★★★★★ *With Best-Selling Instructors* ***Chris Dutton*** *&* ***Aaron Parry***

MAVEN® ANALYTICS

COURSE STRUCTURE

This is a **project-based course** designed for students looking for a practical, hands-on, and highly engaging approach to learning Power BI Desktop for business intelligence

Course resources include:

- **Downloadable PDF eBook** (*200+ pages*) containing all course slides, assignments and reference materials
- **Quizzes** and **Assignments** to reinforce key concepts and simulate real-world scenarios, with step-by-step solution videos
- Complete **Bonus Project** to test your abilities and apply the skills developed throughout the course to a brand-new data set

COURSE OUTLINE

1	**Introducing Power BI Desktop**	*Installing Power BI Desktop, exploring the Power BI workflow, comparing Power BI vs. Excel, etc.*
2	**Connecting & Shaping Data**	*Connecting to data, shaping & transforming tables, using profiling tools, editing, merging & appending queries, etc.*
3	**Creating a Data Model**	*Building relational models, creating table relationships, understanding cardinality and filter flow, etc.*
4	**Calculating Measures with DAX**	*Understanding DAX syntax, adding calculated columns and measures, writing common formulas and functions, etc.*
5	**Visualizing Data with Dashboards**	*Inserting charts and visuals, customizing formats, editing interactions, applying filters and bookmarks, etc.*
6	**Optimizing Power BI Performance**	*Exploring common Power BI optimization tools within the Optimize and External tools menus*

COURSE PROJECT

THE SITUATION

You've just been hired as a Business Intelligence Analyst by **AdventureWorks***, a global manufacturing company that produces cycling equipment and accessories

THE BRIEF

The management team needs a way to **track KPIs** (*sales*, *revenue*, *profit*, *returns*), **compare regional performance**, **analyze product-level trends**, and **identify high-value customers**.

All you've been given is a **folder of raw csv files**, which contain information about transactions, returns, products, customers, and sales territories.

THE OBJECTIVE

Use Power BI Desktop to:

- Connect and transform the raw data
- Build a relational data model
- Create calculated columns and measures with DAX
- Design an interactive dashboard to visualize the data

**This data is provided by Microsoft for informational purposes only as an aid to illustrate a concept. These samples are provided "as is" without warranty of any kind. The example companies, organizations, products, domain names, e-mail addresses, people, places, and events depicted herein are fictitious, and no association with any real company, organization, product, domain name, e-mail address, person, place, or event is intended or should be inferred.*

SETTING EXPECTATIONS

1 What you see on your screen **may not always match mine**

- *Power BI Desktop features are updated frequently, with new versions released each month*
- ***NOTE:** Power BI is currently only compatible with PC/Windows (not available for Mac)*

2 This course is designed to help you build **foundational skills**

- *Our goal is to help you build a deep foundational understanding of the Power BI desktop workflow; some topics may be simplified, and we won't cover some advanced tools (M code, advanced DAX, R/Python visuals, etc.)*

3 This is a **hands-on** and **project-based** learning experience

- *You will get the most value out of this course if you follow along closely with the demos and assignments; we'll be working through the entire BI workflow to create a professional-quality dashboard from scratch*

4 We will not cover **Power BI Service** as part of this course

- *This course focuses on Power BI Desktop specifically; online sharing and collaboration features (app.powerbi.com) require a separate account and are covered in-depth in a separate course*

INTRODUCING POWER BI

MEET POWER BI

In this section we'll **introduce Power BI Desktop**, review the download and installation process, adjust default settings, and explore the Power BI interface and workflow

TOPICS WE'LL COVER:

- **Introducing Power BI**
- **Power BI vs. Excel**
- **Installation Options**
- **Adjusting Settings**
- **Interface & Workflow**
- **Helpful Resources**

GOALS FOR THIS SECTION:

- Download and install Power BI Desktop, and adjust the settings for our course project
- Understand the role that Power BI plays within the broader Microsoft ecosystem
- Explore core components of the Power BI Desktop interface
- Review the business intelligence workflow that we'll follow as we build our course project

MEET POWER BI

Power BI

Microsoft Power BI is a self-service business intelligence platform, which includes both desktop and web-based applications for connecting, modeling, and visualizing data

Learn more at **powerbi.microsoft.com**

Figure 1: Magic Quadrant for Analytics and Business Intelligence Platforms

WHY POWER BI?

Connect, transform and load millions of rows of data

- *Access data from virtually anywhere (database tables, flat files, web, cloud services, folders, etc.), and create fully automated workflows to extract, transform and load data for analysis*

Build relational models to blend data from multiple sources

- *Create table relationships to analyze holistic performance across an entire relational data model*

Define complex calculations using Data Analysis Expressions (DAX)

- *Enhance datasets and enable advanced analytics with powerful and portable DAX expressions*

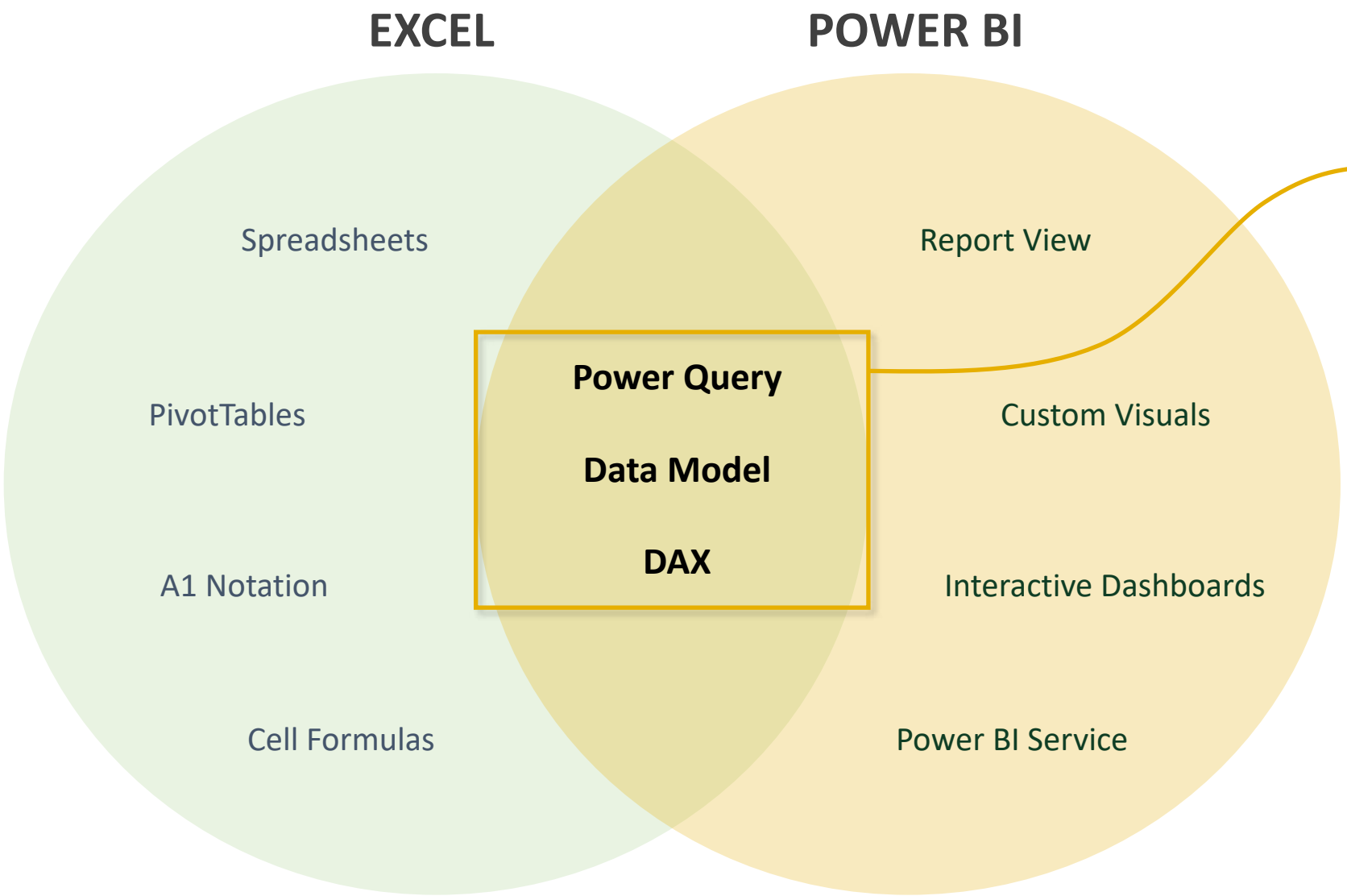
Bring data to life with interactive reports and dashboards

- *Build professional-quality reports and dashboards with best-in-class visualization tools*

Develop a versatile, in-demand skill set

- *Power BI is the industry leader in self-service BI, and the skills you build in this course will be highly transferrable*

EXCEL VS. POWER BI



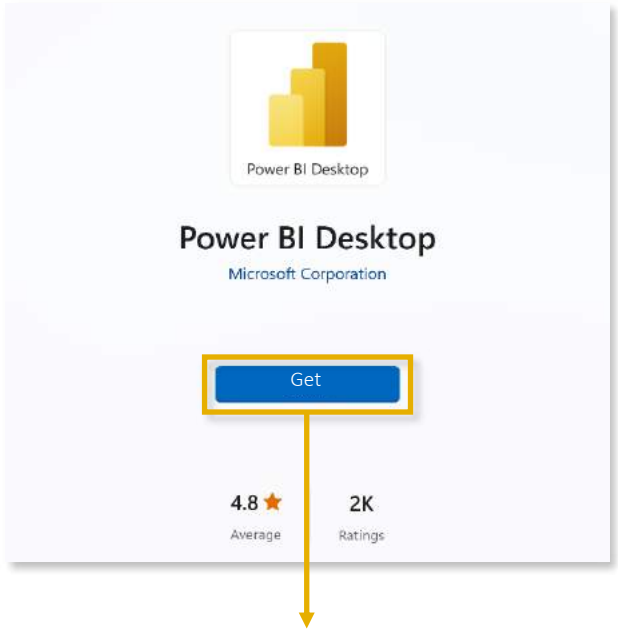
Excel and Power BI are built on top of the **same analytics engines**

- Power BI takes the same data transformation and modeling capabilities and adds **powerful visualization and publishing tools**
- Transitioning is easy; you can import an **entire data model** directly from Excel!

INSTALLING POWER BI DESKTOP

1) Download from **Microsoft store**

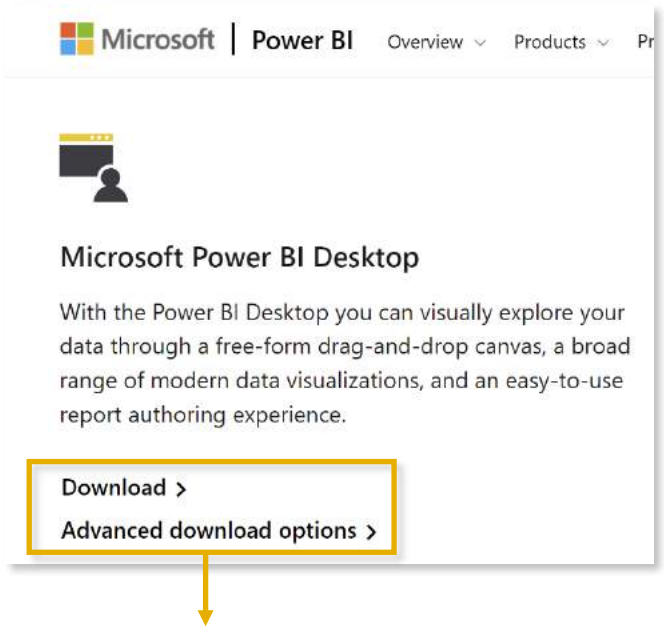
apps.microsoft.com



- Windows handles **automatic updates**
- Updates only elements that have been changed
- Doesn't require administrator access

2) Download **manually from web**

powerbi.microsoft.com/downloads



- **No automatic updates** (allows version control)
- Downloads an executable installation file
- Administrator access may be required

3) Install as part of **Microsoft 365**

microsoft.com/en-us/microsoft-365

Office 365

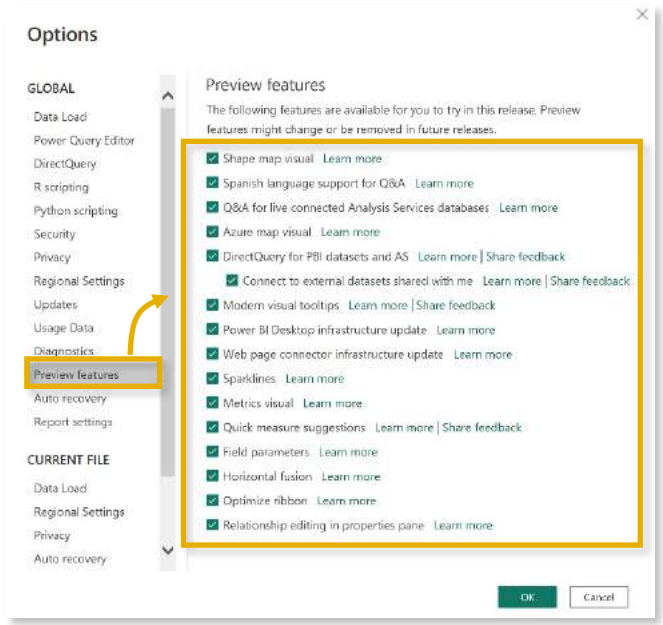
- Power BI Desktop is included as part of select enterprise Office/Microsoft 365 subscriptions
- If your company uses a compatible version of Microsoft 365, talk to an admin about getting access to Power BI

HEY THIS IS IMPORTANT!

You do **NOT** need to register for a Power BI Pro account to access Power BI Desktop

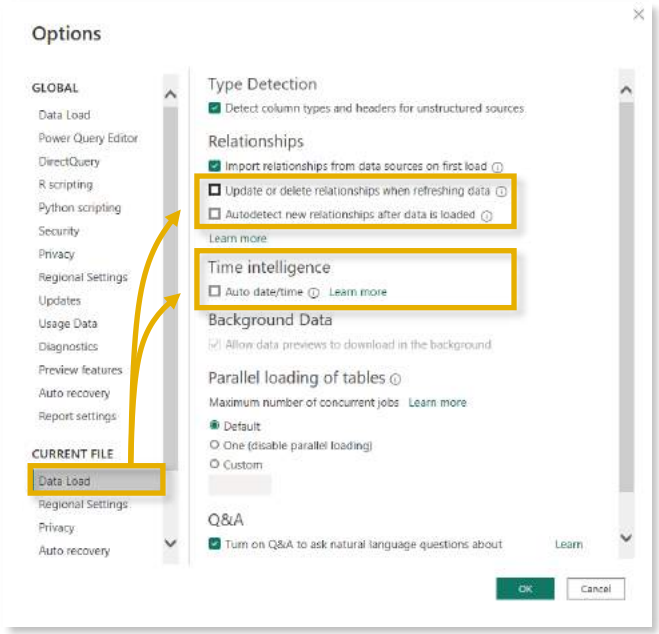
POWER BI SETTINGS

Global > **Preview Features**



Select **all available preview features** by default (these change with each monthly release)

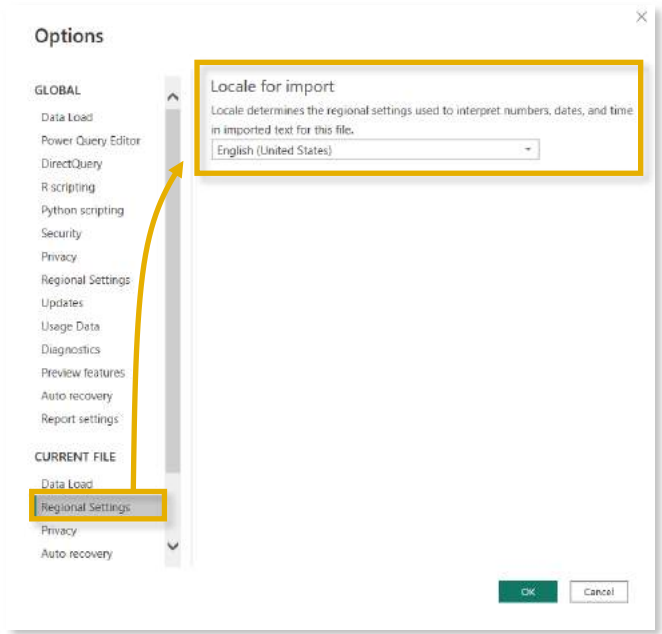
Current File > **Data Load**



Make sure the following options are **NOT selected**:

- ***Update or delete relationships when refreshing data***
- ***Autodetect new relationships after data is loaded***
- ***Time Intelligence > Auto date/time***

Current File > **Regional Settings**



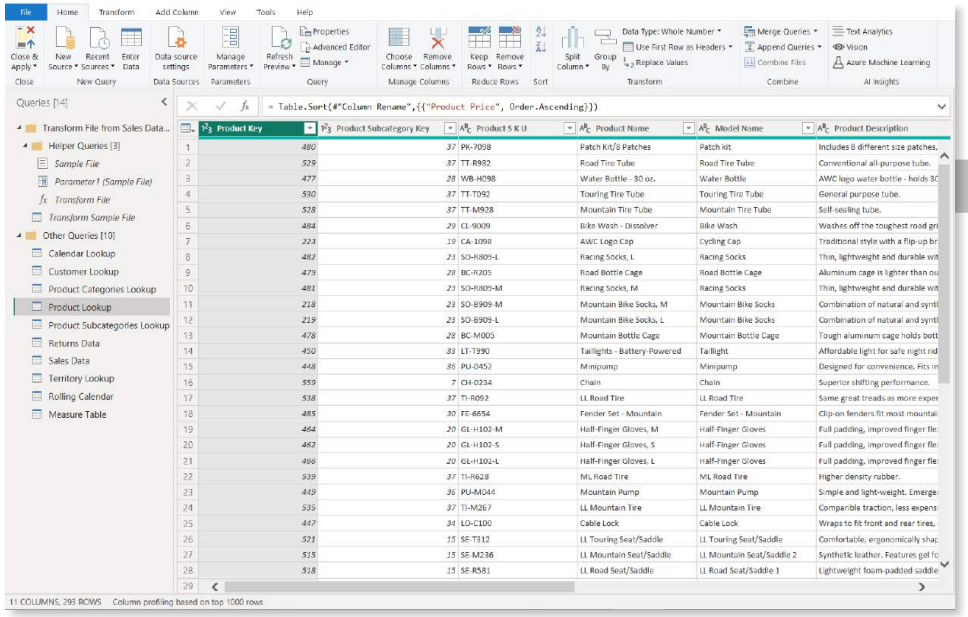
Select ***"English (United States)"*** from the dropdown menu (this will align with the data in course project files)

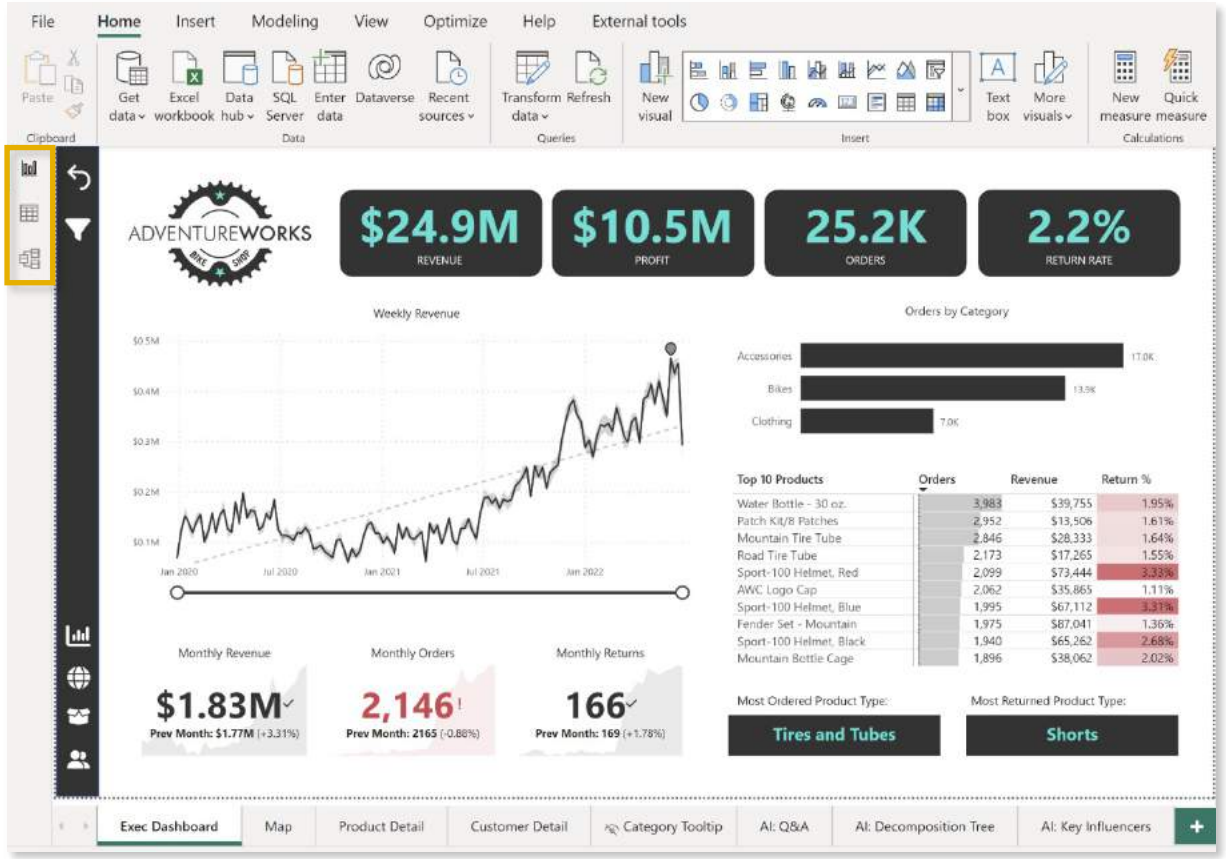
HEY THIS IS IMPORTANT!

Options under **CURRENT FILE** need to be adjusted **every time you open a new Power BI workbook** (these settings do not persist across new .pbix files)

POWER BI WORKFLOW

Raw data is extracted and transformed in the **Power Query editor**, then loaded to the Power BI "front-end"





Power Query Editor

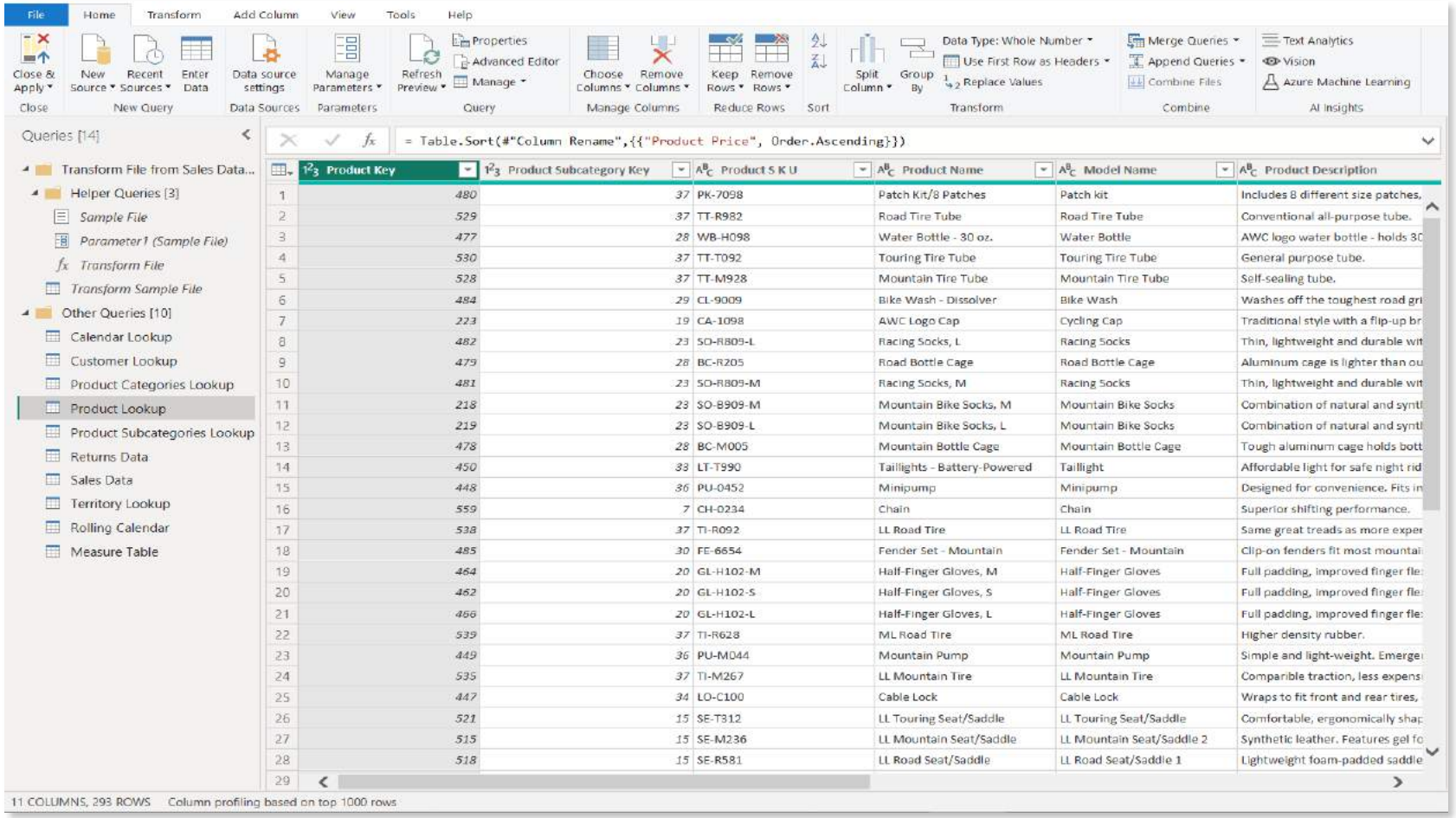
Model View **Data View** **Report View**

Power BI "Back-End"

Power BI "Front-End"

POWER BI WORKFLOW

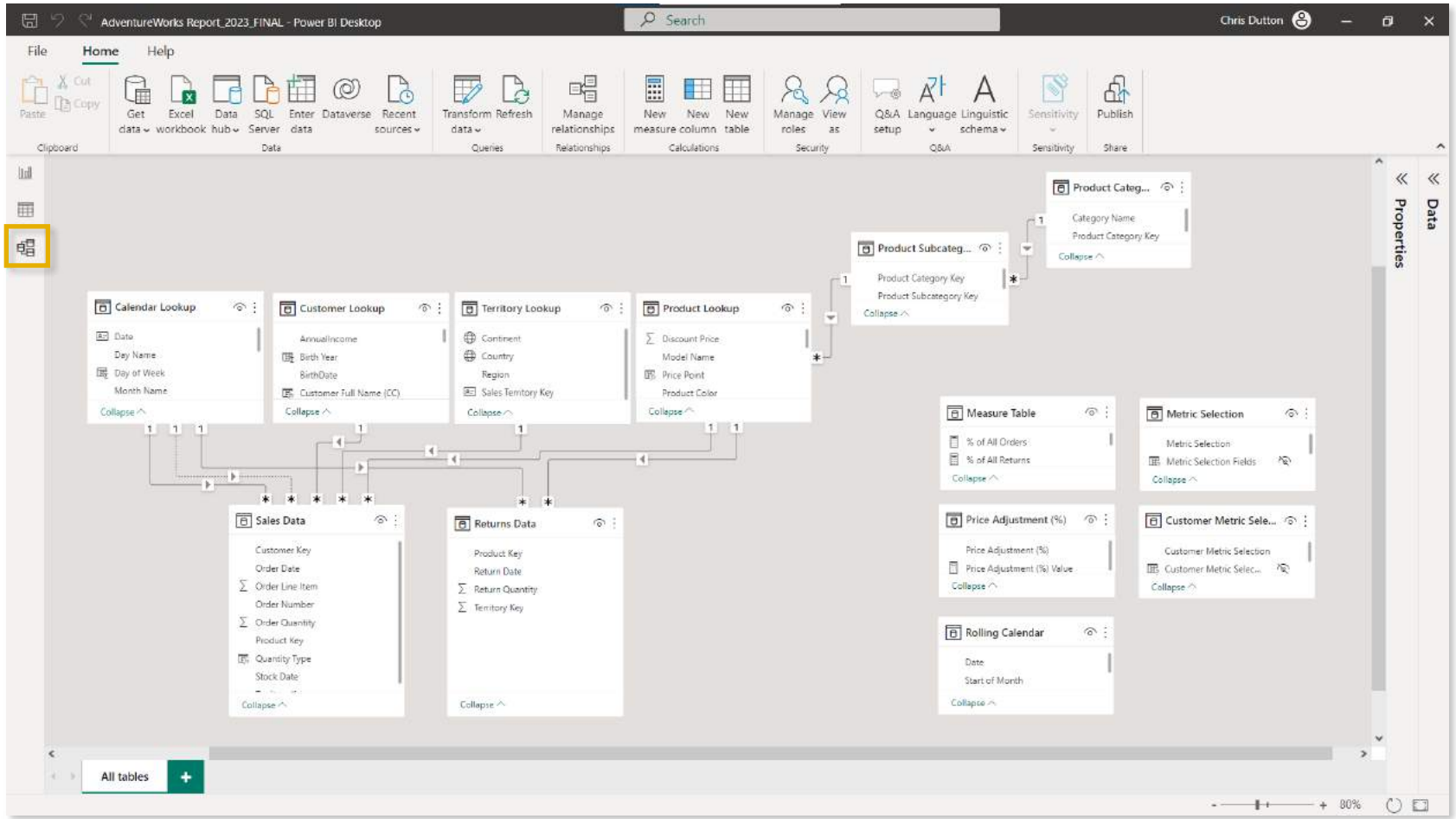
Power Query Editor | Model View | Data View | Report View



