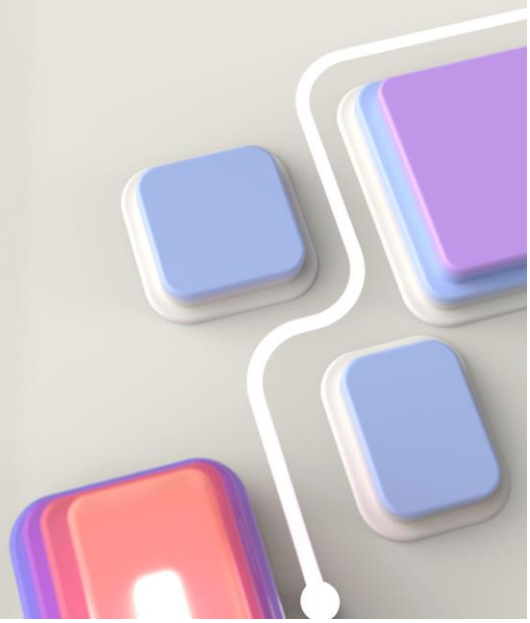
Microsoft

Design and manage analytics solutions using Power BI

Day 1

1

Get started with Microsoft data analytics



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From data to business insights with Power BI

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Roles in Data

Business Analyst

Data Analyst

Data Engineer

Analytics Engineer

Data Scientist

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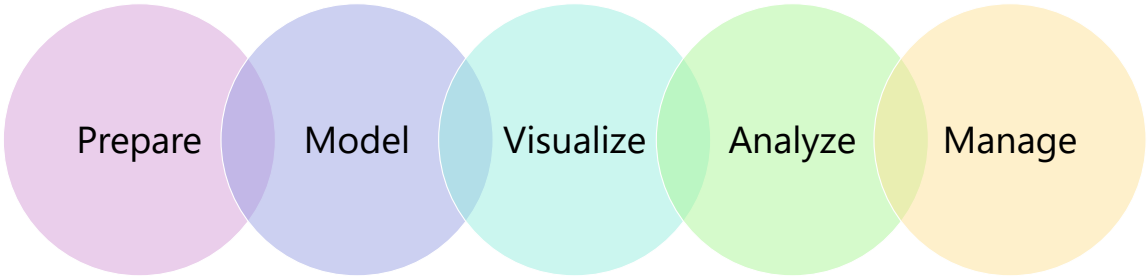
Tasks of a Data Analyst



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Different types of analysis

Data analysis is another form of storytelling with five categories:

- **Descriptive**: Summarize past data
- **Diagnostic**: Explain past data
- **Predictive**: Forecast future data
- **Prescriptive**: Optimize future data
- **Artificial Intelligence**: Learn from data

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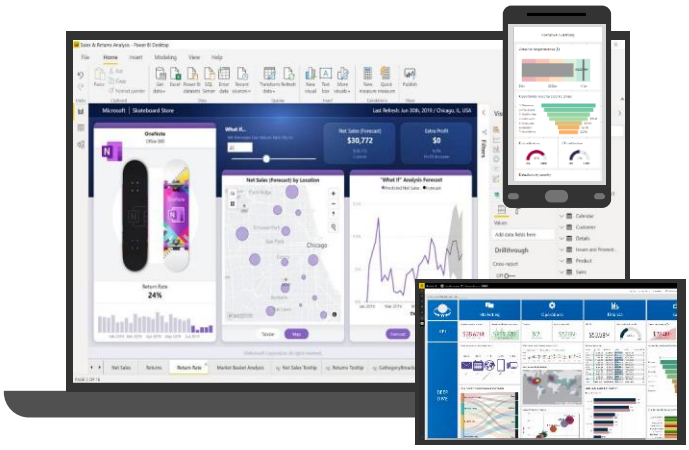
Introduction to Power BI environment

- Create with Power BI Desktop
- Distribute with Power BI service
- Access with Power BI Mobile



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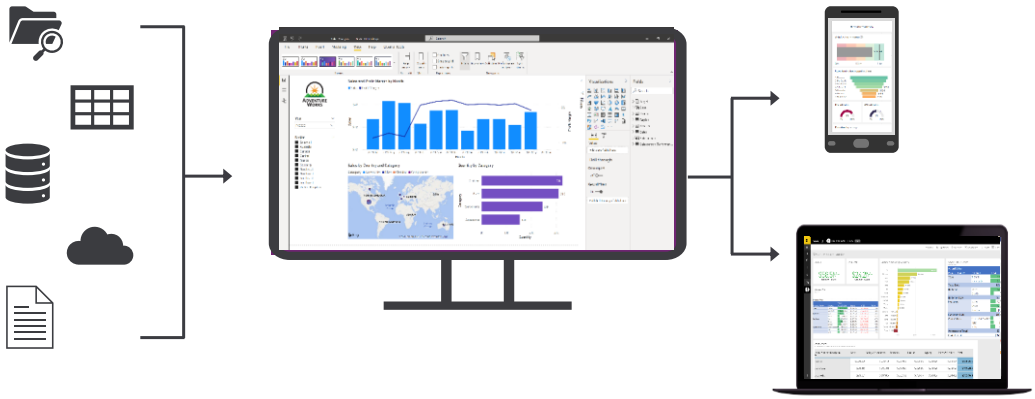
The flow of Power BI

Data sources

Power BI Desktop

Power BI service & Mobile



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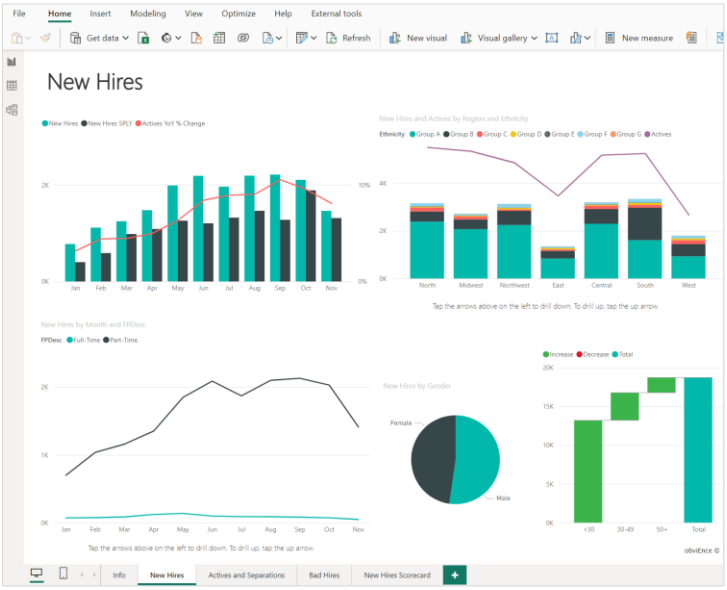
The building blocks of Power BI

Semantic models

- Connected data, transformations, relationships, and calculations.

Visualizations

- Interactive representation of data through various charts and graphics.



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Microsoft Fabric

- **Data Factory**: Data integration combining Power Query with the scale of Azure Data Factory to move and transform data.
- **Data Engineering**: Data engineering with a Spark platform for data transformation at scale.
- **Data Warehouse**: Data warehousing with industry-leading SQL performance and scale to support data use.
- **Data Science**: Data science with Azure Machine Learning and Spark for model training and execution tracking in a scalable environment.
- **Real-Time Intelligence**: Real-time Intelligence to query and analyze large volumes of data in real-time.
- **Power BI**: Business intelligence for translating data to decisions.

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Data teams and Fabric

Fabric's unified management and governance make it easier for data professionals to work together.

Data Engineers	Analytics Engineers	Data Scientists	Data Analysts	Decision Makers
Data Factory, Data Warehouse, Data Engineering, Real-time intelligence	Data Factory, Power BI, Data Engineering, Data Warehouse	Data Science, Azure ML	Power BI	Power BI, Microsoft 365

Data Stewards

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Further reading

Discover data analysis

learn.microsoft.com/training/modules/data-analytics-microsoft/

Get building with Microsoft Power BI

https://learn.microsoft.com/training/modules/get-started-with-power-bi/

Introduction to end-to-end analytics using Microsoft Fabric

https://aka.ms/fabric-intro

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Get data in Power BI

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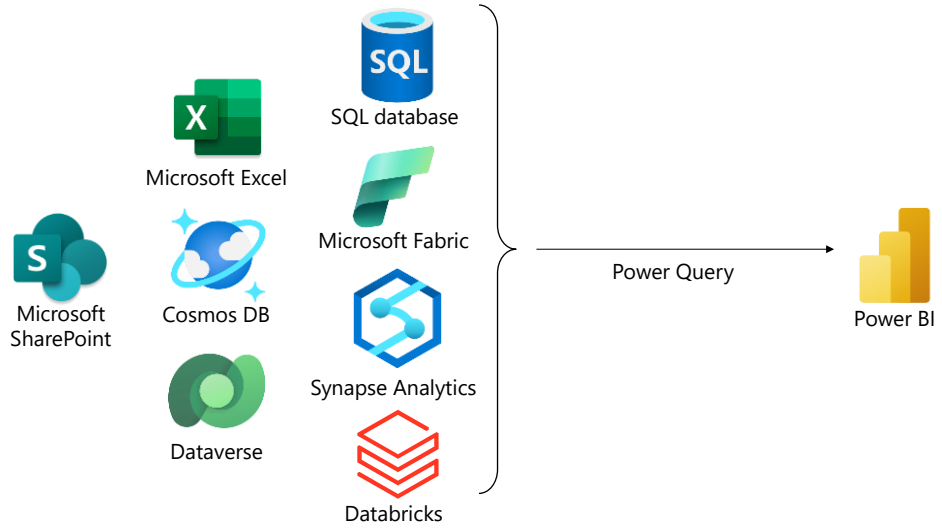
Combine all data into a single semantic model



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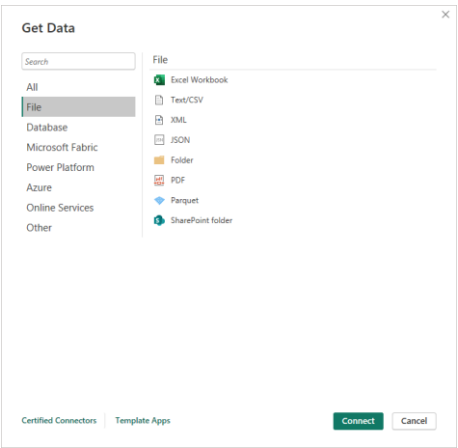
Get data from a wide variety of sources



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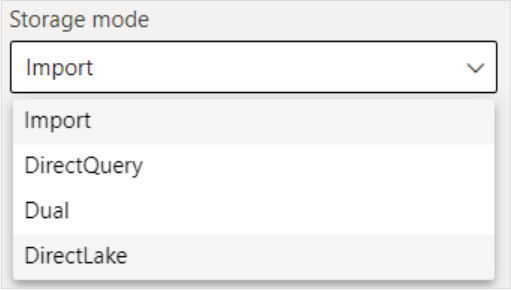
Select a storage mode

Storage mode affects

- Available transformations
- Report performance

**Not all sources support all modes*



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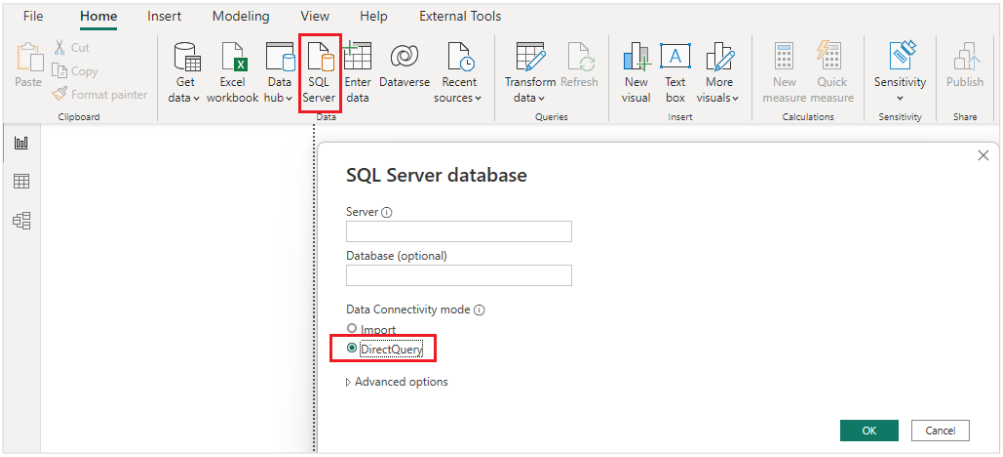
Introduction to DirectQuery



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Implications of using DirectQuery

Benefits	Limitations
Frequently changing data	Dependent on data source performance
Need near real-time	Security between source and destination
Large data volumes	Limited modeling capabilities
Multi-dimensional data	Limited transformation features

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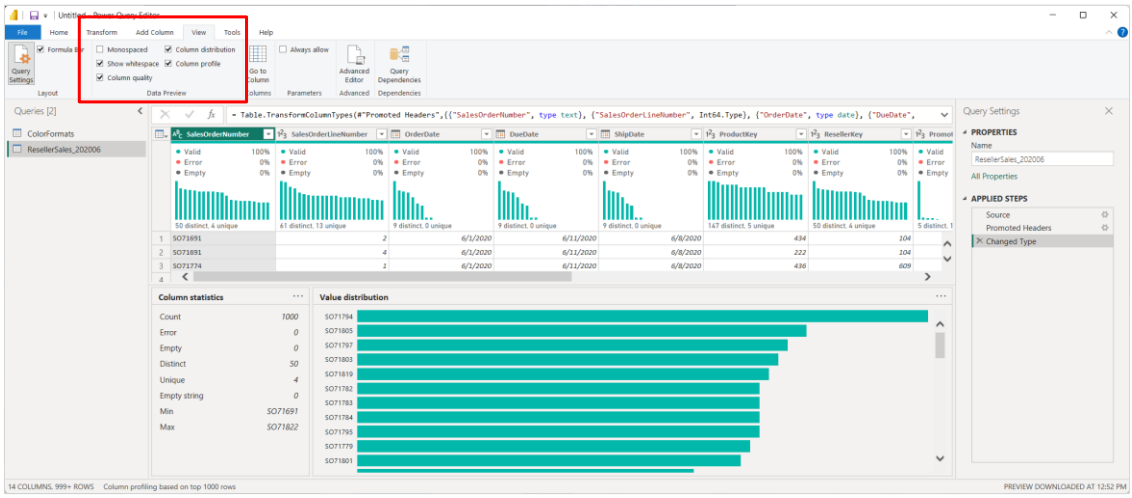
Data profiling options in Power Query Editor



