns**.

F. Select the first cell, then press Ctrl A to select all columns.

G. Remove duplicate rows by select from the ribbon **Home**, **Reduce Rows**, **Remove Rows**, **Remove Duplicates**.

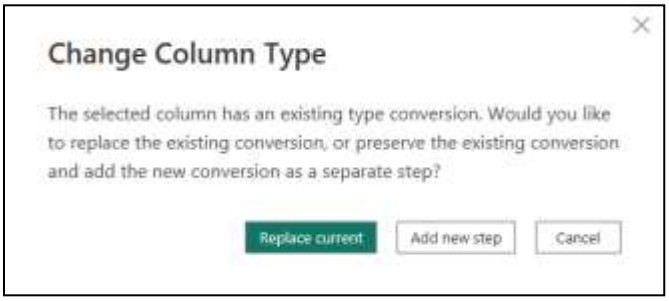
H. Compare the number of rows in the query with the **Rows** column of the table above.

Fix data types

9. Per the following list, change the data type for the listed field:

Query	Fields	Data Type
Internet Sales	• UnitPrice • ExtendedAmount • TaxAmt • Freight	Fixed Decimal Number
Product	• ProductKey	Whole Number
	• StandardCost • ListPrice	Fixed Decimal Number
Promotion	• DiscountPct	Percentage
	• StartDate • EndDate	Date
Customer	• YearlyIncome	Fixed Decimal Number
Geography	• PostalCode	Text

If the Change Column Type dialog box appears, choose **Replace current**.



Remove the original query

Now that the data has been split, you should remove the Original Data query.

10. **Right click** on the **Original Data** query and choose **Delete**.

Close, Apply and Save your report

11. From the Query Editor's ribbon choose **Home**, **Close**, **Close and Apply**.

12. Save your report as **AdventureWorks1000.pbix**.

D. Create a star schema data model

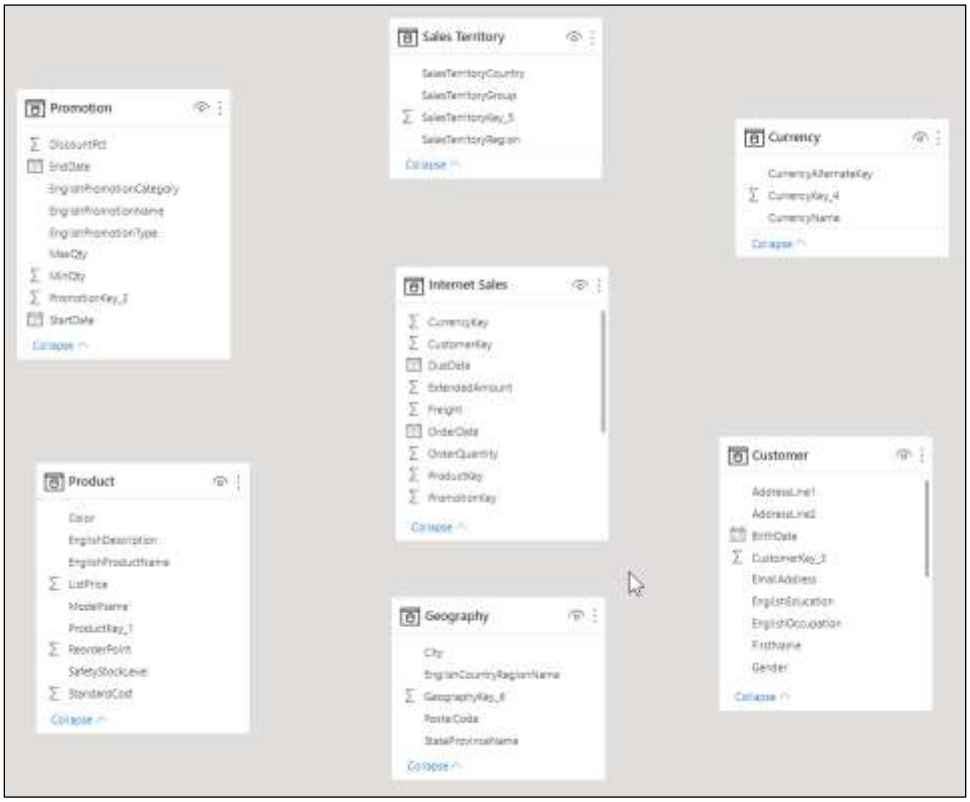
You have successfully split the flat file into multiple tables, and you have removed the original flat file table. The next step is to establish the relationships in a star schema.

If you skipped steps 8 through 12 in the previous exercise just open the **AdventureWorks1000 - Split and Trimmed.pbix** file and then select **File**, **Save As**, and enter the name **AdventureWorks1000.pbix**

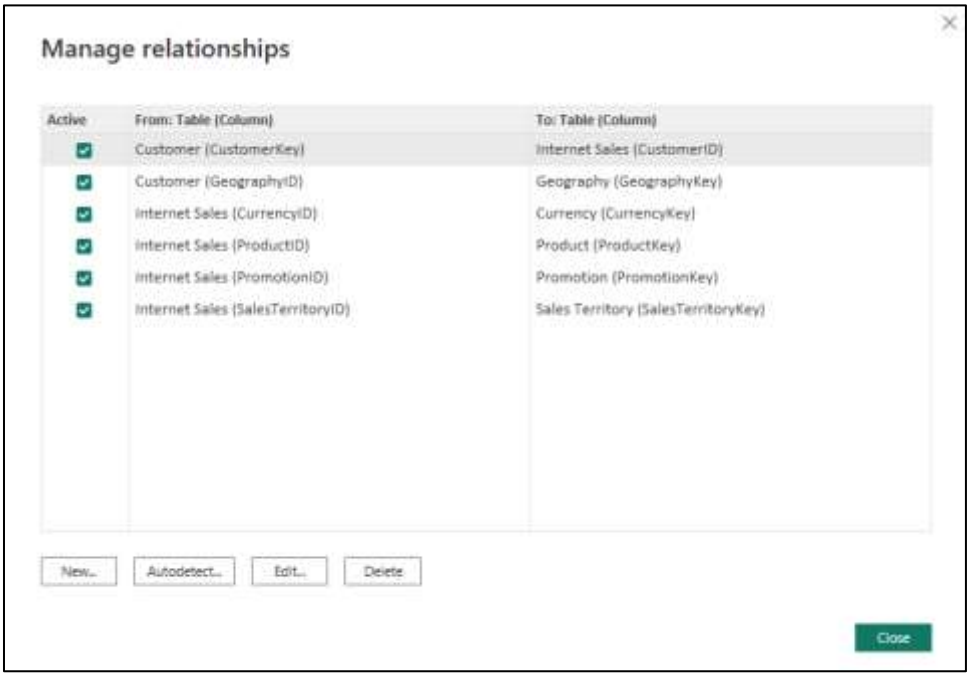
1. Switch to the **model** view.

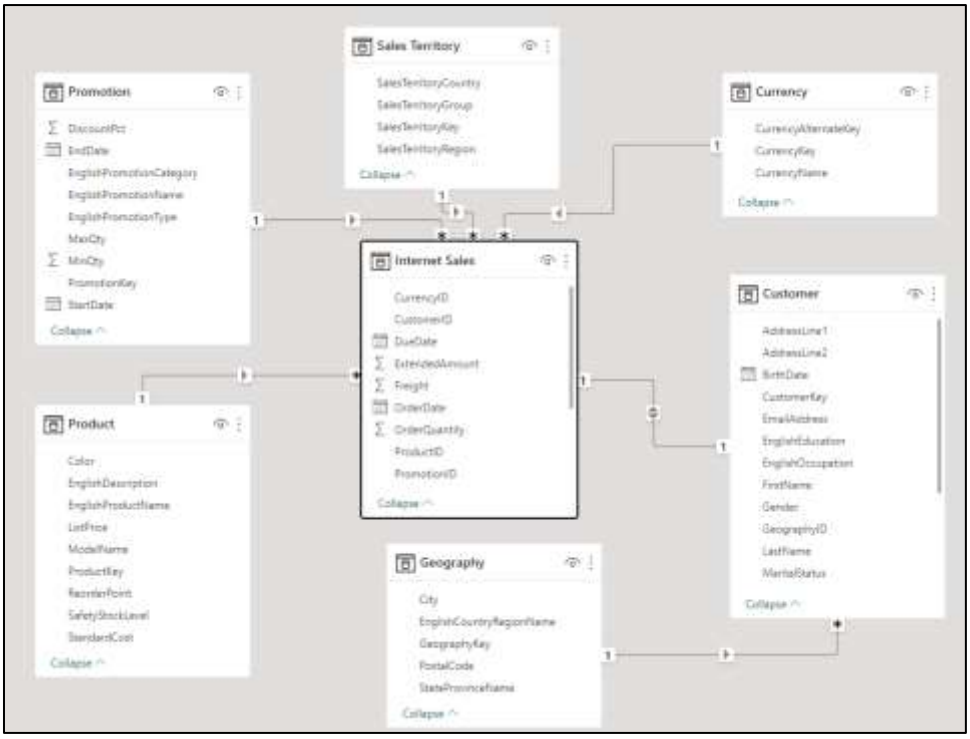
2. Zoom out and see if all the tables are in the design window. If any are missing drag them into the design window.

3. Position the dimension tables around the **Internet Sales** fact table as shown below. The exact location of each table does not matter, but the Internet Sales table should be in the middle.