1 Data is loaded & transformed in the **Power Query Editor**

POWER BI WORKFLOW

Power Query Editor | **Model View** | Data View | Report View

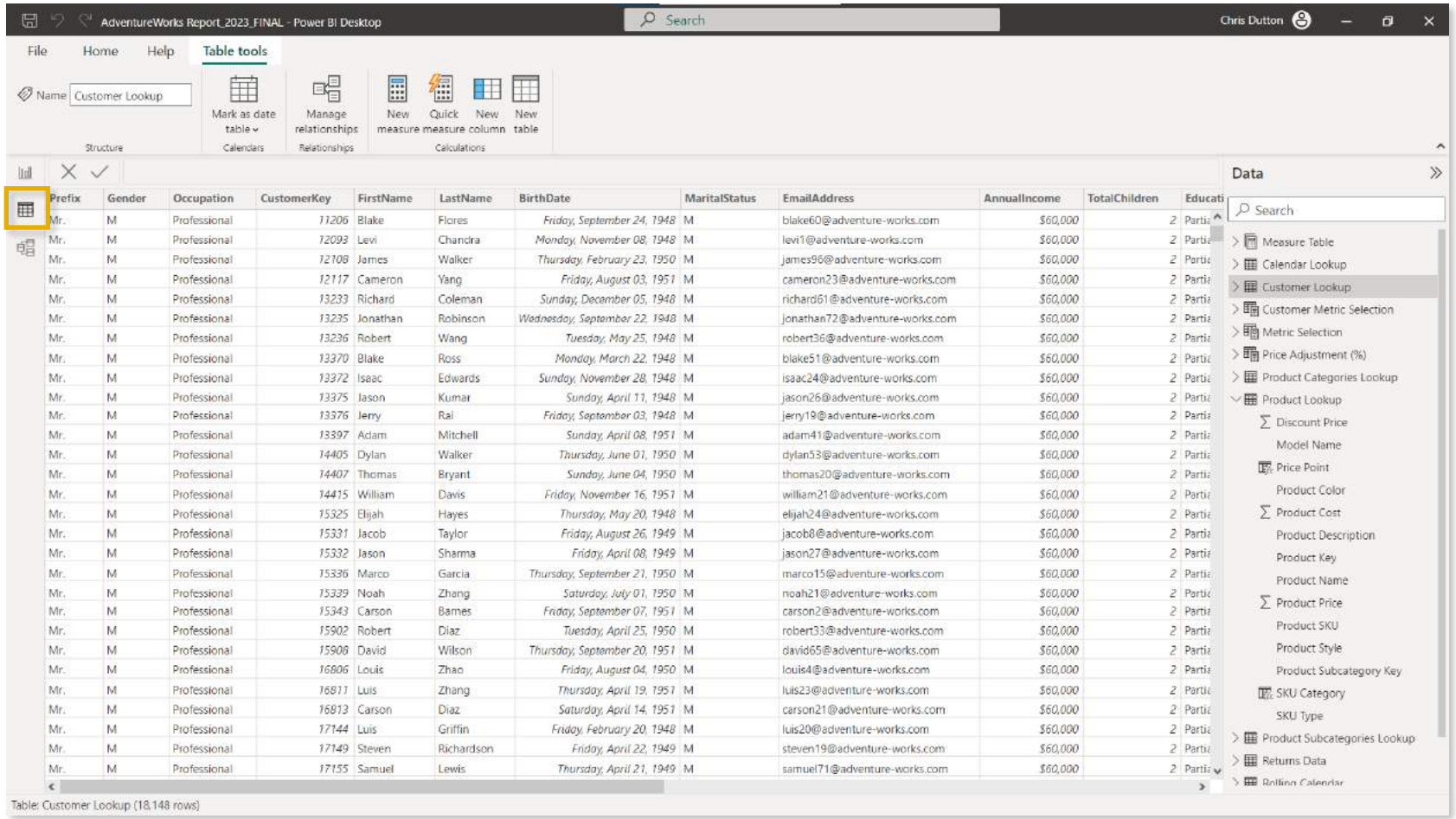


1 Data is loaded & transformed in the **Power Query Editor**

2 Data models are configured in the **Model View**

POWER BI WORKFLOW

Power Query Editor | Model View | **Data View** | Report View

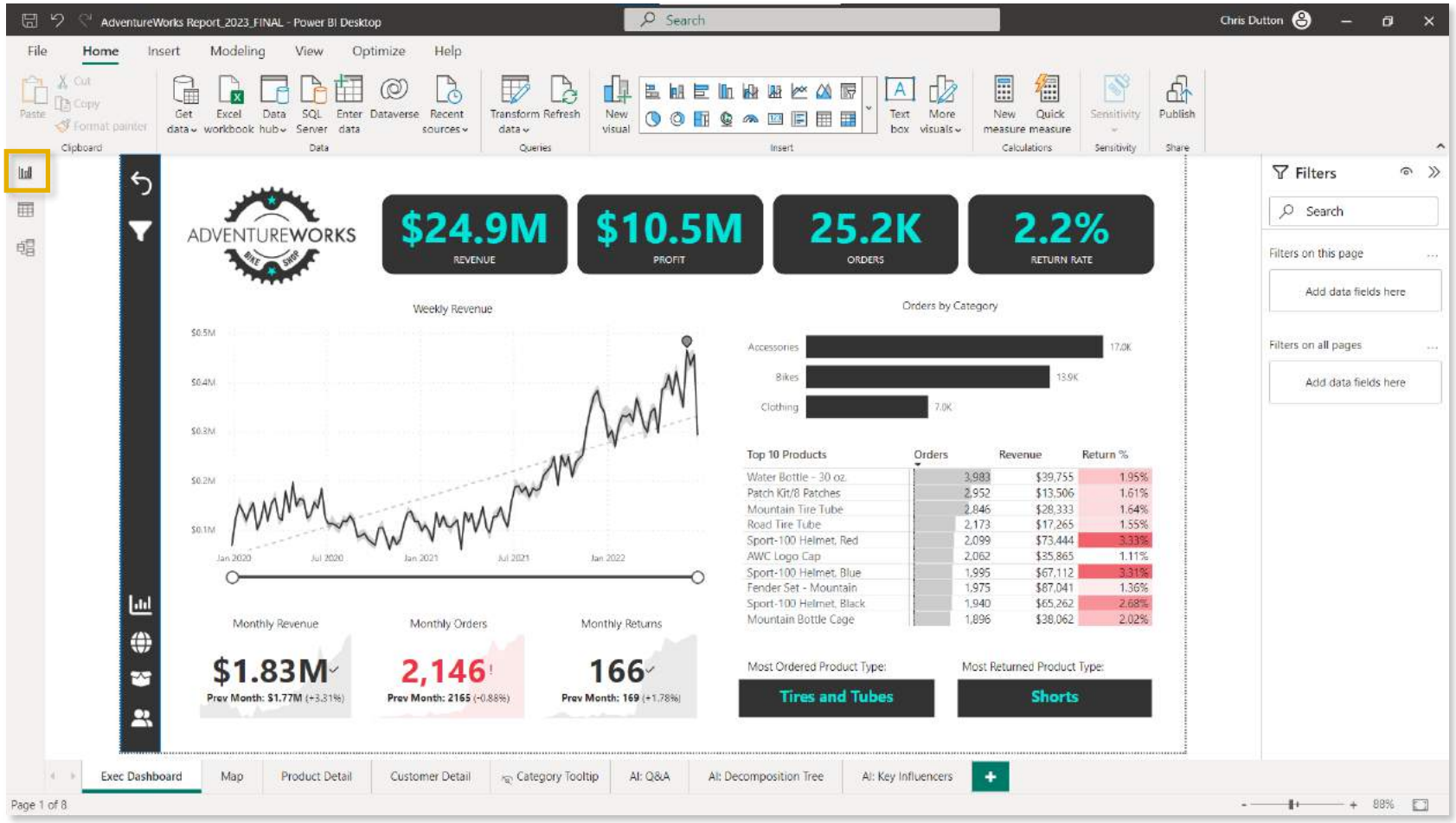


Prefix	Gender	Occupation	CustomerKey	FirstName	LastName	BirthDate	MaritalStatus	EmailAddress	AnnualIncome	TotalChildren	Educati
Mr.	M	Professional	11206	Blake	Flores	Friday, September 24, 1948	M	blake60@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	12093	Levi	Chandra	Monday, November 08, 1948	M	levi1@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	12108	James	Walker	Thursday, February 23, 1950	M	james96@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	12117	Cameron	Yang	Friday, August 03, 1951	M	cameron23@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13233	Richard	Coleman	Sunday, December 05, 1948	M	richard61@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13235	Jonathan	Robinson	Wednesday, September 22, 1948	M	jonathan72@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13236	Robert	Wang	Tuesday, May 25, 1948	M	robert36@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13370	Blake	Ross	Monday, March 22, 1948	M	blake51@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13372	Isaac	Edwards	Sunday, November 28, 1948	M	isaac24@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13375	Jason	Kumar	Sunday, April 11, 1948	M	jason26@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13376	Jerry	Rai	Friday, September 03, 1948	M	jerry19@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	13397	Adam	Mitchell	Sunday, April 08, 1951	M	adam41@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	14405	Dylan	Walker	Thursday, June 01, 1950	M	dylan53@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	14407	Thomas	Bryant	Sunday, June 04, 1950	M	thomas20@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	14415	William	Davis	Friday, November 16, 1951	M	william21@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15325	Elijah	Hayes	Thursday, May 20, 1948	M	elijah24@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15331	Jacob	Taylor	Friday, August 26, 1949	M	jacob8@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15332	Jason	Sharma	Friday, April 08, 1949	M	jason27@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15336	Marco	Garcia	Thursday, September 21, 1950	M	marco15@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15339	Noah	Zhang	Saturday, July 01, 1950	M	noah21@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15343	Carson	Barnes	Friday, September 07, 1951	M	carson2@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15902	Robert	Diaz	Tuesday, April 25, 1950	M	robert33@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	15908	David	Wilson	Thursday, September 20, 1951	M	david65@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	16806	Louis	Zhao	Friday, August 04, 1950	M	louis4@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	16811	Luis	Zhang	Thursday, April 19, 1951	M	luis23@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	16813	Carson	Diaz	Saturday, April 14, 1951	M	carson21@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	17144	Luis	Griffin	Friday, February 20, 1948	M	luis20@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	17149	Steven	Richardson	Friday, April 22, 1949	M	steven19@adventure-works.com	$60,000	2	Partia
Mr.	M	Professional	17155	Samuel	Lewis	Thursday, April 21, 1949	M	samuel71@adventure-works.com	$60,000	2	Partia

1. Data is loaded & transformed in the **Power Query Editor**
2. Data models are configured in the **Model View**
3. Table features & calculations are added in the **Data View**

POWER BI WORKFLOW

Power Query Editor | Model View | Data View | **Report View**



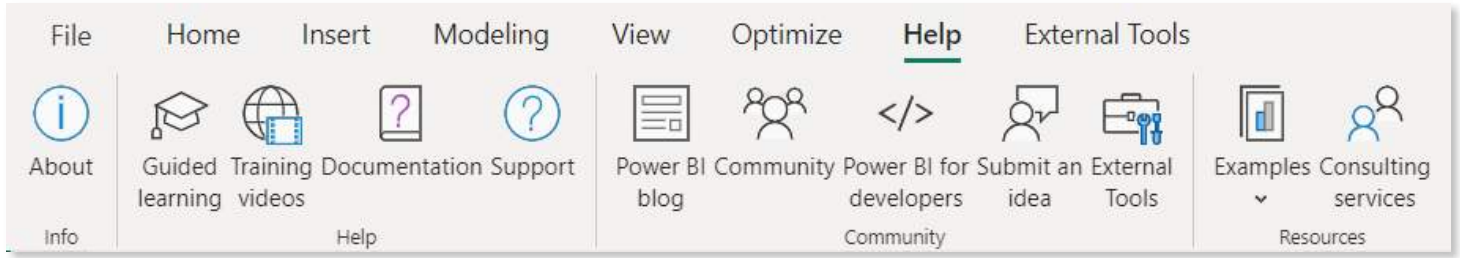
1 Data is loaded & transformed in the **Power Query Editor**

2 Data models are configured in the **Model View**

3 Table features & calculations are added in the **Data View**

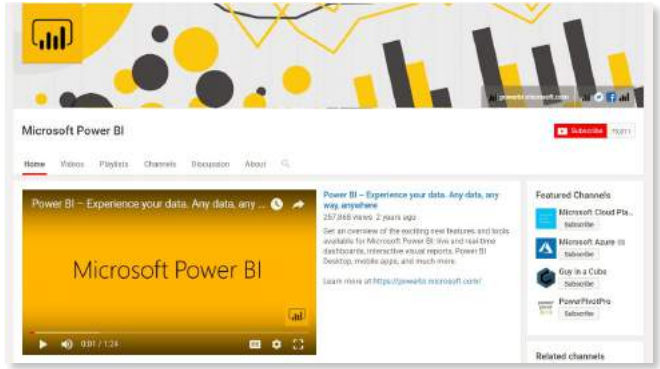
4 Visuals & reports are designed in the **Report View**

HELPFUL RESOURCES

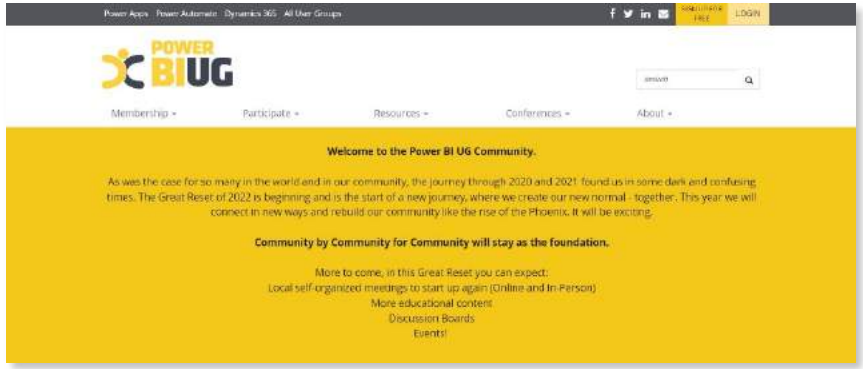


The **Help** tab includes documentation, training videos, sample files, templates, and links to support blogs and communities

The **Microsoft Power BI blog** (*powerbi.microsoft.com/blog*) publishes monthly summaries to showcase new features



The **Microsoft Power BI YouTube Channel** publishes demos, feature summaries, and advanced tutorials (check out "**Guy in a Cube**" too!)



Power BI User Groups (Power BIUG) are communities of users, which include both local meet-ups and helpful online forums (*pbiusergroup.com*)

MONTHLY UPDATES

Power BI is updated monthly, so you may notice ongoing changes to settings, options, tools, etc. Reference the links below to stay up-to-date on product updates and new feature releases:

Power BI Desktop
https://docs.microsoft.com/en-us/power-bi/fundamentals/desktop-latest-update

Power BI Service
https://docs.microsoft.com/en-us/power-bi/fundamentals/service-whats-new

Power Platform
https://learn.microsoft.com/en-us/dynamics365/release-plans/

CONNECTING & SHAPING DATA

CONNECTING & SHAPING DATA

In this section we'll connect to source files and cover some of the most common techniques for **extracting**, **cleaning**, and **shaping data** to prepare it for modeling and analysis

TOPICS WE'LL COVER:

- Intro to Power Query
- Data Connectors
- The Query Editor
- Connection Modes
- Data QA & Profiling
- Table Transformations
- Calendar Tools
- Combining Queries

GOALS FOR THIS SECTION:

- Explore Power BI's query editor and understand the role that Power Query plays in the larger BI workflow
- Introduce different types of connectors and connectivity modes available for getting data into Power BI
- Review tools for checking data quality and key profiling metrics like column distribution, empty values, errors and outliers
- Transform tables using text, numerical and date/time tools, pivot and group records, and create new conditional columns
- Practice combining, modifying and refreshing queries

FRONT-END VS. BACK-END

Power BI Desktop essentially has two distinct environments: a **front-end** and a **back-end**

- The **front-end** includes the **Data**, **Model** & **Report** views, where most of the modeling, analysis and visualization takes place
- The **back-end** includes the **Power Query Editor**, where raw data is extracted, transformed, and loaded to the front-end (ETL)

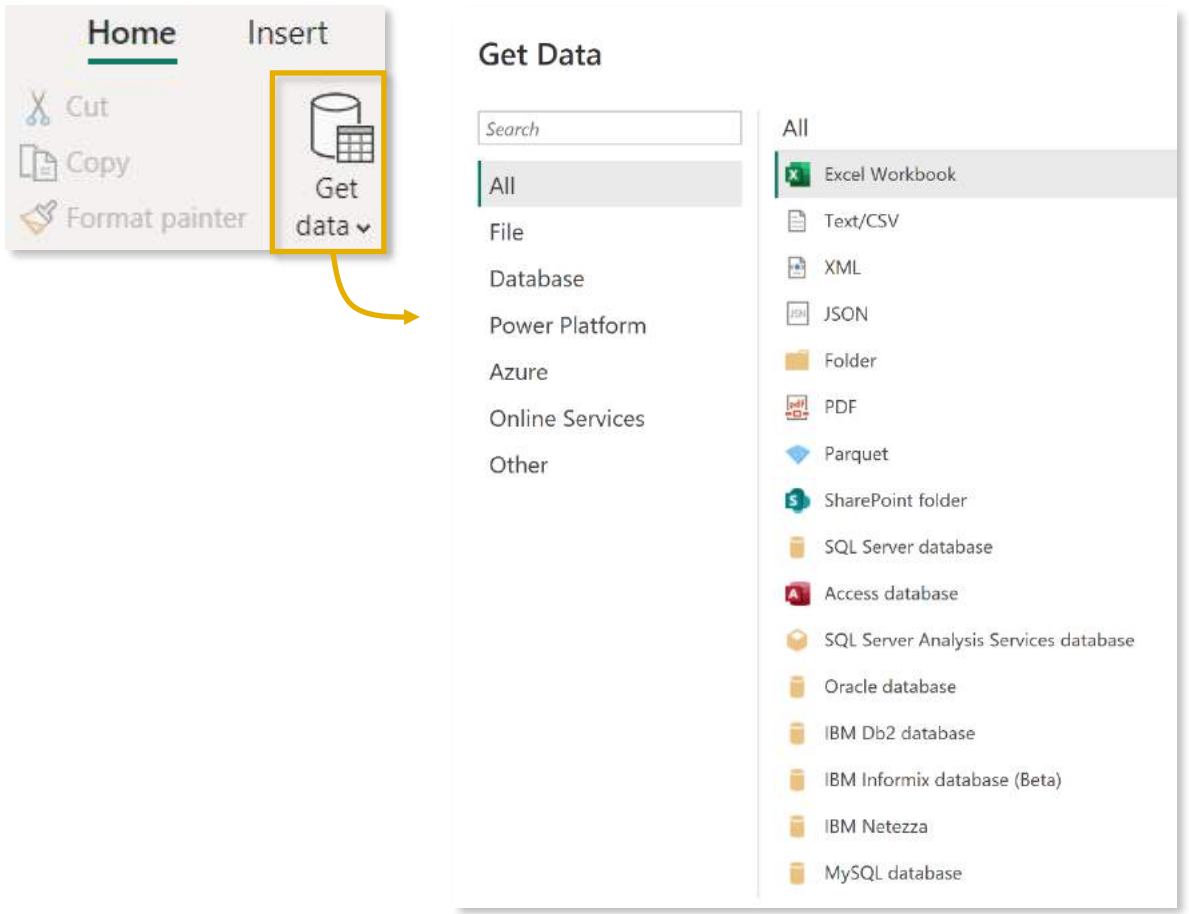
BACK-END

- **Connect** & **extract** data using pre-built connectors
- **Profile** & **QA** the data to explore, clean and prepare it for modeling and analysis
- **Transform** & **shape** tables to add new features, modify values, group records, or sort and filter columns
- **Merge** or **append** queries to join and combine them prior to loading to the front-end
- Perform **advanced transformations** using custom M code (out of scope for this course)

FRONT-END

- **Build data models** by creating table relationships between primary and foreign keys
- **Add calculated measures** & **columns** using Data Analysis Expressions (DAX)
- **Design reports** to visualize the data and create interactive, dynamic dashboards
- **Publish** & **share** your Power BI workbooks using Power BI Service (cloud application)

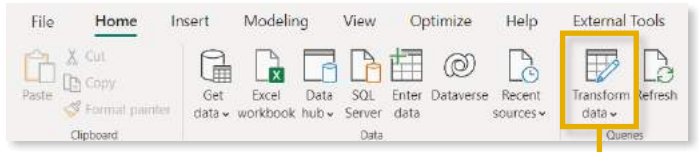
TYPES OF DATA CONNECTORS



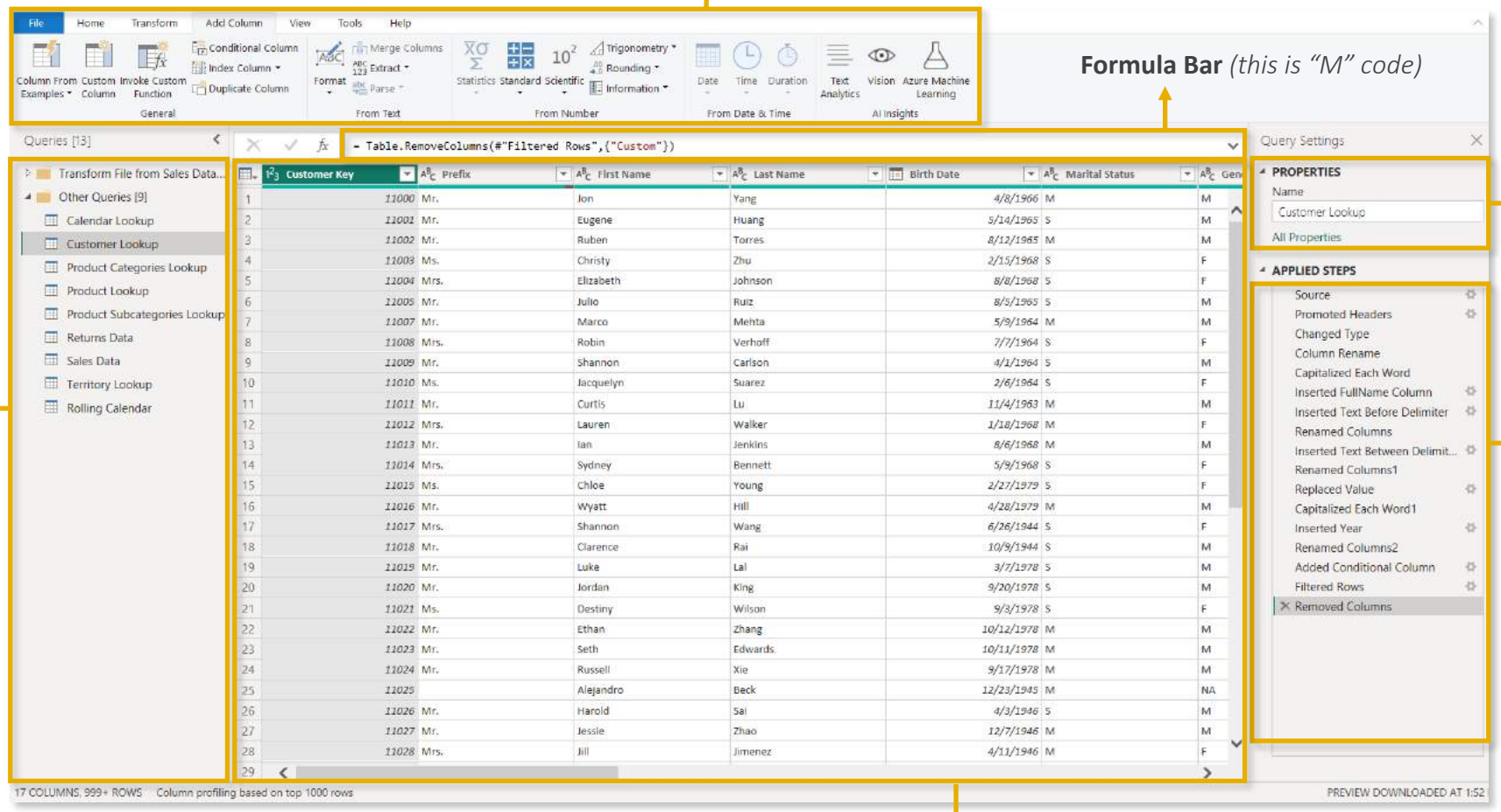
Power BI can connect to virtually **any** type of source data, including (*but not limited to*):

- **Flat files & Folders** (*csv, text, xlsx, etc.*)
- **Databases** (*SQL, Access, Oracle, IBM, etc.*)
- **Power Platform** (*Datasets, Datamarts, Dataflows, Dataverse, etc.*)
- **Azure** (*Azure SQL, Analysis Services, Databricks, etc.*)
- **Online Services** (*SharePoint, GitHub, Dynamics 365, Google Analytics, Salesforce, Power BI Service, etc.*)
- **Other** (*Web feeds, R scripts, Spark, Hadoop, etc.*)

POWER QUERY EDITOR



Query Editing Tools *(Table transformations, calculated columns, etc.)*



Formula Bar *(this is "M" code)*

Queries Pane
(list of all queries)

Table Name & Properties

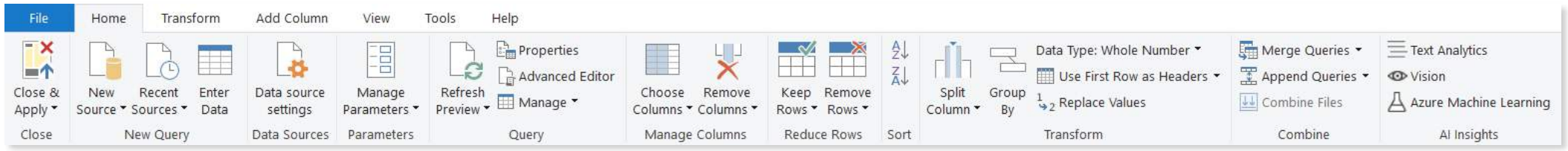
Applied Steps
(like a macro)

Table Preview

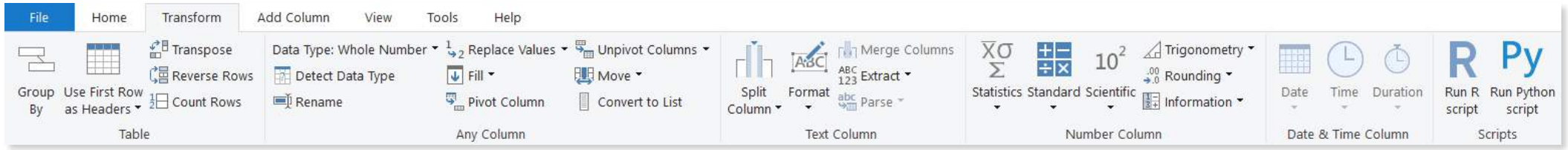
**In older versions of Power BI, the Transform Data option may be named "Edit Queries"*

QUERY EDITING TOOLS

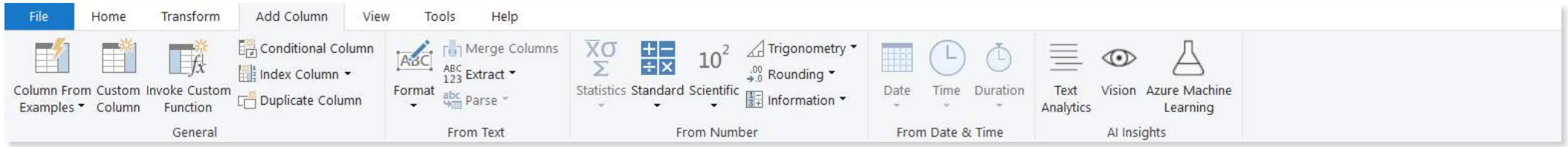
*The **HOME** tab includes **general settings** and **common table transformation tools***



*The **TRANSFORM** tab includes tools to **modify existing columns** (splitting/grouping, transposing, extracting text, etc.)*



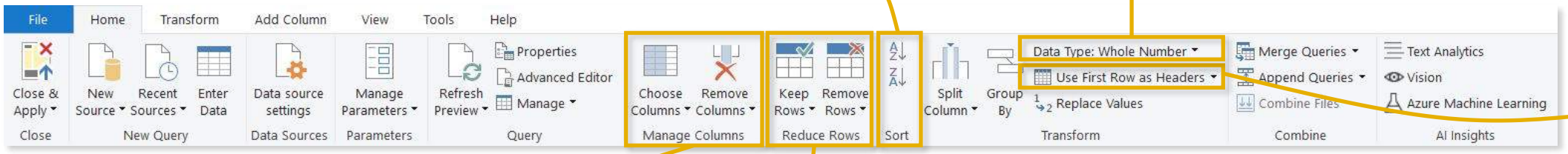
*The **ADD COLUMN** tools **create new columns** (based on conditional rules, text operations, calculations, dates, etc.)*



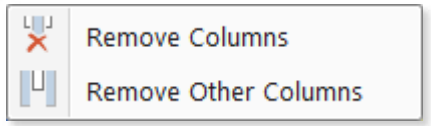
BASIC TABLE TRANSFORMATIONS

Sort values (*A-Z, Low-High, etc.*)

Change data type (*date, $, %, text, etc.*)

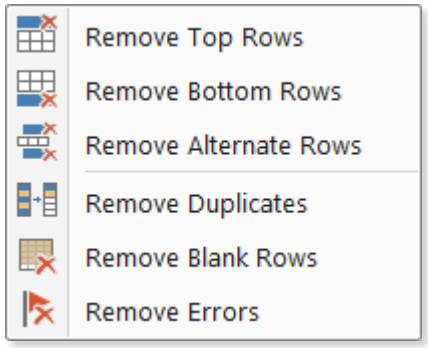


Promote headers



Choose or remove columns

Tip: *use the "Remove Other Columns" option if you always want a specific set*

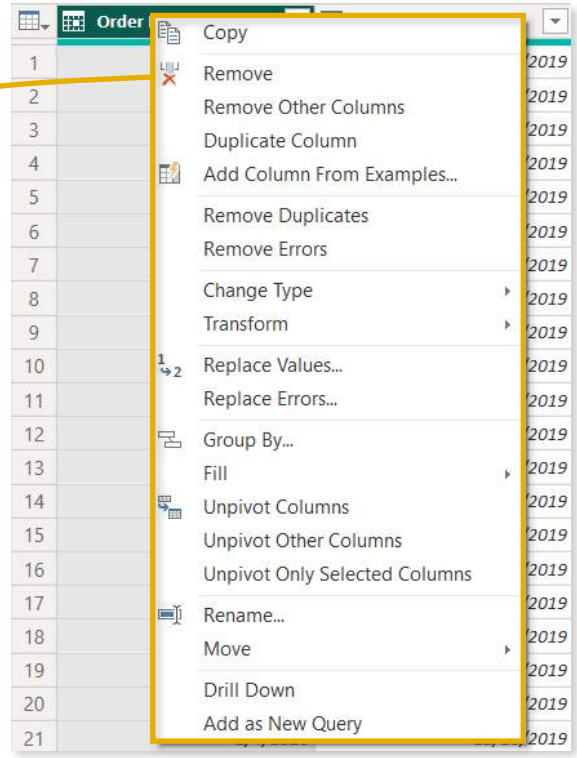


Keep or remove rows

Tip: *use "Remove Duplicates" to create new lookup tables from scratch*

Duplicate, **move** or **rename** columns

Tip: *Right-click column headers to access common tools*



ASSIGNMENT: TABLE TRANSFORMATIONS

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **Welcome aboard!**

Hello, and welcome to the team!