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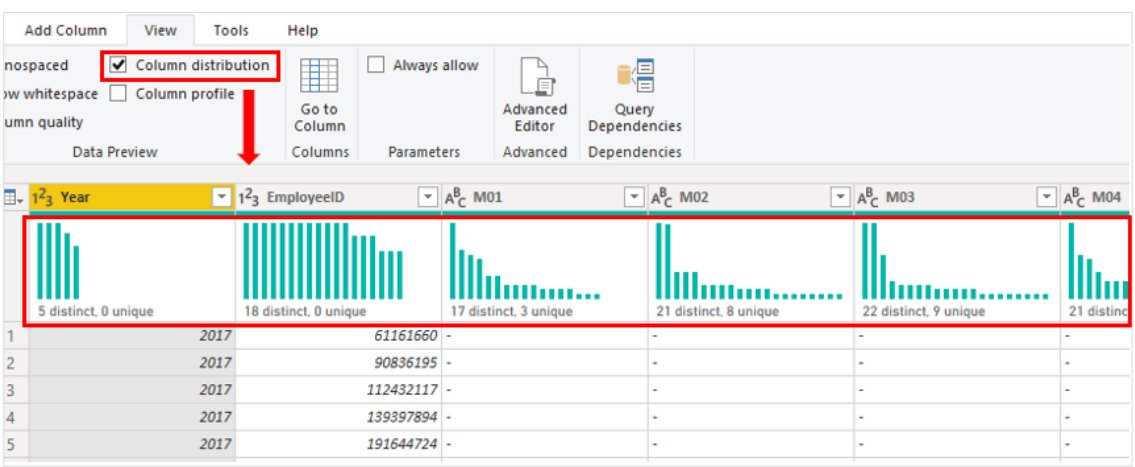
Determine cardinality of a column



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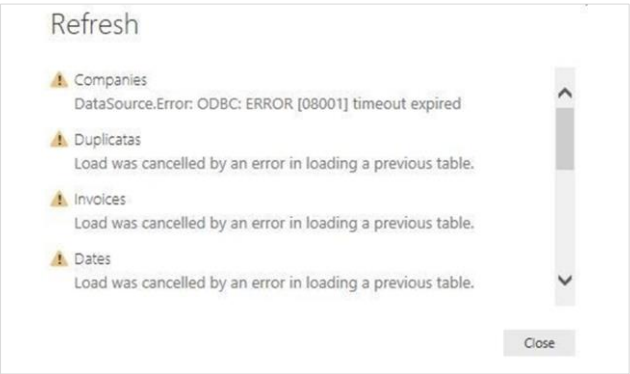
Data import errors

- Possible data load errors:
  - Query Timeout
  - Couldn't find data formatted as a table
  - Could not find file
  - Data type errors



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Further reading

Get data in Power BI

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Clean, transform, and load data

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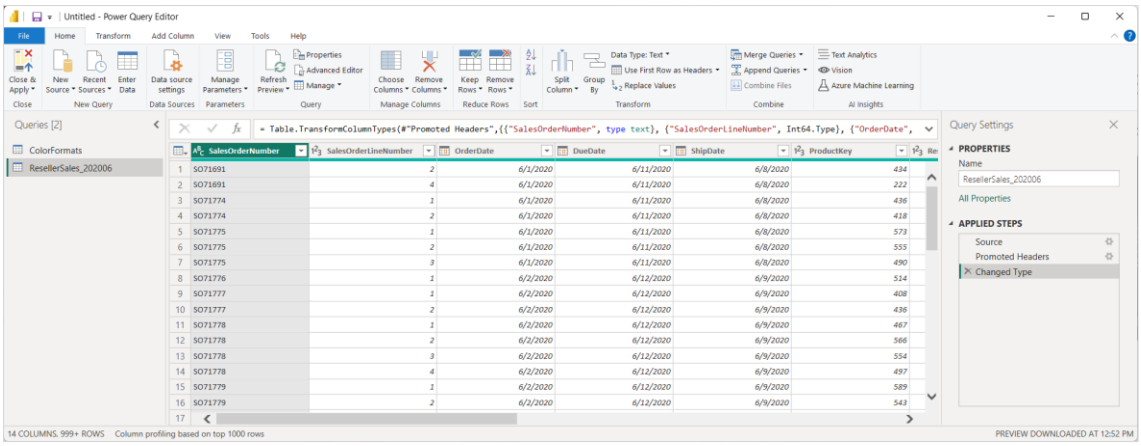
Transform data with Power Query Editor



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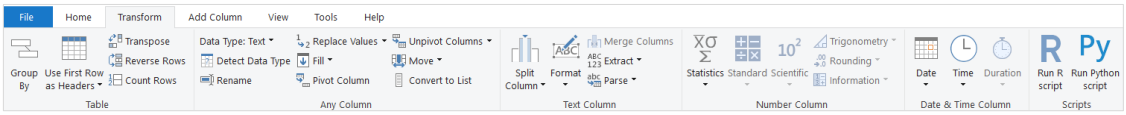
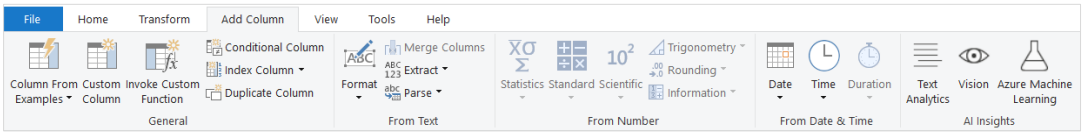
Common transformations

Transform columns, add new, split, extract, and more





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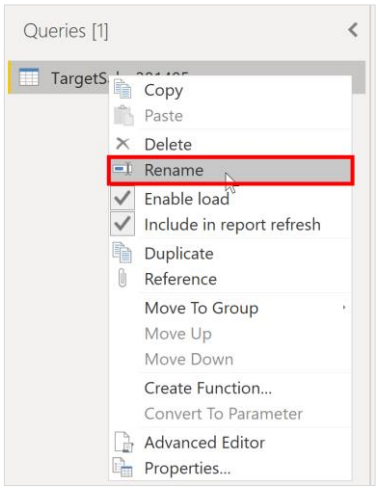
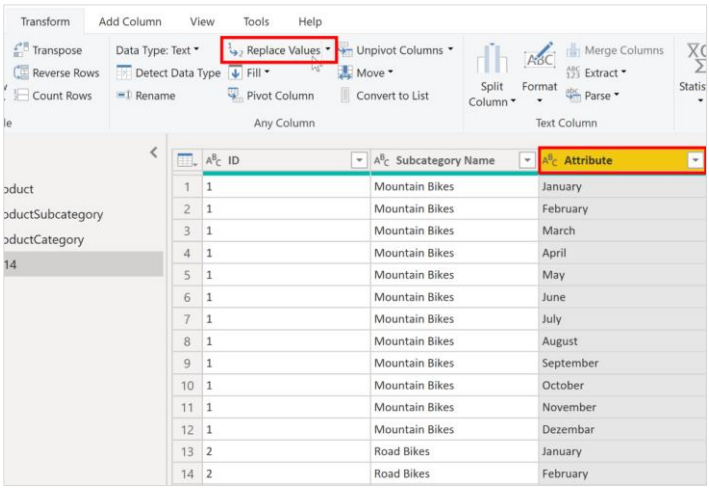
Choose user-friendly values





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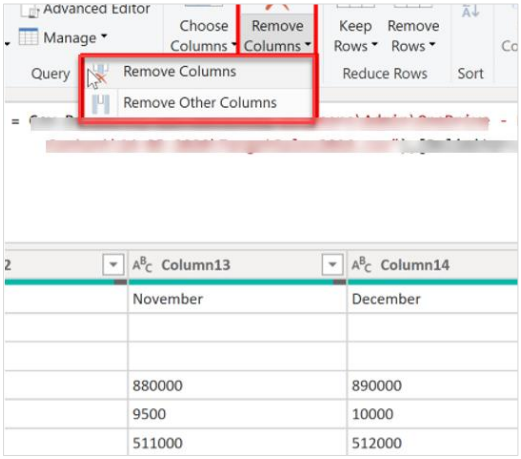
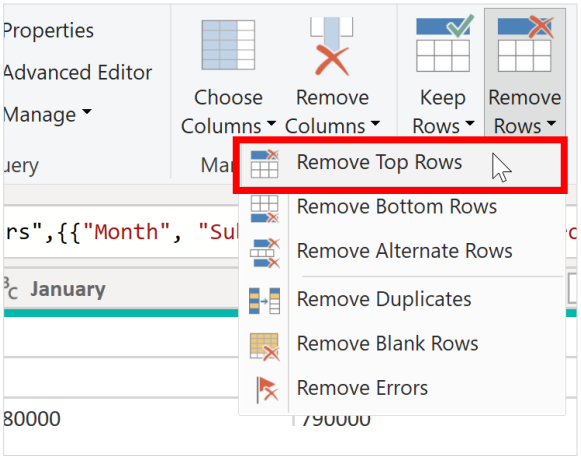
Shaping table structure





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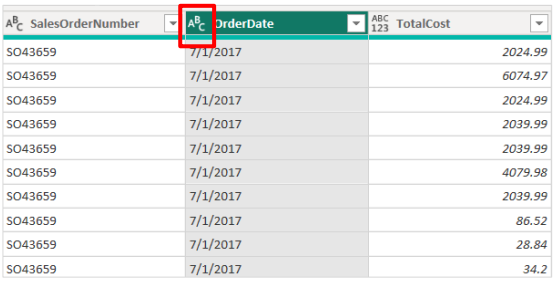
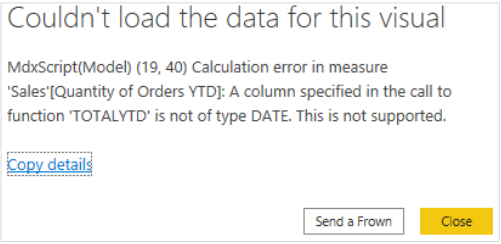
Evaluate and change column data types



SalesOrderNumber	OrderDate	TotalCost
SO43659	7/1/2017	2024.99
SO43659	7/1/2017	6074.97
SO43659	7/1/2017	2024.99
SO43659	7/1/2017	2039.99
SO43659	7/1/2017	2039.99
SO43659	7/1/2017	4079.98
SO43659	7/1/2017	2039.99
SO43659	7/1/2017	86.52
SO43659	7/1/2017	28.84
SO43659	7/1/2017	34.2



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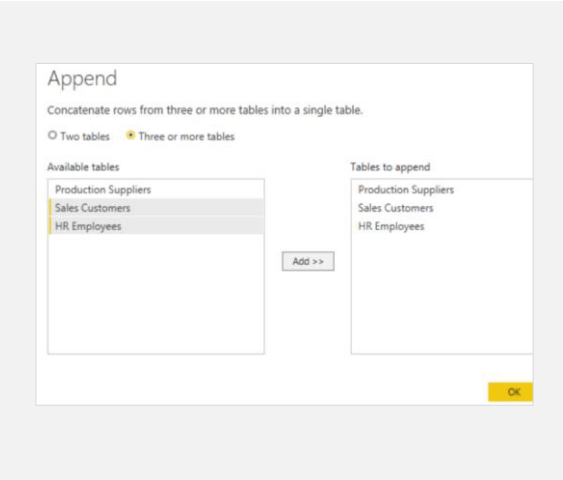
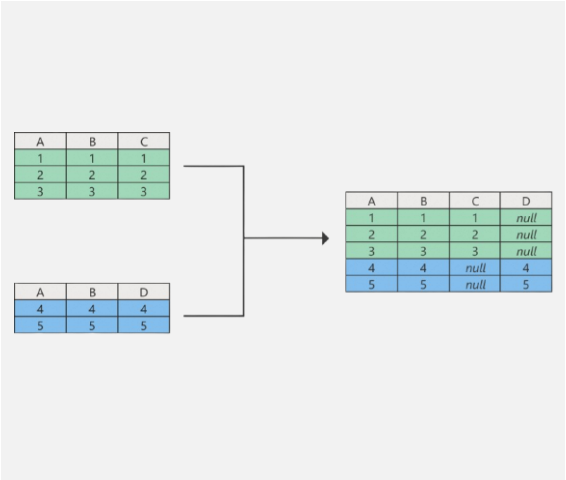
Append multiple queries into one





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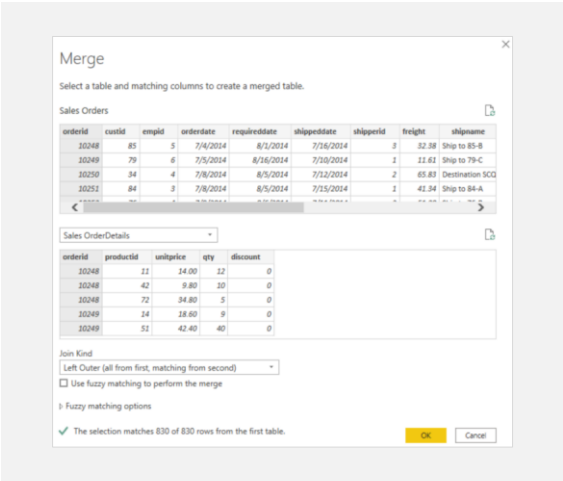
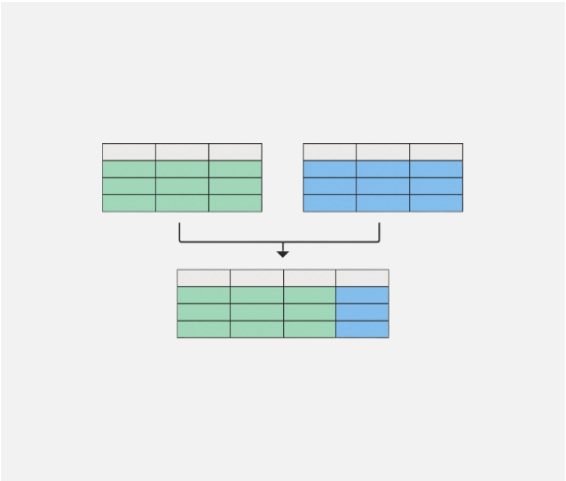
Merge multiple queries into one





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Unpivot or pivot columns

Add or remove table structure to meet your aggregation needs.

	Category Name	Subcategory Name
1	Bikes	Mountain Bikes
2	Bikes	Road Bikes
3	Bikes	Touring Bikes
4	Clothing	Bib-Shorts
5	Clothing	Caps
6	Clothing	Gloves
7	Clothing	Jerseys
8	Clothing	Shorts
9	Clothing	Socks
10	Clothing	Tights
11	Clothing	Vests
12	Accessories	Bike Racks
13	Accessories	Bike Stands
14	Accessories	Bottles and Cages

	Bikes	Components	Clothing	Accessories
1	3	14	8	12

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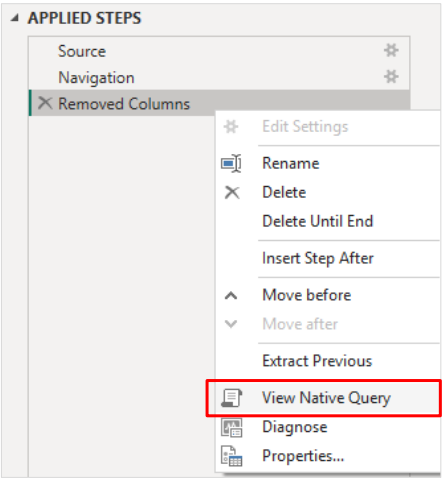
Query folding

Pushes data transformations to the source for better performance and efficiency.