4. Establish the following relationships by either dragging and dropping a key field in one table to the corresponding key in the other table, or by using the Mange Relationships dialog box (from the ribbon select **Home**, **Relationships**, **Manage Relationships**).





5. Save the **AdventureWorks1000.pbix** report.

E. Date tables

What is a date table?

A date table is a table that contains only dates and their related values.

The date table should follow these rules:

- The table must have a date field.
- The date of the first record in the date table must be on or before the first date of all date fields in all the other tables in your data model.
- The date of the last record in the date table must be on or after the last date of all date fields in all the other tables in your data model.
- The date table must have a record for every calendar date that falls between the first and last date. No missing dates are allowed.
- The date table may have other fields that are related to the date field.

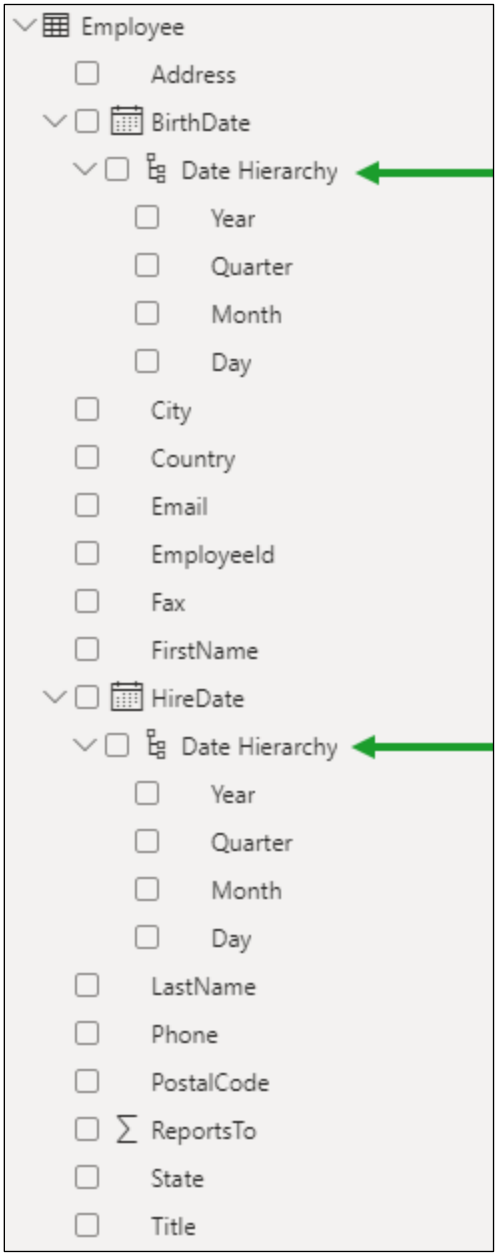
  For example, if your fiscal year begins in September, you might have a date table with these fields and values.

Field Name	Description	Sample Value
Date	The complete date	February 1, 2023
YMD	A text value showing the year month and day separated by spaces	2023 02 01
Year	The number of the year	2023
Qtr Num CY	The number of the date's quarter, per the calendar year.	1
Qtr Num FY	The number of the date's quarter, per the fiscal year.	2
Month Num CY	The number of the date's month, per the calendar year.	2
Month Num FY	The number of the date's month, per the fiscal year.	6
Month Name	The name of the month.	February
Month Name Short	The three-character abbreviation for the month.	Feb
Month Year	A text value showing the three-character abbreviation for the month and the four-digit year.	Feb 2023
Day Num	The number of the day of the month.	1
Day Name	The name of the day of the week.	Wednesday
Day Name Short	The three-character abbreviation for the day of the week.	Wed
Week Day Num	The number for the day of the week (1 for Sunday, 2 for Monday, etc.)	4
Week Num	The number of the date's week within the calendar year.	5

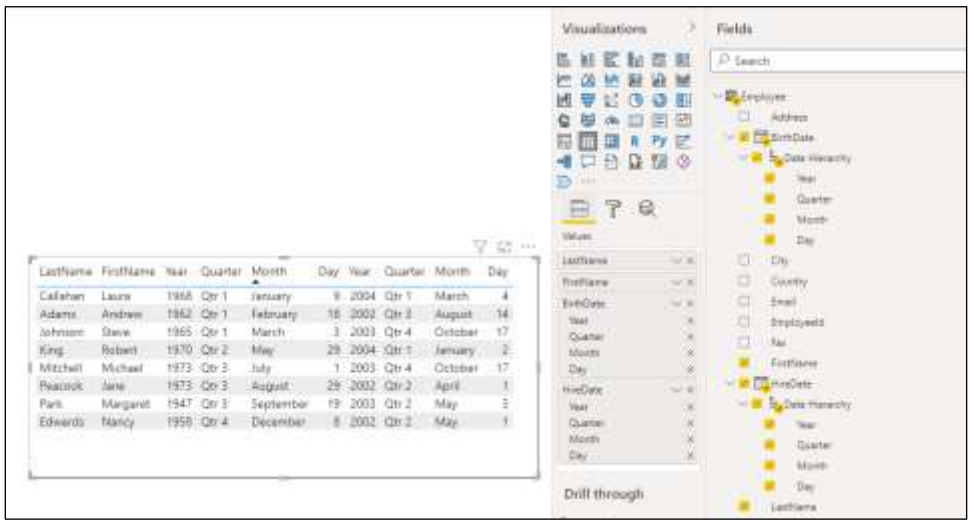
Why do I need a date table?

For every date field in your model, Power BI creates a date table, in the background, to support date hierarchies. So, if you have two date fields in your model, Power BI creates two background date tables, and if you have twenty date fields, Power BI creates twenty background date fields.

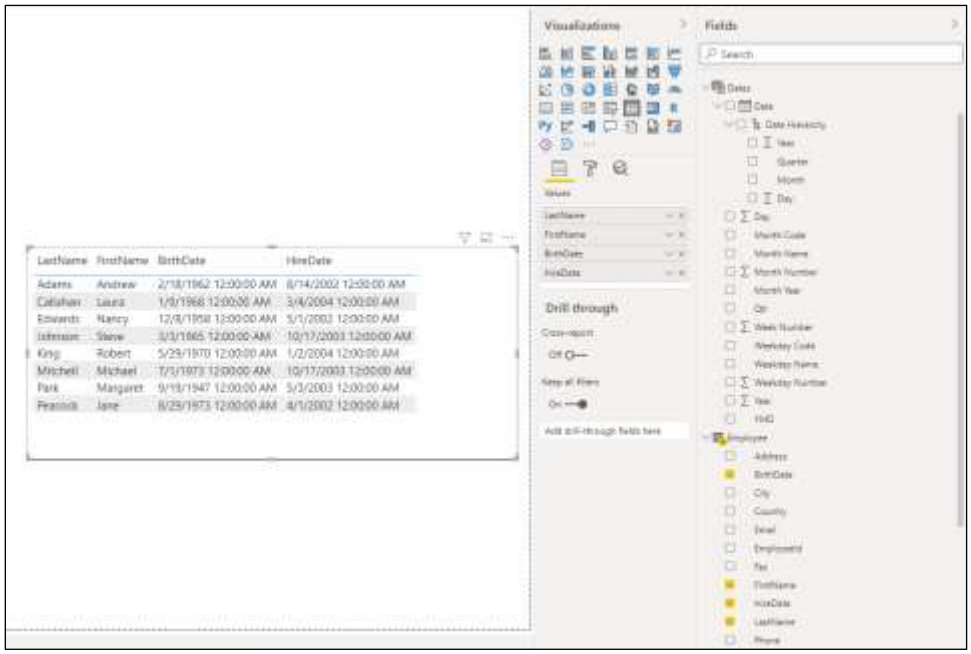
You can see the background date table in the field pane when you click the expand arrow next to a date. For example, in the screen shot below notice both the Employee BirthDate and the HireDate each have Date Hierarchy fields.



You can see the effect of this background date table when you add a date field to a visualization. For example, in the image below, notice that when the user added the BirthDate and HireDate fields to the table, the system automatically added the whole date hierarchy (Year, Quarter, Month and Day).



But, if you create a date table and link it to every date field in your model, then Power BI does not create the hidden date tables, as shown below, thus saving your file from a lot of date bloat.



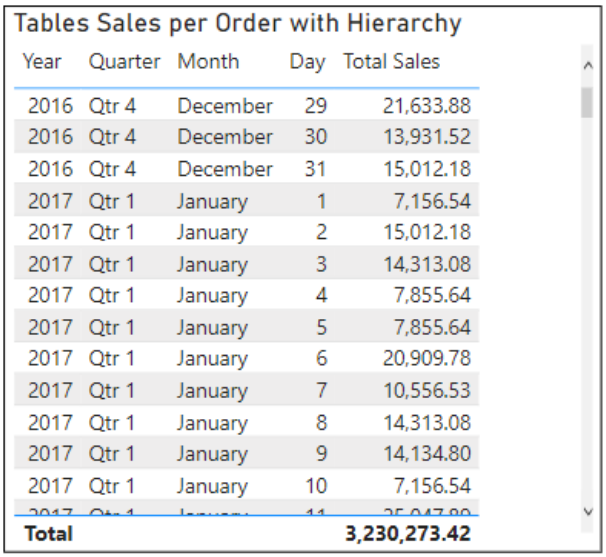
What about Fiscal Years?

Another reason for creating a date table is to handle situations where the fiscal year does not begin on January 1st. Such a table will allow you to easily calculate when the fiscal year begins and ends, as well as which months / quarters are first, second, third, etc. relative to the fiscal year.