We're excited that you'll be helping us develop our new internal reports in Power BI. Looks like you've already gotten started, but we have some new data to add to the model.

Could you please create two new queries to connect to the **Product Category Lookup** and **Product Subcategory Lookup** files attached, and help with a few modifications to the product table?

Thanks!
-ETL

Product Category Lookup
Product Subcategory Lookup

Reply Forward

Key Objectives

1. Create queries to connect to the two new .csv files
2. Name your queries **Product Category Lookup** and **Product Subcategory Lookup**
3. Confirm that column headers have been promoted and that all data types are correct
4. Add a new column to extract all characters before the dash ("-") in the **Product SKU** column, and name it "**SKU Type**"
5. Update the **SKU Type** calculation above to return all characters before *second* dash, instead of the first
6. Replace zeros (**0**) in the **Product Style** column with "**NA**"
7. Close and load to your data model

SOLUTION: TABLE TRANSFORMATIONS

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **Welcome aboard!**

Hello, and welcome to the team!

We're excited that you'll be helping us develop our new internal reports in Power BI. Looks like you've already gotten started, but we have some new data to add to the model.

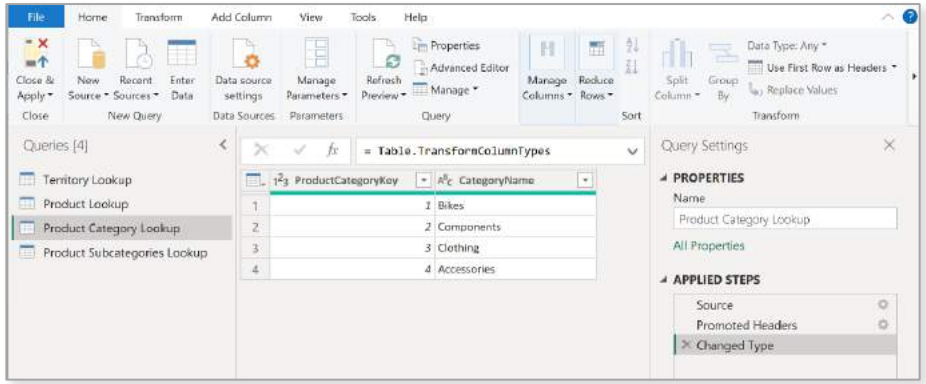
Could you please create two new queries to connect to the **Product Category Lookup** and **Product Subcategory Lookup** files attached, and help with a few modifications to the product table?

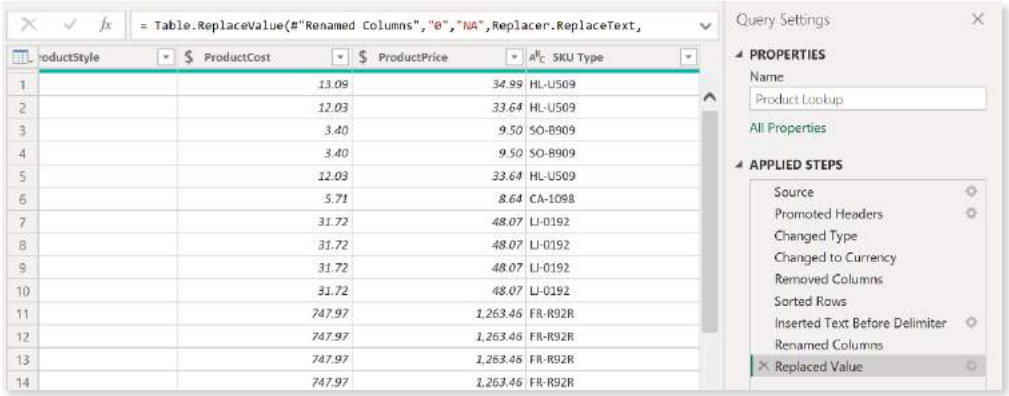
Thanks!
-ETL

Product Category Lookup
Product Subcategory Lookup

Reply Forward

Solution Preview





PRO TIP: STORAGE & CONNECTION MODES

Power BI Desktop supports several types of **storage** and **connection modes**:

- **Import**: Tables are stored in-memory within Power BI and queries are fulfilled by cached data *(default)*
- **DirectQuery**: Tables are connected directly to the source and queries are executed on-demand at the data source
- **Composite Model (Dual)**: Tables come from a mix of Import and DirectQuery modes, or integrate multiple DirectQuery tables
- **Live Connection**: Connect to pre-published Power BI datasets in Power BI Service or Azure Analysis Services

Import

- ✓ Dataset is less than 1GB (after compression) & fast performance
- ✓ Source data does not change frequently
- ✓ No restrictions on Power Query, data modeling, and DAX functions

DirectQuery

- ✓ Dataset is too large to be stored in-memory
- ✓ Source data changes frequently and reports must reflect changes
- ✓ Company policy states that data can only be accessed from the original source

Composite Model

- ✓ Boost performance by setting appropriate storage for each table
- ✓ Combine a DirectQuery model with additional imported data
- ✓ Create a single model from two or more DirectQuery models

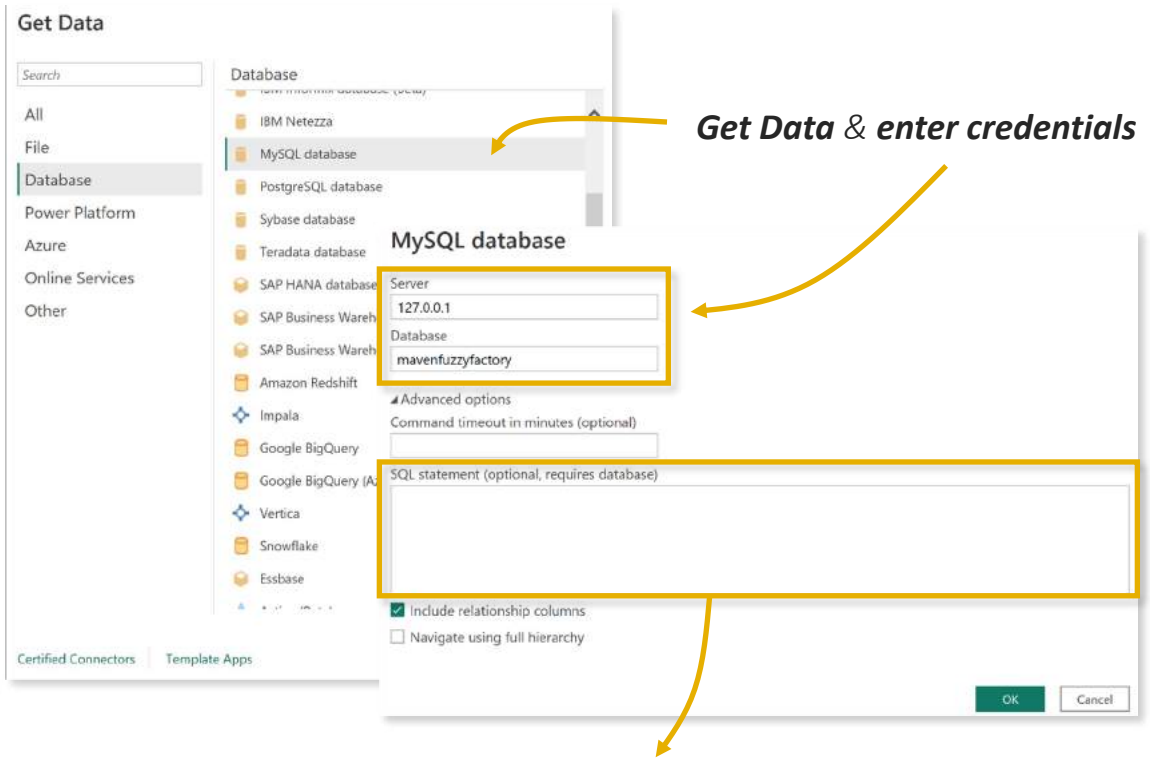
Live Connection

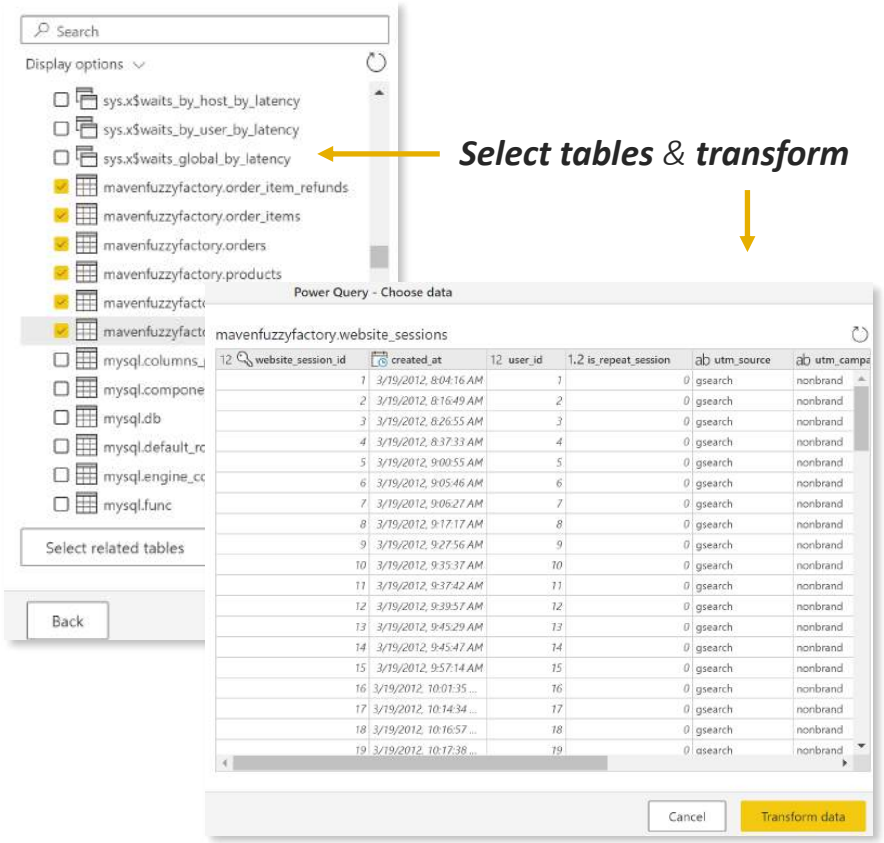
- ✓ Create one dataset that serves as a central source of truth
- ✓ Analyst teams can create different reports from the same source
- ✓ Multi-developer teams where one user builds the model and another works on visualization

Learn more: *https://learn.microsoft.com/en-us/power-bi/connect-data/service-dataset-modes-understand*

CONNECTING TO A DATABASE

Power Query can connect to data from various **database sources** including SQL Server, MS Access, MySQL, PostgreSQL, Oracle, SAP, and more





EXTRACTING DATA FROM THE WEB

Power Query includes a native **Web connector** for importing web-hosted files (csv, xlsx, etc.) or scraping URLs for anything that Power Query can identify as a structured table

List of asset management firms

3 languages

Article Talk Read Edit View history

From Wikipedia, the free encyclopedia

"Asset management company" redirects here. The term may also refer to a bad bank

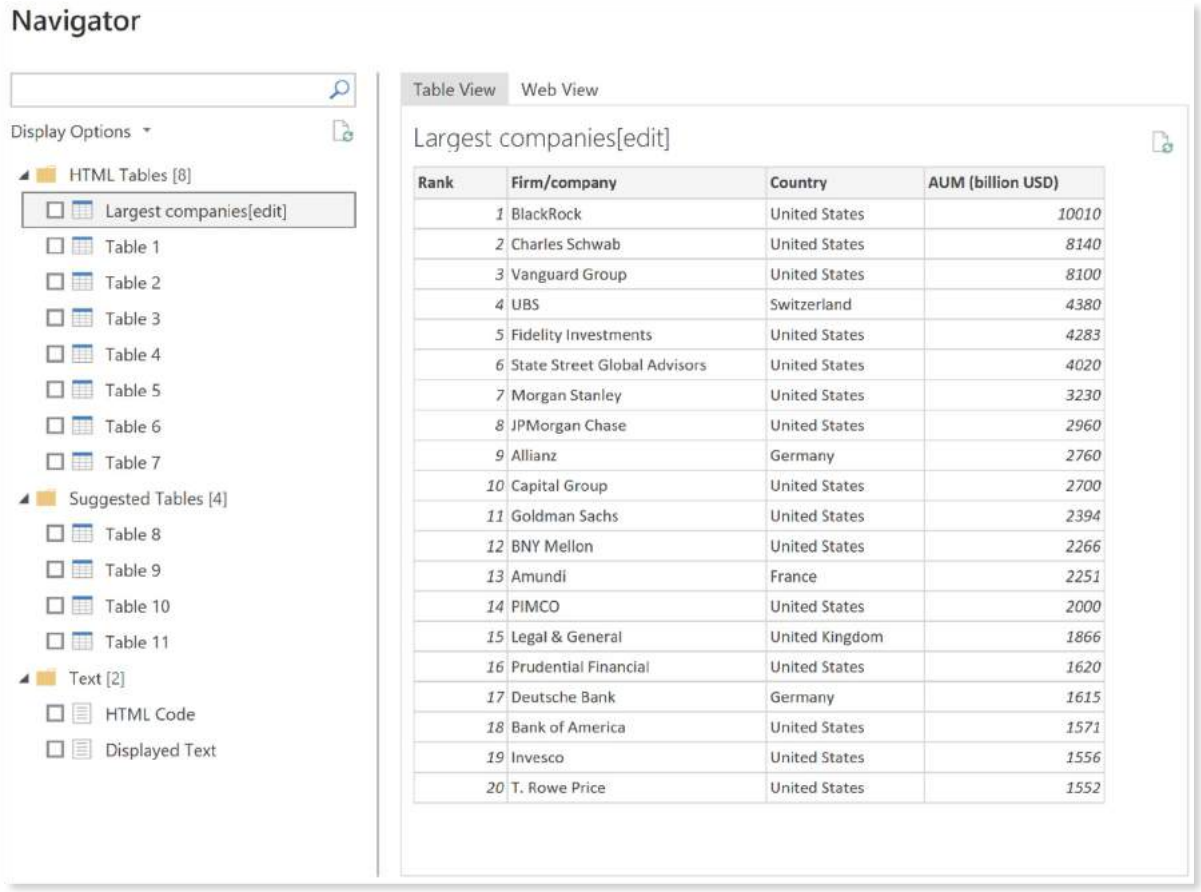
An **asset management company** (**AMC**) is an asset management / investment management company/firm that invests the pooled funds of retail investors in securities in line with the stated investment objectives. For a fee, the company/firm provides more diversification, liquidity, and professional management consulting service than is normally available to individual investors. The diversification of portfolio is done by investing in such securities which are inversely correlated to each other. Money is collected from investors by way of floating various collective investment schemes, e.g. mutual fund schemes. In general, an AMC is a company that is engaged primarily in the business of investing in, and managing, portfolios of securities. A study by consulting firm Casey Quirk, which is owned by Deloitte, found that asset management firms ended 2020 with record highs in both revenue and assets under management.[1]

Largest companies [edit]

The following is a list of the top 20 asset managers in the world (as of 2022), ranked by total assets under management (AUM).[2]

Rank	Firm/company	Country	AUM (billion USD)
1	BlackRock	United States	9,570
2	Vanguard Group	United States	8,100
3	Fidelity Investments	United States	4,283
4	UBS	Switzerland	4,380
5	State Street Global Advisors	United States	4,020
6	Morgan Stanley	United States	3,230
7	JPMorgan Chase	United States	2,960
8	Crédit Agricole	France	2,875
9	Allianz	Germany	2,760
10	Capital Group	United States	2,700
11	Goldman Sachs	United States	2,394
12	BNY Mellon	United States	2,266
13	Amundi	France	2,251
14	PIMCO	United States	2,000
15	Legal & General	United Kingdom	1,866
16	Edward Jones Investments	United States	1,700
17	PGIM	United States	1,620
18	Deutsche Bank	Germany	1,615
19	Bank of America	United States	1,571
20	Invesco	United States	1,556

https://en.wikipedia.org/wiki/List_of_asset_management_firms



Navigator

Display Options

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  - Largest companies[edit]
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  - Table 2
  - Table 3
  - Table 4
  - Table 5
  - Table 6
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- Suggested Tables [4]
  - Table 8
  - Table 9
  - Table 10
  - Table 11
- Text [2]
  - HTML Code
  - Displayed Text

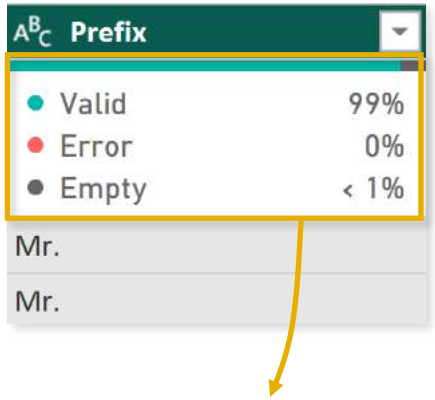
Table View | Web View

Largest companies[edit]

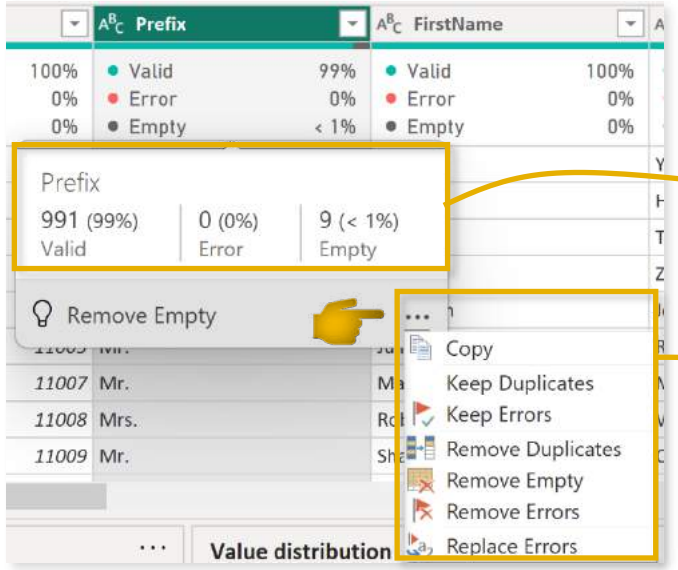
Rank	Firm/company	Country	AUM (billion USD)
1	BlackRock	United States	10010
2	Charles Schwab	United States	8140
3	Vanguard Group	United States	8100
4	UBS	Switzerland	4380
5	Fidelity Investments	United States	4283
6	State Street Global Advisors	United States	4020
7	Morgan Stanley	United States	3230
8	JPMorgan Chase	United States	2960
9	Allianz	Germany	2760
10	Capital Group	United States	2700
11	Goldman Sachs	United States	2394
12	BNY Mellon	United States	2266
13	Amundi	France	2251
14	PIMCO	United States	2000
15	Legal & General	United Kingdom	1866
16	Prudential Financial	United States	1620
17	Deutsche Bank	Germany	1615
18	Bank of America	United States	1571
19	Invesco	United States	1556
20	T. Rowe Price	United States	1552

DATA PROFILING: COLUMN QUALITY

Profiling tools like **column quality**, **column distribution**, and **column profile** allow you to explore the quality, composition, and distribution of your data before loading it into the Power BI front-end



Column quality *shows the percentage of values within a column that are* ***valid****, contain* ***errors****, or are* ***empty***



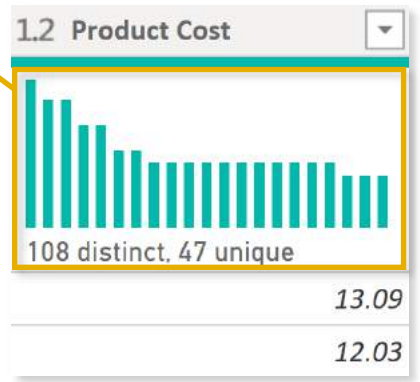
Hover over the column quality box to see the ***number of records*** *in each category*

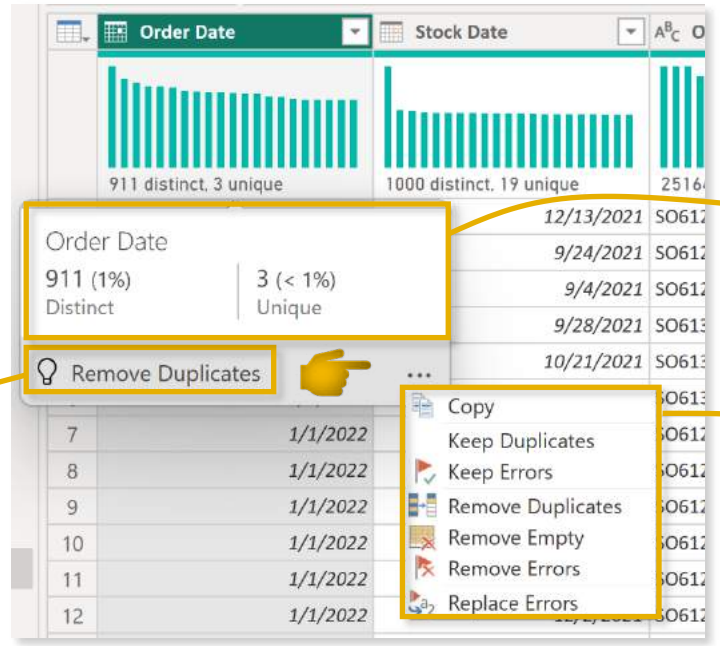
Click the ***options menu*** *to remove duplicates, errors or empty values*

PRO TIP: Profiling tools are a great way to **quickly find and address common data quality issues in one place**, instead of having to manually apply multiple tools or filters

DATA PROFILING: COLUMN DISTRIBUTION

Column distribution *provides a sample distribution of the data in a column*





Suggested action *based on column distribution results*

Hover over the column quality box to see the ***number of distinct & unique records***

Click the ***options menu*** *to remove duplicates, errors or empty values*

DATA PROFILING: COLUMN PROFILE

Column profile *provides a more holistic view of the data in a column, including a sample distribution and profiling statistics*

Column statistics *provide more detailed profiling metrics, including:*

Count = **293**

(total number of values in column)

Distinct Count = **119**

(total number of distinct values, whether they appear once or multiple times)

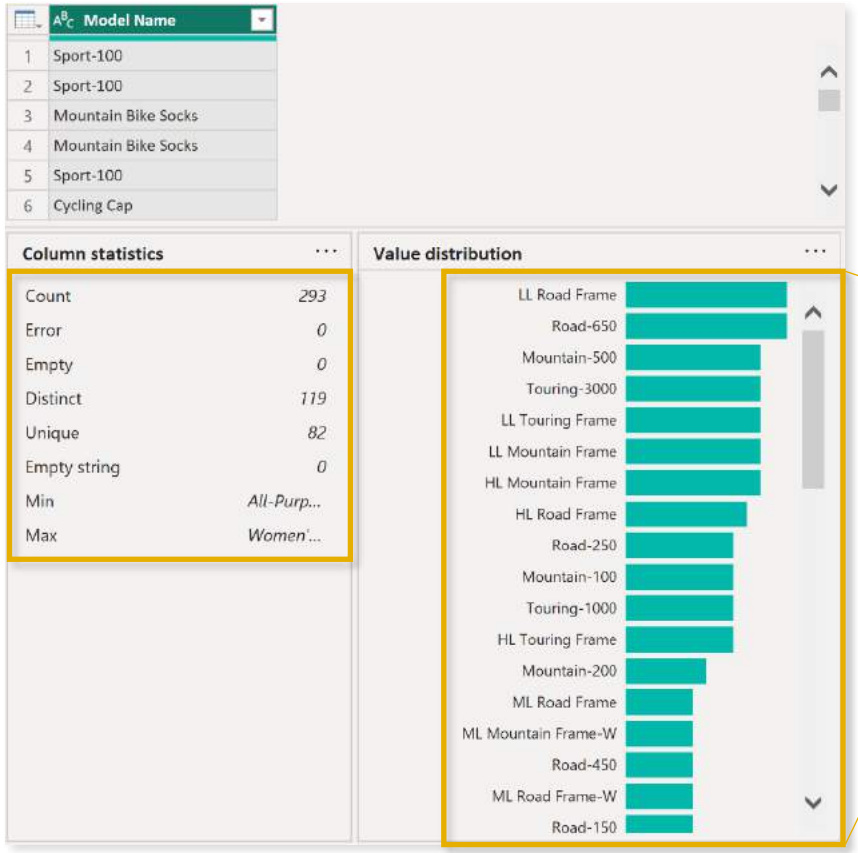
Unique = **82**

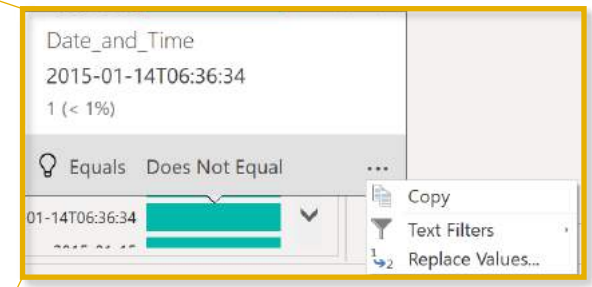
(total number of values that appear exactly once)

Min & Max

(lowest and highest observed values)

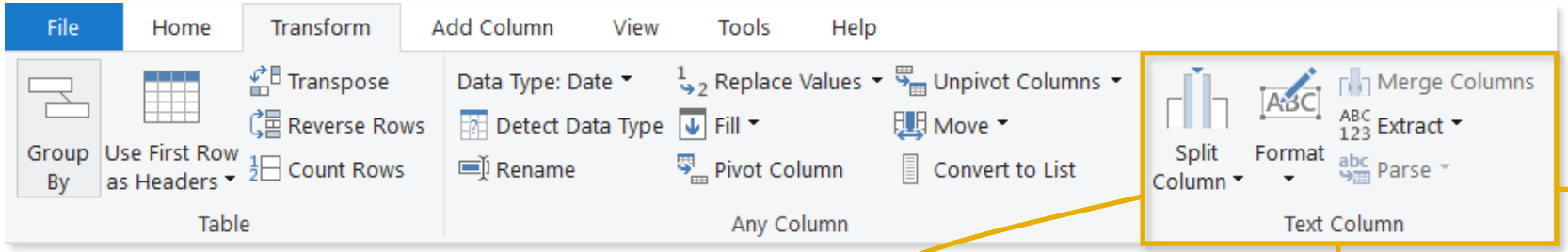
Note: *Typically only useful for numerical values*



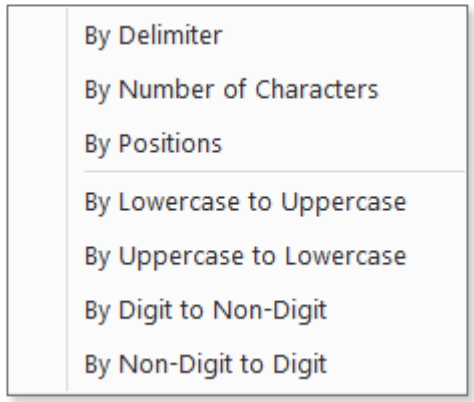


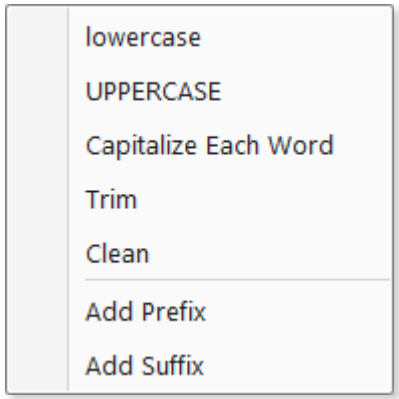
Hover over the value distribution bar for ***suggested transformations*** *and additional options*

TEXT TOOLS



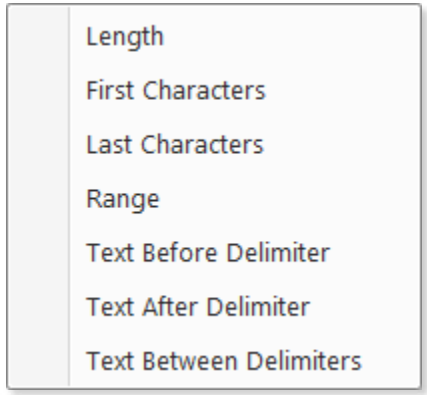
Split a text column based on a specific delimiter, number of characters, or other attributes





Format a text column to upper, lower or proper case, or add a prefix or suffix

Tip: *Use "Trim" to eliminate leading & trailing spaces, or "Clean" to remove non-printable characters*



Extract characters from text based on fixed lengths, first/last characters, ranges or delimiters

HEY THIS IS IMPORTANT!