Supported sources

- Relational databases
- OData feeds
- Active Directory



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Performance recommendations

- Only keep necessary data
- Check data types
- Reduce cardinality
- Disable query load
- Use parameters

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Further reading

Clean, transform, and load data in Power BI

https://learn.microsoft.com/training/modules/clean-data-power-bi/

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Configure a semantic model

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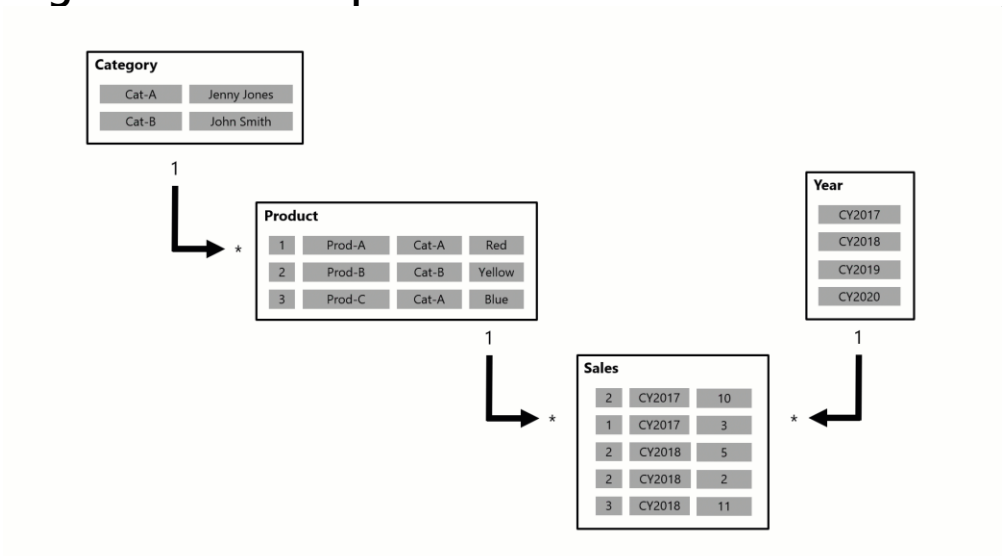
Configure relationships



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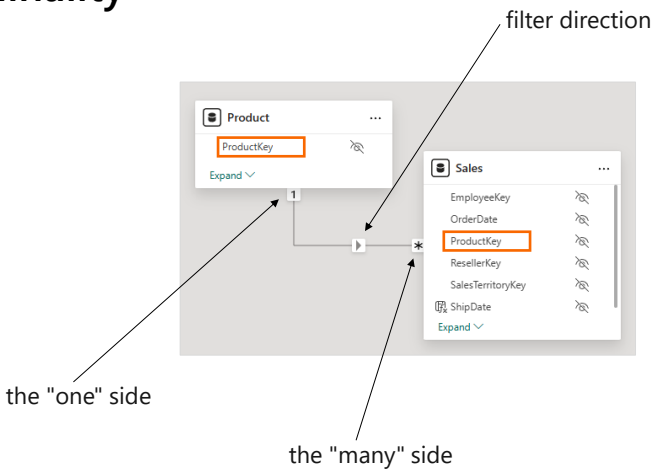
Understand cardinality

- One-to-many **(1:*)**
- Many-to-one **(*:1)**
- One-to-one **(1:1)**
- Many-to-many **(*:*)**



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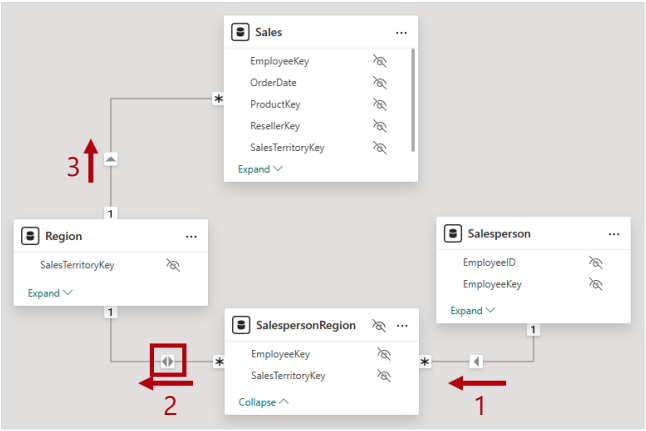
Understand cross filter direction

The direction determines how filters propagate:

Cardinality	Cross filter direction
1:* or *:1	Single or both
1:1	Both
:	Single to either table, or both



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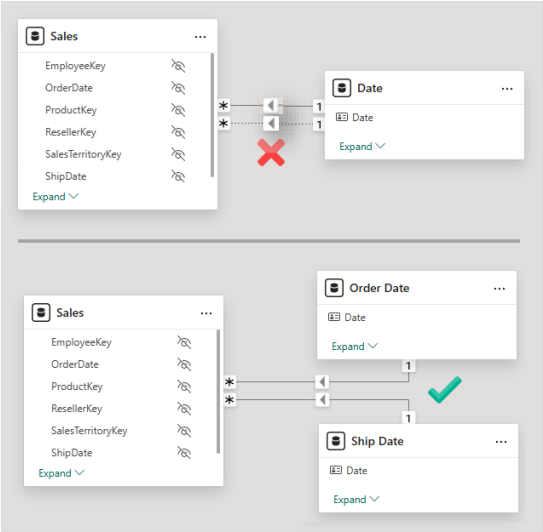
Active vs. inactive relationships

- There can only be one active relationship between 2 tables.
- Inactive relationships can only be made active during the evaluation of a model calculation by using the `USERELATIONSHIP` DAX function.



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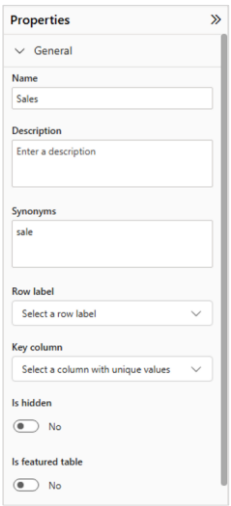
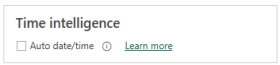
Configure table properties

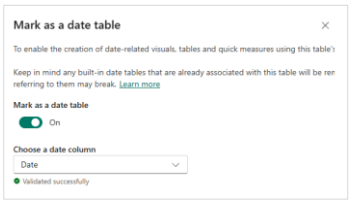
- Name
- Description
- Synonyms
- Row label
- Is hidden



- Disable auto date/time



- Mark as data table



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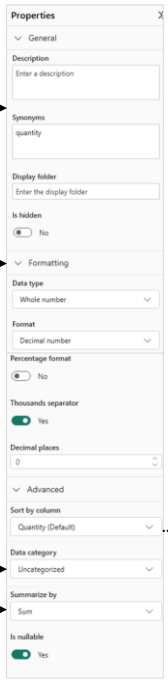
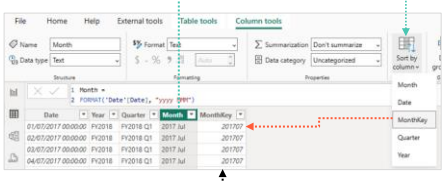
Configure columns

- General properties
- Column formatting
- Categorize data
- Set summarization (Σ)
- Sort order





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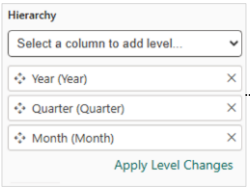
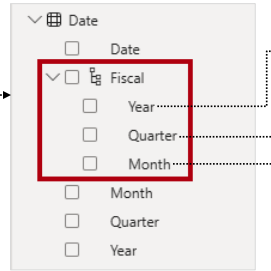
Configure Hierarchies

Relationships *between* columns





Year	Sales
FY2018	$16,429,043
FY2018 Q1	$3,195,733
2017 Jul	$489,328
2017 Aug	$1,540,072
2017 Sep	$1,166,332
FY2018 Q2	$4,874,023
FY2018 Q3	$4,069,304
FY2018 Q4	$4,289,983
FY2019	$27,979,780
FY2020	$33,139,748
Total	$77,548,570

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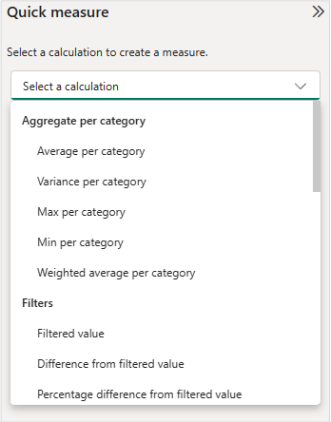
Use Quick measures

Calculations extend the data in your semantic model

Configure properties, just like columns



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Further reading

Configure a semantic model

https://learn.microsoft.com/training/modules/configure-semantic-model-power-bi

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Create DAX calculations in semantic models

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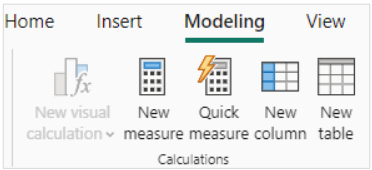
What is DAX?

- **D**ata **A**nalysis E**x**pressions
- Library of functions and operators
- Build formulas and expressions
- Creates calculations: measures, columns, and tables



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DAX Syntax

A. Measure name

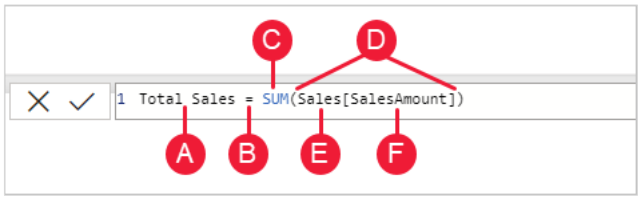
B. Equal sign operator

C. DAX function

D. Parenthesis ()

E. Reference to table

F. Reference to column



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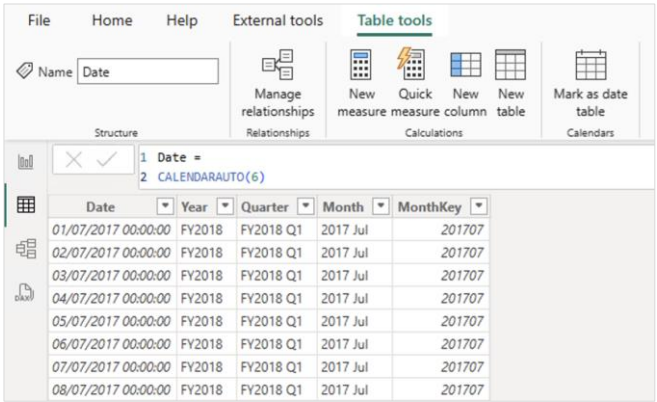
Create calculated tables

- Defined using DAX expressions.
- Computed & stored in data model.
- Useful for aggregating data or creating custom tables.
- Table and calculator icon.

```
Date = CALENDARAUTO(6)
```



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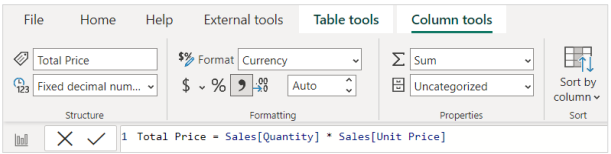
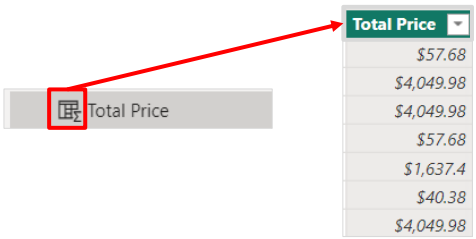
Create calculated columns

- Calculated for each row in the table.
- Computed & stored in data model.
- Useful "helper/connector columns."
- Recalculated during data refresh.
- Table and Sigma icon.






```
Total Price = Sales[Quantity] * Sales[Unit Price]
```

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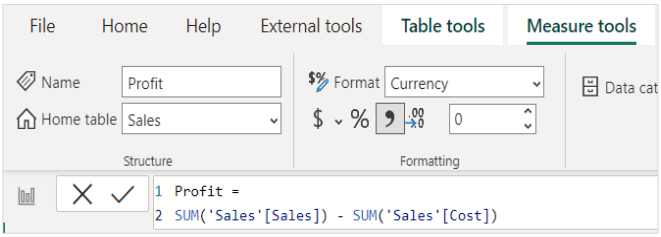
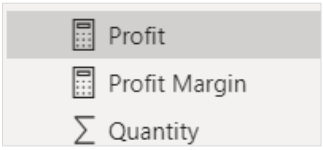
Create measures

- Defined with DAX definitions.
- Computed on the fly.
- Not stored in data model.
- Responsive to interactions.
- Indicated by calculator icon.






```
Profit = SUM('Sales'[Sales]) - SUM('Sales'[Cost])
```

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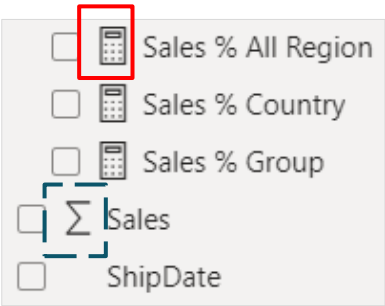
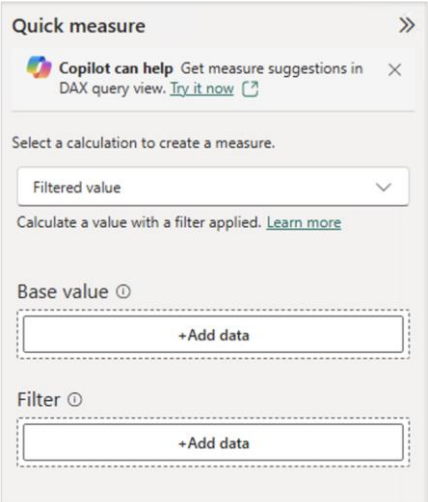
Implicit vs. Explicit vs. Quick measures





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Common DAX functions

Function	Descriptions
SUM()	Adds up values
MIN(), MAX()	Smallest/largest value
FILTER()	Returns a filtered table
CALCULATE()	Core DAX function to change context
ALL(), REMOVEFILTERS()	Remove filters
FORMAT()	Format numbers/dates

```
TotalSales = SUM(Sales[Amount])
TotalCost = SUM(Sales[Cost])
Profit = [TotalSales] - [TotalCost]
ProfitMargin = DIVIDE([Profit], [TotalSales])
```