Exercise: Create a Hierarchy-based Table visualization.

In the following exercises you will create multiple date-based visuals using the Internet Sales table in the AdventureWorks1000 report. You will then create a date table and see its effect on the report.

1. If necessary, open the **AdventureWorks1000.pbix** file.
2. Switch to the **Report** view.
3. Add a **table** visualization to the page.
4. Add the **'Internet Sales' [OrderDate]** and **'Internet Sales' [Extended Amount]** to the Columns well.
5. For this visual, rename **Sum of Extended Amount** to **Total Sales**.
6. Add a **Visual Border** to this visualization.
7. Turn on and enter the following Title: **Tables Sales per Order with Hierarchy**.



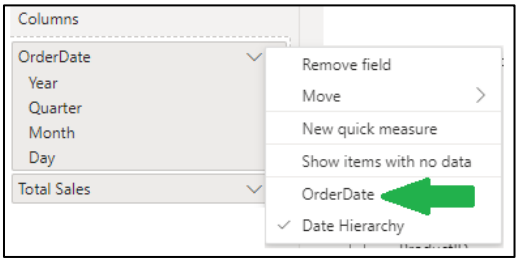
Tables Sales per Order with Hierarchy

Year	Quarter	Month	Day	Total Sales
2016	Qtr 4	December	29	21,633.88
2016	Qtr 4	December	30	13,931.52
2016	Qtr 4	December	31	15,012.18
2017	Qtr 1	January	1	7,156.54
2017	Qtr 1	January	2	15,012.18
2017	Qtr 1	January	3	14,313.08
2017	Qtr 1	January	4	7,855.64
2017	Qtr 1	January	5	7,855.64
2017	Qtr 1	January	6	20,909.78
2017	Qtr 1	January	7	10,556.53
2017	Qtr 1	January	8	14,313.08
2017	Qtr 1	January	9	14,134.80
2017	Qtr 1	January	10	7,156.54
Total				3,230,273.42

Exercise: Create a non-Hierarchy-based Table visualization.

1. Duplicate the visual and move the new visual underneath the previous one.

2. In the columns well, click the **OrderDate** drop-down and choose **OrderDate**.



3. In the **fields pane**, select the **OrderDate** field, and then on the ribbon's **Column tools** tab, change the format to **mm/dd/yyyy**.

4. Change the title to **Total Sales per Order Date No Hierarchy**.

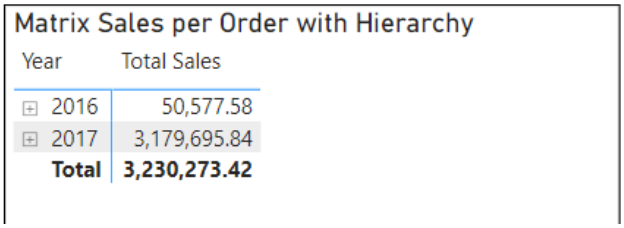
5. Notice the difference between the visual that uses the built-in hierarchy with the visual that just displays the OrderDate.

Exercise: Create a Hierarchy-based Matrix visualization

1. Again, duplicate the first visual, the one with the hierarchy, and place the copy underneath the previous two visuals.

2. Change the third visual into a matrix.

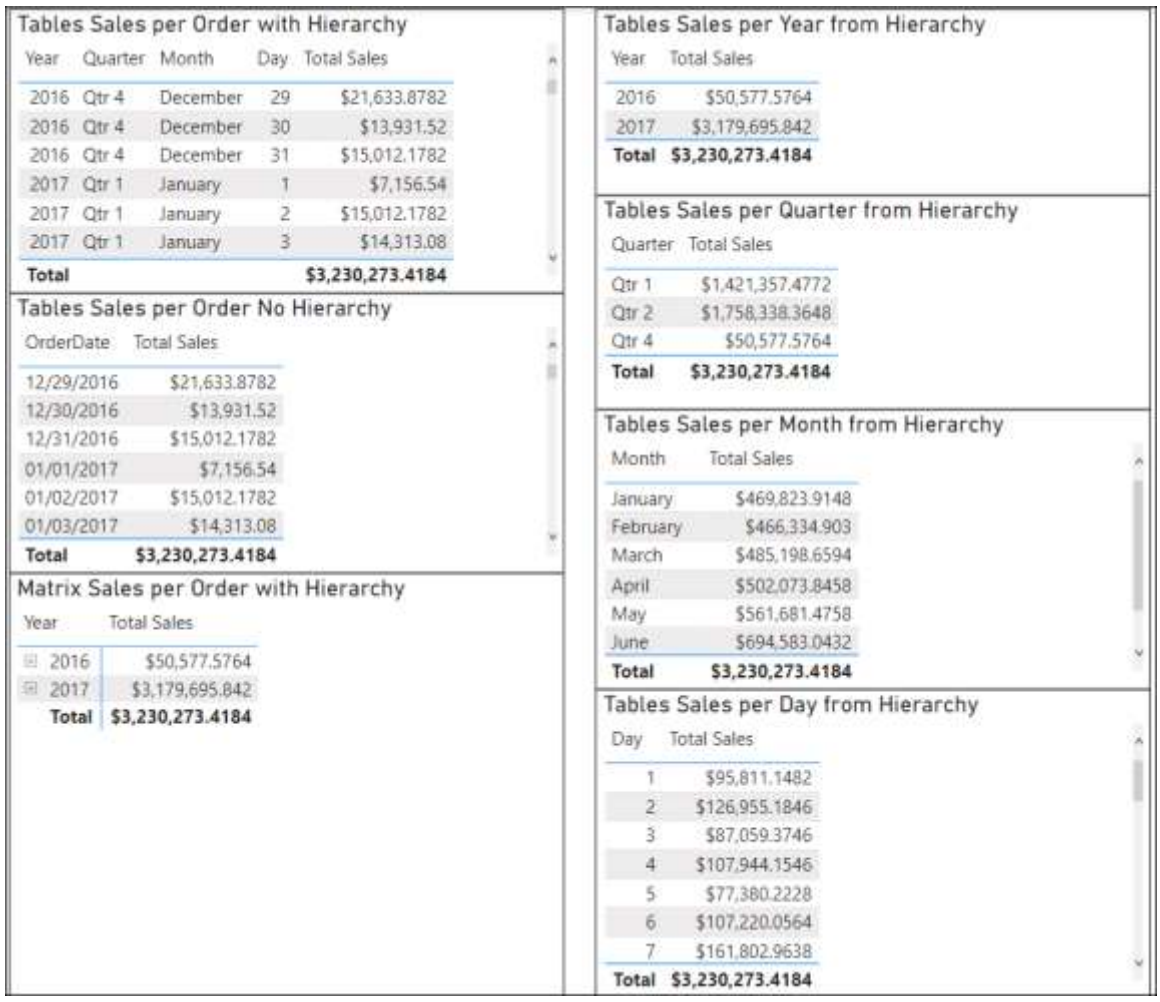
3. Change the title to **Matrix Sales per Order with Hierarchy**.



4. Notice the matrix gives you the option to drill down through the years, quarters, months, and dates.

Exercise: Create more Hierarchy-based visualizations

1. Duplicate the first visual and place the copy to the right of the others.
2. Delete the OrderDate from the columns well.
3. In the fields pane, expand the **OrderDate**, and then expand the **Date Hierarchy**.
4. Drag the **Year** field to the top of the Columns well.
5. Change the Title to **Tables Sales per Year from Hierarchy**.
6. Repeat steps 1 through 5 for the **Quarter**, **Month** and then **Day**.