You can access many tools from both the **Transform** and **Add Column** menus - the difference is whether you want to **ADD** a new column or **OVERWRITE** an existing one

ASSIGNMENT: TEXT TOOLS

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **Customer domains**

Hi!

We're looking to better understand where our customers may be coming from, based on their email domains.

Could you please create a new column in the customer table that will allow us do this?

Thanks!
-ETL

Reply Forward

Key Objectives

1. Duplicate the email address column and name it "**Domain Name"**
2. In the new column, remove all text/characters except for the domain name
3. Use transformation steps to clean up and capitalize the domain names (i.e. "**Adventure Works**")
4. Save & Apply changes

SOLUTION: TEXT TOOLS

NEW MESSAGE

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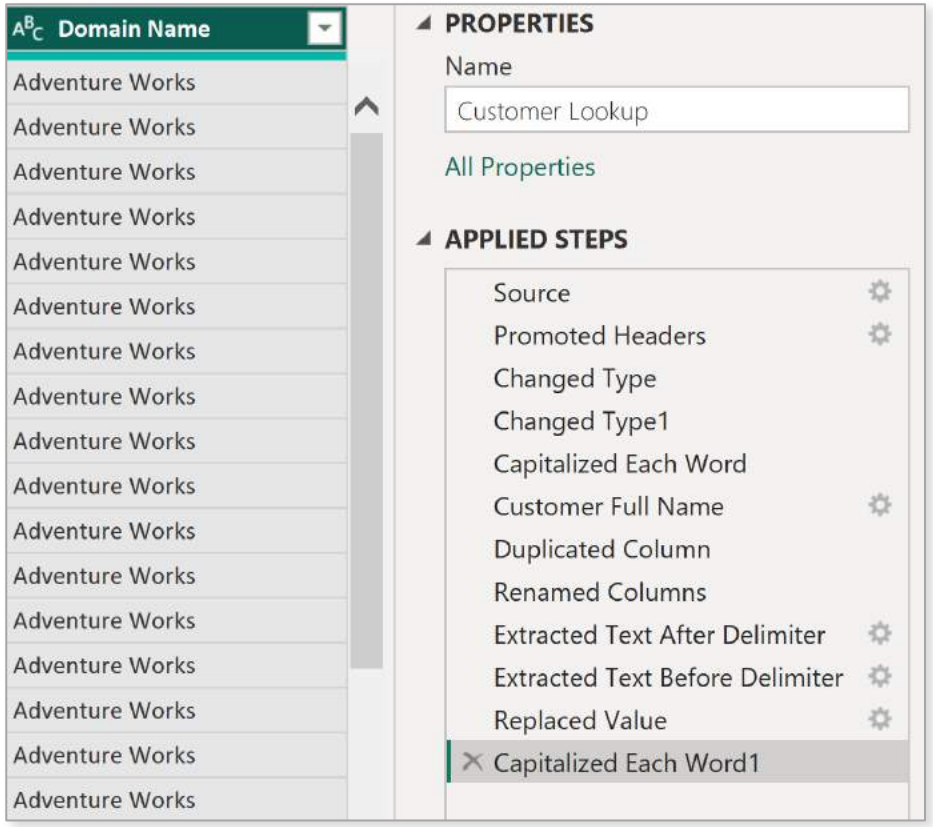
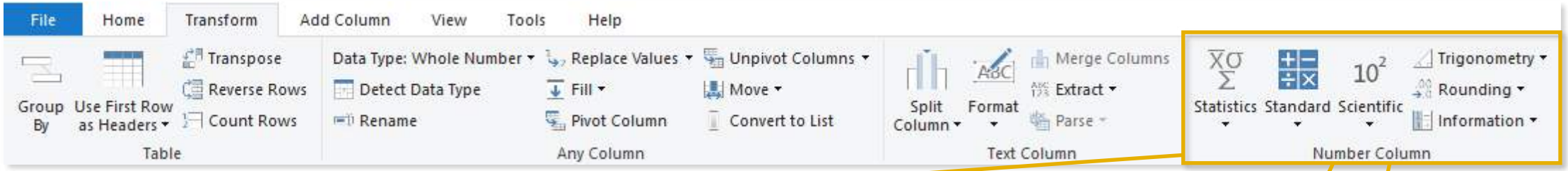
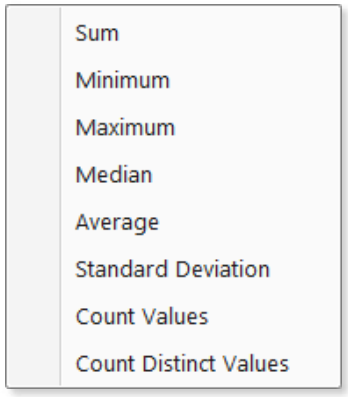
Solution Preview



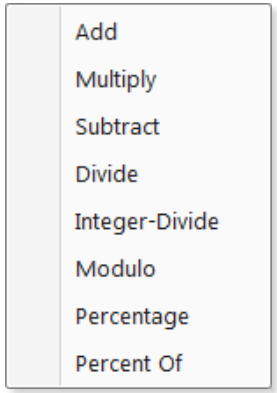
NUMERICAL TOOLS



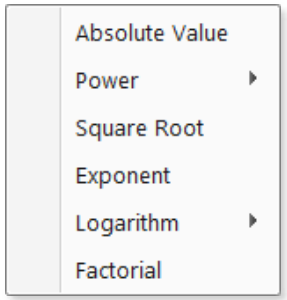


Statistics functions allow you to evaluate basic stats for a selected column (sum, min/max, average, count, count distinct, etc.)

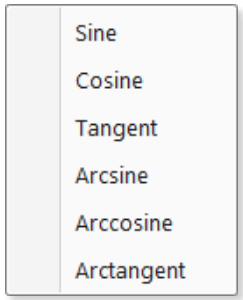
Note: *These tools return a SINGLE value, and are commonly used to explore a table rather than prepare it for loading*



Standard



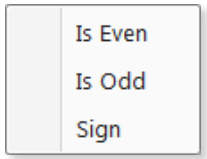
Scientific



Trigonometry

Standard, **Scientific** and **Trigonometry** tools allow you to apply standard operations (addition, multiplication, division, etc.) or more advanced calculations (power, logarithm, sine, tangent, etc.) to each value in a column

Note: *Unlike the Statistics tools, these are applied to each row in the table*



Information tools allow you to define binary flags (*1/0 or TRUE/FALSE*) to mark rows as even, odd, positive or negative

ASSIGNMENT: NUMERICAL TOOLS

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **Need some stats for leadership**

Hi again,

Leadership is asking us to validate some high-level stats about our products and customers. Can you please help me answer the following questions?

We don't really need to store these values anywhere, so make sure to restore the tables back to their original state once you're done pulling the stats.

Thank you!
-ETL

Reply Forward

Key Objectives

1. What is our average product cost?
2. How many colors do we sell our products in?
3. How many distinct customers do we have?
4. What is the maximum annual customer income?
5. Return the tables to their original state

SOLUTION: NUMERICAL TOOLS

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **Need some stats for leadership**

Hi again,

Leadership is asking us to validate some high-level stats about our products and customers. Can you please help me answer the following questions?

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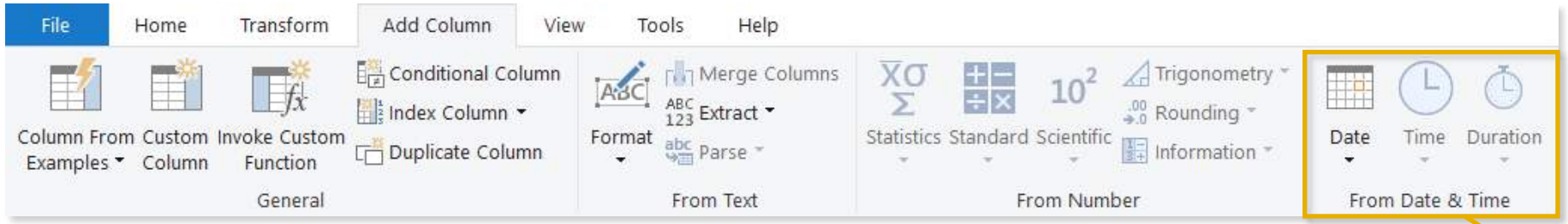
Thank you!
-ETL

Reply Forward

Solution Preview

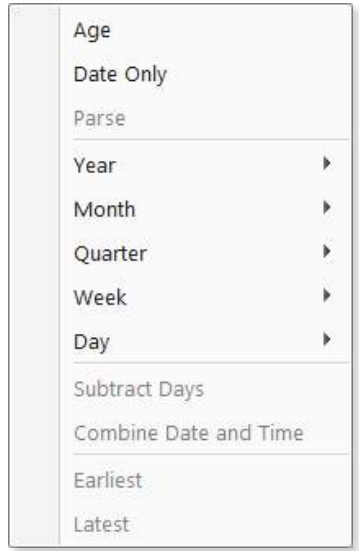
1. What is our average product cost? **($413.66)**
2. How many colors do we sell our products in? **(10)**
3. How many distinct customers do we have? **(18,148)**
4. What is the maximum annual customer income? **($170k)**
5. Return the tables to their original state

DATE & TIME TOOLS



Date & Time tools are relatively straight-forward, and include the following options:

- **Age**: Difference between the current date and the date in each row
- **Date Only**: Removes the time component from a date/time field
- **Year/Month/Quarter/Week/Day**: Extracts individual components from a date field (time-specific options include Hour, Minute, Second, etc.)
- **Earliest/Latest**: Evaluates the earliest or latest date from a column as a single value (can only be accessed from the "Transform" menu)



Note: *You will almost always want to perform these operations from the "Add Column" menu to build out new fields, rather than transforming an individual date/time column*

PRO TIP: Load up a table containing a **single date column** and use Date tools to build out an **entire calendar table**

CREATING A CALENDAR TABLE

	Date
1	1/1/2020
2	1/2/2020
3	1/3/2020
4	1/4/2020
5	1/5/2020
6	1/6/2020
7	1/7/2020
8	1/8/2020
9	1/9/2020
10	1/10/2020
11	1/11/2020
12	1/12/2020
13	1/13/2020
14	1/14/2020
15	1/15/2020
16	1/16/2020
17	1/17/2020
18	1/18/2020
19	1/19/2020
20	1/20/2020
21	1/21/2020
22	1/22/2020
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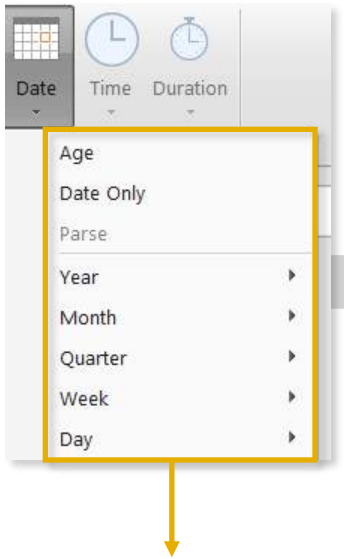
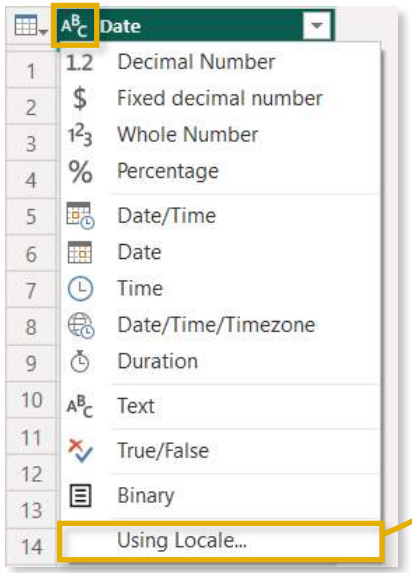
25	1/25/2020
26	1/26/2020
27	1/27/2020
28	1/28/2020

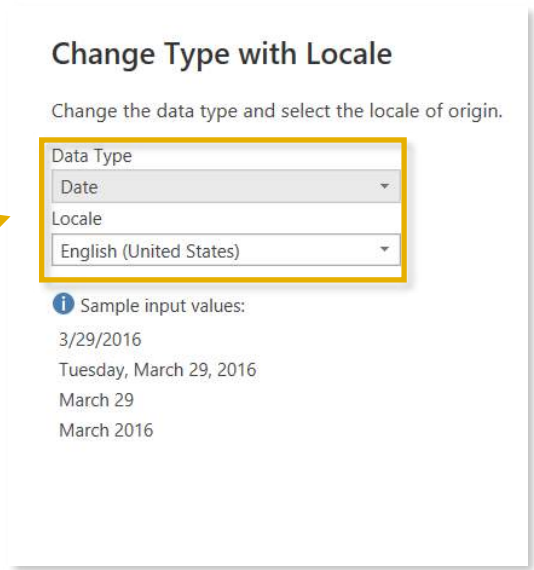


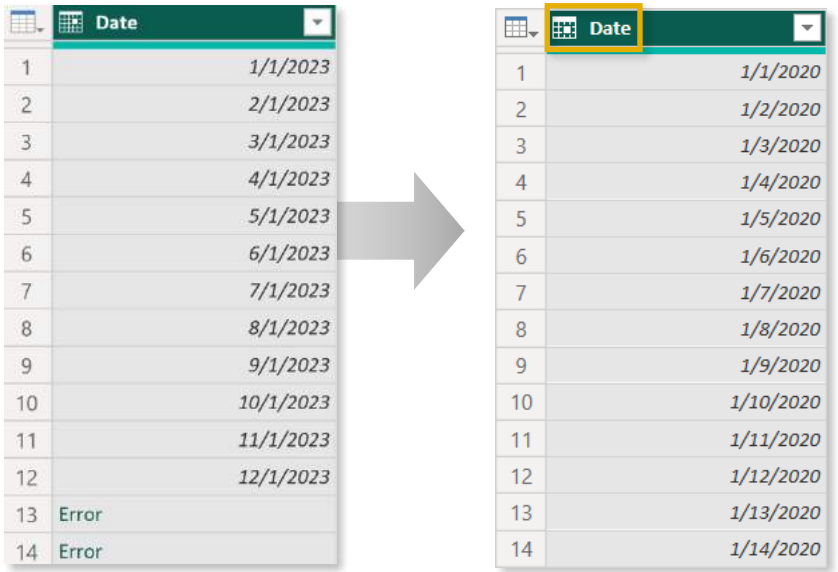
Use the **Date** options in the **Add Column** menu to quickly build out an entire calendar table from a list of dates

	Date	Day Name	Start of Week	Start of Month	Month Name
1	1/1/2020	Wednesday	12/29/2019	1/1/2020	January
2	1/2/2020	Thursday	12/29/2019	1/1/2020	January
3	1/3/2020	Friday	12/29/2019	1/1/2020	January
4	1/4/2020	Saturday	12/29/2019	1/1/2020	January
5	1/5/2020	Sunday	1/5/2020	1/1/2020	January
6	1/6/2020	Monday	1/5/2020	1/1/2020	January
7	1/7/2020	Tuesday	1/5/2020	1/1/2020	January
8	1/8/2020	Wednesday	1/5/2020	1/1/2020	January
9	1/9/2020	Thursday	1/5/2020	1/1/2020	January
10	1/10/2020	Friday	1/5/2020	1/1/2020	January
11	1/11/2020	Saturday	1/5/2020	1/1/2020	January
12	1/12/2020	Sunday	1/12/2020	1/1/2020	January
13	1/13/2020	Monday	1/12/2020	1/1/2020	January
14	1/14/2020	Tuesday	1/12/2020	1/1/2020	January
15	1/15/2020	Wednesday	1/12/2020	1/1/2020	January
16	1/16/2020	Thursday	1/12/2020	1/1/2020	January
17	1/17/2020	Friday	1/12/2020	1/1/2020	January
18	1/18/2020	Saturday	1/12/2020	1/1/2020	January
19	1/19/2020	Sunday	1/19/2020	1/1/2020	January
20	1/20/2020	Monday	1/19/2020	1/1/2020	January
21	1/21/2020	Tuesday	1/19/2020	1/1/2020	January
22	1/22/2020	Wednesday	1/19/2020	1/1/2020	January
23	1/23/2020	Thursday	1/19/2020	1/1/2020	January
24	1/24/2020	Friday	1/19/2020	1/1/2020	January
25	1/25/2020	Saturday	1/19/2020	1/1/2020	January
26	1/26/2020	Sunday	1/26/2020	1/1/2020	January
27	1/27/2020	Monday	1/26/2020	1/1/2020	January
28	1/28/2020	Tuesday	1/26/2020	1/1/2020	January

CHANGE TYPE WITH LOCALE







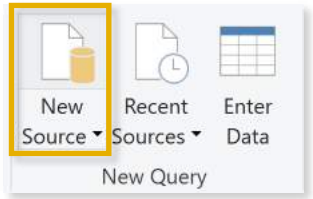
1) Left click the data type icon in the column header and select the **Using Locale** option

2) Select **Date** as the data type and **English (United States)** as the locale for all datasets in this course (regardless of your actual location)

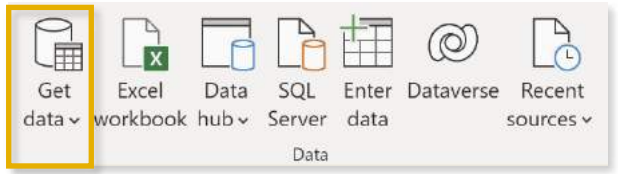
3) Confirm that the **data type is correctly recognized**. You should see a calendar icon next to the column name in the header and no errors in the column

PRO TIP: ROLLING CALENDARS

1 Create a new **blank query** & name it "***Rolling Calendar***"

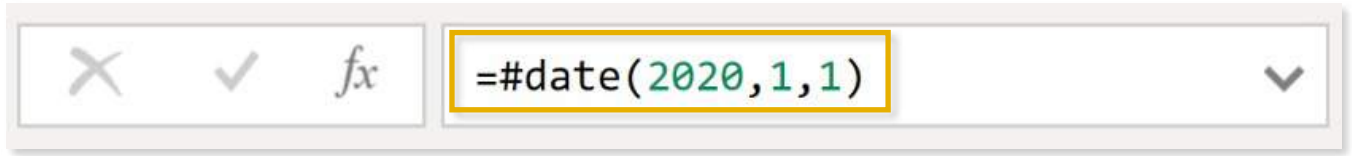


Power Query: *New Source > Blank Query*



Front end: *Get Data > Blank Query*

2 In the formula bar, type a **"literal"** to generate a start date:



Format as: *YYYY, MM, DD*

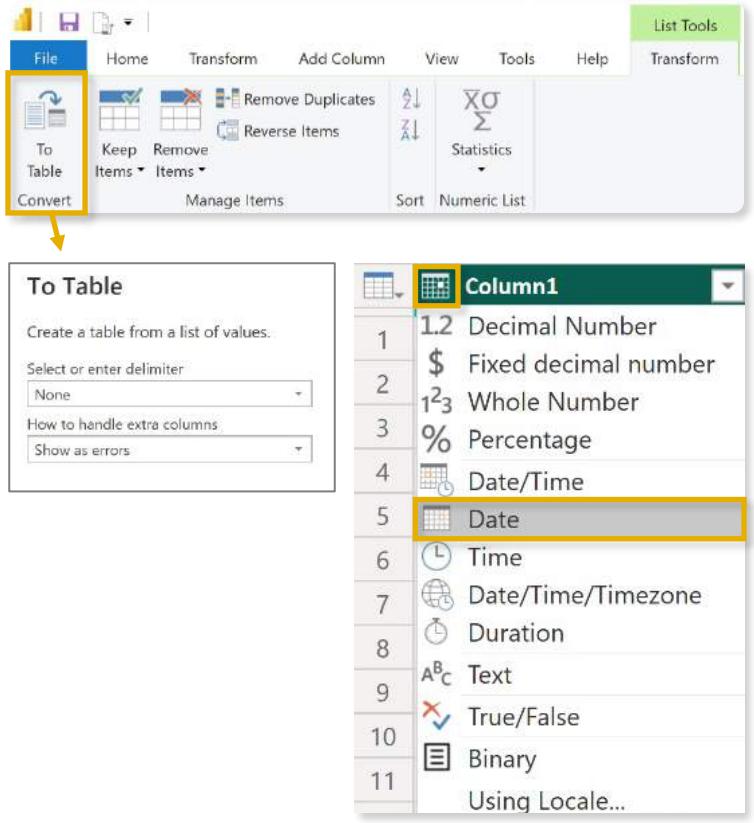
3 Click the fx icon to **add a custom step**, and enter the following formula to generate a list of dates between the start date and the current day:

```
= List.Dates(
    Source,
    Number.From(DateTime.LocalNow()) - Number.From(Source),
    #duration(1, 0, 0, 0)
  )
```

Note: *If your first applied step is named something other than "**Source**", use that name in your formula (this is common for non-US users)*

PRO TIP: ROLLING CALENDARS

4 Convert the resulting list into a **Table** and set the data type as a **Date**



5 Rename the column to "**Date**" and add calculated date columns (year, month, quarter, etc.) using the **Add Column** tools

	Date	Year	Start of Quarter	Start of Month
1	1/1/2020	2020	1/1/2020	1/1/2020
2	1/2/2020	2020	1/1/2020	1/1/2020
3	1/3/2020	2020	1/1/2020	1/1/2020
4	1/4/2020	2020	1/1/2020	1/1/2020
5	1/5/2020	2020	1/1/2020	1/1/2020
6	1/6/2020	2020	1/1/2020	1/1/2020
7	1/7/2020	2020	1/1/2020	1/1/2020
8	1/8/2020	2020	1/1/2020	1/1/2020
9	1/9/2020	2020	1/1/2020	1/1/2020
10	1/10/2020	2020	1/1/2020	1/1/2020
11	1/11/2020	2020	1/1/2020	1/1/2020
12	1/12/2020	2020	1/1/2020	1/1/2020
13	1/13/2020	2020	1/1/2020	1/1/2020
14	1/14/2020	2020	1/1/2020	1/1/2020
15	1/15/2020	2020	1/1/2020	1/1/2020
16	1/16/2020	2020	1/1/2020	1/1/2020
17	1/17/2020	2020	1/1/2020	1/1/2020
18	1/18/2020	2020	1/1/2020	1/1/2020
19	1/19/2020	2020	1/1/2020	1/1/2020
20	1/20/2020	2020	1/1/2020	1/1/2020
21	1/21/2020	2020	1/1/2020	1/1/2020

ASSIGNMENT: CALENDAR TABLES

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **New date fields**

Hi,

We need to add a few fields to our calendar table to help us analyze sales trending over time.

Could you please add the following columns when you get a chance?

Thanks!
-ETL

Reply Forward

Key Objectives

Add the following columns to the calendar table:

1. **Month Name** (e.g. “January”)
2. **Month Number** (e.g. “1”)
3. **Start of Year** (e.g. “1/1/2020”)
4. **Year** (e.g. “2020”)

SOLUTION: CALENDAR TABLES

NEW MESSAGE

From: **Ethan T. Langer** *(Analytics Manager)*

Subject: **New date fields**

Hi,

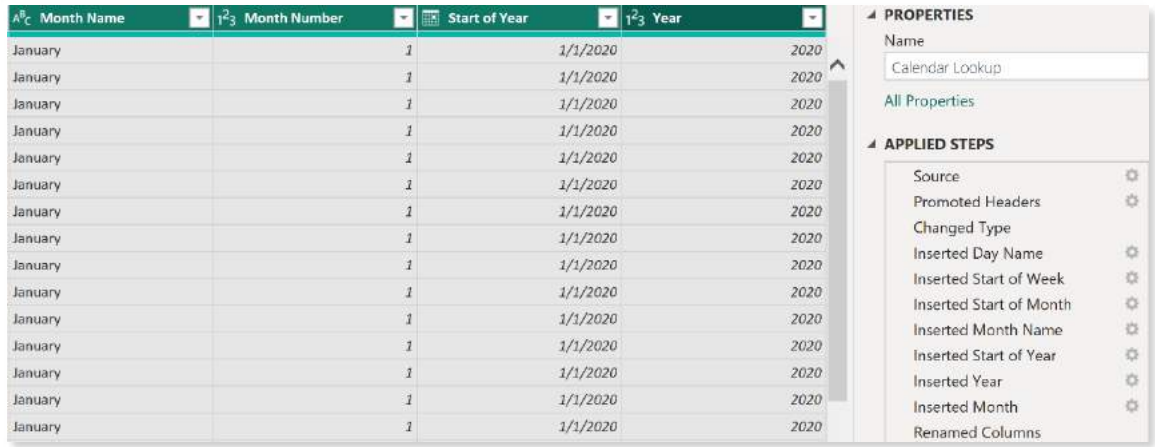
We need to add a few fields to our calendar table to help us analyze sales trending over time.

Could you please add the following columns when you get a chance?