} Compound measure (promotes reuse)

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Iterator functions

SUMX, COUNTX, AVERAGEX, MINX, MAXX, …

Useful for:

- Complex summarizations
- Higher grain summarization
- Ranking

iterate over each sales order ~~line~~ (higher grain summarization)

```
Revenue Avg Order =
AVERAGEX(
    VALUES('Sales Order'[Sales Order]),
    [Revenue]
)
```

Month	Revenue	Discount	Revenue Avg Order Line	Revenue Avg Order
2017 Jul	$1,423,357.32	$326,219.06	$2,220.53	$4,352.77
2017 Aug	$2,057,902.45	$1,031,506.86	$2,179.98	$8,794.45
2017 Sep	$2,523,947.55	$1,342,355.67	$2,014.32	$9,670.30
2017 Oct	$561,681.48	$0.00	$3,228.05	$3,228.05
2017 Nov	$4,764,920.16	$2,692,205.61	$2,227.64	$12,441.04
2017 Dec	$596,746.56	$0.00	$3,174.18	$3,174.18
2018 Jan	$1,327,674.63	$475,813.07	$2,329.25	$5,698.17
2018 Feb	$3,936,463.31	$2,237,412.77	$2,321.03	$12,301.45
2018 Mar	$700,873.18	$0.00	$3,200.33	$3,200.33
2018 Apr	$1,519,275.24	$588,995.26	$2,182.87	$6,356.80
2018 May	$2,960,378.09	$1,514,891.49	$2,219.17	$9,642.93
2018 Jun	$1,487,671.19	$1,659,893.12	$1,398.19	$4,752.94

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Calculated columns vs. measures

	Calculated columns	Measures
Purpose	Adds a new column to a table	Defines how to summarize model data
Evaluation	Evaluated using row context at data refresh time	Evaluated using filter context at query time
Storage	Stores a value for each row in the table (Import mode)	Never stores values in the model
Use in visuals	Can filter, group, or summarize data (as implicit measures)	Designed specifically to summarize data
Performance impact	Can increase memory usage and model size	More efficient; better performance in large models
Ideal for	New fields for slicing or relationships	Dynamic calculations based on filters

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Further reading

Write DAX formulas for Power BI

https://learn.microsoft.com/training/modules/dax-power-bi-write-formulas

Create DAX calculations in semantic models

https://learn.microsoft.com/training/modules/dax-power-bi-create-calculations/

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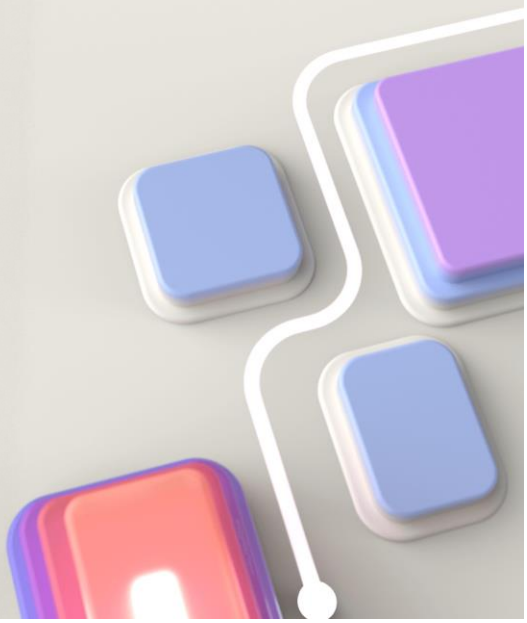
Modify DAX filter context



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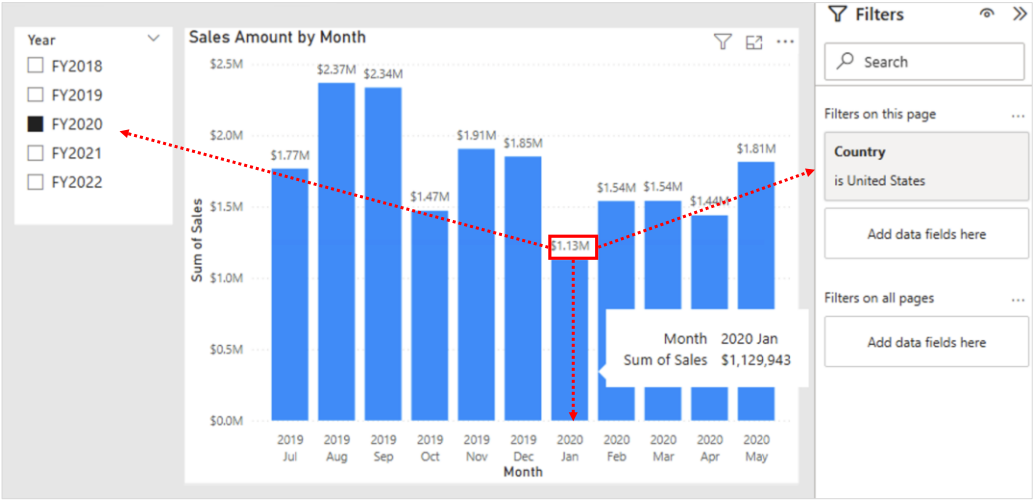
Understanding filter context

Measures are "dynamic," depending on filters.



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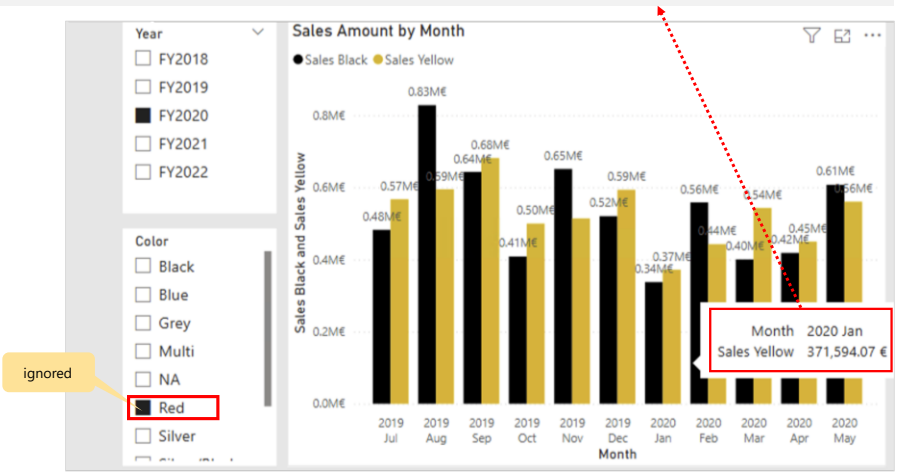
Modify filter context using CALCULATE()

```
Sales Black = CALCULATE(SUM(Sales[Sales]), 'Product'[Color]="Black")
Sales Yellow = CALCULATE(SUM(Sales[Sales]), 'Product'[Color]="Yellow")
```



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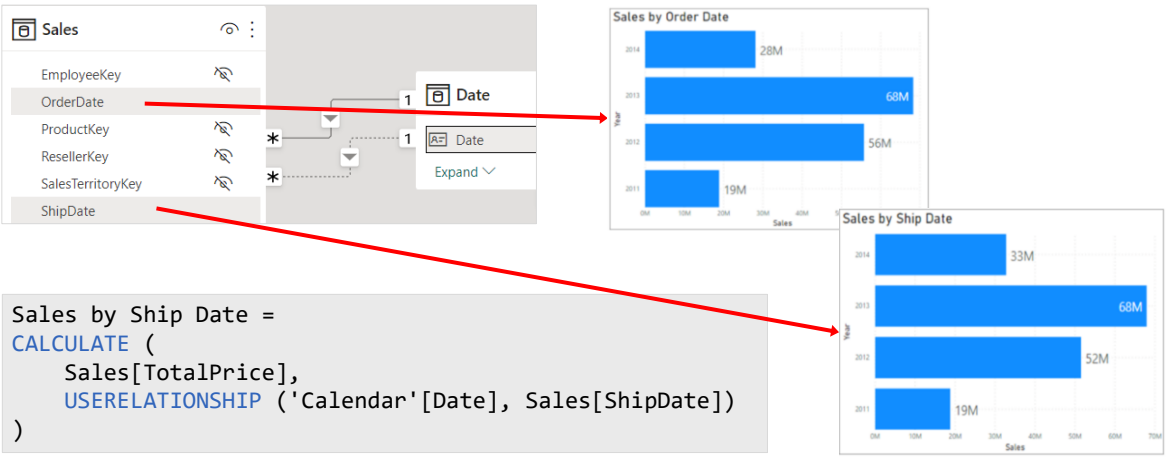
Use inactive relationships with DAX

Enable additional table filtering without impacting the active relationship.




```
Sales by Ship Date =
CALCULATE (
    Sales[TotalPrice],
    USERELATIONSHIP ('Calendar'[Date], Sales[ShipDate])
)
```

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REMOVEFILTERS()

Break out of the current filter context

```
Revenue % Total Region =
VAR CurrentRegionRevenue = [Revenue]
VAR TotalRegionRevenue =
    CALCULATE(
        [Revenue],
        REMOVEFILTERS('Sales Territory')
    )
RETURN
    DIVIDE(
        CurrentRegionRevenue,
        TotalRegionRevenue
    )
```

Recalculate Revenue, as if no sales territory filter is applied

So we can calculate percentage-of-total

Reseller Revenue

Group	Country	Region	Revenue	Revenue % Total Region
Europe	France	France	$4,607,537.94	5.73%
		Total	**$4,607,537.94**	**5.73%**
	Germany	Germany	$1,983,988.04	2.47%
		Total	**$1,983,988.04**	**2.47%**
	United Kingdom	United Kingdom	$4,279,008.83	5.32%
		Total	**$4,279,008.83**	**5.32%**
	Total		**$10,870,534.80**	**13.51%**
North America	Canada	Canada	$14,377,925.60	17.87%
		Total	**$14,377,925.60**	**17.87%**
	United States	Central	$7,906,008.18	9.83%
		Northeast	$6,932,842.01	8.62%
		Northwest	$12,435,076.00	15.46%
		Southeast	$7,867,416.23	9.78%
		Southwest	$18,466,458.79	22.95%
		Total	**$53,607,801.21**	**66.63%**
	Total		**$67,985,726.81**	**84.51%**
Pacific	Australia	Australia	$1,594,335.38	1.98%
		Total	**$1,594,335.38**	**1.98%**
	Total		**$1,594,335.38**	**1.98%**
Total			**$80,450,596.98**	**100.00%**

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Further reading

Modify DAX filter context in semantic models

https://learn.microsoft.com/training/modules/dax-power-bi-modify-filter

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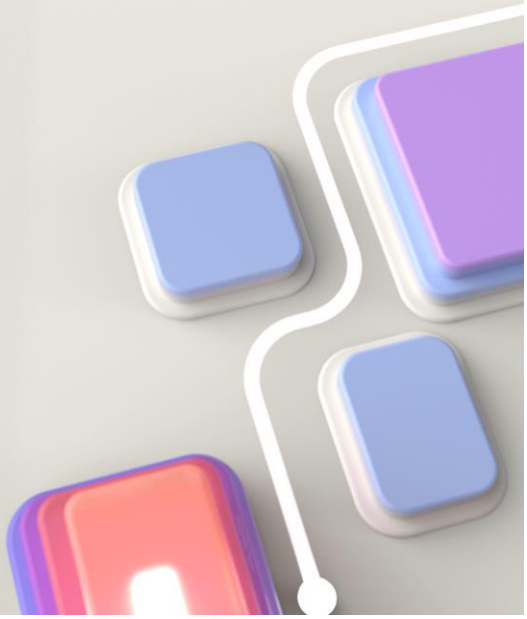
Use DAX time intelligence functions



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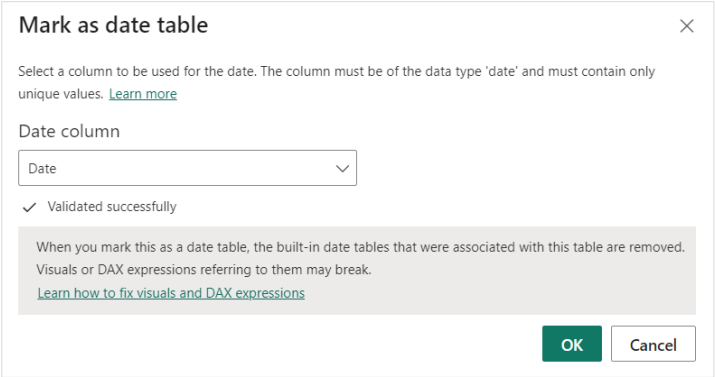
Create a common date table



Mark as date table

- Contain unique values.
- Span full years.
- Not contain BLANKs.
- Not have any missing dates.

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Use DAX time intelligence functions

Summarizations over time

- TOTALYTD, TOTALQTD, TOTALMTD
- DATESBETWEEN
- ...

Comparisons over time

- DATEADD
- SAMEPERIODLASTYEAR
- PREVIOUSQUARTER, PREVIOUSYEAR
- ...

```
Total Sales Previous Month =
  CALCULATE(SUM(Sales[Total Price]),
            PREVIOUSMONTH('Date'[Date]))
```

Year	Month	Total Sales	Total Sales Previous Month
2015	March	$39,979.9	$41,207.2
2015	April	$55,699.39	$39,979.9
2015	May	$56,823.7	$55,699.39
2015	June	$39,088	$56,823.7
2015	July	$55,464.93	$39,088
2015	August	$49,981.69	$55,464.93
2015	September	$59,733.02	$49,981.69
2015	October	$70,328.5	$59,733.02
2015	November	$45,913.36	$70,328.5

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Point in time calculations

LASTDATE() Returns the last date in the current context

```
Stock on Hand =
   CALCULATE(SUM(Inventory[UnitsBalance]),
             LASTDATE('Date'[Date]))
```

111 units on stock on Nov 30, 2019

FY2020 Mountain-200 Bike Stock

Product	2019 Jul	2019 Aug	2019 Sep	2019 Oct	2019 Nov	2019 [illegible]	2020 Jan	2020 Feb	2020 Mar	2020 Apr	2020 May
Mountain-200 Black, 38	151	171	99	172	30	168	168	168	168	168	168
Mountain-200 Black, 42	165	186	116	176	76	167	167	167	167	167	167
Mountain-200 Black, 46	182	184	131	172	111	190	190	190	190	190	190
Mountain-200 Silver, 38	171	173	129	190	85	190	190	190	190	190	190
Mountain-200 Silver, 42	177	169	109	170	120	162	162	162	162	162	162
Mountain-200 Silver, 46	181	158	126	178	88	163	163	163	163	163	163
Total	**1,027**	**1,041**	**710**	**1,058**	**510**	**1,040**	**1,040**	**1,040**	**1,040**	**1,040**	**1,040**

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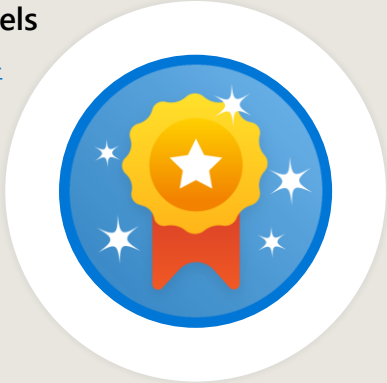
Further reading

Use DAX time intelligence functions in semantic models

https://learn.microsoft.com/training/modules/dax-power-bi-time-intelligence/



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Create visual calculations

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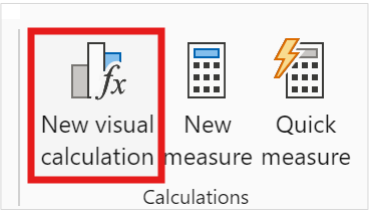
What are visual calculations?