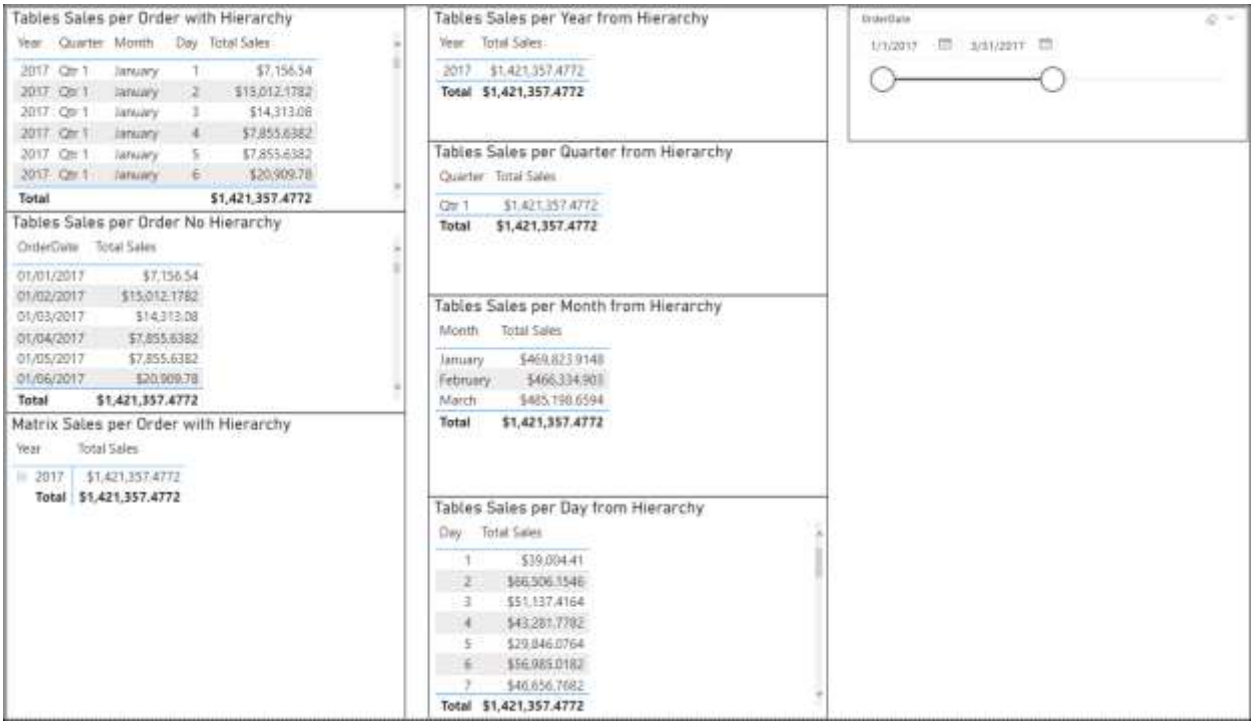


Exercise: Add a slicer for the first quarter of 2017

1. Add a slicer for the OrderDate to the page.

2. Set the slicer's start date to 1/1/2017 and the end date to and 3/31/2017.

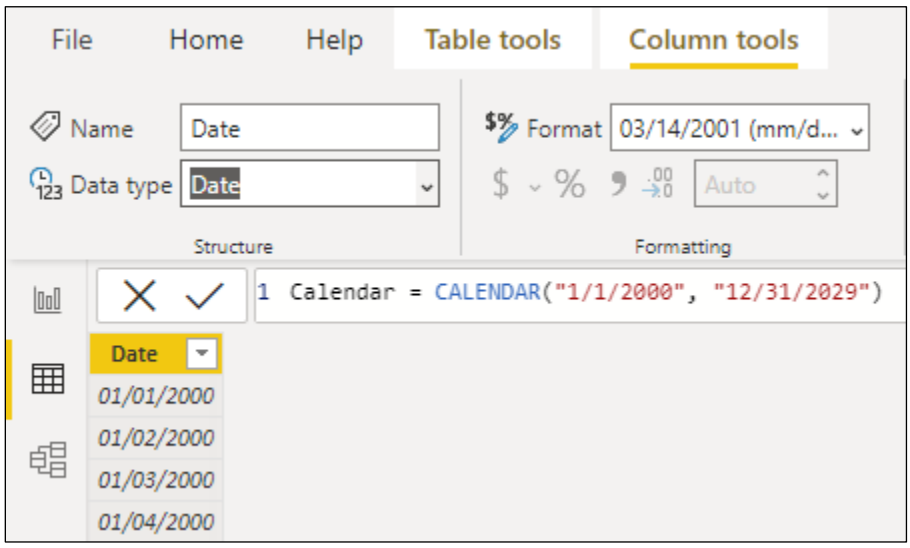
3. Format the slicer as desired.



Multiple ways to create a date table

You can create a data table in multiple ways. In the following exercises you will create three date tables, compare the results, and then finally choose one to keep and delete the others.

Exercise: Create a date table with the Calendar() function



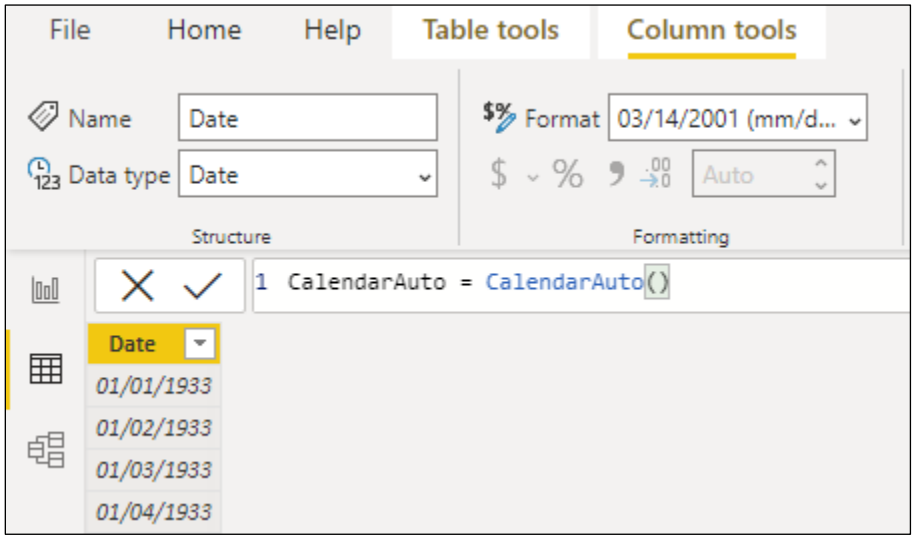
1. If necessary, open the **AdventureWorks1000.pbix** report.
2. Switch to the **data** view.
3. From the ribbon select **Home**, **Calculations**, **New table**.
4. Enter the following formula:

   Calendar = CALENDAR("1/1/2000", "12/31/2029")

   The CALENDAR() function creates a date table with one date field that starts with the first entered date and ends with the last entered date.
5. In the fields pane, **expand** the **Calendar table** and select the **Date** field.
6. From the ribbon select **Column** tools, **Structure**, **Data type** and choose **Date**.
7. From the ribbon select **Column** tools, **Formatting**, **Format** and choose the **mm/dd/yyyy** format.

Exercise: Create a date table with the CalendarAuto() function

The CALENDARAUTO() function creates a calendar, but instead of asking you for the start and end date, it examines the dates in your data model and selects the first date found and ends with the last date found.



1. If necessary, switch to the **data** view.

2. From the ribbon select **Home**, **Calculations**, **New table**.

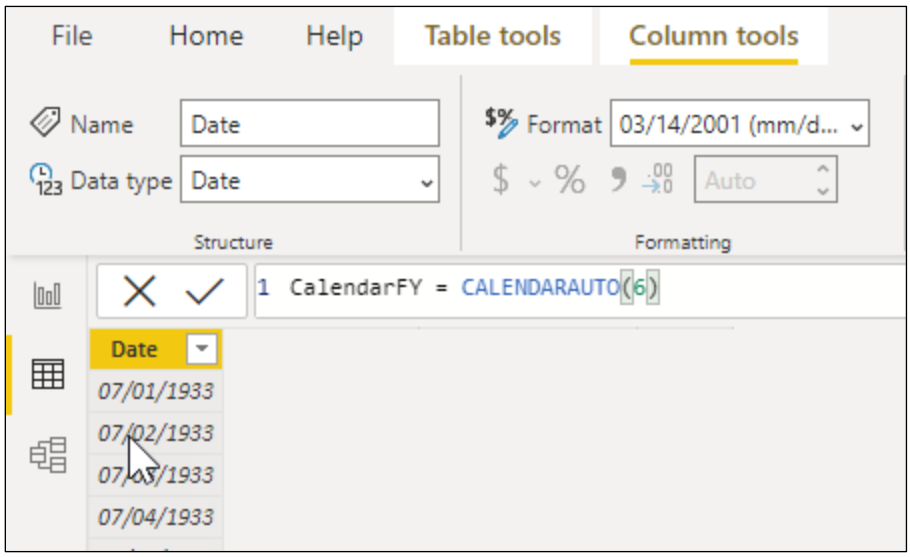
3. Enter the following formula:

   CalendarAuto = CalendarAuto()

4. As we did in the previous exercise, expand the **CalendarAuto** table, select the **Date** field, and change the **data type** to **Date** and the format to **mm/dd/yyyy**.

Exercise: Create a fiscal year date table

The CalendarAuto() function has an optional parameter that allows you to enter the end month of a fiscal year. When used, the function starts the calendar on the first date of the fiscal year based on the first date found in your model. It also ends with the end date of the fiscal year of the last date found in your model.



1. Switch to the data view.

2. From the ribbon select **Home**, **Calculations**, **New table**.

3. Enter the following formula:

   CalendarFY = CalendarAuto(6)

4. Change the data type to **Date** and the format to **mm/dd/yyyy** as we did in the previous exercises.

Mark the date table

After creating your table, you need to mark it as the "date table" for this data model. In this next exercise you will mark the **CalendarFY** as your date table and then delete the other two calendar tables.

Exercise: Mark the date table

1. **Right click** on the **CalendarFY** table and choose **Mark as date table**, **Mark as date table**.

2. In the Mark as date table dialog box, click the **Date Column** drop down and choose the **Date** field.

3. Click **OK**.

4. Right click on the **Calendar** table and choose **Delete from model**, and then click **OK**.

5. Repeat the process to delete the **CalendarAuto** table.

6. Return to the **Report** view and notice the visualizations have not changed.

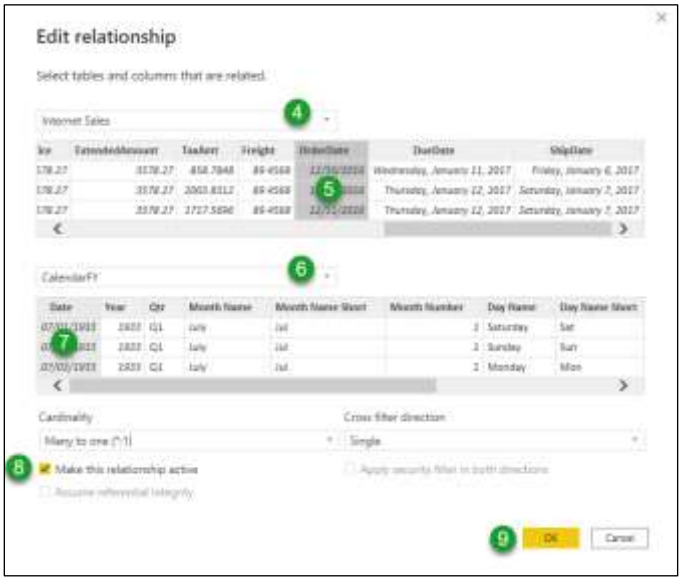
7. In the fields pane, expand the **Internet Sales** and its **OrderDate** field and notice they have not changed either.