Thanks!
-ETL

Reply Forward

Solution Preview

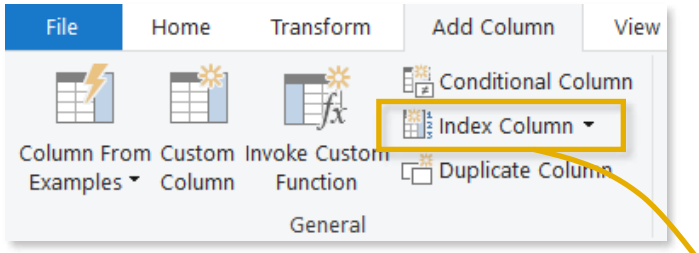


Month Name	Month Number	Start of Year	Year
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020
January	1	1/1/2020	2020

PROPERTIES
Name
Calendar Lookup
All Properties

APPLIED STEPS
Source
Promoted Headers
Changed Type
Inserted Day Name
Inserted Start of Week
Inserted Start of Month
Inserted Month Name
Inserted Start of Year
Inserted Year
Inserted Month
Renamed Columns

INDEX COLUMNS

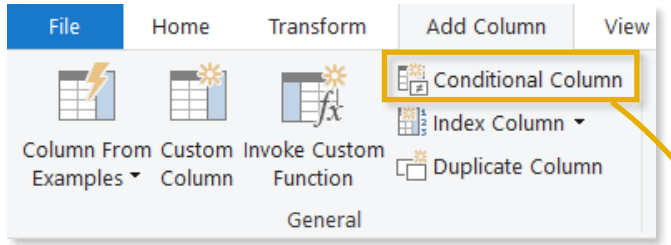


Index Columns contain a list of sequential values that can be used to identify each unique row in a table (*typically starting from 0 or 1*)

These are often used to create **unique IDs** that can be used to form relationships between tables (*more on that later!*)

	Index	Order Date	Stock Date	Order Number	Product Key
1	1	1/1/2020	9/21/2019	SO45080	332
2	2	1/1/2020	12/5/2019	SO45079	312
3	3	1/1/2020	10/29/2019	SO45082	350
4	4	1/1/2020	11/16/2019	SO45081	338
5	5	1/2/2020	12/15/2019	SO45083	312
6	6	1/2/2020	10/12/2019	SO45084	310
7	7	1/2/2020	12/18/2019	SO45086	314
8	8	1/2/2020	10/9/2019	SO45085	312
9	9	1/3/2020	10/3/2019	SO45093	312
10	10	1/3/2020	9/29/2019	SO45090	310
11	11	1/3/2020	12/11/2019	SO45088	345
12	12	1/3/2020	10/24/2019	SO45092	313
13	13	1/3/2020	12/16/2019	SO45089	351
14	14	1/3/2020	10/26/2019	SO45091	314
15	15	1/3/2020	9/11/2019	SO45087	350
16	16	1/3/2020	9/11/2019	SO45094	310
17	17	1/4/2020	10/30/2019	SO45096	312
18	18	1/4/2020	10/30/2019	SO45097	313
19	19	1/4/2020	9/15/2019	SO45098	310
20	20	1/4/2020	12/7/2019	SO45095	344

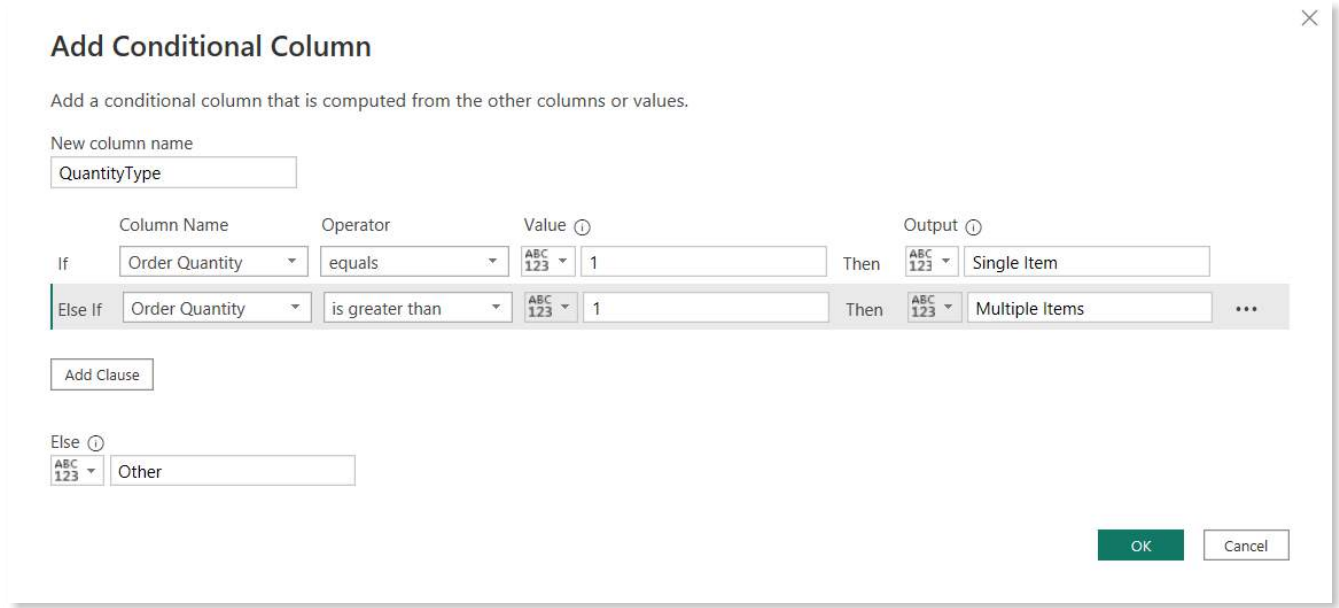
CONDITIONAL COLUMNS



Conditional Columns allow you to define new fields based on logical rules and conditions (IF/THEN statements)

Here we're creating a conditional column named **Quantity Type**, which is based on **Order Quantity**:

- *If Order Quantity **=1**, Quantity Type = "**Single Item**"*
- *Else If Order Quantity **>1**, Quantity Type = "**Multiple Items**"*
- *Else; Quantity Type = "**Other**"*



CALCULATED COLUMN BEST PRACTICES

As a best practice, table transformations and column calculations should ideally happen **as close to the original data source as possible**, to optimize performance and speed

Data Source

Power Query

Power BI Front-End

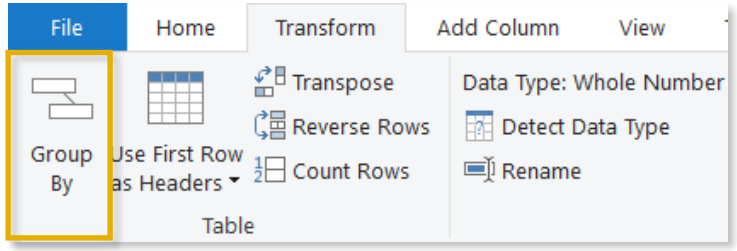
Published Reports

UPSTREAM → **DOWNSTREAM**

HEY THIS IS IMPORTANT!

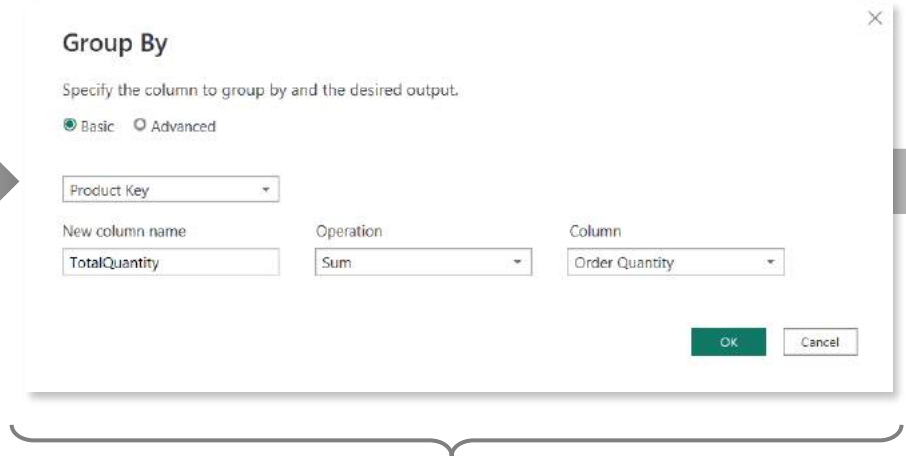
This is not a strict rule or requirement but can significantly impact performance for very large or complex data models. Where you define calculations often depends on several factors *(accessibility, complexity, business requirements, etc.)*, so we will practice creating columns using both Power Query and the Power BI front-end (DAX) throughout this course

GROUPING & AGGREGATING



Group By allows you to aggregate data at a different level or "grain"
(*i.e. group daily records into monthly, aggregate transactions by store, etc.*)

	Order Date	Product Key	Customer Key	Order Quantity
1	6/25/2022	214	14719	1
2	10/8/2021	214	21990	1
3	12/30/2021	214	22098	1
4	6/29/2022	214	22748	1
5	8/16/2021	214	27821	1
6	10/9/2021	214	15685	1
7	8/9/2021	214	14951	1
8	1/19/2022	214	23101	1
9	9/23/2021	214	17158	1
10	1/19/2022	214	24196	1
11	6/29/2022	214	12963	1
12	9/13/2021	214	12715	1
13	10/2/2021	214	14846	1
14	7/31/2021	214	11290	1
15	11/24/2021	214	22103	1
16	8/1/2021	214	16982	1
17	10/12/2021	214	20410	1
18	9/10/2021	214	14217	1
19	10/22/2021	214	19642	1
20	8/11/2021	214	11666	1

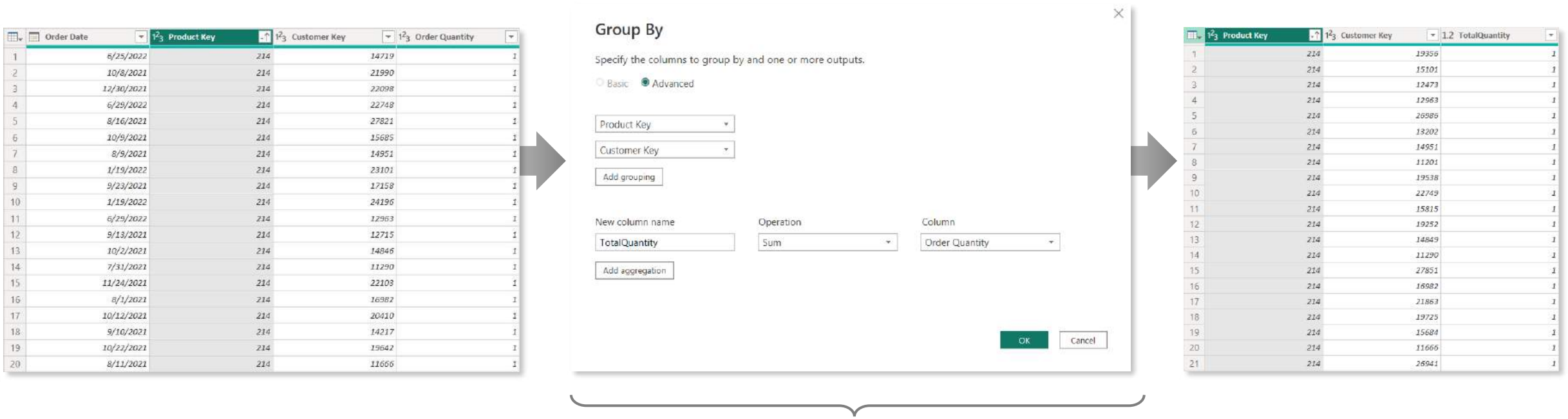


	Product Key	TotalQuantity
1	214	2099
2	215	1940
3	220	1995
4	223	4151
5	226	392
6	229	408
7	232	424
8	235	381
9	310	169
10	311	139
11	312	179
12	313	168
13	314	157
14	320	65
15	322	39
16	324	72
17	326	65

*Here we're transforming a daily, transaction-level table into a summary of **Total Quantity** by **Product Key***

***NOTE:** Any fields not specified in the Group By settings are lost*

GROUPING & AGGREGATING



*This time we're transforming the daily, transaction-level table into a summary of **Total Quantity** grouped by both **Product Key** and **Customer Key** (using the "Advanced" option)*

***NOTE:** This is like creating a PivotTable in Excel and pulling in **Sum of Order Quantity** with **Product Key** and **Customer Key** as row labels*

PIVOTING & UNPIVOTING

Pivoting describes the process of turning **distinct row values into columns**, and **unpivoting** describes the process of turning **distinct columns into rows**

	Date	Product Category	North Region	Central Region	South Region
1	7/1/2022	Bikes	10	19	25
2	7/1/2022	Components	14	31	16
3	7/1/2022	Clothing	35	32	46

PIVOT

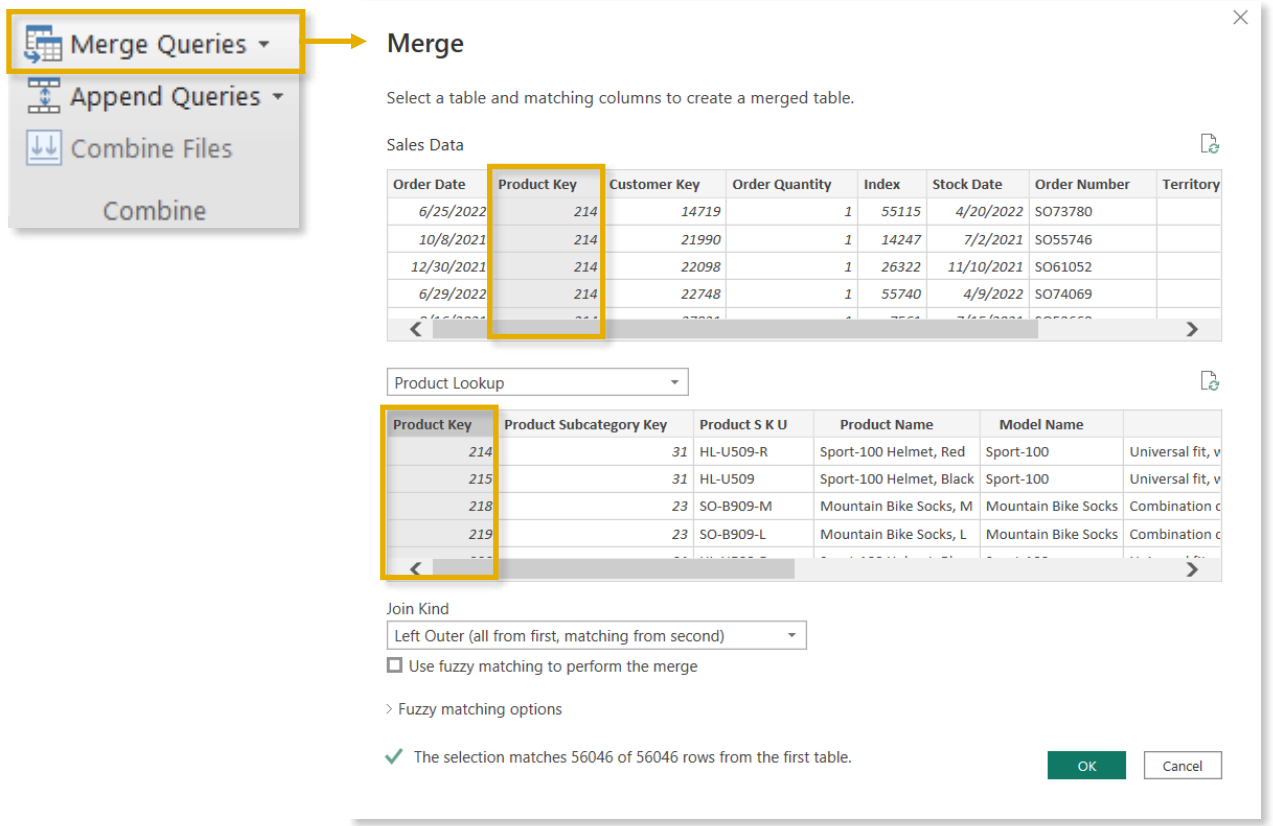
UNPIVOT

	Date	Product Category	Region	Quantity Sold
1	7/1/2022	Bikes	North Region	10
2	7/1/2022	Bikes	Central Region	19
3	7/1/2022	Bikes	South Region	25
4	7/1/2022	Components	North Region	14
5	7/1/2022	Components	Central Region	31
6	7/1/2022	Components	South Region	16
7	7/1/2022	Clothing	North Region	35
8	7/1/2022	Clothing	Central Region	32
9	7/1/2022	Clothing	South Region	46

*Imagine the table on a hinge; **pivoting** rotates it from **vertical** to **horizontal**, and **unpivoting** rotates it from **horizontal** to **vertical***

***NOTE: Transpose** works very similarly, but doesn't recognize unique values; instead, the entire table is transformed so that each row becomes a column and vice versa*

MERGING QUERIES



Merging queries allows you to **join tables** based on a common column (like a lookup in Excel)

*In this case we're merging the **Sales Data** table with the **Product Lookup** table, which share a common **Product Key** column*

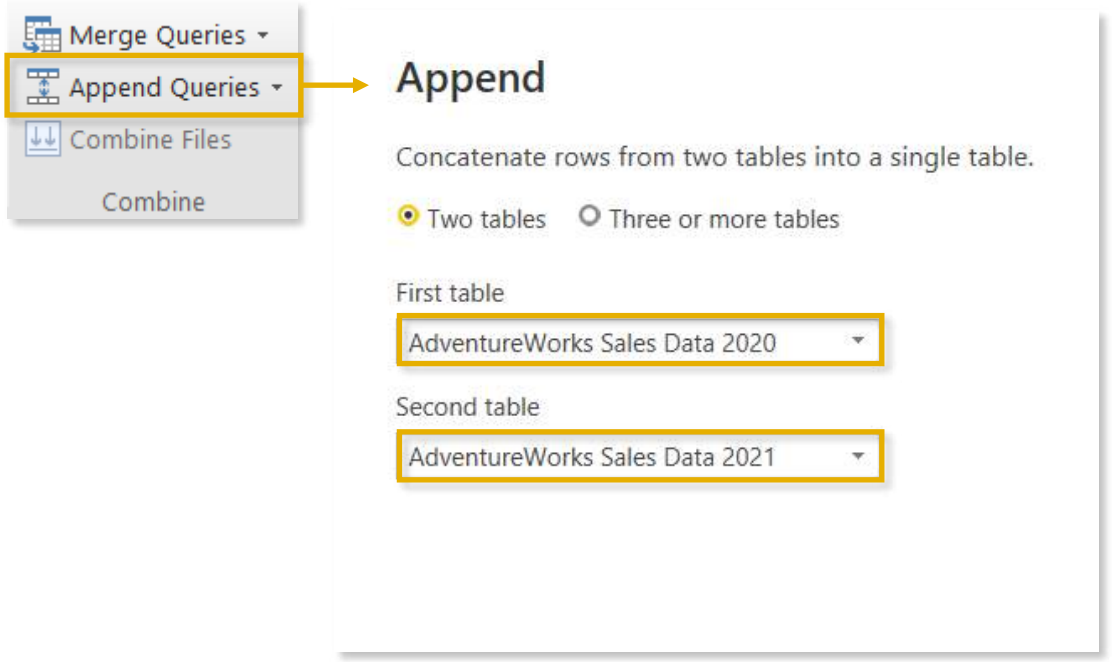
***NOTE**: Merging **adds columns** to an existing table/query*

HEY THIS IS IMPORTANT!

Just because you can merge tables, doesn't mean you should!

In many cases, it's better to keep tables separate and define **relationships** between them in the data model (*more on that soon!*)

APPENDING QUERIES



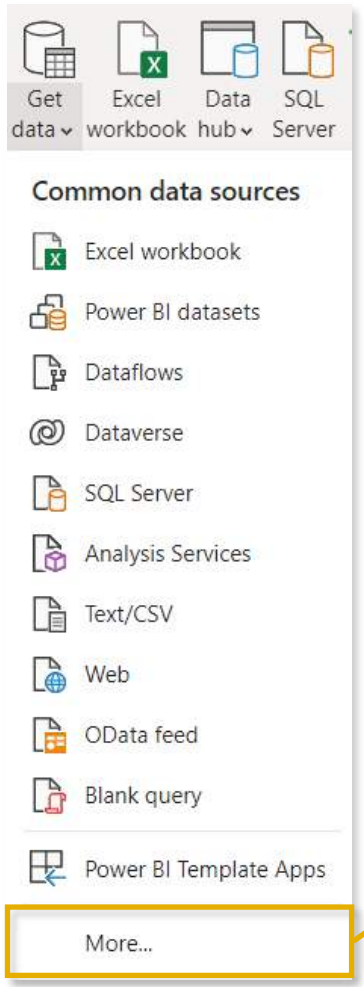
Appending queries allows you to **combine** or **stack** tables sharing the exact same column structure and data types

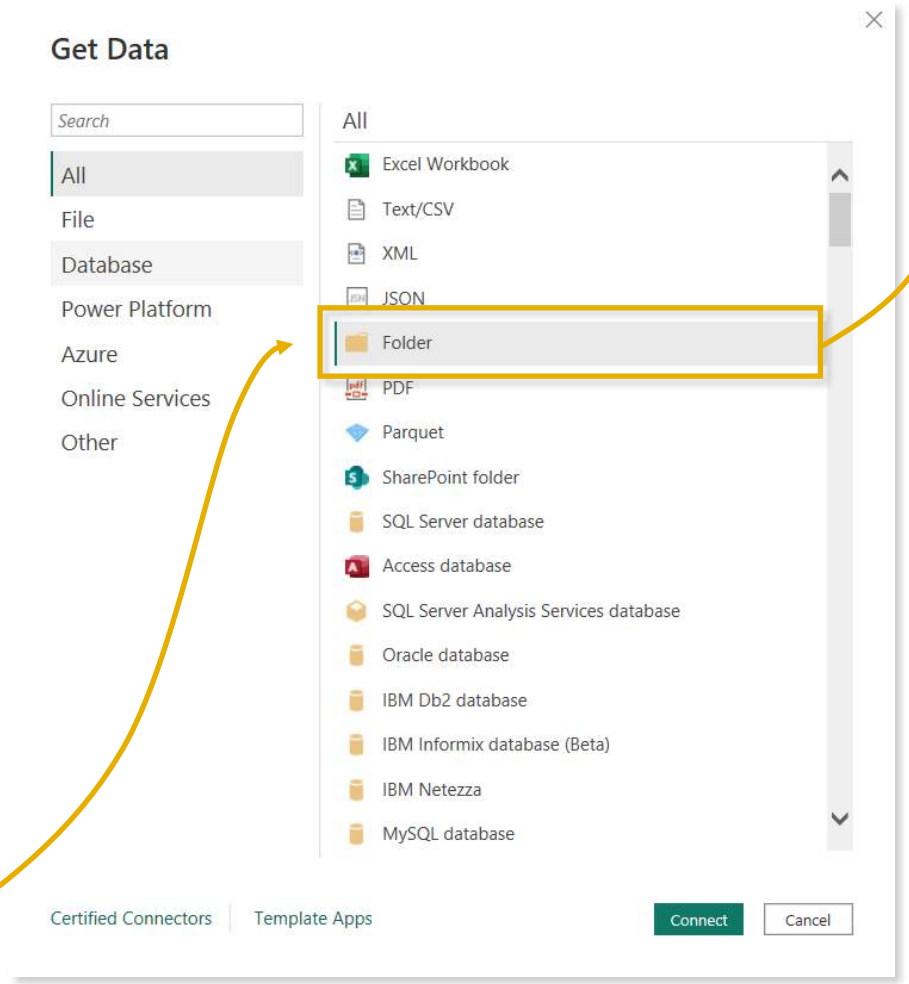
*Here we're appending the **AdventureWorks Sales 2020** table to the **AdventureWorks Sales 2021** table, which is valid since they share identical table structures*

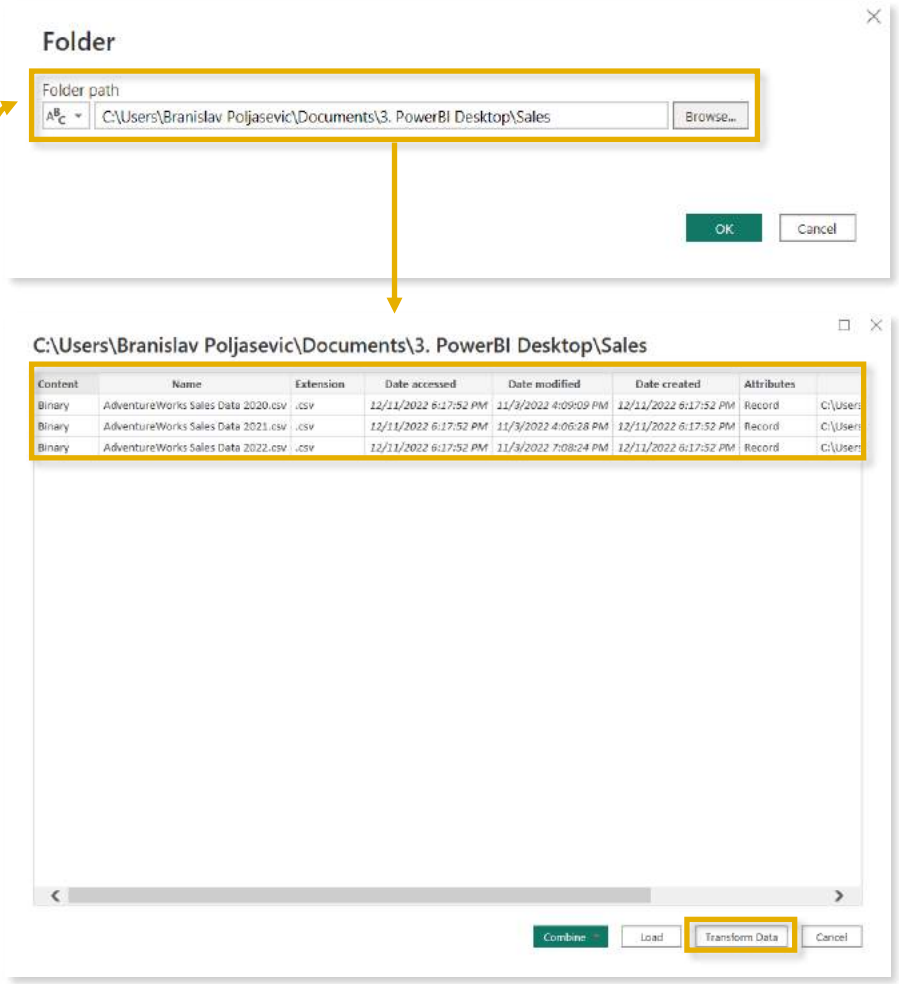
***NOTE:** Appending **adds rows** to an existing table/query*

PRO TIP: *Use the **Folder** option (Get Data > More > Folder) to **append all files within a specified folder** (assuming they share the same structure); as you add new files, simply refresh the query and they will automatically append!*

PRO TIP: APPENDING FILES FROM A FOLDER

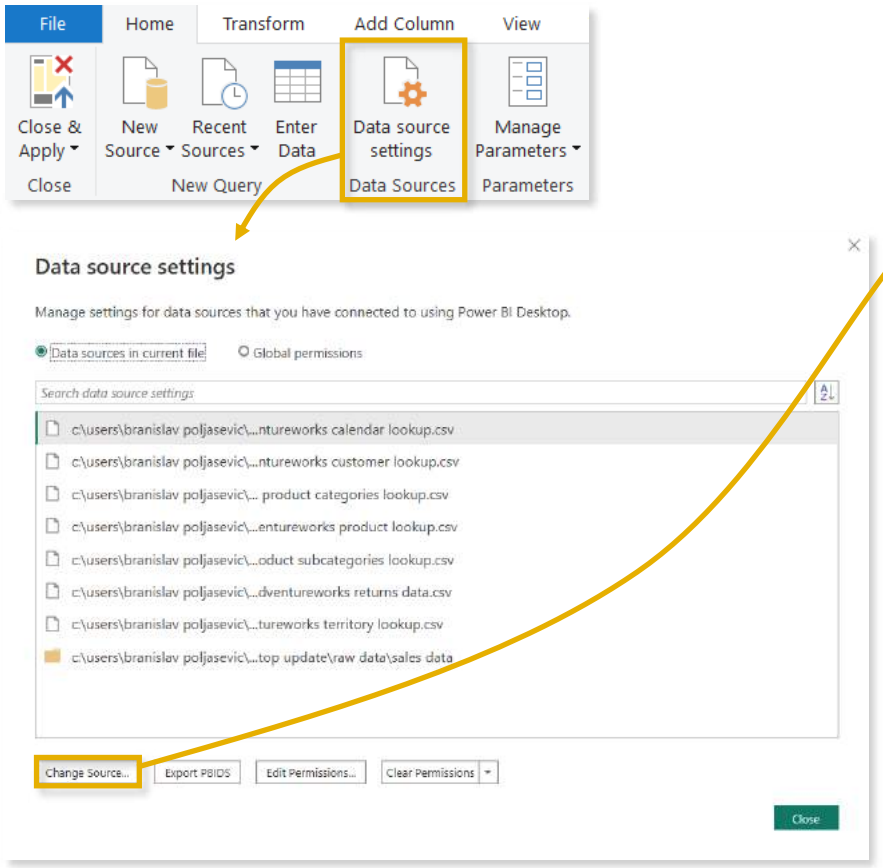


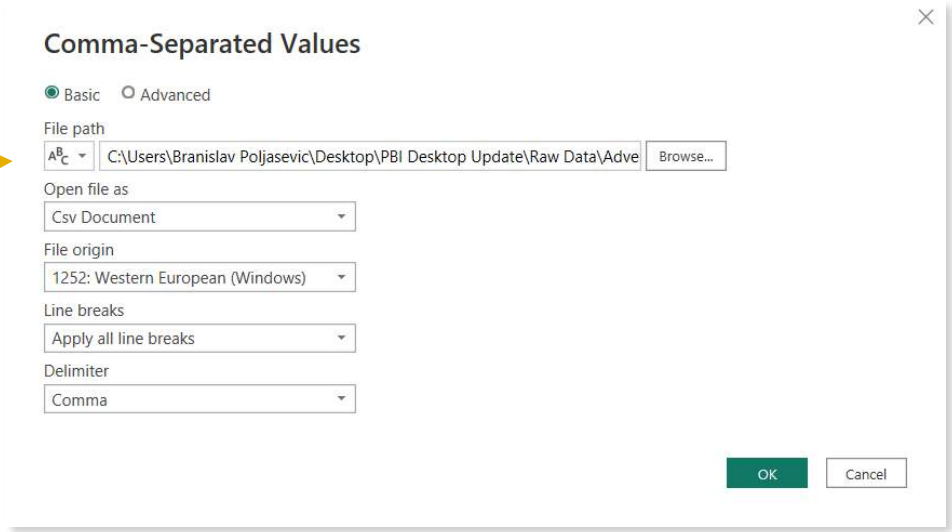




DATA SOURCE SETTINGS

Data Source Settings allow you to manage existing data connections, file paths and permissions



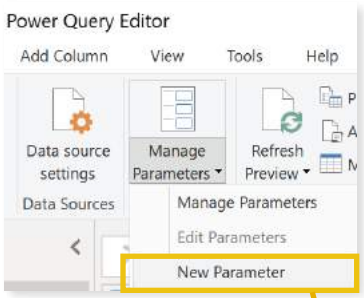


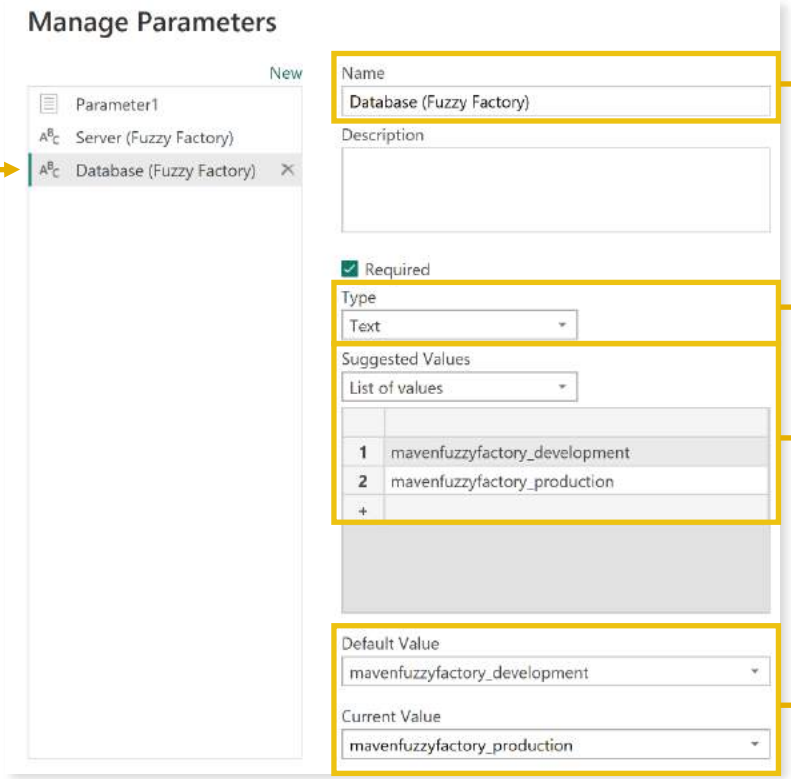
HEY THIS IS IMPORTANT!