- DAX calculations
- Stored on the visual
- Visual representation of calculations



Compared to measures that are stored in the semantic model and must be added to a visual.

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Explore the visual calculation interface

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Create a visual calculation

- Start with a visual
- Add new visual calculation
- Add a calculation in formula bar, such as:

```
1 Profit = [Sales Amount]-[Total Product Cost]
```

Fiscal Year	Sales Amount	Total Product Cost	Profit
FY2018	$23,860,891.17	$20,824,957.60	3,035,933.57
FY2019	$34,070,108.50	$30,362,108.34	3,708,000.16
FY2020	$51,878,274.54	$46,070,842.02	5,807,432.52
Total	**$109,809,274.20**	**$97,257,907.95**	**12,551,366.25**

```
Profit = [Sales Amount] – [Total Product Cost]
```

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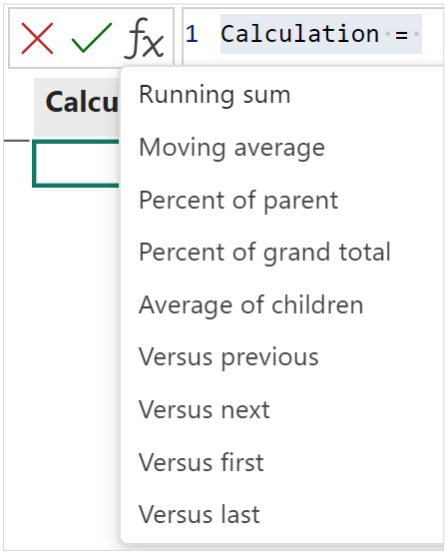
Use templates

Templates reduce code complexity by using a single function to perform complex calculations.



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Hide visual calculations

- Hide fields in the visual matrix when:
  - The visual calculation depends on the field.
  - The field doesn't make sense for your visual.

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Use the Axis parameter

- Determines evaluation direction

Parameters	Icon
ROWS	↓↓
COLUMNS	⇉
ROWS COLUMNS	↓⇅↓
COLUMNS ROWS	⇄

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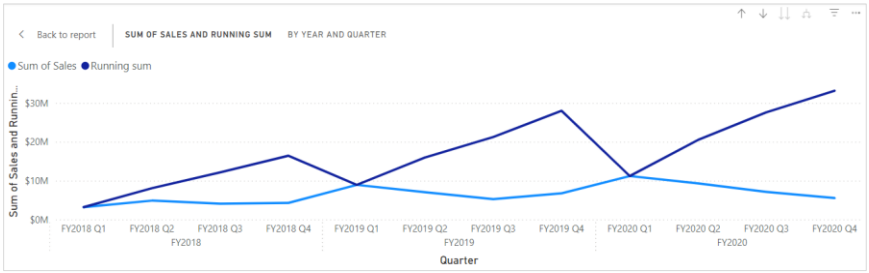
Use the Reset parameter

- Doesn't reset by default
- HIGHESTPARENT
- LOWESTPARENT



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Further reading

Create visual calculations in Power BI Desktop

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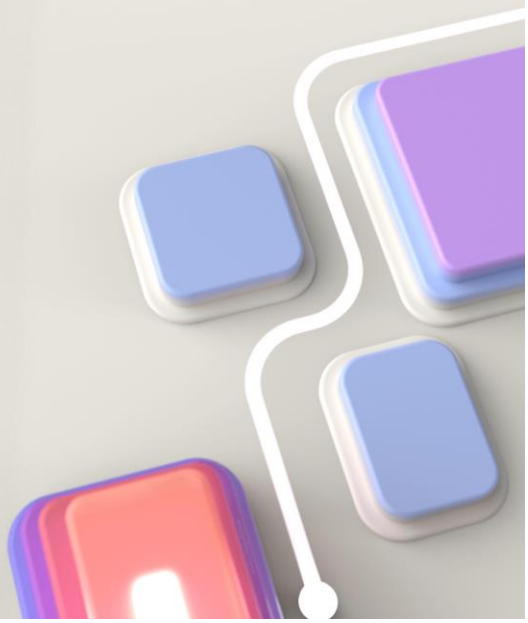
Design Power BI reports



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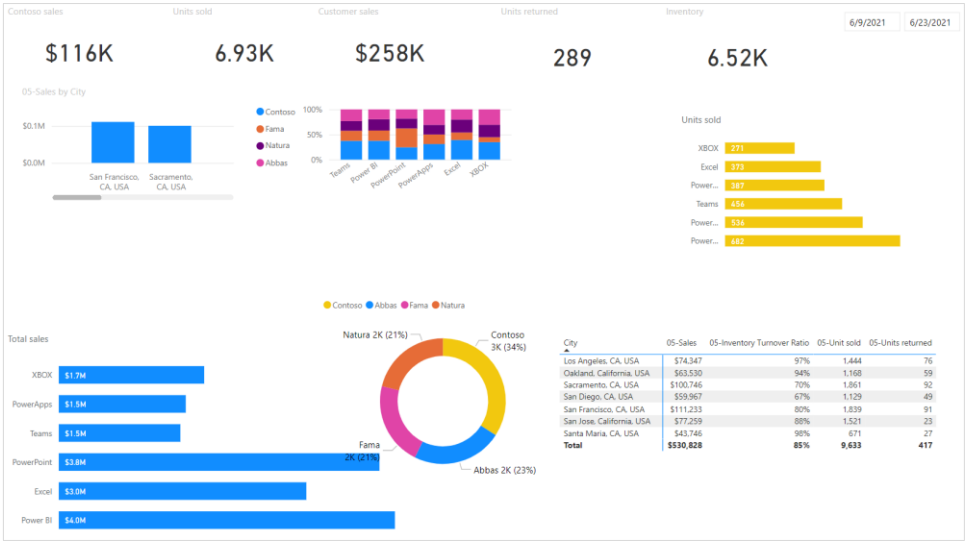
What do you think about this report?



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Design an appealing report layout

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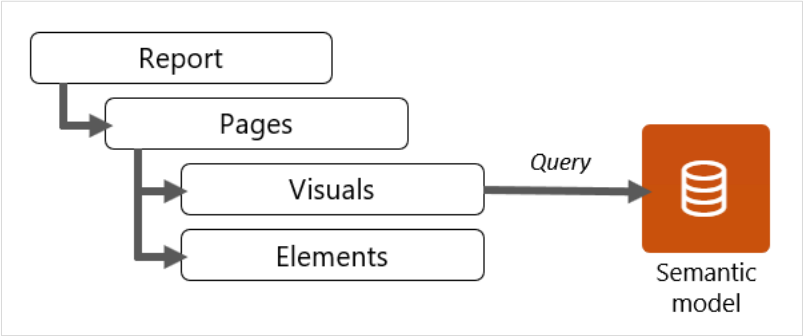
Report structure



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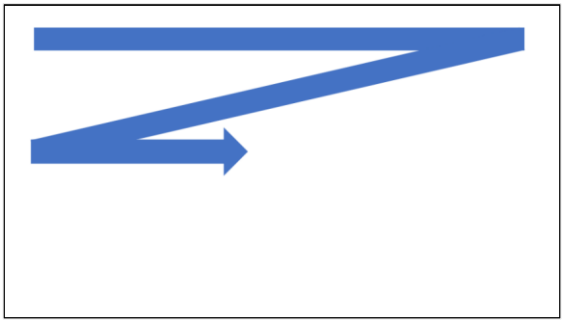
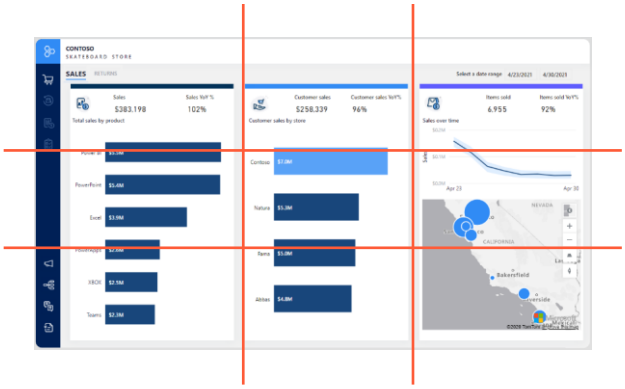
Design the report layout

Placement



Rule of thirds



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Margins and object spacing

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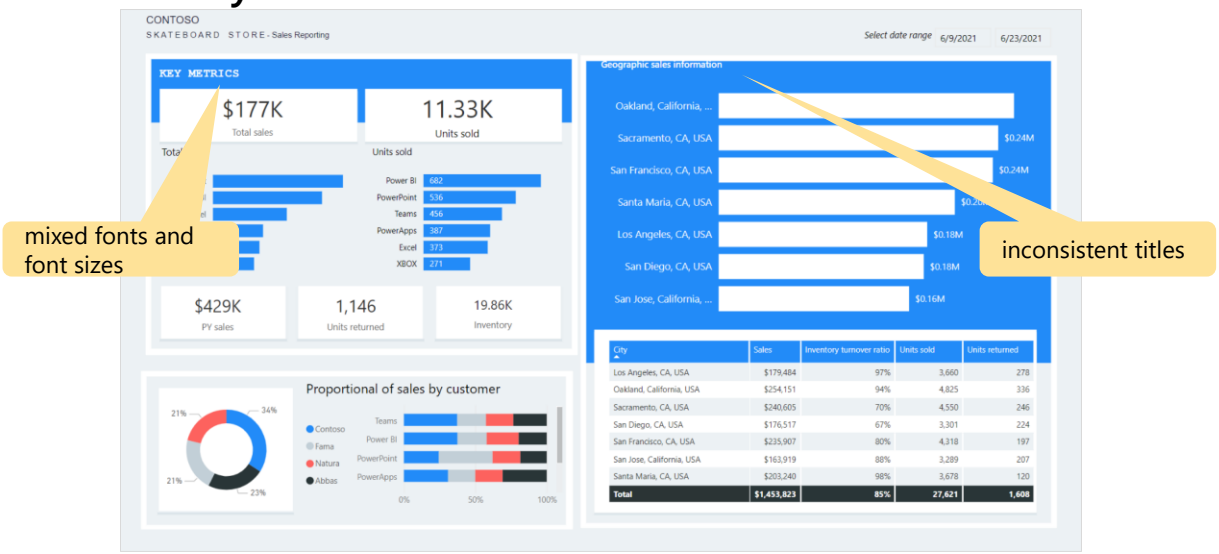
Consistency



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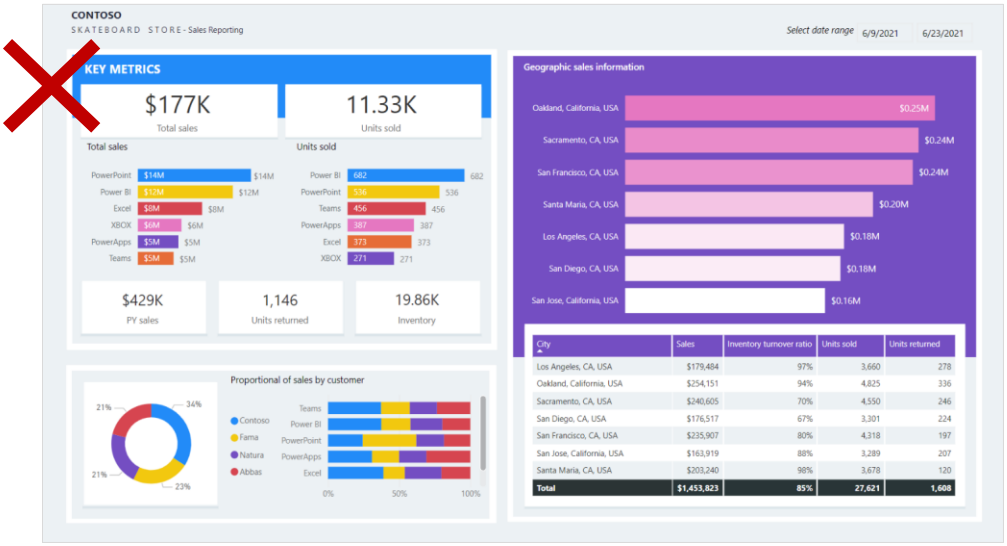
Use color sparingly and meaningfully



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Use color sparingly and meaningfully

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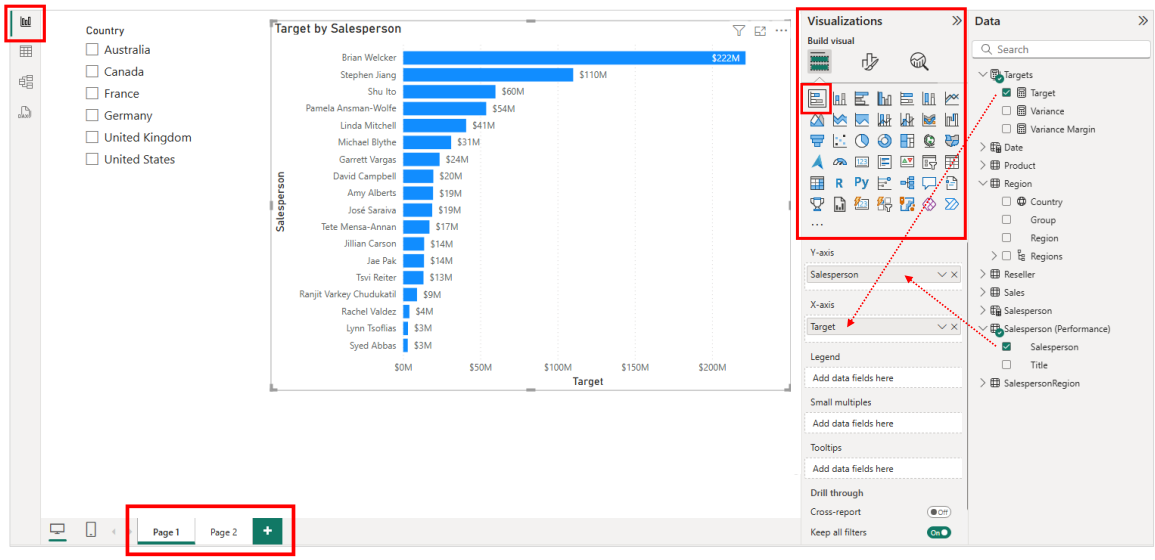
Add visualizations to reports