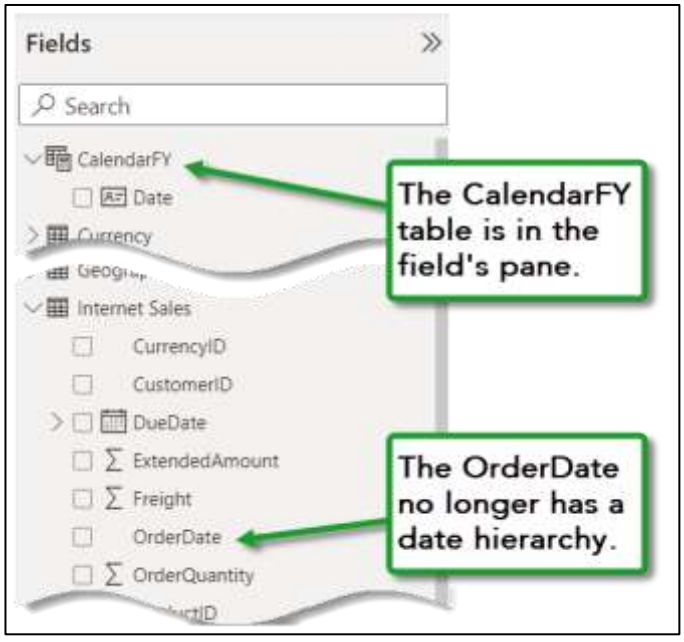
Relating the date table

Now that you have created your date table, marked it as a date table, you can begin creating relationships between the new date table and the fact and dimension tables in your star schema. You will start with the **'Internet Sales' OrderDate** field.

Exercise: Relate the date table to the 'Internet Sales' [Order Date] field.

1. If necessary, switch to the **Report** view.
2. From the ribbon, select **Modeling**, **Relationships**, **Manage Relationships**.
3. Click the **New** button.
4. For the first drop down choose **Internet Sales**.
5. Scroll to the right and select the **OrderDate** field.
6. For the second drop down choose **CalendarFY**.
7. Click in the **Date** field.
8. Verify the **Make this relationship active** is checked.
9. Click **OK** and then **Close**.
10. Notice the visuals have changed, and that the 'Internet Sales' [Order Date] field no longer has a date icon, and its expand button is gone because it no longer has a built in hierarchy.
11. Notice the **CalendarFY** table now appears in the fields pane, and it does have an expand icon. However, it does not have a date hierarchy.





Exercise: Add new date-oriented columns

Your date table should have additional date-oriented columns that you might use in your visualizations. In this exercise you will add many date-oriented columns to the date table.

1. Switch to the **data view**, select the **CalendarFY** table and then, for each calculated listed below, click **Home**, **Calculations**, **New Column** and enter the calculation.

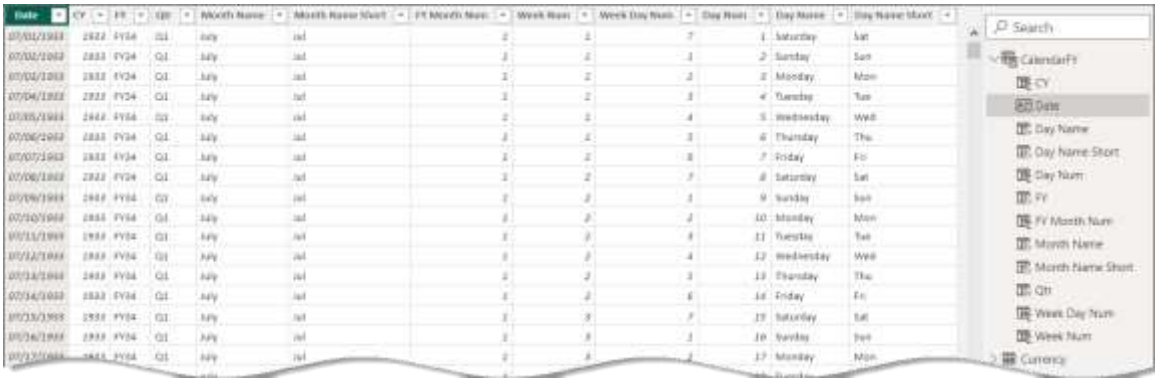
Column = Calculation	Results
CY = `Year([Date])` This formula returns the calendar year of the selected date.	1933
`FY = "FY" & Right(If( Month([Date])<7, Year([DATE]), Year([Date])+1 ),2)` Tip: Use **SHIFT ENTER** to insert a line break, and the **TAB** key to indent text. This formula returns "FY" followed by a two-digit year. To calculate the year number this function uses the Year, Month, and Right functions. The **Year()** function returns the four-digit calendar year of the selected date. The **Month()** function returns the month number of the selected date. The **If()** function returns one value if a test returns TRUE and a different value if the test returns FALSE. In this formula the test determines if the month of the selected date is less than 7. If TRUE, the current calendar year is returned. If the month is 7 or later, the next calendar year is returned. The **Right()** function returns a specified number of characters from the right side of a value. In this formula the last 2 digits of the calculated fiscal year are returned.	FY33

Column = Calculation	Results
`Qtr = "Q" & Format(EDate([Date], -6), "Q")` This formula returns a "Q" followed by the quarter number of the selected date, relative to the fiscal year. This formula uses the Format() and EDate(), which are explained below. The **Format()** function returns a value in a specified format. Here the "Q" represents the format for quarter number. The **EDate()** function returns the date that is the indicated number of months before or after the selected date. Here we used a negative 6 so it calculates the date that is 6 months before the date field. Putting it all together this formula displays a "Q" and then calculates the date 6 months prior to the [Date] column, and then formats that date as a quarter number.	Q1
`Month Name = Format([Date],"mmmm")` This formula uses the Format() function to return the full name of the month.	July
`Month Name Short = Format([Date],"mmm")` This formula uses the Format() function to return a three-character abbreviation for the name of the month. For example, for September it will return Sep.	Jul

Column = Calculation	Results
FY Month Num = Month(EDate([Date],-6)) This formula returns the month number of the selected date, relative to the fiscal year. Normally July 1st would be in the 7th month. But since fiscal year starts in July, July is the first month. So, to calculate a 1 we take the date, subtract six months, and then find the calendar month number of that date. This formula uses the EDate() and Month() functions, which are explained below. The **EDate()** function returns the date that is the indicated number of months before or after the selected date. Here we used a negative 6 so it calculated the date that is 6 months before the date field. The **Month()** function returns the month number of the calculated date. In our case it returns the month number of the date that is 6 months before the date field.	1
Week Num = **WEEKNUM(EDate([Date],-6))** This formula returns the week number relative to the start of the fiscal year.	1
Week Day Num = **WEEKDAY([Date])** This formula returns the number of the day of the week. For example, Sunday = 1, Monday = 2, etc.	1

Column = Calculation	Results
Day Num = Day([Date]) This formula returns the day of the month	1
Day Name = Format([Date],"dddd") This formula uses the Format() function to return the full name of the day of the week.	Saturday
Day Name Short= Format([Date],"ddd") This formula uses the Format() function to return a three-character abbreviation for the name of the day of the week.	Sat

2. Compare your screen with the screen shot below.



F. Create and edit a Hierarchy

What is a hierarchy?

A hierarchy is an organization construct that uses a top-down style. For example, in a government you would have the Country at the top level, the State or Province at level 2, the County at level 3, the City or Town at level 4, and Postal Code at level 5. In a date hierarchy you could have Year at the top level, Quarter at level 2, Month at level 3, and Day at level 4.

As you will see in the next couple of exercises, to create a hierarchy, you should do the following:

A. Determine which table will have the hierarchy.

B. Determine which fields will be in the hierarchy, and their order.

C. In the **fields pane**, **expand** the table's **list of fields**.

D. **Right click** on the **field** that will be **at the top level** of the hierarchy and choose **Create hierarchy**.

E. **Rename** the newly created hierarchy.

F. **Right click** on the **next field** that will be in the hierarchy, and choose **Add to hierarchy**, and then choose the desired hierarchy.

G. Repeat step 6 for the other hierarchy fields.

Exercise: Create a hierarchy for the date table

Now that you have created your date table, you will want to establish the following date hierarchy: Fiscal Year, Quarter, Month, and Date.

1. If necessary, switch to the **Data** view.

2. Expand the **CalendarFY** table.

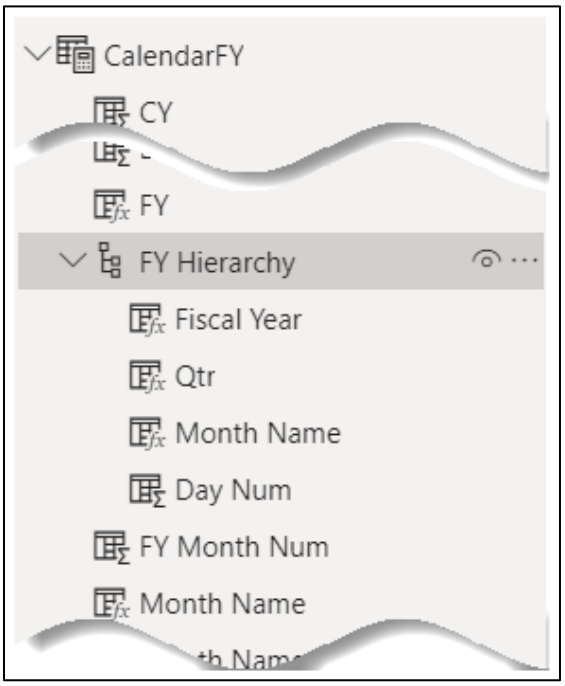
3. Right click on the **FY** field and choose **Create hierarchy**.