Connections to local files reference the **exact file path**, so if the file name or location changes you will need to update your data source settings

PRO TIP: DATA SOURCE PARAMETERS

Use **parameters** to dynamically manage and update connection paths in the Power Query editor



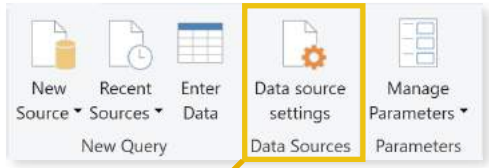


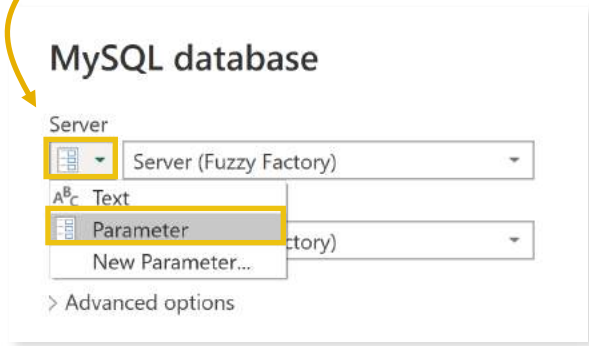
*Parameter **name***
(Name of the query/table)

*Parameter **type***
(Any value, text, date, etc.)

*Parameter **value***
(Any value, list, query)

*Parameter **type***
(Default & current)



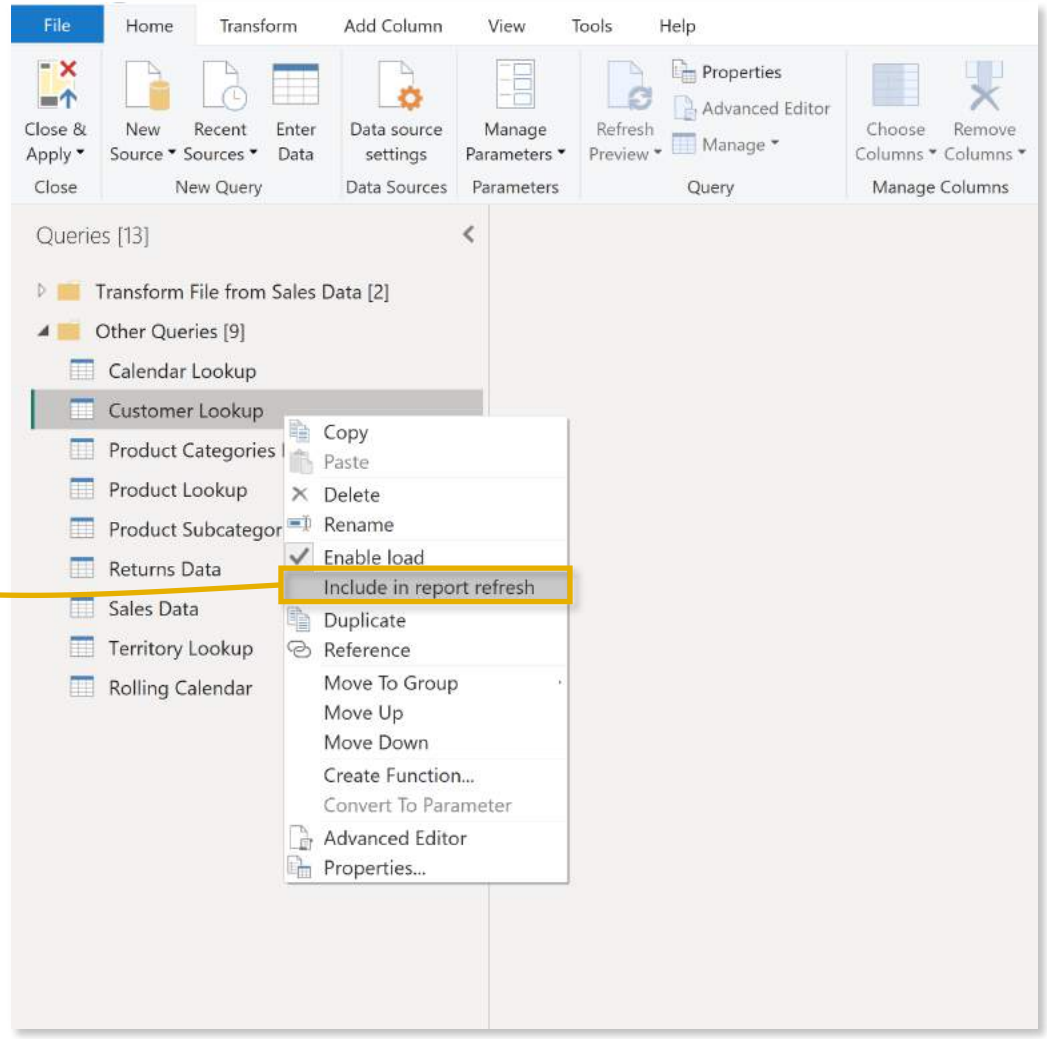


Update** Server & Database connection text values **with parameters

REFRESHING QUERIES

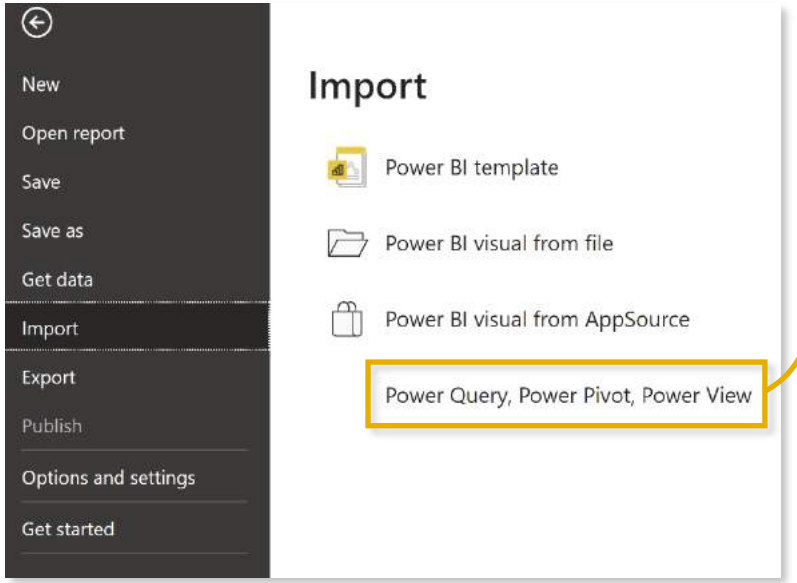
By default, ***all queries*** will refresh when you use the **Refresh** command from the **Home** tab

From the Query Editor, uncheck **Include in report refresh** to exclude individual queries from the refresh



PRO TIP: Exclude queries from refresh that don't change often (like lookups or static data tables)

PRO TIP: IMPORTING EXCEL MODELS



Already have a fully-built model in Excel?

You can import models built in Excel directly into Power BI Desktop using: ***Import > Power Query, Power Pivot, Power View***

Imported models retain the following:

- Data source **connections** and **queries**
- Query editing procedures and **applied steps**
- Table **relationships**, **hierarchies**, **field settings**, etc.
- All **calculated columns** and **DAX measures**

PRO TIP: If you are more comfortable working in Excel, build your models there first then import to Power BI!

**In older versions of Power BI, this import option may be called "Excel Workbook Contents"*

POWER QUERY BEST PRACTICES

Get organized before connecting and loading data

- *Define clear and intuitive table/query names from the start, and establish an organized file/folder structure if you are working with local flat files to avoid changes to file names or paths*

Disable report refresh for any static data sources

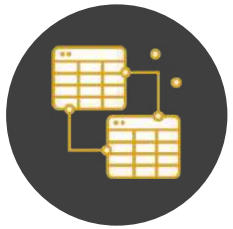
- *There's no need to constantly refresh data sources that don't change, like lookups or static data tables*

When working with large tables, only load the data you need

- *Don't include hourly data when you only need daily, or transaction-level data when only need a product-level summary (extra data will only slow your report down!)*

CREATING A DATA MODEL

CREATING A DATA MODEL



In this section we'll cover **foundational data modeling topics** like normalization, fact and dimension tables, primary and foreign keys, relationship cardinality and filter flow

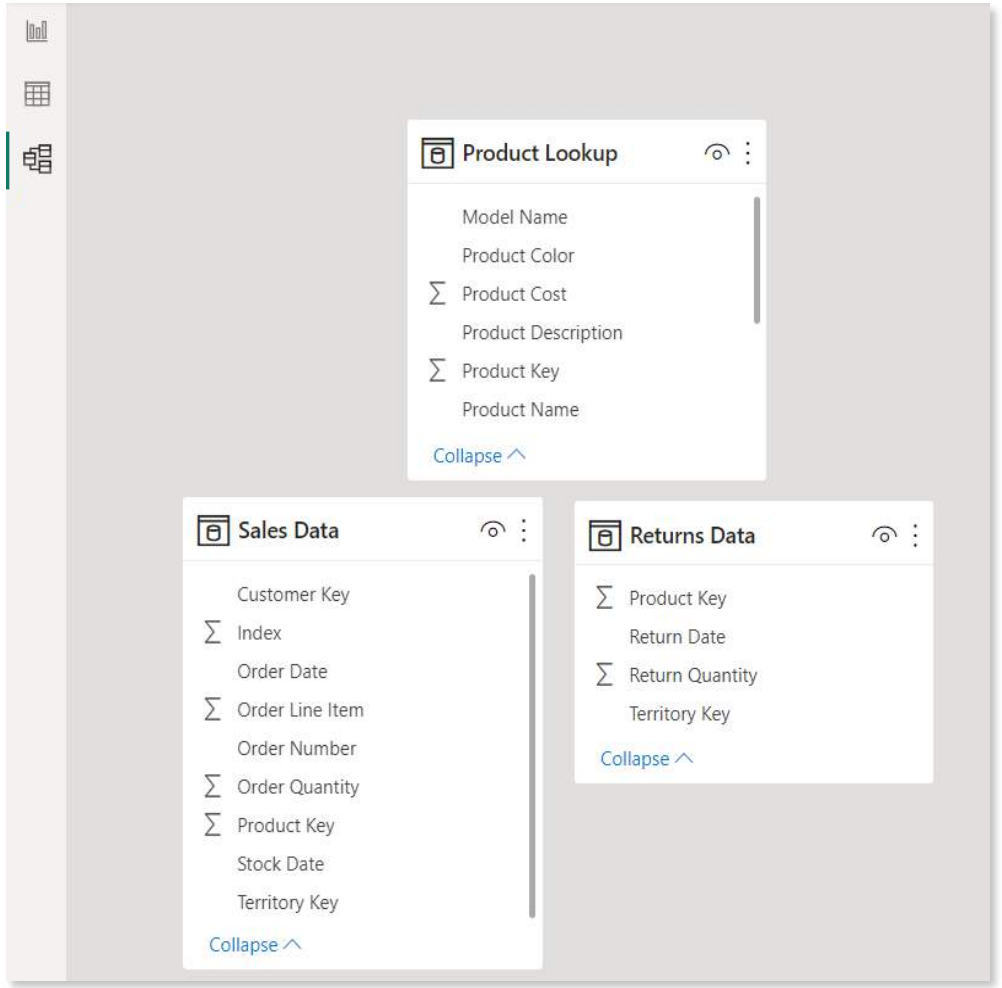
TOPICS WE'LL COVER:

- Data Modeling 101
- Normalization
- Facts & Dimensions
- Primary & Foreign Keys
- Cardinality
- Filter Flow
- Common Schemas
- Hierarchies

GOALS FOR THIS SECTION:

- Understand the basic principles of data modeling, including normalization, fact & dimension tables and common schemas
- Create table relationships using primary and foreign keys, and discuss different types of relationship cardinality
- Configure report filters and trace filter context as it flows between related tables in the model
- Explore data modeling options like hierarchies, data categories and hidden fields

WHAT IS A DATA MODEL?

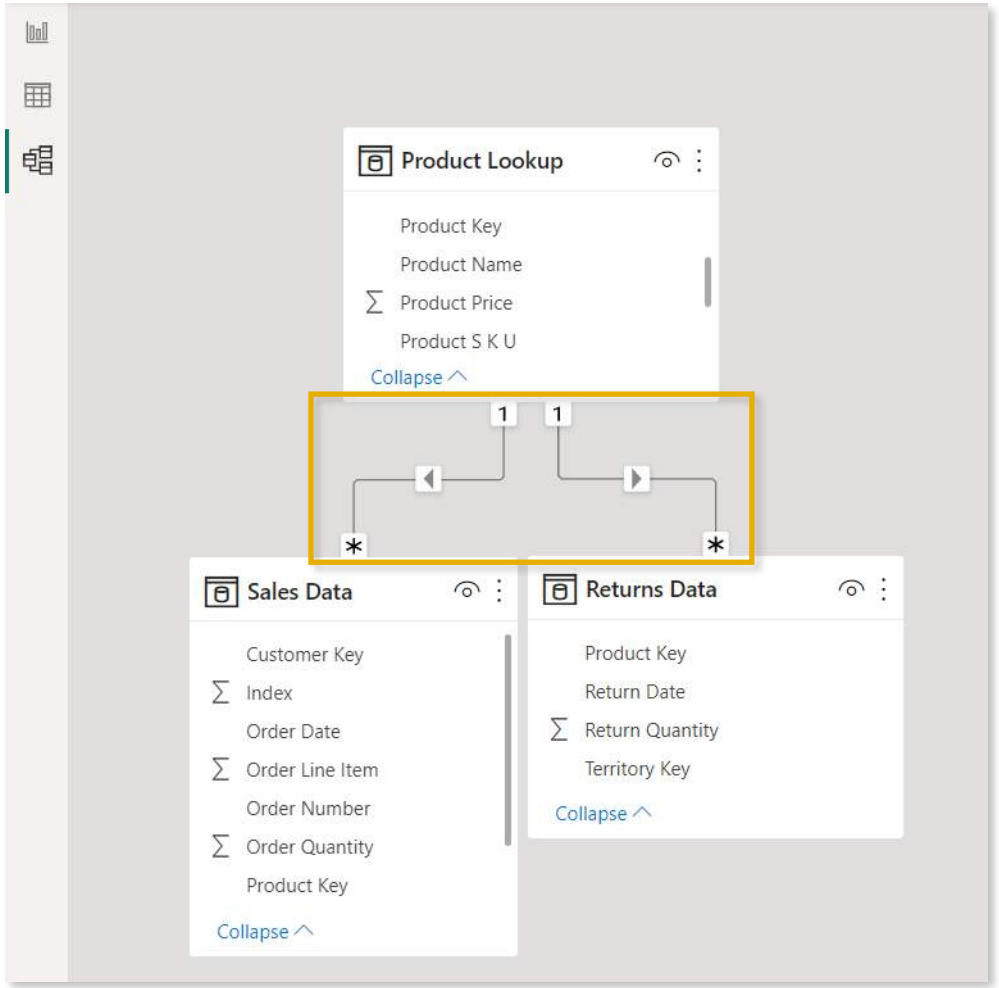


This **IS NOT** a data model

- This is a collection of independent tables, which share no connections or relationships
- If you tried to visualize **Orders** and **Returns** by **Product**, this is what you'd get

ProductName	OrderQuantity	ReturnQuantity
All-Purpose Bike Stand	84,174	1,828
AWC Logo Cap	84,174	1,828
Bike Wash - Dissolver	84,174	1,828
Cable Lock	84,174	1,828
Chain	84,174	1,828
Classic Vest, L	84,174	1,828
Classic Vest, M	84,174	1,828
Classic Vest, S	84,174	1,828
Fender Set - Mountain	84,174	1,828
Total	**84,174**	**1,828**

WHAT IS A DATA MODEL?



This **IS** a data model!

- The tables are connected via relationships, based on a common field (Product Key)
- Now **Sales** and **Returns** data can be filtered using fields from the **Product Lookup** table!

ProductName	OrderQuantity	ReturnQuantity
All-Purpose Bike Stand	234	8
AWC Logo Cap	4,151	46
Bike Wash - Dissolver	1,706	25
Classic Vest, L	182	4
Classic Vest, M	182	7
Classic Vest, S	157	8
Fender Set - Mountain	3,960	54
Half-Finger Gloves, L	840	18
Half-Finger Gloves, M	918	16
Total	**84,174**	**1,828**

DATABASE NORMALIZATION

Normalization is the process of organizing the tables and columns in a relational database to reduce redundancy and preserve data integrity. It's commonly used to:

- **Eliminate redundant data** to decrease table sizes and improve processing speed & efficiency
- **Minimize errors and anomalies** from data modifications (inserting, updating or deleting records)
- **Simplify queries** and structure the database for meaningful analysis

In a normalized database, each table should serve a **distinct** and **specific** purpose (*i.e. product information, transaction records, customer attributes, store details, etc.*)

date	product_id	quantity	product_brand	product_name	product_sku	product_weight
1/1/1997	869	5	Nationeel	Nationeel Grape Fruit Roll	52382137179	17
1/7/1997	869	2	Nationeel	Nationeel Grape Fruit Roll	52382137179	17
1/3/1997	1	4	Washington	Washington Berry Juice	90748583674	8.39
1/1/1997	1472	3	Fort West	Fort West Fudge Cookies	37276054024	8.28
1/6/1997	1472	2	Fort West	Fort West Fudge Cookies	37276054024	8.28
1/5/1997	2	4	Washington	Washington Mango Drink	96516502499	7.42
1/1/1997	76	4	Red Spade	Red Spade Sliced Chicken	62054644227	18.1
1/1/1997	76	2	Red Spade	Red Spade Sliced Chicken	62054644227	18.1
1/5/1997	3	2	Washington	Washington Strawberry Drink	58427771925	13.1
1/7/1997	3	2	Washington	Washington Strawberry Drink	58427771925	13.1
1/1/1997	320	3	Excellent	Excellent Cranberry Juice	36570182442	16.4

*Models that aren't normalized contain **redundant, duplicate data**. In this case, all of the product-specific fields could be stored in a separate table containing a unique record for each **product id***

This may not seem critical now, but minor inefficiencies can become major problems at scale!

FACT & DIMENSION TABLES

Data models generally contain two types of tables: **fact** ("data") tables, and **dimension** ("lookup") tables:

- **Fact tables** contain **numerical values** or metrics used for summarization *(sales, orders, transactions, pageviews, etc.)*
- **Dimension tables** contain **descriptive attributes** used for filtering or grouping *(products, customers, dates, stores, etc.)*

date	product_id	quantity
1/1/1997	869	5
1/1/1997	1472	3
1/1/1997	76	4
1/1/1997	320	3
1/1/1997	4	4
1/1/1997	952	4
1/1/1997	1222	4
1/1/1997	517	4
1/1/1997	1359	4
1/1/1997	357	4
1/1/1997	1426	5
1/1/1997	190	4
1/1/1997	367	4
1/1/1997	250	5
1/1/1997	600	4
1/1/1997	702	5

*This **Fact** table contains **quantity** values, along with **date** and **product_id** fields*

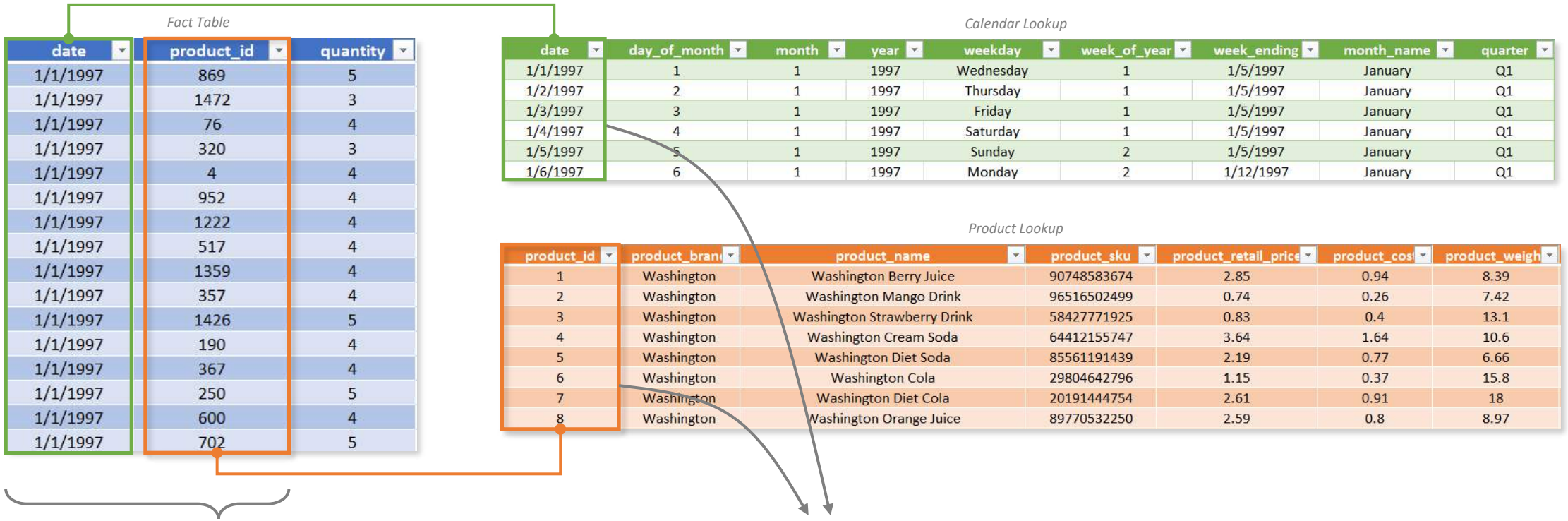
date	day_of_month	month	year	weekday	week_of_year	week_ending	month_name	quarter
1/1/1997	1	1	1997	Wednesday	1	1/5/1997	January	Q1
1/2/1997	2	1	1997	Thursday	1	1/5/1997	January	Q1
1/3/1997	3	1	1997	Friday	1	1/5/1997	January	Q1
1/4/1997	4	1	1997	Saturday	1	1/5/1997	January	Q1
1/5/1997	5	1	1997	Sunday	2	1/5/1997	January	Q1
1/6/1997	6	1	1997	Monday	2	1/12/1997	January	Q1

*This **Calendar Lookup** table contains attributes about each **date** (month, year, quarter, etc.)*

product_id	product_brand	product_name	product_sku	product_retail_price	product_cost	product_weight
1	Washington	Washington Berry Juice	90748583674	2.85	0.94	8.39
2	Washington	Washington Mango Drink	96516502499	0.74	0.26	7.42
3	Washington	Washington Strawberry Drink	58427771925	0.83	0.4	13.1
4	Washington	Washington Cream Soda	64412155747	3.64	1.64	10.6
5	Washington	Washington Diet Soda	85561191439	2.19	0.77	6.66
6	Washington	Washington Cola	29804642796	1.15	0.37	15.8
7	Washington	Washington Diet Cola	20191444754	2.61	0.91	18
8	Washington	Washington Orange Juice	89770532250	2.59	0.8	8.97

*This **Product Lookup** table contains attributes about each **product_id** (brand, SKU, price, etc.)*

PRIMARY & FOREIGN KEYS



Fact Table

date	product_id	quantity
1/1/1997	869	5
1/1/1997	1472	3
1/1/1997	76	4
1/1/1997	320	3
1/1/1997	4	4
1/1/1997	952	4
1/1/1997	1222	4
1/1/1997	517	4
1/1/1997	1359	4
1/1/1997	357	4
1/1/1997	1426	5
1/1/1997	190	4
1/1/1997	367	4
1/1/1997	250	5
1/1/1997	600	4
1/1/1997	702	5

Calendar Lookup

date	day_of_month	month	year	weekday	week_of_year	week_ending	month_name	quarter
1/1/1997	1	1	1997	Wednesday	1	1/5/1997	January	Q1
1/2/1997	2	1	1997	Thursday	1	1/5/1997	January	Q1
1/3/1997	3	1	1997	Friday	1	1/5/1997	January	Q1
1/4/1997	4	1	1997	Saturday	1	1/5/1997	January	Q1
1/5/1997	5	1	1997	Sunday	2	1/5/1997	January	Q1
1/6/1997	6	1	1997	Monday	2	1/12/1997	January	Q1

Product Lookup

product_id	product_brand	product_name	product_sku	product_retail_price	product_cost	product_weight
1	Washington	Washington Berry Juice	90748583674	2.85	0.94	8.39
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3	Washington	Washington Strawberry Drink	58427771925	0.83	0.4	13.1
4	Washington	Washington Cream Soda	64412155747	3.64	1.64	10.6
5	Washington	Washington Diet Soda	85561191439	2.19	0.77	6.66
6	Washington	Washington Cola	29804642796	1.15	0.37	15.8
7	Washington	Washington Diet Cola	20191444754	2.61	0.91	18
8	Washington	Washington Orange Juice	89770532250	2.59	0.8	8.97

These are **foreign keys** (FK)

*They contain multiple instances of each value, and relate to **primary keys** in dimension tables*

These are **primary keys** (PK)

*They uniquely identify each row of the table, and relate to **foreign keys** in fact tables*

RELATIONSHIPS VS. MERGED TABLES

*Can't I just merge queries or use lookup functions to **pull everything into one single table**?*