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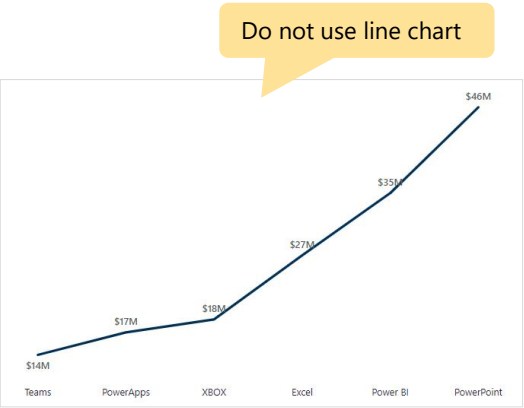
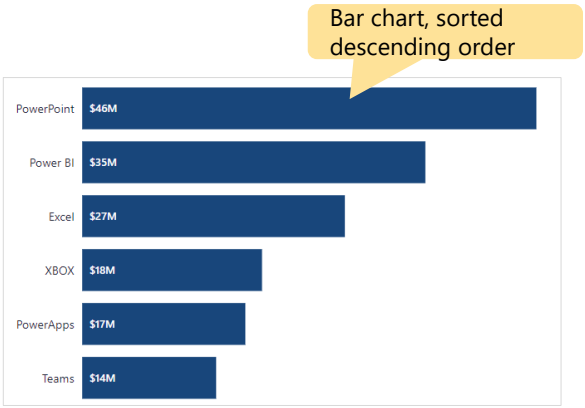
Categorical visuals





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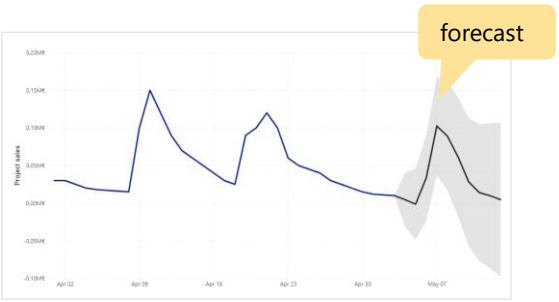
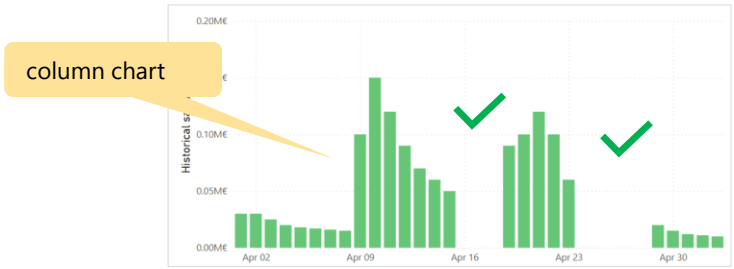
Time series visuals





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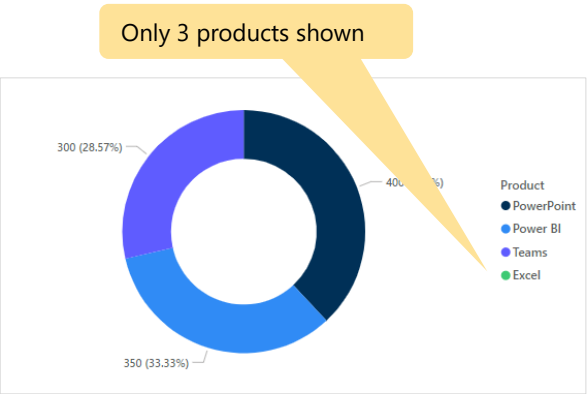
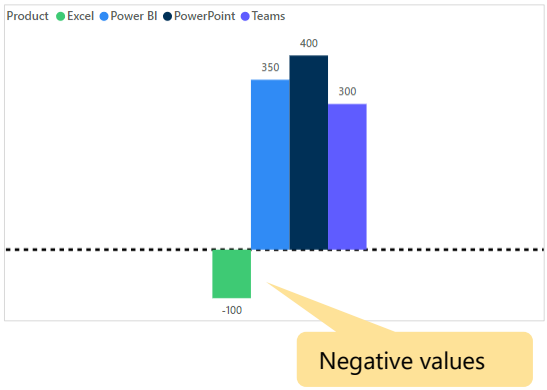
Proportional visuals





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Grid visuals

table

Product	Sales	Units sold
Power BI	$244,885	2,881
PowerPoint	$172,320	2,154
Excel	$102,250	2,045
Teams	$88,144	3,148
PowerApps	$80,496	2,236
XBOX	$74,400	1,860
Total	$762,495	14,324

matrix

Inventory on hand breakdown

City	On hand	Inventory turnover ratio	Days sales of inventory
Los Angeles, CA, USA	32	100%	
Power BI	2	100%	
Excel	0	100%	
PowerPoint	0	100%	
Teams	30	99%	
PowerApps	0	100%	
Total	1,706	97%	

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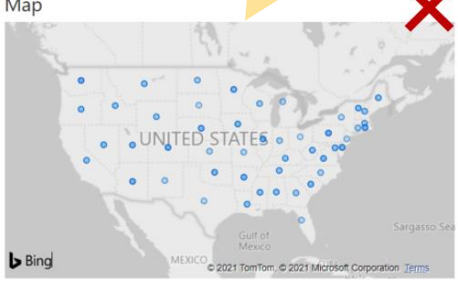
Geospatial visuals

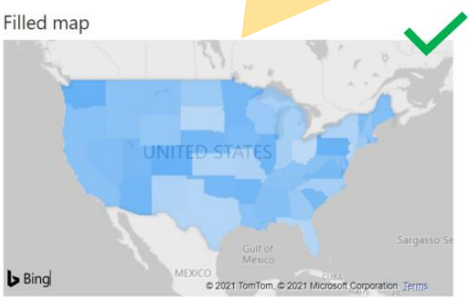
map, with bubbles

Map



filled map, color graduations

Filled map



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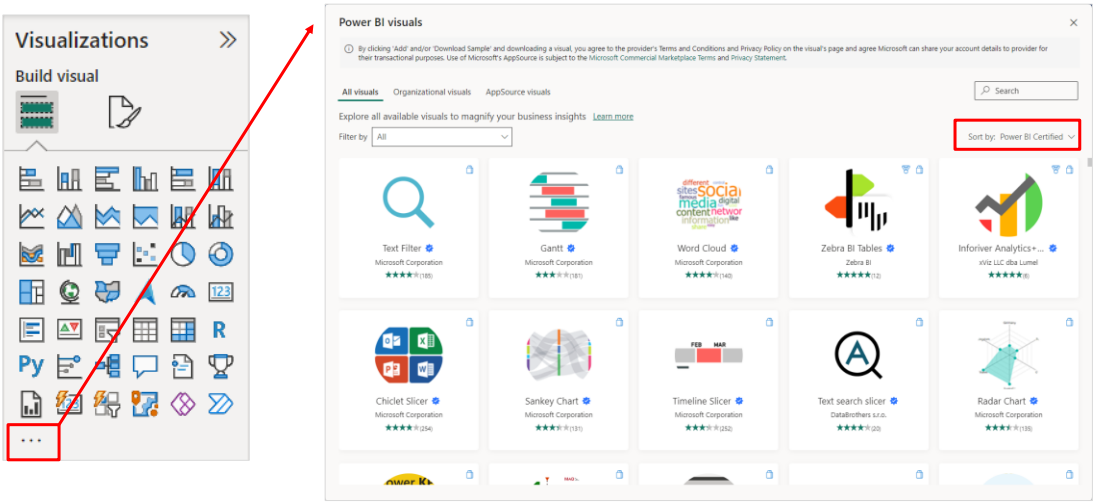
Import custom visuals from AppSource



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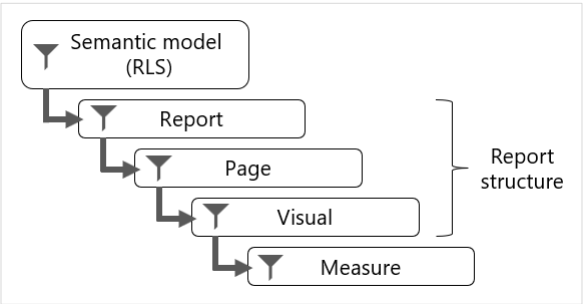
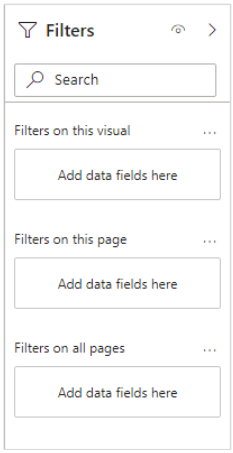
Report filtering

Filtering can occur at five different levels of a report.





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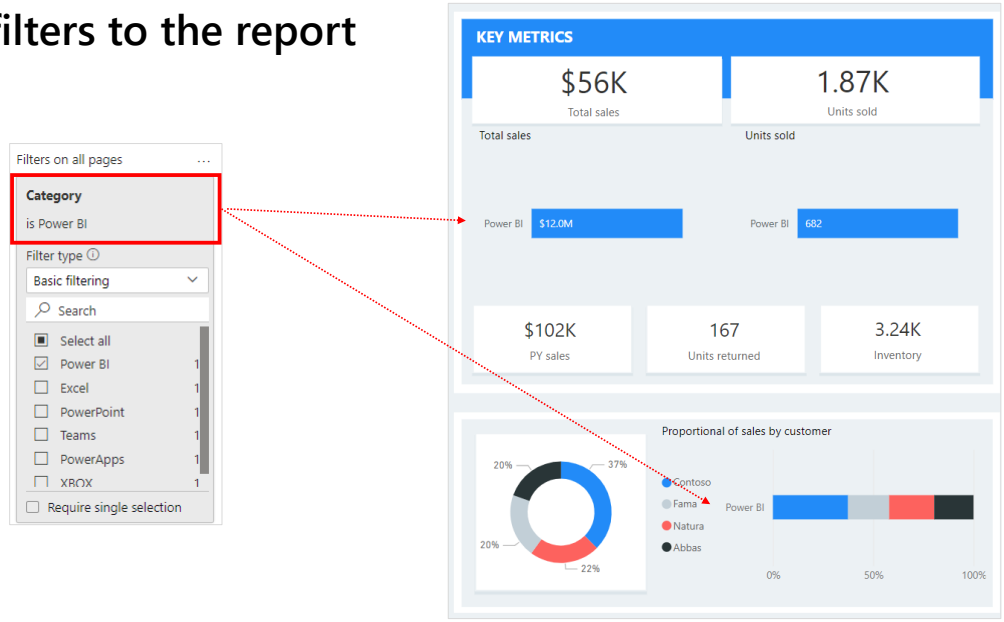
Apply filters to the report



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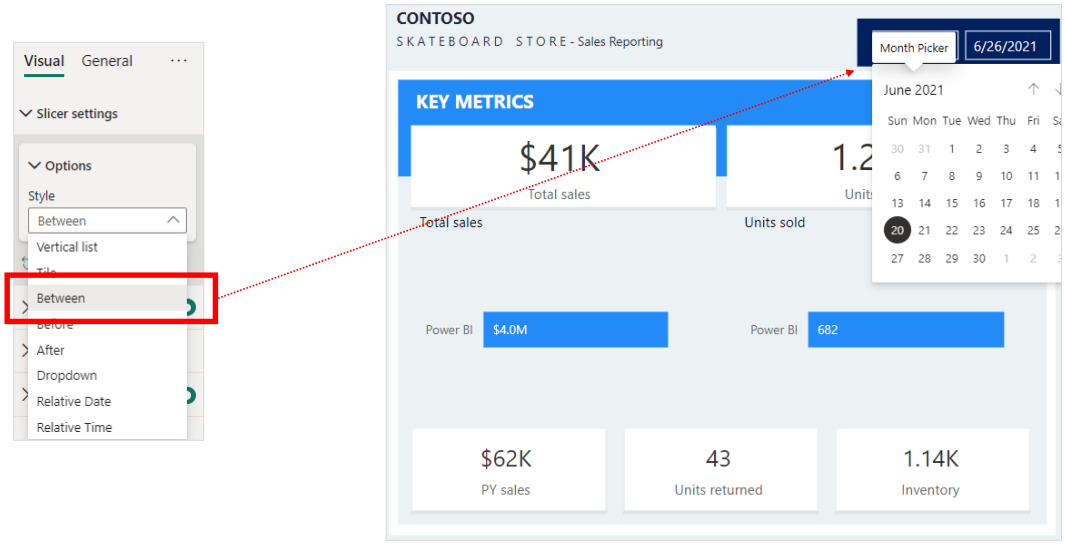
Apply filters with slicers



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Further reading

Design Power BI reports

https://learn.microsoft.com/training/modules/power-bi-effective-reports/

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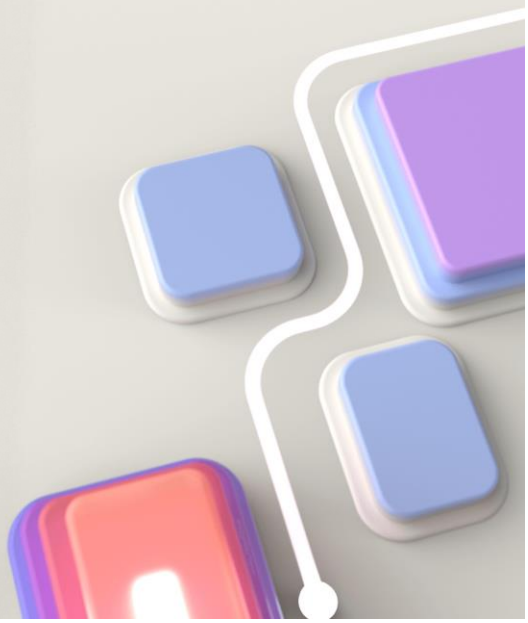
Enhance reports for user experience