   Notice a new **FY Hierarchy** field appears under the Date field.

4. Expand the **FY Hierarchy**. Notice the FY field is in the hierarchy.

5. **Right click** on the **FY** field, choose **Rename,** and enter **Fiscal Year** as the new name.

6. For the **Qtr**, **Month Name** and **Day Name** fields, **right click** on the field, select **Add to hierarchy**, and choose **FY Hierarchy**.



Exercise: Updating the Visuals

1. Switch to the **Report** view.

2. Select the **first table visual** and **remove** the **OrderDate** field from the Columns well.

3. Add the **'CalendarFY' [FY Hierarchy]** field to the top of the Columns well.

4. Notice the Fiscal Year, Qty, Month Name, and Day Num columns are added to the visualization.

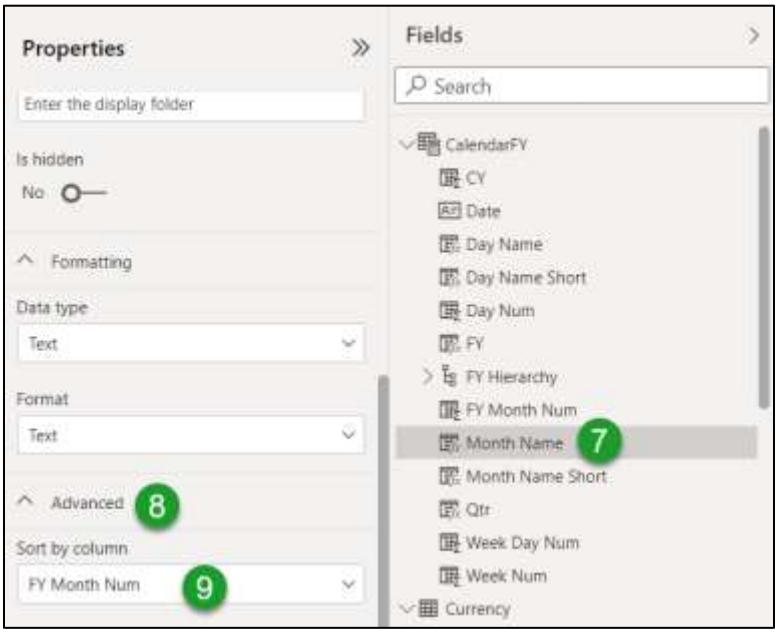
5. Scroll through the table's records and notice the Month Names are in alphabetical order (February, January, March).

6. Switch to the **Model** view.

7. In the Fields pane select the **'FY Calendar' [Month Name]** field.

8. Expand the **Properties** pane, then expand the **Advanced** section.

9. Change the **Sort by column** property to **FY Month Num**.



10. Return to the **Review** view.

11. Notice the **Month Names** are now sorted as January, February, March.

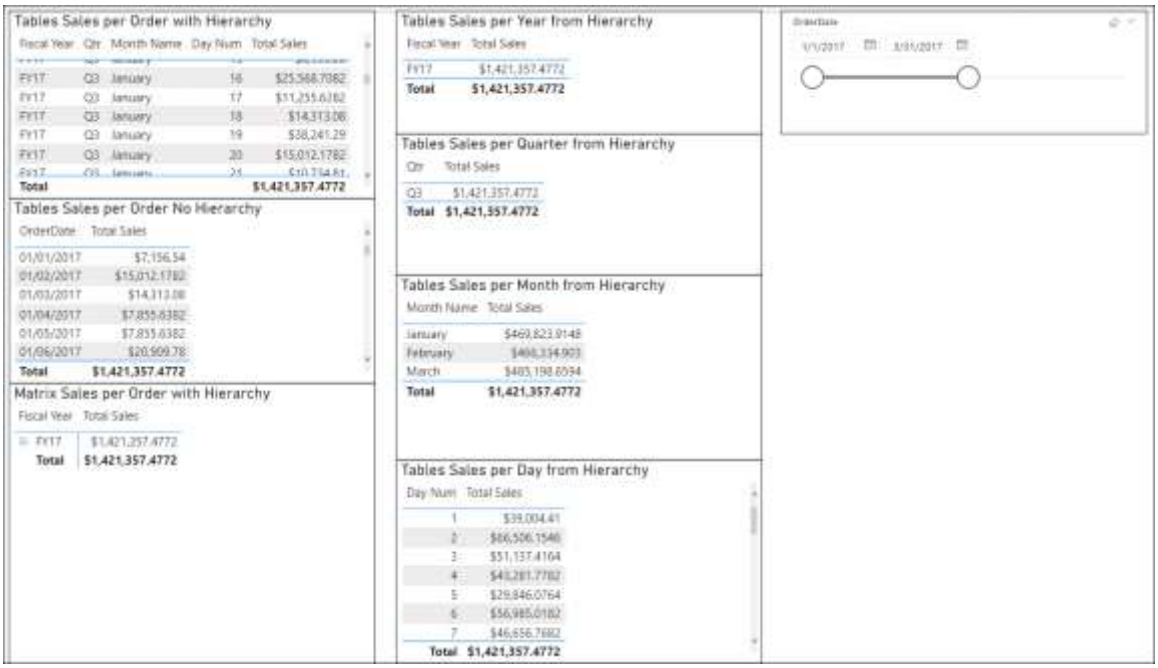
12. For the **Matrix Sales per Order with Hierarchy** visualization, remove the **OrderDate** from the **Rows** well and insert the **FY Hierarchy** instead.

13. For the visualizations listed below, in the **Columns** well, remove the **OrderDate** and instead insert the specified field, and remove its parent fields.

Visualization	Field to insert	Parents to remove
Table Sales per Year from Hierarchy	Fiscal Year	*None*
Table Sales per Quarter from Hierarchy	Qtr	Fiscal Year
Table Sales per Month from Hierarchy	Month Name	Fiscal Year, Qtr
Table Sales per Day from Hierarchy	Day Num	Fiscal Year, Qtr, Month Name

14. Save your report.

15. Compare your screen with the screen shot below:



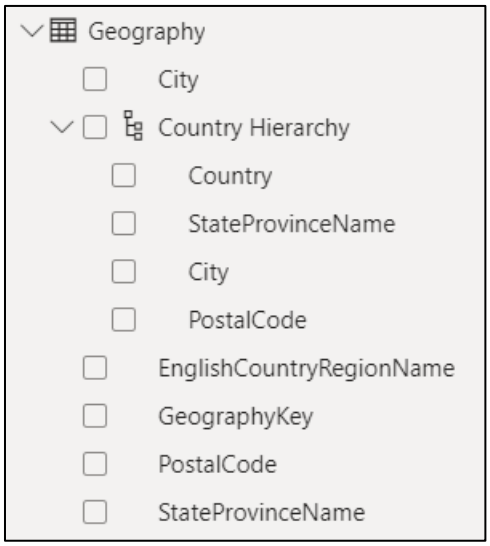
You have seen that creating a date table with a date hierarchy and relating the date table to another table's date field is an effective way to handle fiscal years.

You have also seen that creating a date table, reduces the overhead associated with each table having its own hidden date table.

Exercise: Create other hierarchies

In this exercise you will create a geographical hierarchy for County, State/Province, City and finally Postal code.

1. In the field list, expand the **Geography** table.
2. **Right click** on the **EnglishCountryRegionName** field and choose **Create hierarchy**.
3. **Right click** on the new hierarchy and rename it **Country Hierarchy**.
4. Expand the Hierarchy.
5. Rename the hierarchy's **EnglishCountryRegionName** field as **Country**.
6. For each of the following fields, **right click** on the field, select **Add to hierarchy**, and choose **Country Hierarchy**.
   - StateProvinceName
   - City
   - PostalCode



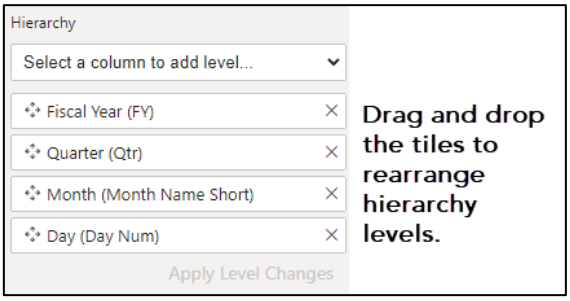
Edit a Hierarchy

After a hierarchy has been created you can modify it. In this exercise you will fine tune the Fiscal Year Hierarchy.

1. Go to **Model** view.
2. In the fields pane, expand the **CalendarFY** table's list of fields.
3. Expand the **FY Hierarchy**.
4. **Right click** on the **Month Name** field, choose **Rename**, then enter the **Month**.
5. Repeat the process and rename **Qtr** to **Quarter** and **Day Num** to **Day**.
6. If necessary, **expand** the **properties pane**, and then click on the **FY Hierarchy**.