- Anonymous confused man

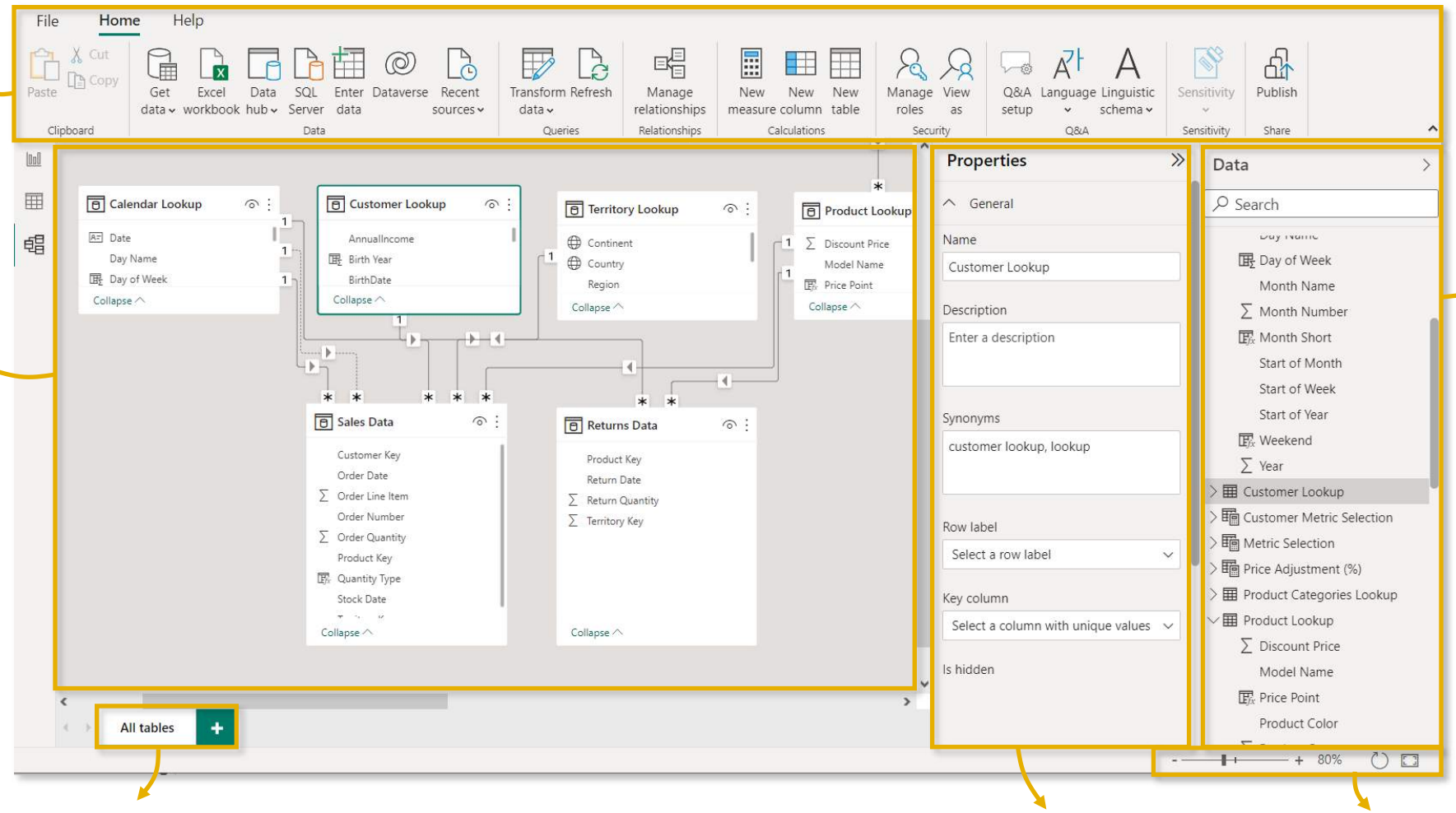
*Original **Fact Table** fields* | *Attributes from **Calendar Lookup** table* | *Attributes from **Product Lookup** table*

date	product_id	quantity	day_of_month	month	year	weekday	month_name	quarter	product_brand	product_name	product_sku	product_weight
1/1/1997	869	5	1	1	1997	Wednesday	January	Q1	Nationeel	Nationeel Grape Fruit Roll	52382137179	17
1/7/1997	869	2	7	1	1997	Tuesday	January	Q1	Nationeel	Nationeel Grape Fruit Roll	52382137179	17
1/3/1997	1	4	3	1	1997	Friday	January	Q1	Washington	Washington Berry Juice	90748583674	8.39
1/1/1997	1472	3	1	1	1997	Wednesday	January	Q1	Fort West	Fort West Fudge Cookies	37276054024	8.28
1/6/1997	1472	2	6	1	1997	Monday	January	Q1	Fort West	Fort West Fudge Cookies	37276054024	8.28
1/5/1997	2	4	5	1	1997	Sunday	January	Q1	Washington	Washington Mango Drink	96516502499	7.42
1/1/1997	76	4	1	1	1997	Wednesday	January	Q1	Red Spade	Red Spade Sliced Chicken	62054644227	18.1
1/1/1997	76	2	1	1	1997	Wednesday	January	Q1	Red Spade	Red Spade Sliced Chicken	62054644227	18.1
1/5/1997	3	2	5	1	1997	Sunday	January	Q1	Washington	Washington Strawberry Drink	58427771925	13.1
1/7/1997	3	2	7	1	1997	Tuesday	January	Q1	Washington	Washington Strawberry Drink	58427771925	13.1
1/1/1997	320	3	1	1	1997	Wednesday	January	Q1	Excellent	Excellent Cranberry Juice	36570182442	16.4

You can, **but it's extremely inefficient!**

- Merging tables creates **redundancy** and often requires **significantly more memory and processing power** to analyze compared to a relational model with multiple small tables

THE MODEL VIEW



Menu Ribbon
(*Home, Help*)

Model canvas

Data / Field List

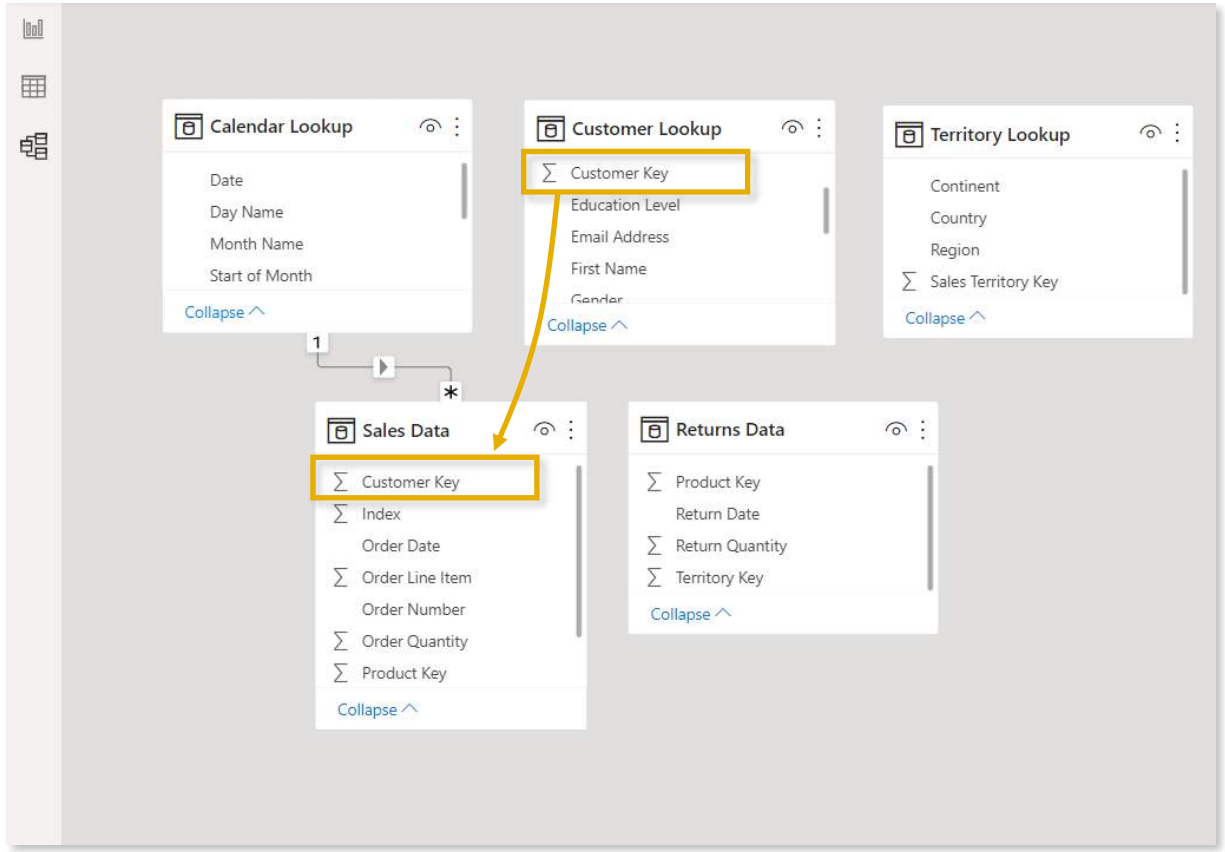
Model layout tabs

Properties pane
(Name, synonym, format, etc.)

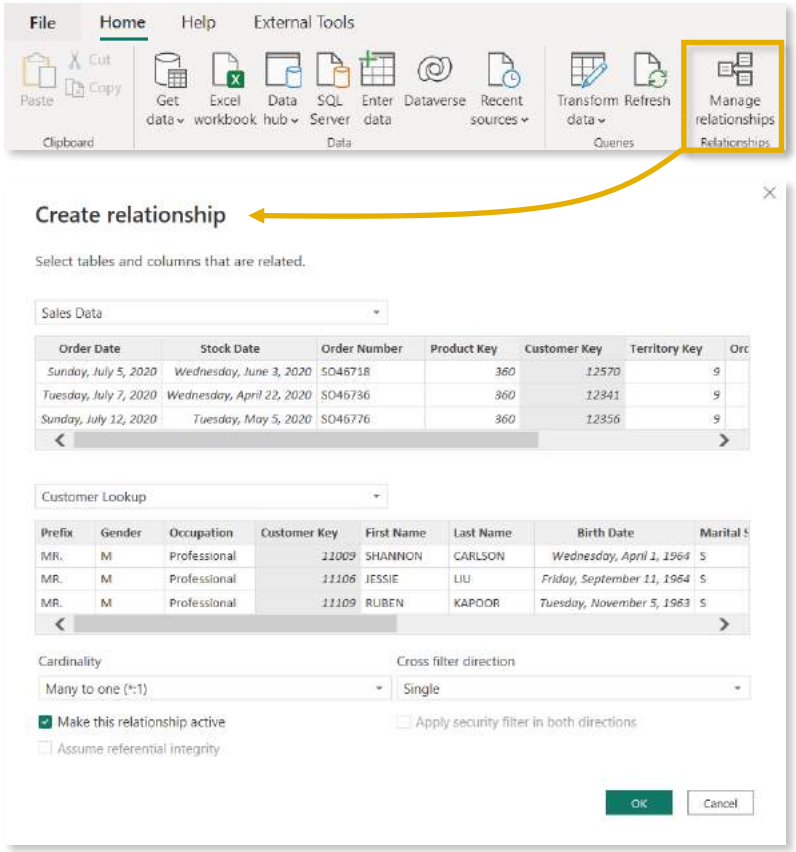
View Options
(*Zoom, Reset Layout, Fit to Page)*

CREATING TABLE RELATIONSHIPS

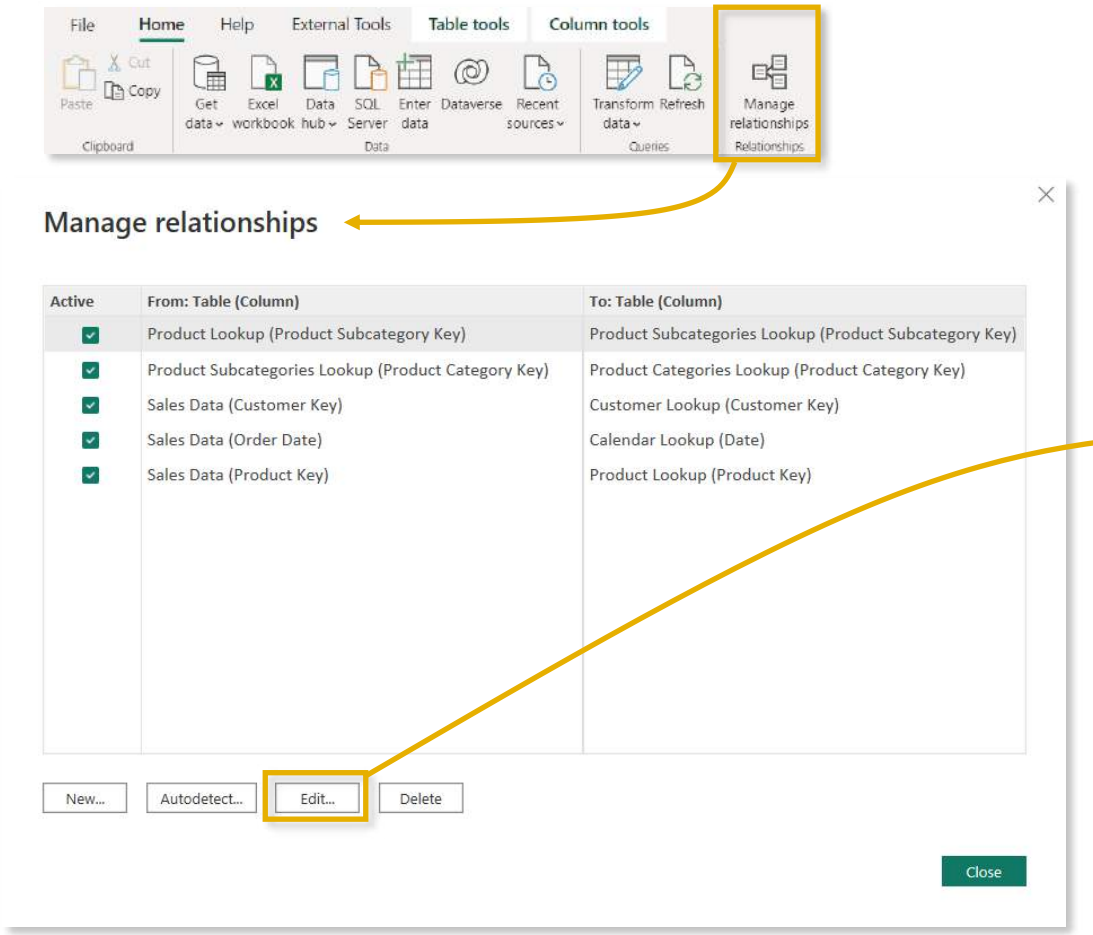
OPTION 1: Click and drag to connect primary and foreign keys within the **Model** view

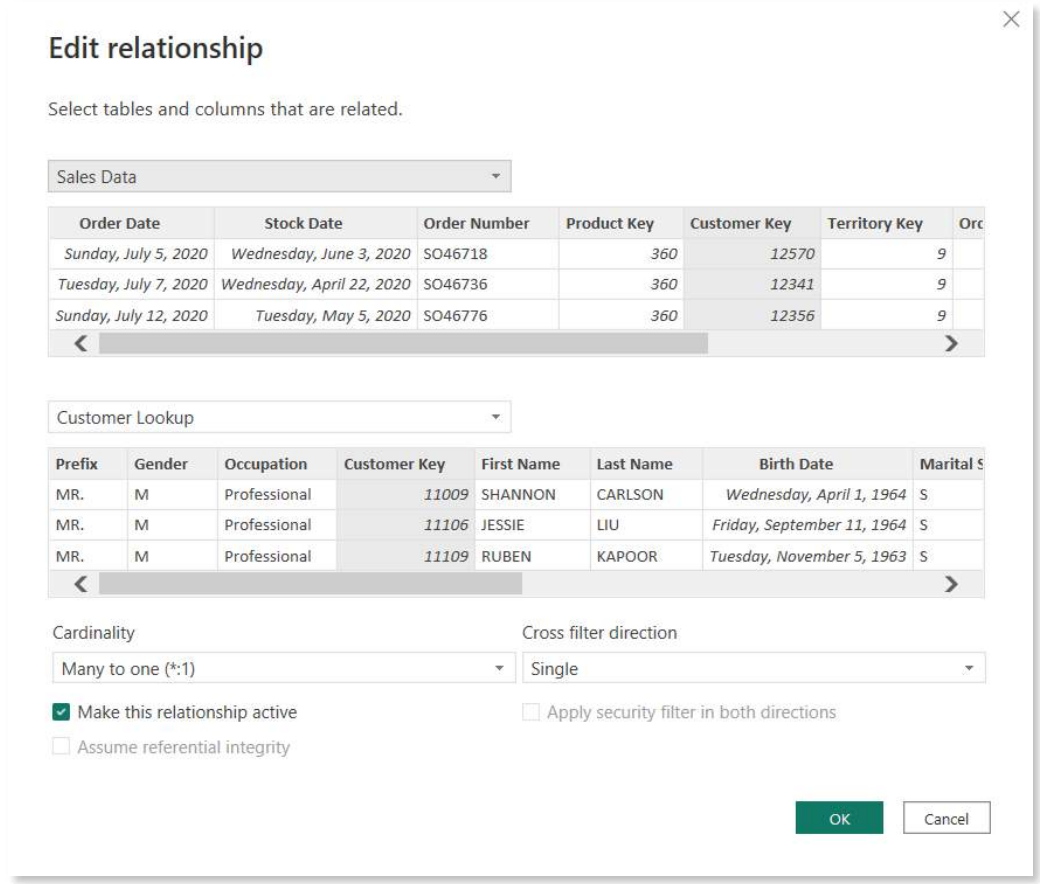


OPTION 2: Add or detect relationships using the **Manage Relationships** dialog box



MANAGING & EDITING RELATIONSHIPS

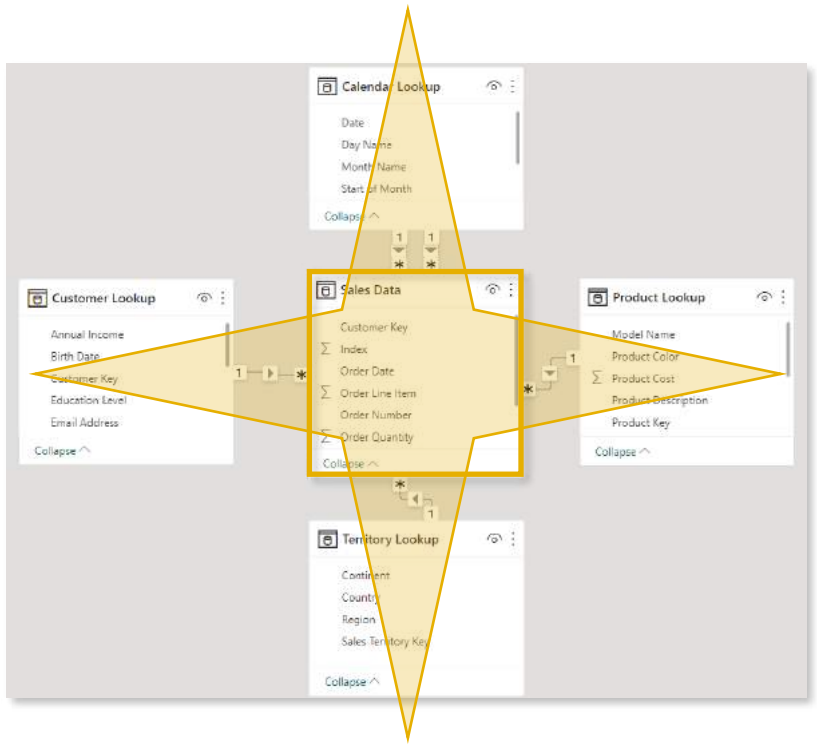




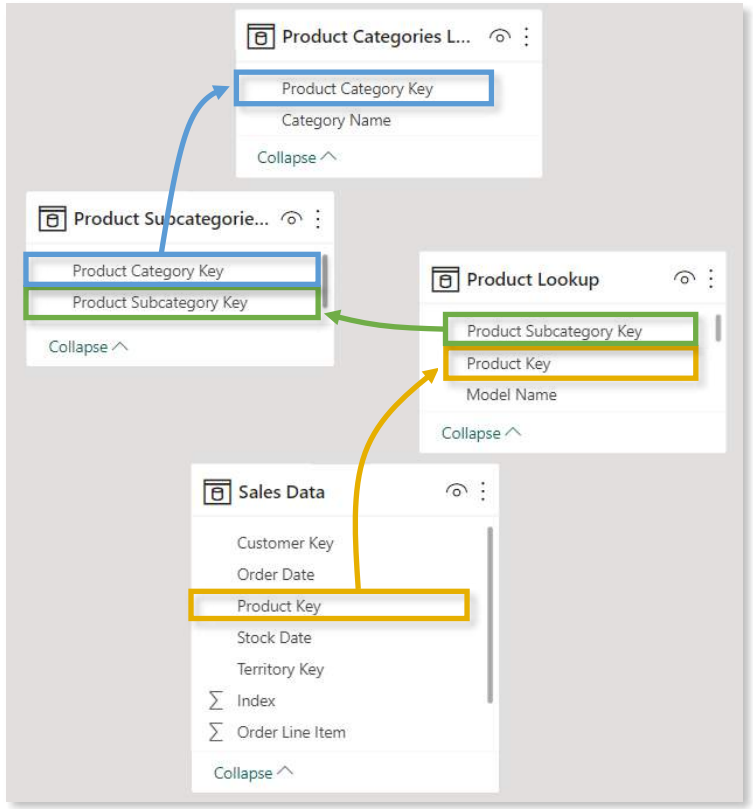
Launch the **Manage Relationships** dialog box or double-click a relationship to modify it

Editing tools allow you to **activate or deactivate** relationships and manage **cardinality** and **filter direction** – more on that soon!

STAR & SNOWFLAKE SCHEMAS



A **star schema** is the simplest and most common type of data model, characterized by a single fact table surrounded by related dimension tables



A **snowflake schema** is an extension of a star, and includes relationships between dimension tables and related sub-dimension tables

ASSIGNMENT: TABLE RELATIONSHIPS

NEW MESSAGE

From: **Dana Modelle** *(Analyst)*

Subject: **Need a favor…**

Hey there,

Ethan shared the data model you've been working on, and we might have an issue…

Last night I left my laptop open, and my cat Dennis somehow got his paws on our model. Now all the relationships are gone!

Could you please rebuild the model, including all three product tables? I owe you one!

-Dana

Reply Forward

Key Objectives

1. Delete all existing table relationships
2. Create a star schema by creating relationships between the Sales, Calendar, Customer, Product and Territories tables
3. Connect all three product tables (Product, Subcategory, Category) in a snowflake schema
4. Use the matrix visual to confirm that you can filter Order Quantity values using fields from each dimension table

SOLUTION: TABLE RELATIONSHIPS

NEW MESSAGE

From: **Dana Modelle** *(Analyst)*

Subject: **Need a favor…**

Hey there,

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Last night I left my laptop open, and my cat Dennis somehow got his paws on our model. Now all the relationships are gone!

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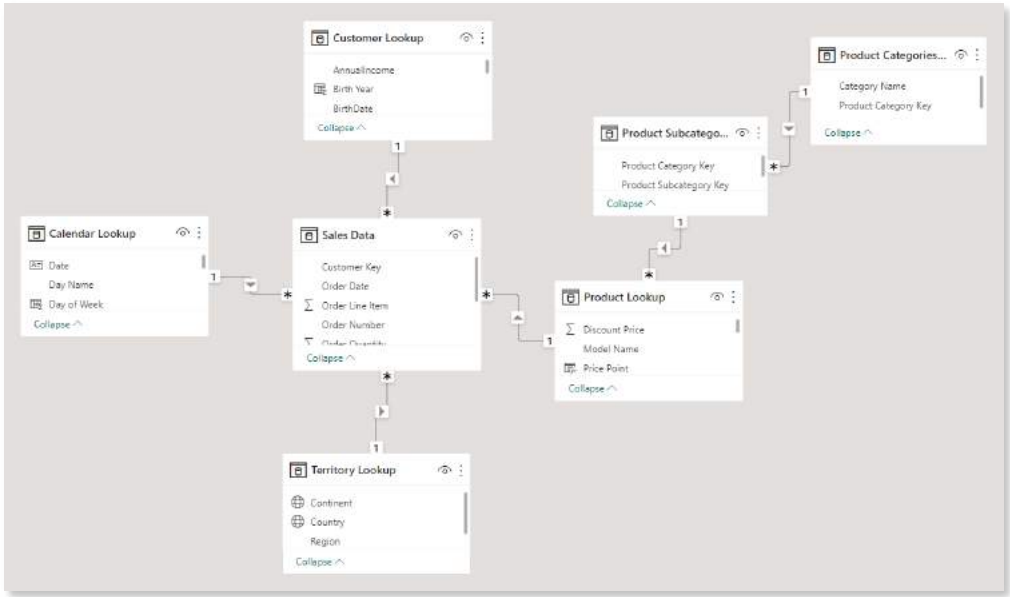
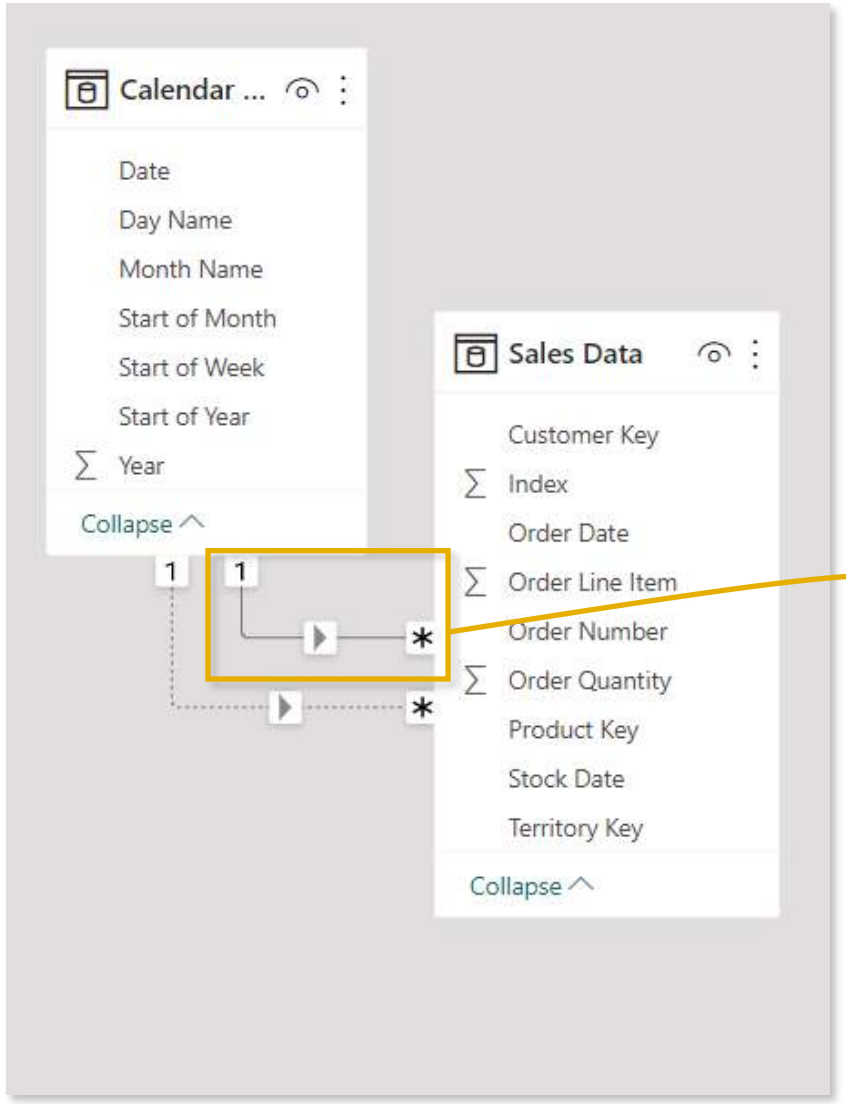
-Dana