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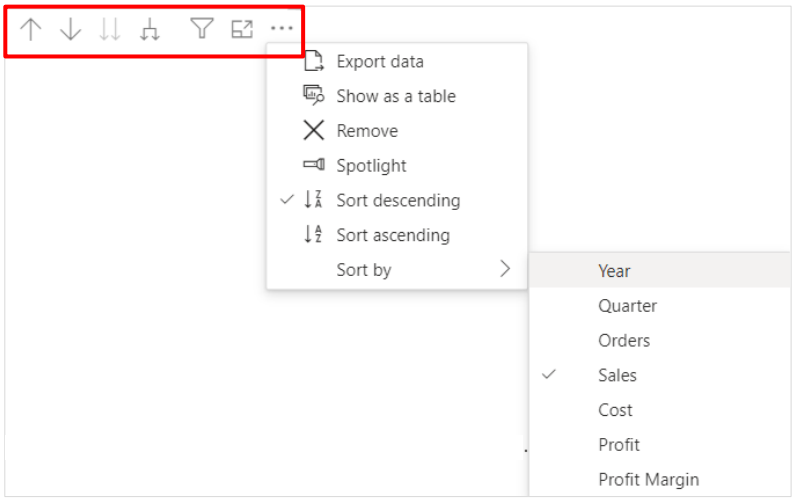
Sort visuals in the most effective order



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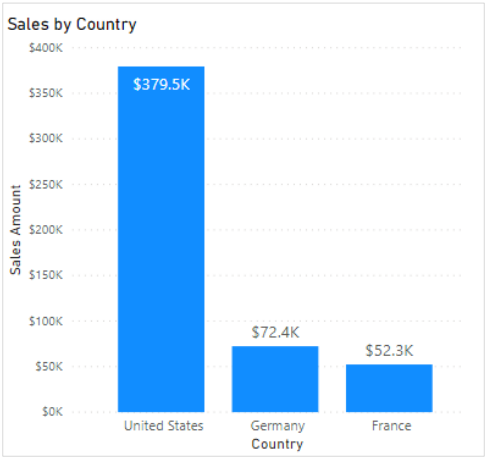
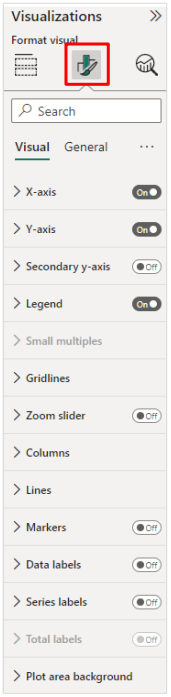
Format and configure visualizations

Common options:

- Title
- Background
- Border
- Font type/size/color
- Data labels
- Tooltips





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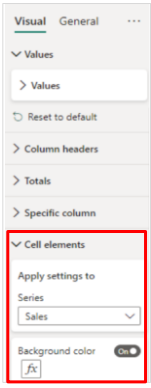
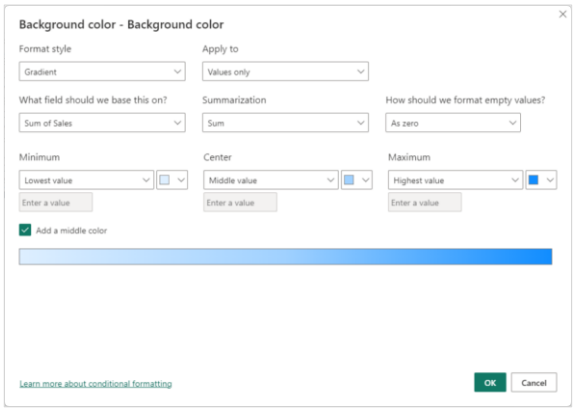
Configure conditional formatting

Enhance certain visuals with dynamic color schemes.





Region	Sales
Australia	$1,391,025
Canada	$13,875,633
Central	$7,633,387
France	$4,527,840
Germany	$1,877,743
Northeast	$6,715,354
Northwest	$12,004,822
Southeast	$7,638,607
Southwest	$18,001,116
United Kingdom	$3,883,043
Total	**$77,548,570**

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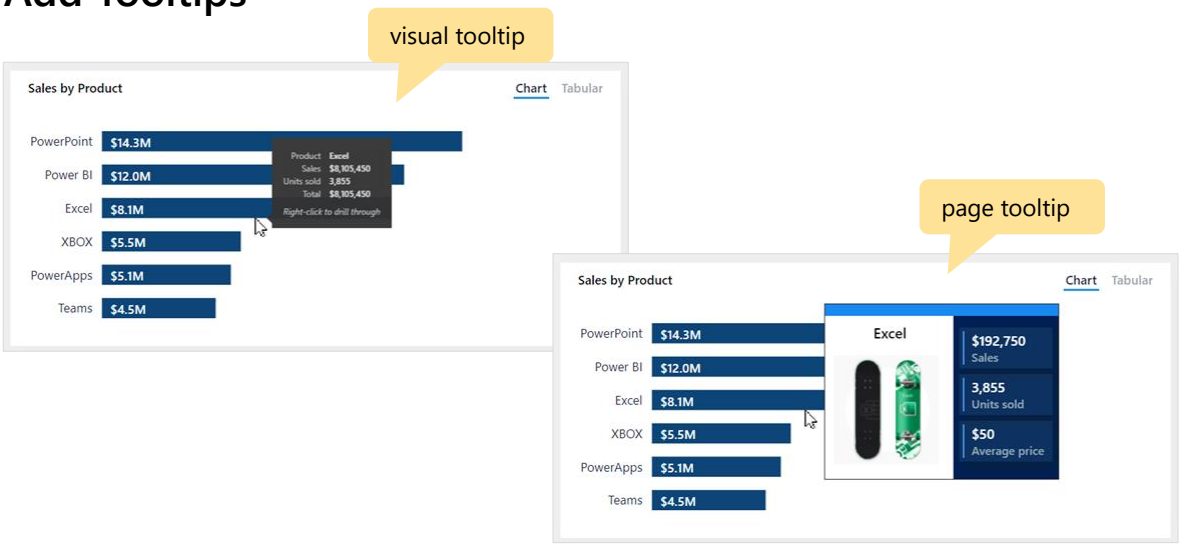
Add Tooltips



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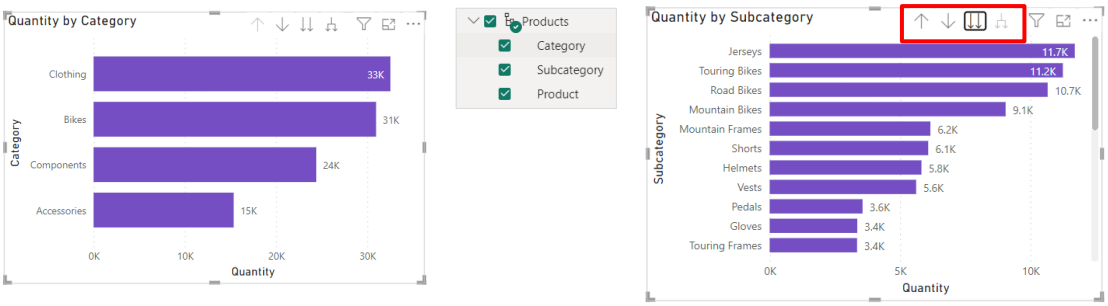
Drill down through a hierarchy in a visual



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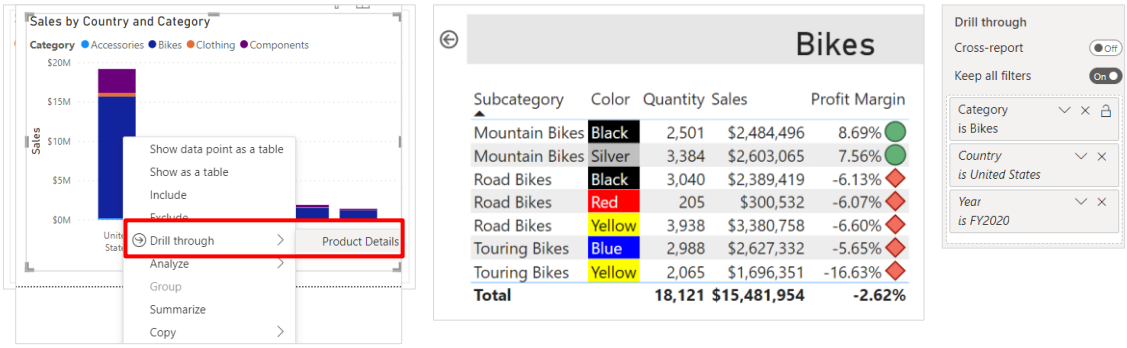
Drill through from one visual to another



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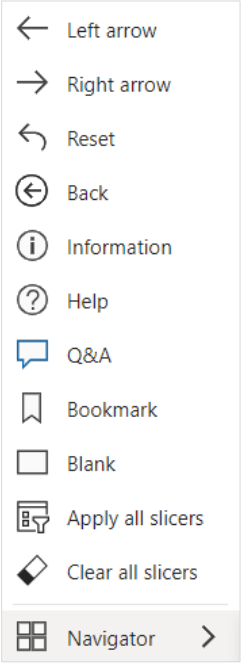
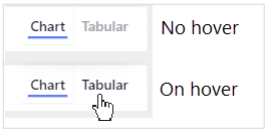
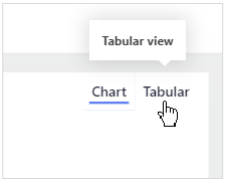
Add shapes and buttons

- Enhance reports with:
  - Text boxes
  - Images
  - Shapes
- Improve navigation with Buttons.







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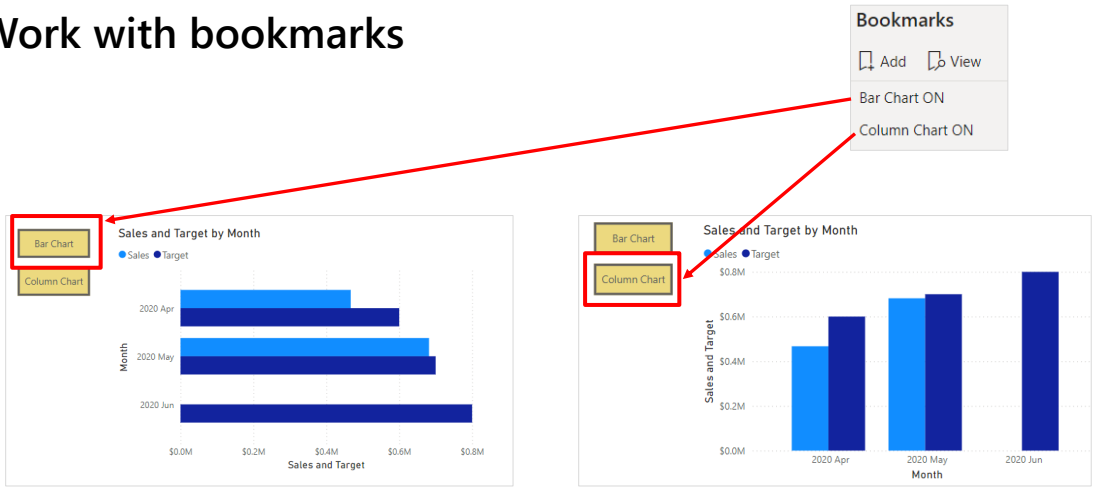
Work with bookmarks



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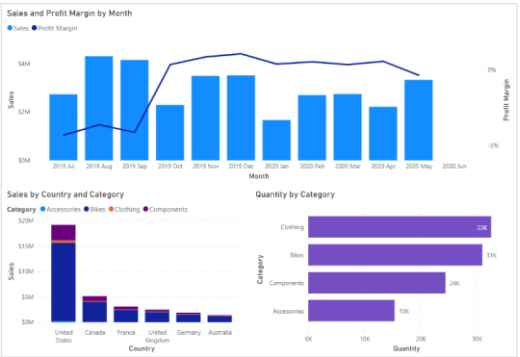
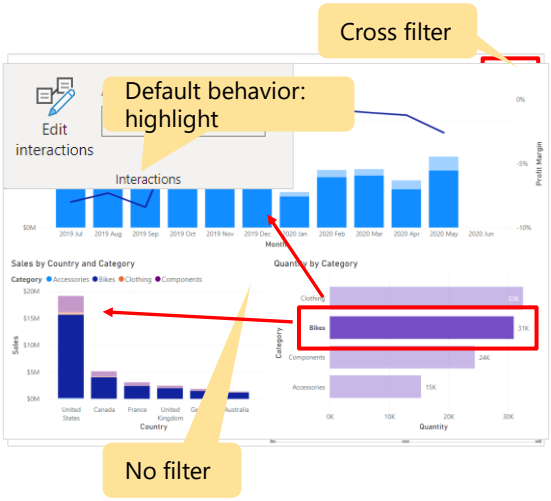
Cross-highlight between visuals





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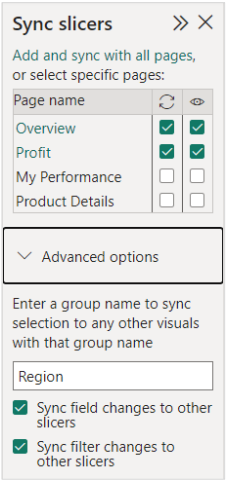
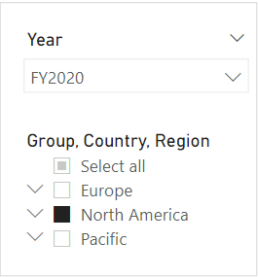
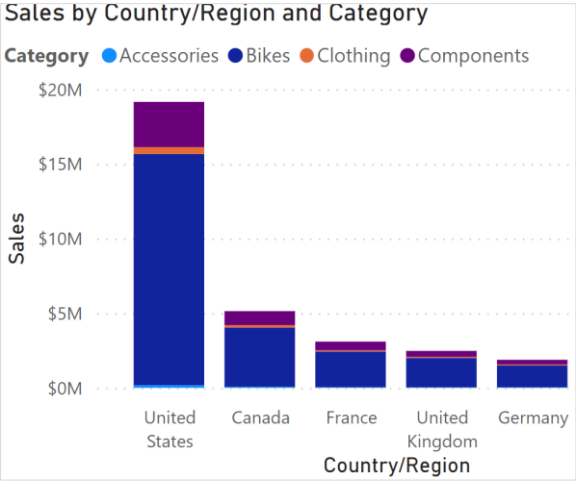
Sync slicers







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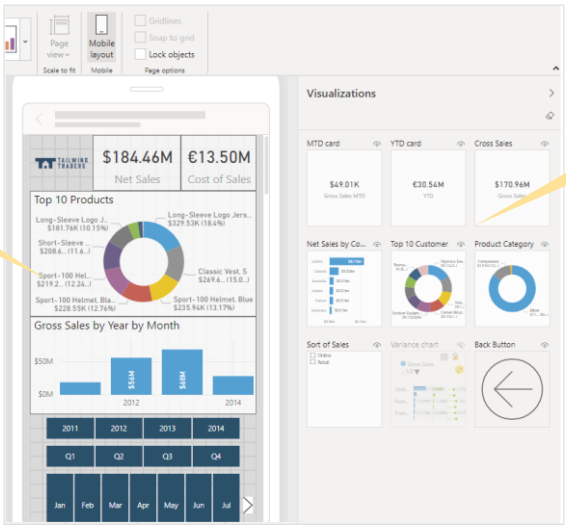
Design for mobile use