7. Notice the following options:

   - You can enter a **description** for the hierarchy.
   - You can add more levels using the **Select a column to add level…** drop down.
   - You can hide a hierarchy.
   - You can **rearrange** the hierarchy levels by dragging and dropping the levels as desired. When finished click **Apply Level Changes.**
   - Click the x next to a level to remove it from the hierarchy.



8. Click **Apply Level Changes**.

6. DAX Calculations and Measures

Complete this unit and you'll be able to:

A. Define DAX

B. Create calculations

C. Create measures

A. What is DAX?

DAX is an acronym for Data Analysis Expressions.

DAX is a formula language

DAX is a formula language composed of a library of functions and operators that can be used to build formulas. DAX is used in multiple Microsoft Products including Power BI, Analysis Services and Power Pivot.[2]

DAX is not a programming language

DAX is not a programming language.[3] To understand the difference between a formula language and a programming language, consider the difference between Excel macros and Excel formulas and functions. Excel's VBA macro language is an object-oriented programming language that can sequentially execute commands that will manipulate your spreadsheet. In contrast, Excel's formulas and functions perform calculations that affect the cells or group of cells to which they are applied.

What can I do with DAX?

DAX allows you to add three types of calculations to your data model:

- Calculated tables
- Calculated columns
- Measures

DAX Calculations

Whether it is a calculated table, column, or measure the calculation has three parts: the name of the calculation, an equal sign, and the formula.

```
Calculation Name = Dax formula
```

The DAX formula can include the following:

- DAX functions
- Operators
- References to model objects
- Variables
- Constants
- White space

[2] See https://docs.microsoft.com/en-us/dax/
[3] See https://en.wikipedia.org/wiki/Data_Analysis_Expressions

Where can I learn more about DAX?

You can learn more about DAX from multiple resources including:

- Microsoft's Data Analysis Expressions (DAX) Reference found at https://docs.microsoft.com/en-us/dax/.
- Microsoft's DAX function Reference gives detailed information about over 250 DAX functions. For each function it shares its syntax, parameters, return values, and examples. It can be viewed at https://docs.microsoft.com/en-us/dax/dax-function-reference.
- The DAX Guide is a project of SQLBI which includes a reference to DAX functions, operators, statements, data types. It is found at https://dax.guide/.
- Use DAX in Power BI Desktop is a 2-hour 27-minute, seven-module learning path provided by Microsoft. It can be found at https://docs.microsoft.com/en-us/learn/paths/dax-power-bi/.
- Introducing DAX Video Course is a free 150 minute "introductory video course about the DAX language" provided by SQLBI. You can learn more at https://www.sqlbi.com/p/introducing-dax-video-course/.

B. DAX Functions

Like functions in many other programs, each DAX function is a word followed by parenthesis. Most functions have arguments, but some do not. Even when there are no arguments, the parentheses are required. Some arguments are required, and others are optional. Either way, the arguments are always listed inside the parenthesis, and are separated by commas.

```
FunctionName(Argument1, Argument2, …)
```

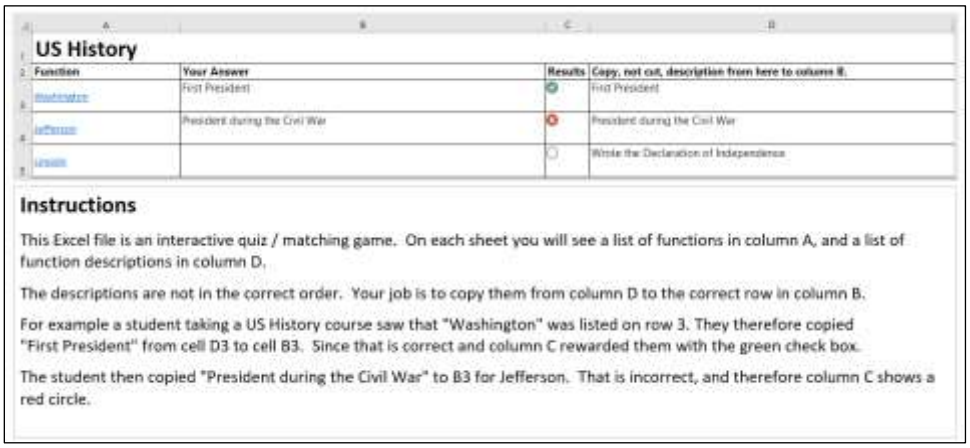
To help decrease the DAX learning curve, Microsoft intentionally used many of the same function names that are found in Excel.

Exercise – Match that Function

To help you learn and familiarize yourself with many of the DAX functions, you will perform the following Match that Function exercise.

1. From your exercise files folder, open **Match that Function.xlsx**.

2. Read the instructions on the Instructions sheet.



3. Select the Aggregate sheet, and for each function name copy the description from column D to the correct row in column B.

   Note: DO NOT CUT AND PASTE THE DESCRIPTION.
   Cutting (CTRL X) and pasting will ruin the conditional formatting in column C.

4. Repeat the process for the other sheets.

C. DAX Operators

As listed below, DAX uses many of the same mathematical, logical, and text operators as Excel.

Operator	Mathematical Operation
+	Add
-	Subtract
*	Multiply
/	Divide
^	Raise to the power of an exponent

Operator	Textual Operation
&	Concatenate

Operator	Comparison Operation
=	Equals
==	Exactly equals
>	Greater than
>=	Greater than or equal to
<	Less than
<=	Less than or equal to
<>	Not equal to

Operator	Logical Operation
&&	AND
||	OR
IN	In a list
NOT	Reverses the logical operation

D. DAX Variables

When you create a DAX formula you can create variables that store the result of an expression. You can then use that variable name in the formula.

To declare a variable, use the keyword VAR followed by the variable name, an equal sign, and the variables expression (value or calculation).

```
VAR <name> = <expression>
```

When a variable is declared in a DAX calculation, the calculation must explicitly state the value that is to be returned.

For example, the following DAX calculation creates a measure named Three. It creates two variables named **One** and **Two**. It then uses the keyword **Return** to tell the computer that the results of the measure should be the value of the One variable plus the value of the Two variable.

```
1  Three =
2      VAR One = 1
3      VAR Two = 2
4      Return
5          One + Two
```

The variable name can use upper- or lower-case letters, and digits between 0 and 9. No spaces are allowed. The variable name must not start with a digit. You may also use a _ (single underscore) or __ (double underscore) as variable prefix.

You may not use reserved keywords (words like VAR and Return that show up in blue) for your variable name. Names of existing tables are also not allowed for variable names.

E. Measures

A measure is like a calculated column. It is often used to aggregate data. Calculated columns store their results in the file. Measures do not store their results, but instead their values are calculated when the report / visual is generated.

In this exercise you will learn about three different types of measures: **Implicit Measures**, **Explicit Measures**, and **Quick Measures**. You will see that an Implicit Measure is automatically calculated based on a field's default summary function, and that an Explicit Measure is based on a formula you create. You will also see that the Quick Measures feature is a way to get Power BI to help you create the formula for an Explicit Measure.

1. If necessary, open the **AdventureWorks1000.pbix** report, and switch to the **Report** view.

2. Create a new page and name it "**Measures**".

Add an Implicit Measure

1. Add a **Matrix** visualization.

2. Add the **'Internet Sales' [ExtendedAmount]** field to the **Values** well.

3. In the values well, click the **ExtendedAmount** drop down and notice Sum is selected.

   The sum of the ExtendedAmount is an implicit measure because you did not explicitly request the sum function.

Change the default measure

1. Switch to the model view.

2. In the fields pane, expand the **Internet Sales** table and select the **ExtendedAmount** field.

3. If necessary, expand the **Properties pane**, then **scroll down** and **expand** the **Advanced** section.

   Notice the **Summarize by** property is set to **Sum**.

   This setting determined our implicit calculation.

4. Click the Summarized by drop down and change the default to **Max**.

5. Return to the **Report** view.

   Notice the label now explicitly states it is the **Sum of ExtendedAmount**.

6. In the Values well, click the x to **remove** the **ExtendedAmount**.

7. **Add** the **'Internet Sales' [ExtendedAmount]** again, and then click the drop down.

   Notice the field is now set to return the Maximum value.

8. Return to the **Model** view and change the default back to **Sum**.

Create an Explicit Measure

You will now create an explicit measure where you explicitly tell Power BI that you want a sum of the 'Internet Sales' [ExtendedAmount] field.

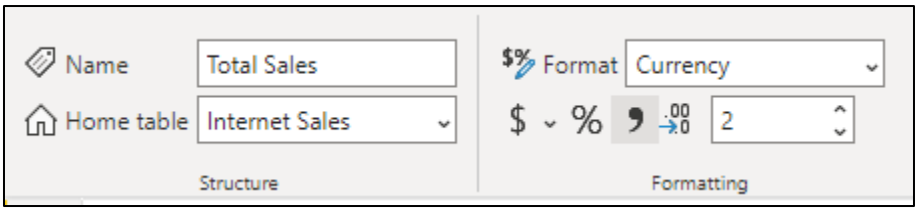
1. Return to the **Report** view.