Optimize report layout for scrolling



Select included visuals and slicers

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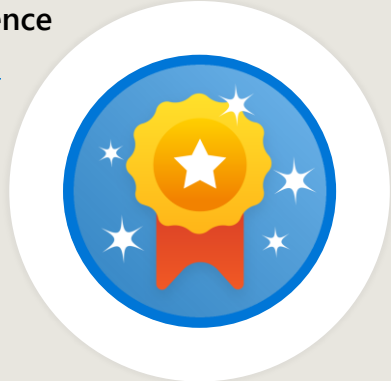
Further reading

Enhance Power BI report designs for the user experience

https://learn.microsoft.com/training/modules/power-bi-effective-user-experience/



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Perform analytics in Power BI

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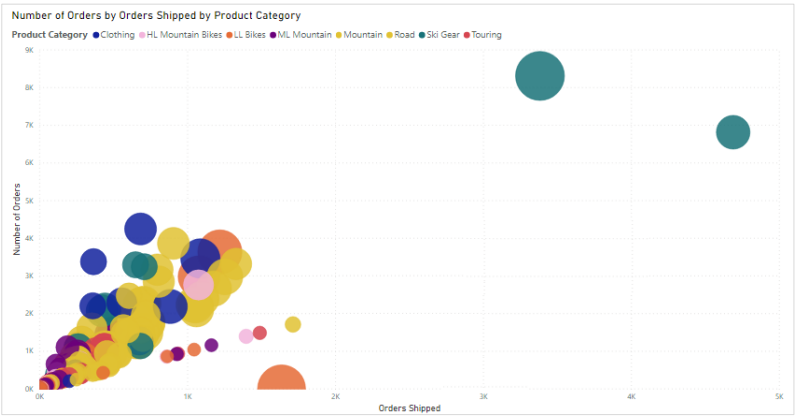
Identify outliers in data

- Unexpected deviations in data.
- Scatter charts can detect outliers.
- Use DAX to define and analyze outliers dynamically.



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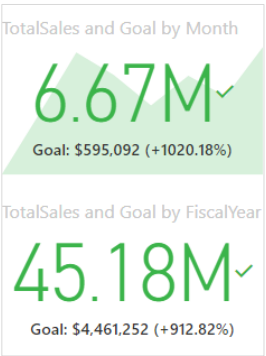
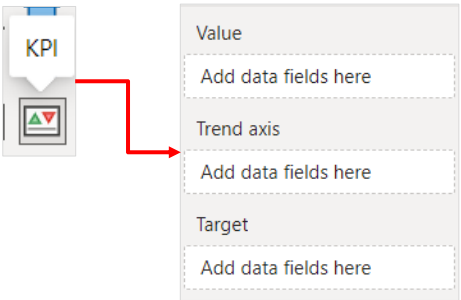
Key Performance Indicator visual

At-a-glance insights into performance against predefined targets.





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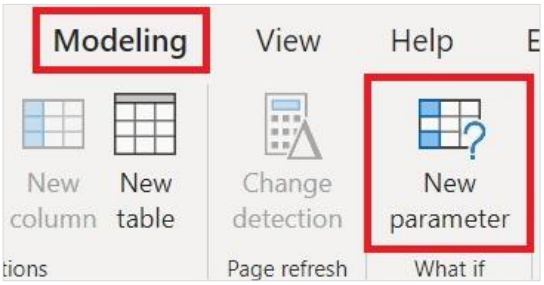
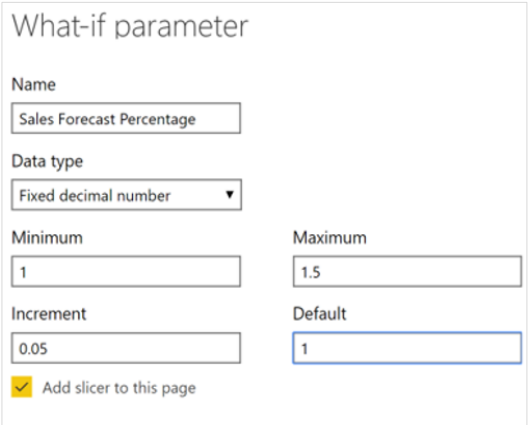
What-if parameters

Enable scenario planning and interactive exploration for better decision-making.





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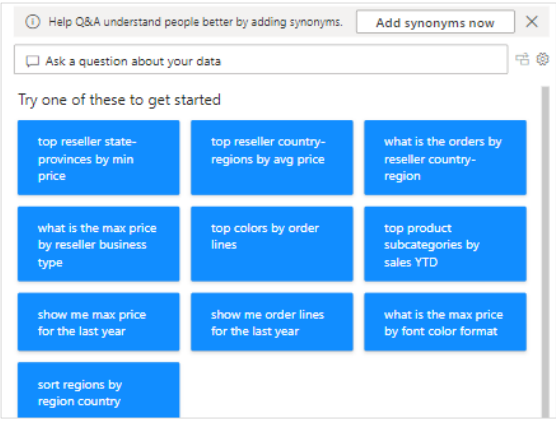
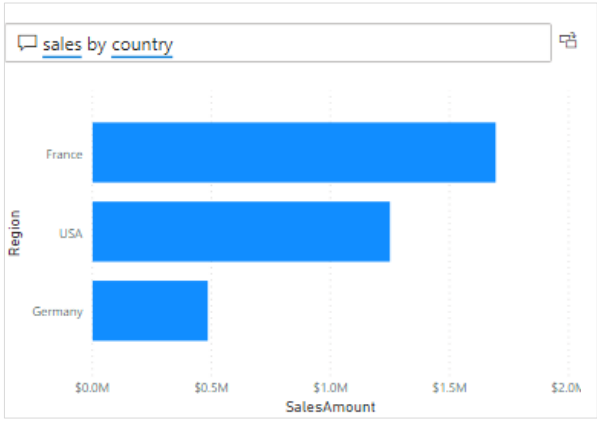
AI in the Q&A feature

Use natural language to ask questions about data and create visuals for insights.





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Decomposition tree visual

Visualize data hierarchies for in-depth exploration and pattern discovery.

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Further reading

Perform analytics in Power BI

https://learn.microsoft.com/training/modules/perform-analytics-power-bi/

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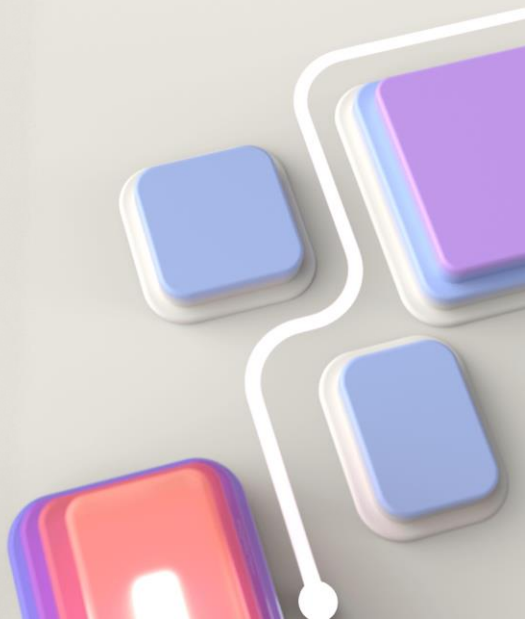
Optimize model performance (optional)



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Use variables to improve performance and readability

Without variable:

```
Sales YoY Growth =
   DIVIDE (
       ( [Sales] - CALCULATE ( [Sales], PARALLELPERIOD ( 'Date'[Date], -12, MONTH ) ) ),
       CALCULATE ( [Sales], PARALLELPERIOD ( 'Date'[Date], -12, MONTH ) ) )
```

With variable:

```
Sales YoY Growth =
     VAR SalesPriorYear = CALCULATE ( [Sales], PARALLELPERIOD ( 'Date'[Date], -12, MONTH ) )
     VAR SalesVariance =  DIVIDE ( ( [Sales] - SalesPriorYear ), SalesPriorYear )
  RETURN
  SalesVariance
```

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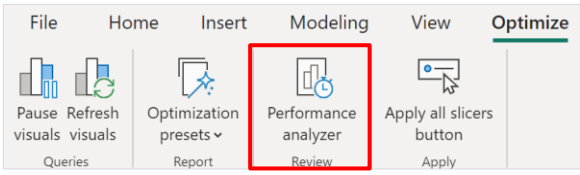
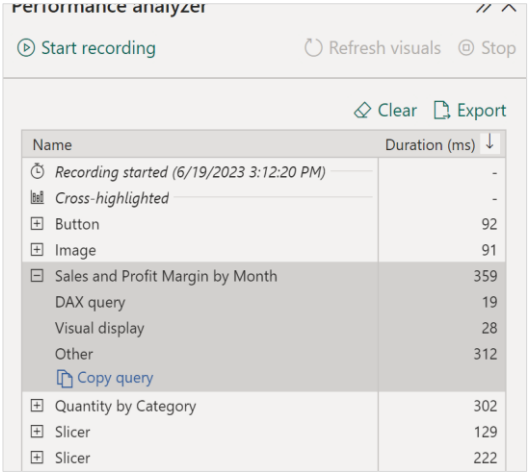
Tune report performance

Performance analyzer in Power BI Desktop

- Record report interactions.
- Review query and rendering times.
- Identify bottlenecks, optimize queries.





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Analyze query plans for optimization opportunities

```
Count Customers =
CALCULATE (
    DISTINCTCOUNT ( Order[ProductID] ),
    FILTER ( Order, Order[OrderQty] >= 5 )
)
```

```
Count Customers =
CALCULATE (
    DISTINCTCOUNT ( Order[ProductID] ),
    KEEPFILTERS (Order[OrderQty] >= 5 )
)
```

Sales by Year	
DAX query	2754
Visual display	57
Other	160
Copy query	

Sales by Year	
DAX query	54
Visual display	57
Other	160
Copy query	

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Further reading

Optimize a model for performance in Power BI

https://learn.microsoft.com/training/modules/optimize-model-power-bi/

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Manage workspaces in Power BI

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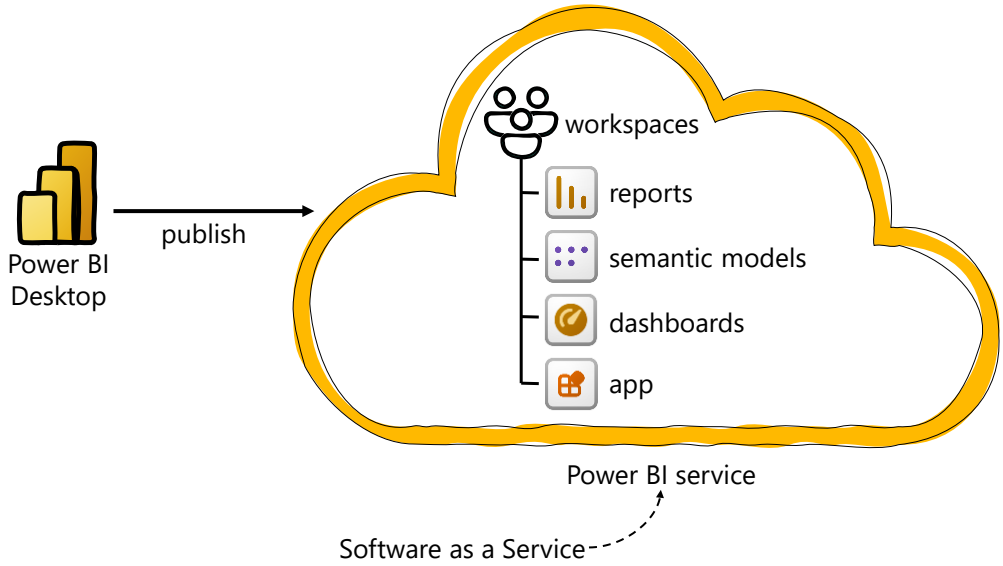
Understand the Power BI Service



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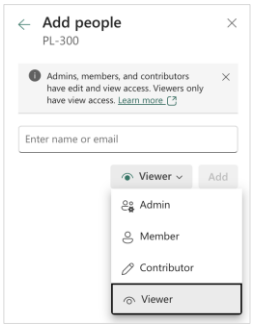
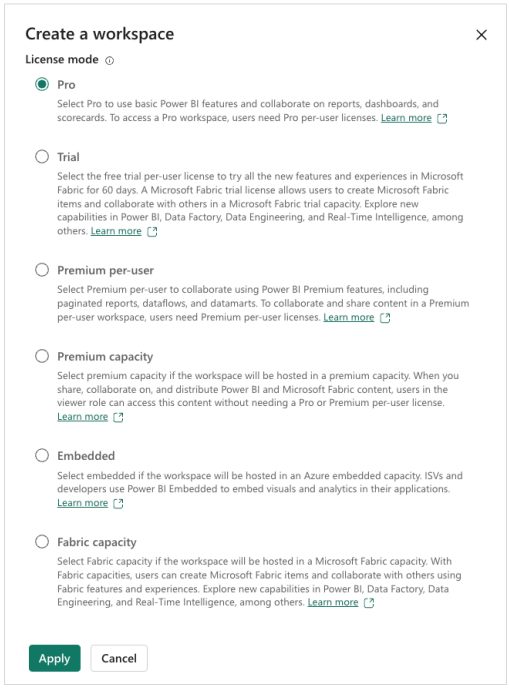
Understand Workspaces

- My Workspace vs Shared Workspaces
- License mode
- Grant access to a workspace





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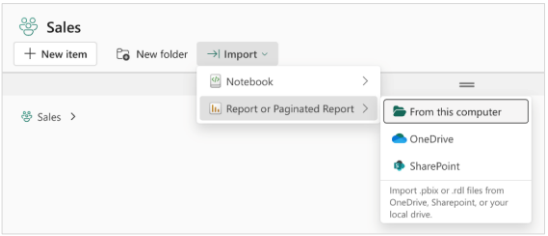
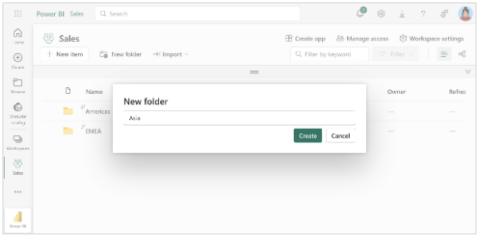
Publish to Power BI Service

Publish from Power BI Desktop

Upload a Power BI report



Organize items in folders



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Further reading

Manage workspaces in Power BI

https://learn.microsoft.com/training/modules/manage-workspaces-power-bi-service/

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