2. Right click on the **Internet Sales** table and choose **New measure**.

3. Enter the following formula:

```
Total Sales = Sum('Internet Sales'[ExtendedAmount])
```

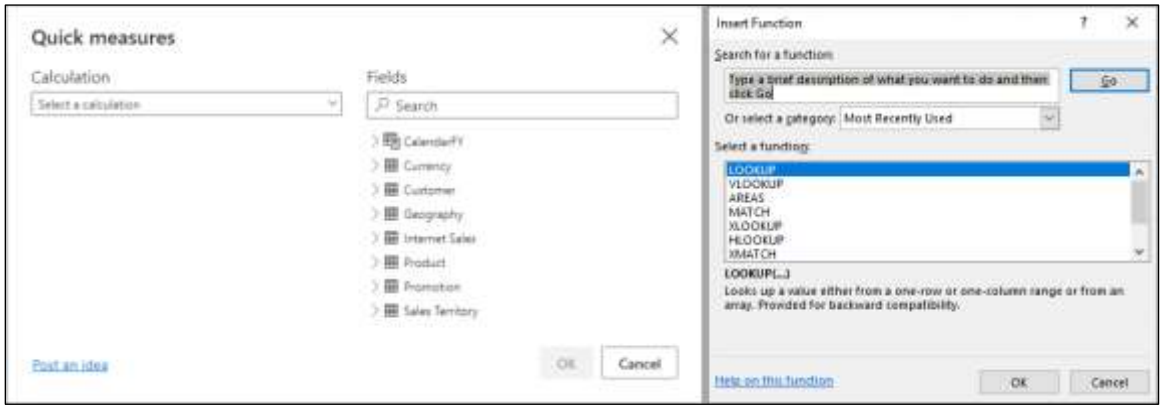
4. In the fields pane, select the **Total Sales** field, and then on the ribbon's **Measure tools** menu verify the **Format** is **Currency** with **2 decimal places**.



5. Add the **Total Sales** measure to the **values well**.

Create a Quick Measure

Creating a quick measure in Power BI is somewhat like inserting a function into Excel with the Insert Function dialog box. As you will see the Calculation drop down gives you many measures that you can create with this wizard like dialog box.



1. Right click on the **Internet Sales** table and choose **New quick measure**.

2. Click the Calculation drop down arrow and scroll down through the list.

   Notice the drop down is composed of the following categories.
   - Aggregates per category
   - Filters
   - Time Intelligence
   - Totals
   - Mathematical operations
   - Text

   Notice multiple measures are indented underneath the various categories.

3. In the **Time Intelligence** category, choose the **Month to-date total**.

4. In the **Fields search box** enter **ExtendedAmount**,
   then **drag** the **ExtendedAmount** field to the **Base value** well.

5. **Erase** the **search box**, then **expand** the **CalendarFY** table.

6. Drag and drop the **Date** field to the **Date well**.

7. Click **OK**.

8. Select the new **ExtendedAmount MTD** field and on the ribbon's **Measure tools** menu change its format to **Currency** with **2 decimal places**.

9. Add the **ExtendedAmount MTD** field to the **Values well**.

   Notice because our matrix does not include any date fields, the Extended Amount MTD is blank.

10. From the **CalendarFY** table, drag the **FiscalYear Hierarchy** to the **Rows well**.

    The matrix now shows years.

11. Click the **Expand all down one level in the hierarchy** button .

    The matrix now shows quarters.

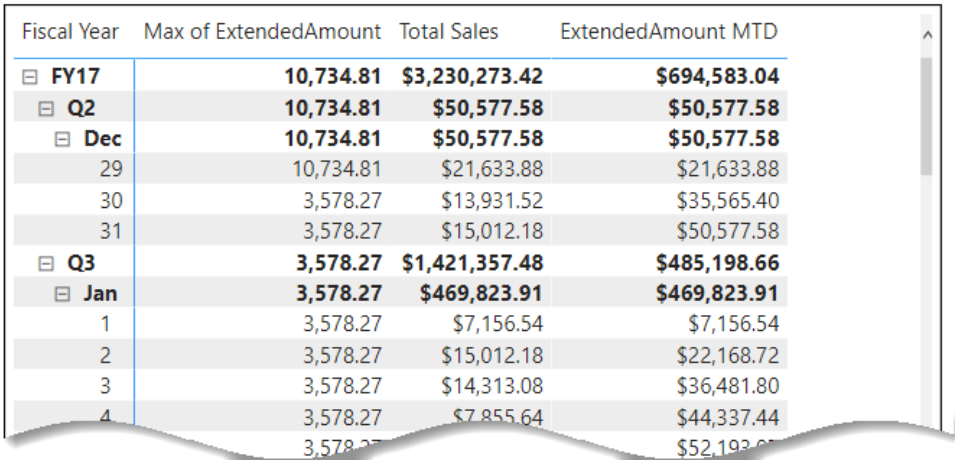
12. Click the **Expand all down one level in the hierarchy** button .

    The matrix now shows months.

13. Click the **Expand all down one level in the hierarchy** button .

    The matrix now shows days.

    Notice the ExtendedAmount MTD total is increasing each day, and then starts again from zero the following month.



Fiscal Year	Max of ExtendedAmount	Total Sales	ExtendedAmount MTD
FY17	**10,734.81**	**$3,230,273.42**	**$694,583.04**
Q2	**10,734.81**	**$50,577.58**	**$50,577.58**
Dec	**10,734.81**	**$50,577.58**	**$50,577.58**
29	10,734.81	$21,633.88	$21,633.88
30	3,578.27	$13,931.52	$35,565.40
31	3,578.27	$15,012.18	$50,577.58
Q3	**3,578.27**	**$1,421,357.48**	**$485,198.66**
Jan	**3,578.27**	**$469,823.91**	**$469,823.91**
1	3,578.27	$7,156.54	$7,156.54
2	3,578.27	$15,012.18	$22,168.72
3	3,578.27	$14,313.08	$36,481.80
4	3,578.27	$7,855.64	$44,337.44
	3,578.27		$52,193.08

7. Practice Lab

Complete this unit and you will have shown you can:

A. Prepare a data model with a star schema

B. Create a date table

C. Create report pages

D. Use various Power BI tools

A. Import the data and create a star schema

In this exercise you will create a new report for Adventure Works 2020. You will import the data from Excel, examine the data mode, split a table into two parts, and finally create a star schema.

1. Start Power BI to create a new report.

2. Get the data from **Adventure Works DW 2020.xlsx**.
   Select all the tables and click **Load**.

3. Switch to **Data** view and examine the **Sales** table.

   This table holds sales information. Ideally it should be split into two tables.

   Sales Order
   This table should hold information about the order but not the order details. For example, it should track the order #, date, customer info, etc. but should not include the product, quantity, unit price and other fields specific to a line item.

   Sales Order Line Item
   This table should hold information specific to individual line items.

   Common Key
   Determine which field you will use to link the two tables.

   Useless fields
   Determine which fields, if any, are not needed, and therefore should be deleted.

   Missing calculated fields
   Determine which calculated fields need to be added to either table.

4. In Excel, Word, Notepad, or on paper create a plan for which fields will belong in which new table.

   Does your plan include the key fields that will link the two tables?

5. Go to the **Query Editor**.

6. Copy the Sales table and name the copy **Sales Order**.

7. Remove the fields that do not belong in the **Sales Order** table.
8. **Remove duplicate records** from the Sales Order table.
9. Copy the Sales table again and name the copy **Sales Order Line Item**.
10. Remove the fields that do not belong in the **Sales Order Line Item** table.
11. Where needed, **add** any **calculated columns**.
12. Remove the original **Sales** table.
13. **Close and apply** your changes.
14. Switch to the **Model** view and create a star schema for the various tables. Be sure each **fact** table has the proper relationships to its **dimensions** tables.

B. Add Date table(s)

1. Create a date tables using either the Calendar() function or the CalendarAuto() function. Assume the business ends their fiscal year on December 31st.

2. Add the following columns to the date table(s)

   - **Year** – Format it as a four-digit calendar year.
   - **Quarter** – Format it as Q1, Q2, etc.
   - **Month Number** – Format it as 1, 2, 3, … 10, 11, 12.
   - **Month Full Name** – Example: January
   - **Month Short Name** – Example: Jan
   - **Day of Week Number** – Example: 1, 2, 3, … 7
   - **Day of Week Full Name** – Example: Sunday, Monday, … Saturday
   - **Day of Week Short Name** – Example: Sun, Mon, … Sat
   - **Date Code** – this should return the date formatted as YYYY-MM-DD

   Feel free to give these columns different names if desired.

3. Designate the new table as a date table.

4. Relate the date table(s) to the various date fields.

C. Create report pages

1. Create the following report pages:

   - Welcome
     On this page add a text box with a welcome message explaining that the purpose and use of this Power BI report. Find and download from the web an AdventureWorks logo and include it on this welcome page.

   - Table of contents
     This page should include buttons that link to the other pages.

   - Sales information
     These pages, one per year, should include professional looking visuals that tell a story regarding:

     - Total income for the year
     - Total income per sales territory
     - Total income per country
     - Total income per channel (Resellers vs Internet)
     - Total income per product category

     The page should also include a nice page title and a button that links back to the table of contents page.

     If the page is too crowded for all these visualizations, feel free to use multiple pages. Or, if you want an extra challenge, put them all on one page where some of the visuals are hidden until the user clicks a button that applies a bookmark that shows the desired visuals.

   - Top Resellers
     This page should show a professional looking visualization for the top 10 resellers. It should also include a slicer for year so users can see who the top 10 resellers are per the selected year.

   - Year to Date Sales
     This page should include a professional looking table or matrix that shows each date of the selected year, and the total year-to-date sales for the date. It should also include a slicer so users can select a specific year.

D. Use tools

1. Experiment with the following tools to make sure you know how they work:

    - Focus mode
    - Export data
    - Filters and slicers affecting this visual
    - Edit interactions
    - Show as a table
    - Changing colors with themes