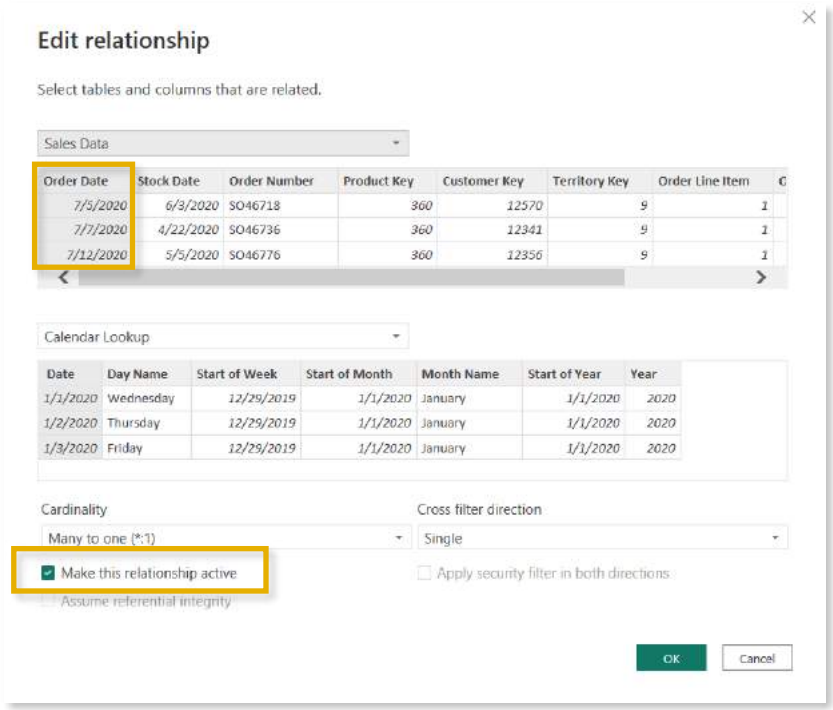
Reply Forward

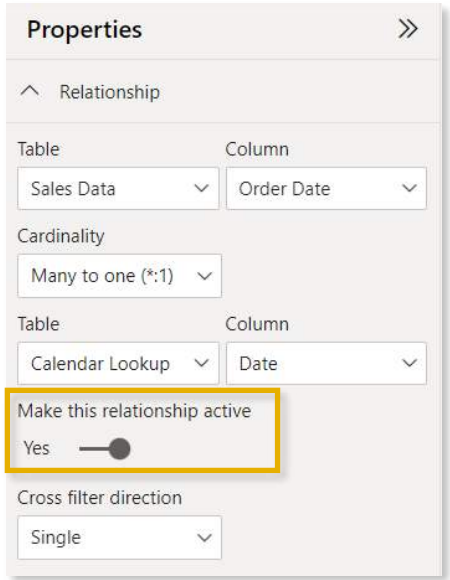
Solution Preview



PRO TIP: ACTIVE & INACTIVE RELATIONSHIPS



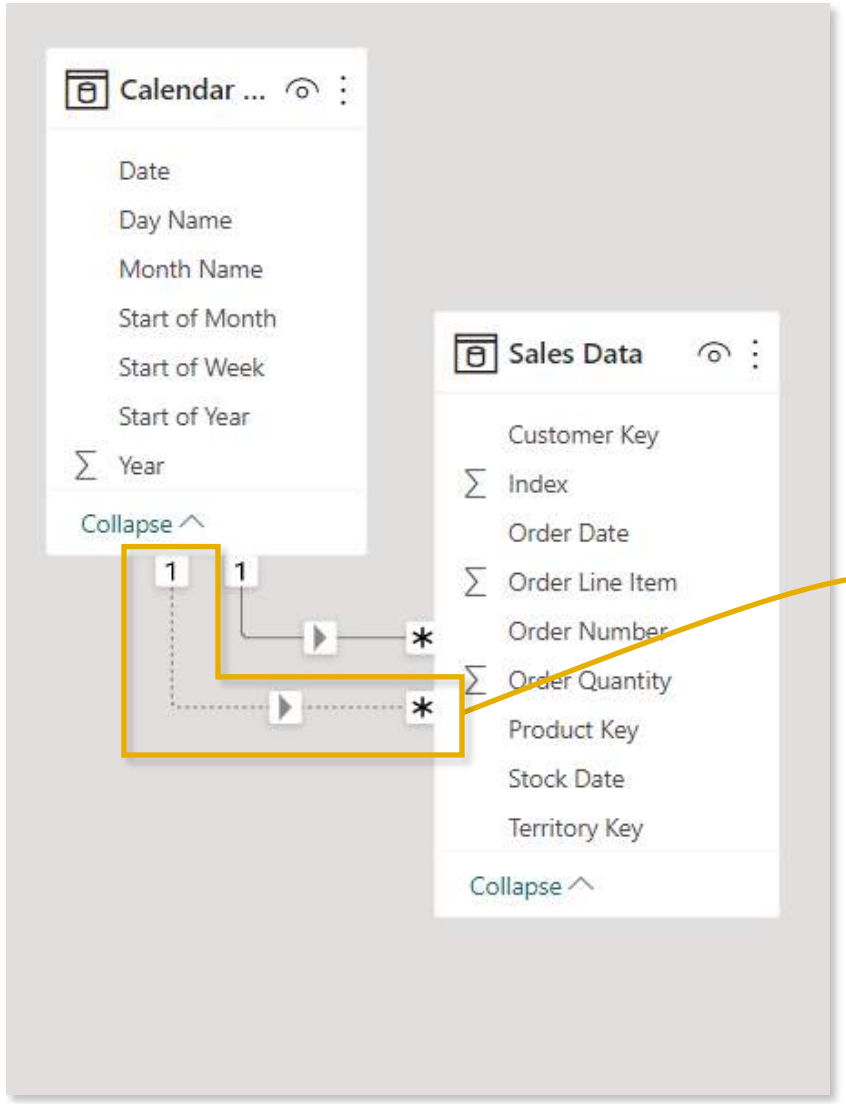


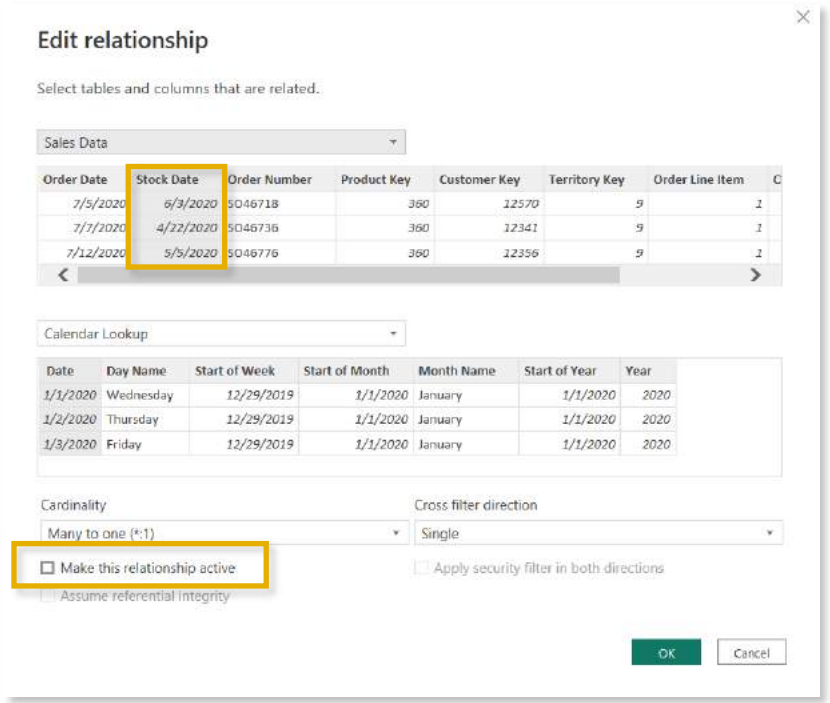


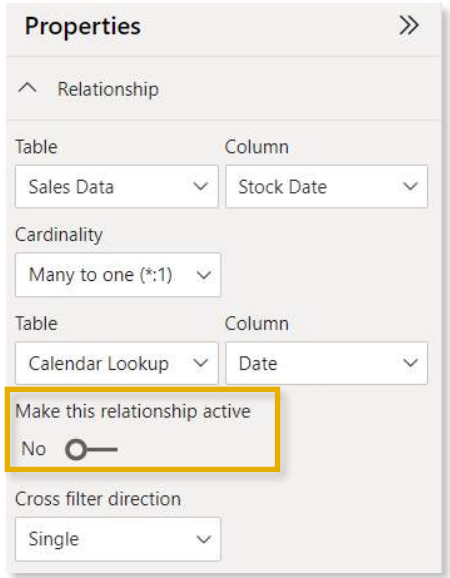
The **Sales Data** table contains two date fields (**Order Date** & **Stock Date**), but there can only be ***one active relationship*** to the Date key in the Calendar table

You can set relationships to active or inactive from either the **Edit Relationships** dialog box or the **Properties** (you must deactivate one before activating another)

PRO TIP: ACTIVE & INACTIVE RELATIONSHIPS



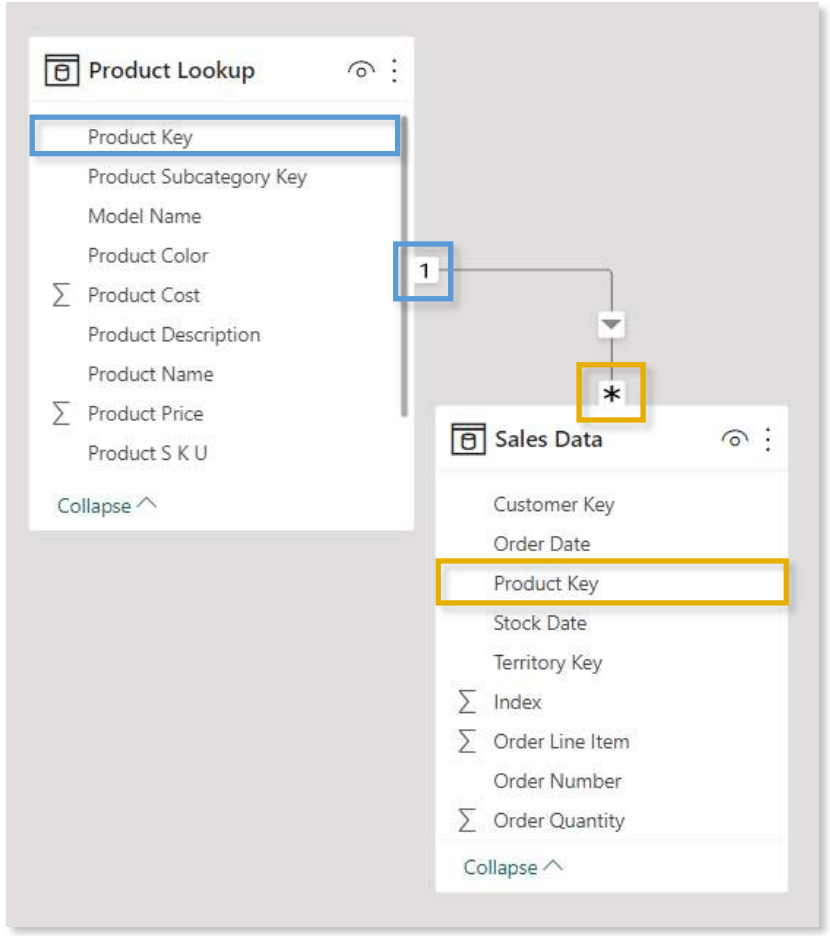




The **Sales Data** table contains two date fields (**Order Date** & **Stock Date**), but there can only be ***one active relationship*** to the Date key in the Calendar table

You can set relationships to active or inactive from either the **Edit Relationships** dialog box or the **Properties** (you must deactivate one before activating another)

RELATIONSHIP CARDINALITY



Cardinality refers to the uniqueness of values in a column

- Ideally, all relationships in the data model should follow a **one-to-many** cardinality: **one** instance of each primary key, and **many** instances of each foreign key

*In this example there is only **ONE instance of each Product Key** in the Product table (noted by a "**1**"), since each row contains **attributes of a single product** (name, SKU, description, price, etc.)*

*There are **MANY instances of each Product Key** in the Sales table (noted by an asterisk *****), since there are **multiple sales for each product***

EXAMPLE: ONE-TO-ONE CARDINALITY

Product Lookup

product_id	product_name	product_sku
4	Washington Cream Soda	64412155747
5	Washington Diet Soda	85561191439
7	Washington Diet Cola	20191444754
8	Washington Orange Juice	89770532250

Price Lookup

product_id	product_price
4	$3.64
5	$2.19
7	$2.61
8	$2.59

- Connecting the two tables above using **product_id** creates a **one-to-one relationship**, since each product ID only appears once in each table
- This isn't necessarily a "bad" relationship, but you can simplify the model by merging the tables into a single, valid dimension table

product_id	product_name	product_sku	product_price
4	Washington Cream Soda	64412155747	$3.64
5	Washington Diet Soda	85561191439	$2.19
7	Washington Diet Cola	20191444754	$2.61
8	Washington Orange Juice	89770532250	$2.59

NOTE: *this still respects the rules of normalization, since all rows are unique and capture product-specific attributes*

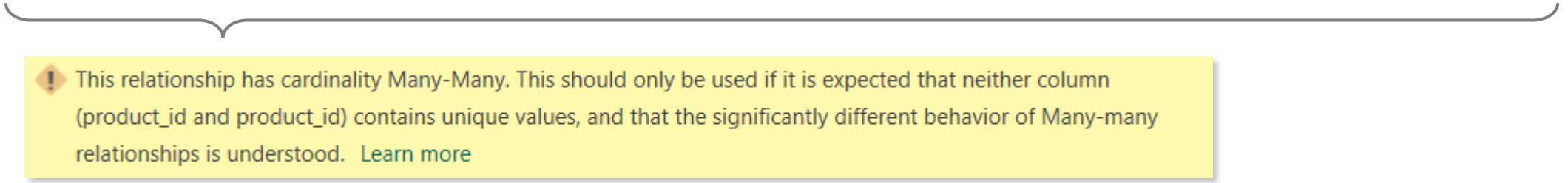
EXAMPLE: MANY-TO-MANY CARDINALITY

Product Lookup

product_id	product_name	product_sku
4	Washington Cream Soda	64412155747
4	Washington Diet Cream Soda	81727382373
5	Washington Diet Soda	85561191439
7	Washington Diet Cola	20191444754
8	Washington Orange Juice	89770532250

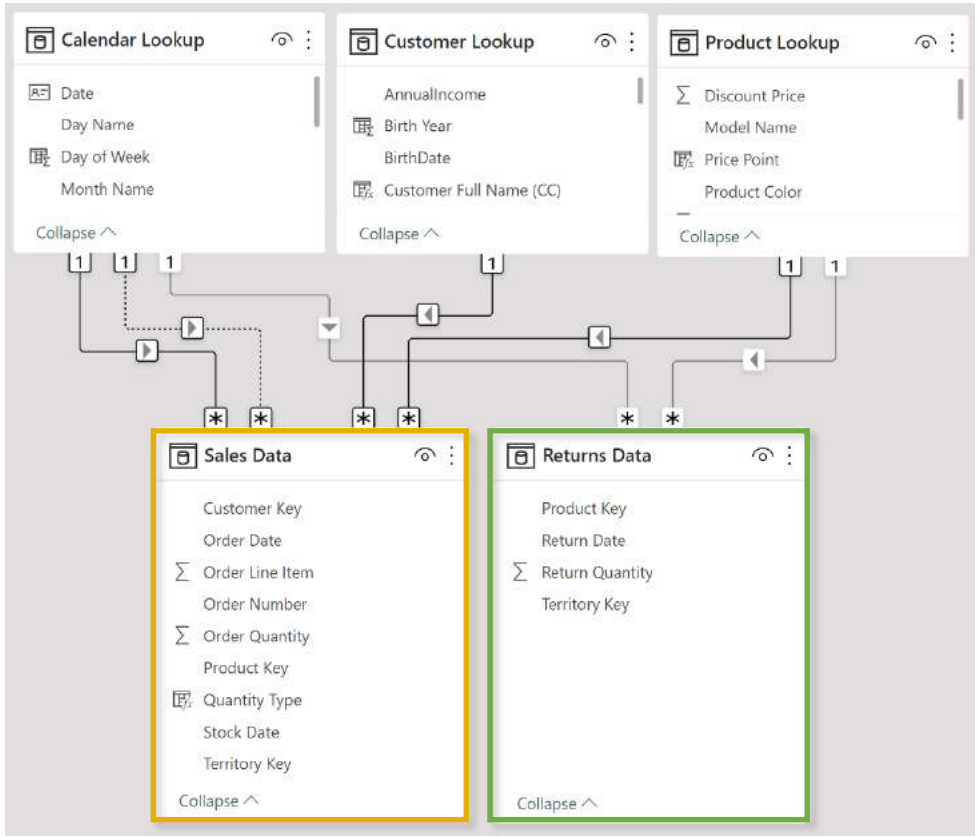
Sales

date	product_id	transactions
1/1/2017	4	12
1/2/2017	4	9
1/3/2017	4	11
1/1/2017	5	16
1/2/2017	5	19
1/1/2017	7	11



- If we try to connect the tables above using **product_id**, we'll get a **many-to-many relationship** warning since there are multiple instances of product_id in both tables
- Even if we force this relationship, how would we know which product was actually sold on each date – **Cream Soda** or **Diet Cream Soda**?

CONNECTING MULTIPLE FACT TABLES



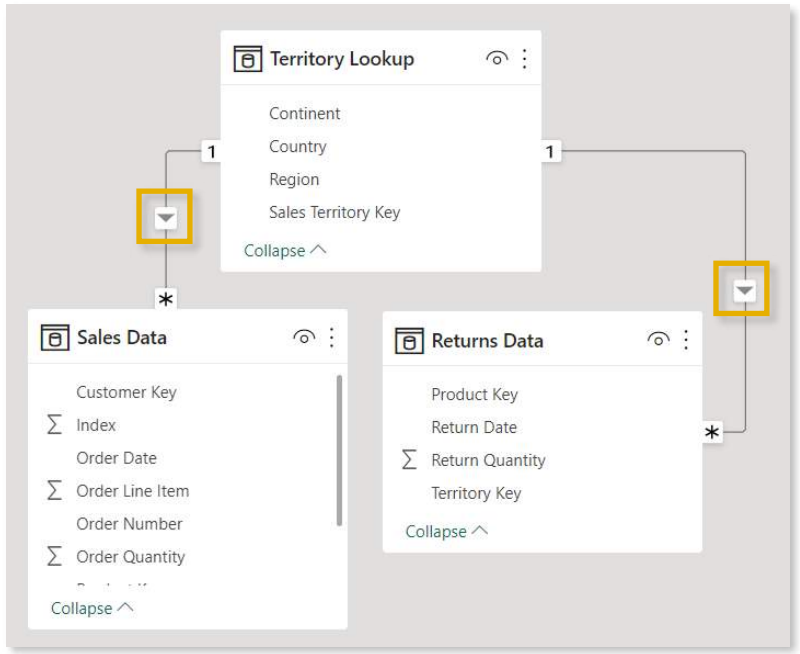
This model contains two fact tables: **Sales Data** and **Returns Data**

- Since there is no primary/foreign key relationship, we can't connect them directly to each other
- But we *can* connect each fact table to related lookups, which allows us to filter both sales and returns data **using fields from any shared lookup tables**
- We can view orders and returns by product since both tables relate to Product Lookup, but we can't view returns by customer since no relationship exists

HEY THIS IS IMPORTANT!

Generally speaking, fact tables should **connect through shared dimension tables, not directly to each other**

FILTER CONTEXT & FLOW



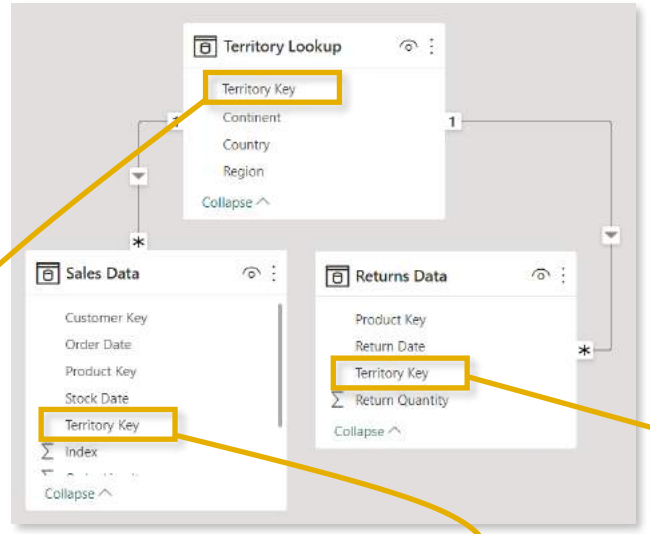
Here we have two data tables (**Sales Data** and **Returns Data**), connected to **Territory Lookup**

The arrows show the **filter direction**, and point from the one (**1**) side of the relationship to the many (*****) side

- When you filter a table, that **filter context** is passed to any related "downstream" tables, following the arrow's direction
- Filter context CANNOT flow "upstream"

PRO TIP: Arrange lookup tables above fact tables in your model as a visual reminder that **filters always flow downstream**

EXAMPLE: FILTER FLOW



In this model, the only way to filter both **Sales** and **Returns** data by **Territory** is to use the **Territory Key** from the lookup table, which is upstream and related to both fact tables

- Filtering using Territory Key from the **Sales** table yields **incorrect Returns values**, since the filter context can't flow to any other table
- Filtering using Territory Key from the **Returns** table yields **incorrect Sales values**, and is limited to territories that exist in the returns table

TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	270
2	40	
3	30	
4	17,191	362
5	49	1
6	9,694	238
7	7,862	186
8	7,950	163
9	17,951	404
10	9,694	204
Total	**84,174**	**1,828**

*Filtering by **Territory Lookup**[Territory Key]*

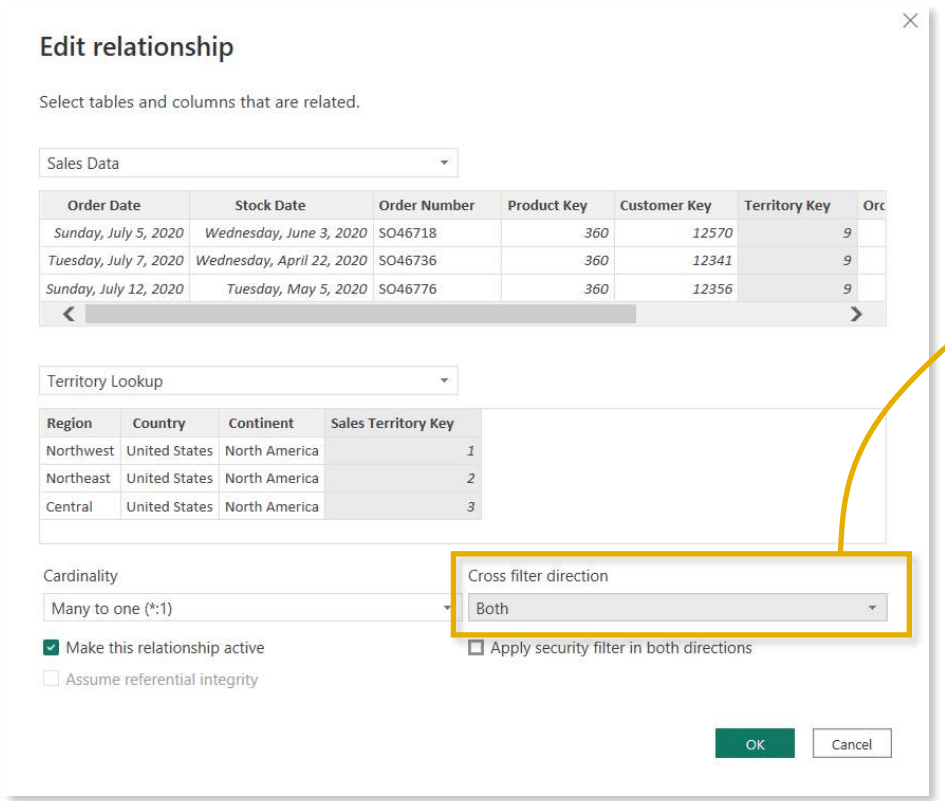
TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	1,828
2	40	1,828
3	30	1,828
4	17,191	1,828
5	49	1,828
6	9,694	1,828
7	7,862	1,828
8	7,950	1,828
9	17,951	1,828
10	9,694	1,828
Total	**84,174**	**1,828**

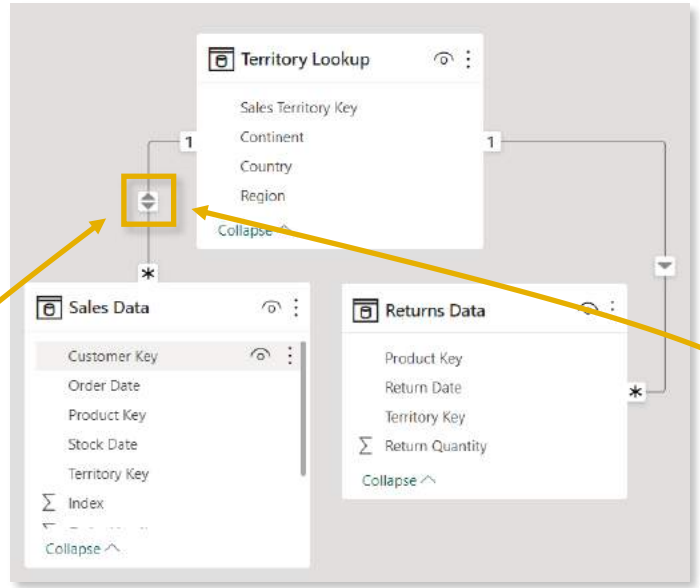
*Filtering by **Sales Data**[Territory Key]*

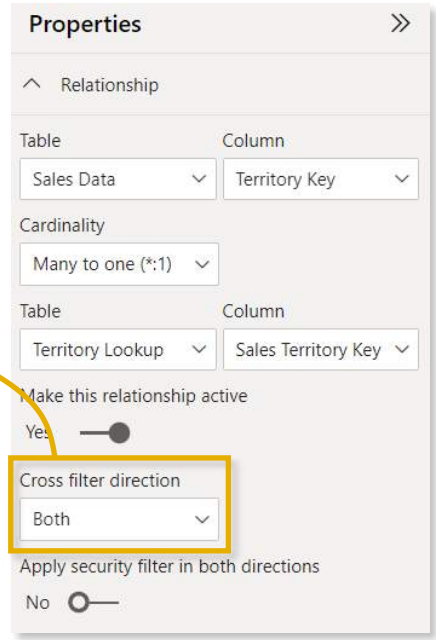
TerritoryKey	OrderQuantity	ReturnQuantity
1	84,174	270
4	84,174	362
5	84,174	1
6	84,174	238
7	84,174	186
8	84,174	163
9	84,174	404
10	84,174	204
Total	**84,174**	**1,828**

*Filtering by **Returns Data**[Territory Key]*

BI-DIRECTIONAL FILTERS





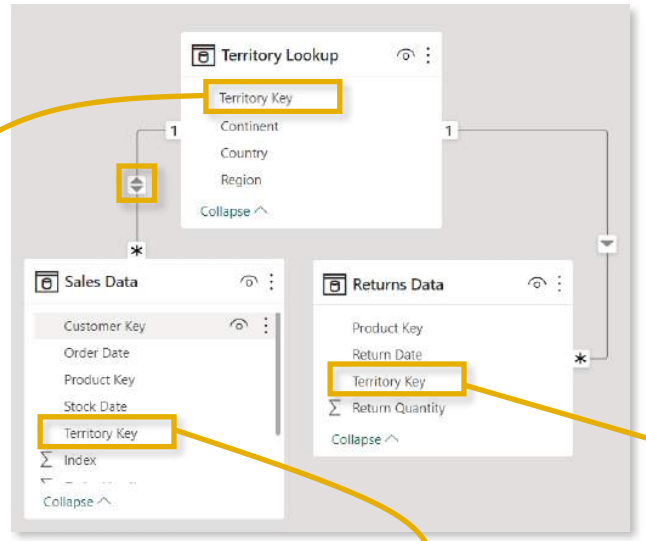


Updating the **cross-filter direction** from **Single** to **Both** allows filter context to flow in either direction

- In this example, filters applied to the **Sales** table can pass up to the **Territory Lookup** table, then down to **Returns**

**The "Apply security filter in both directions" option relates to row-level security (RLS) settings, which are out of scope for this course*

EXAMPLE: BI-DIRECTIONAL FILTERS



With two-way cross-filtering enabled between **Sales** and **Territory**, we now see correct values using **Territory Key** from *either* table

- Filter context can now pass up to the **Territory Lookup** table, then downstream to **Returns**
- However, we still see incorrect values when filtering using Territory Key from the **Returns** table, since the filter context is isolated to that single table

TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	270
2	40	
3	30	
4	17,191	362
5	49	1
6	894	238
7	7,862	186
8	7,950	163
9	17,951	404
10	9,694	204
Total	**84,174**	**1,828**

*Filtering by **Territory Lookup**[Territory Key]*

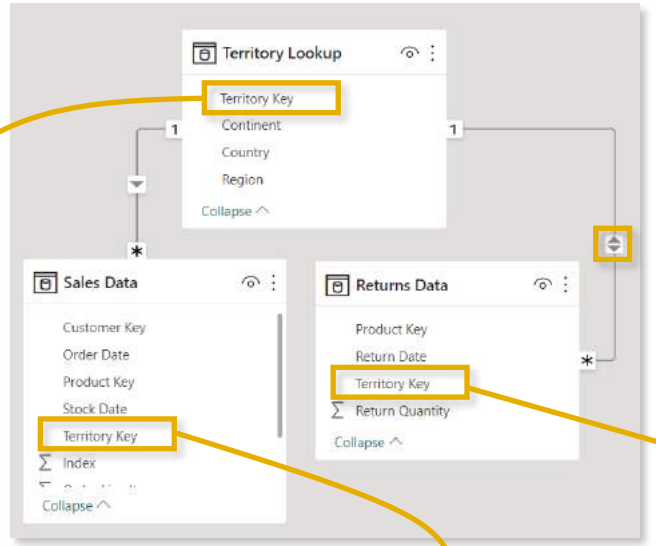
TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	270
2	40	
3	30	
4	17,191	362
5	49	1
6	894	238
7	7,862	186
8	7,950	163
9	17,951	404
10	9,694	204
Total	**84,174**	**1,828**

*Filtering by **Sales Data**[Territory Key]*

TerritoryKey	OrderQuantity	ReturnQuantity
1	84,174	270
4	84,174	362
5	84,174	1
6	84,174	238
7	84,174	186
8	84,174	163
9	84,174	404
10	84,174	204
Total	**84,174**	**1,828**

*Filtering by **Returns Data**[Territory Key]*

EXAMPLE: BI-DIRECTIONAL FILTERS



In this case, we've enabled two-way cross-filtering between the **Returns** and **Territory** tables

- As expected, we now see incorrect values when filtering using Territory Key from the **Sales** table, since the filter context is isolated to that single table
- While the values *appear* to be correct when filtering using Territory Key from the **Returns** table, we're **missing sales data** from any territories that didn't appear in the returns table (specifically Territories **2** & **3**)

TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	270
2	40	
3	30	
4	17,191	362
5	49	1
6	10,894	238
7	7,862	186
8	7,950	163
9	17,951	404
10	9,694	204
Total	**84,174**	**1,828**

*Filtering by **Territory Lookup**[Territory Key]*

TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	1,828
2	40	1,828
3	30	1,828
4	17,191	1,828
5	49	1,828
6	10,894	1,828
7	7,862	1,828
8	7,950	1,828
9	17,951	1,828
10	9,694	1,828
Total	**84,174**	**1,828**

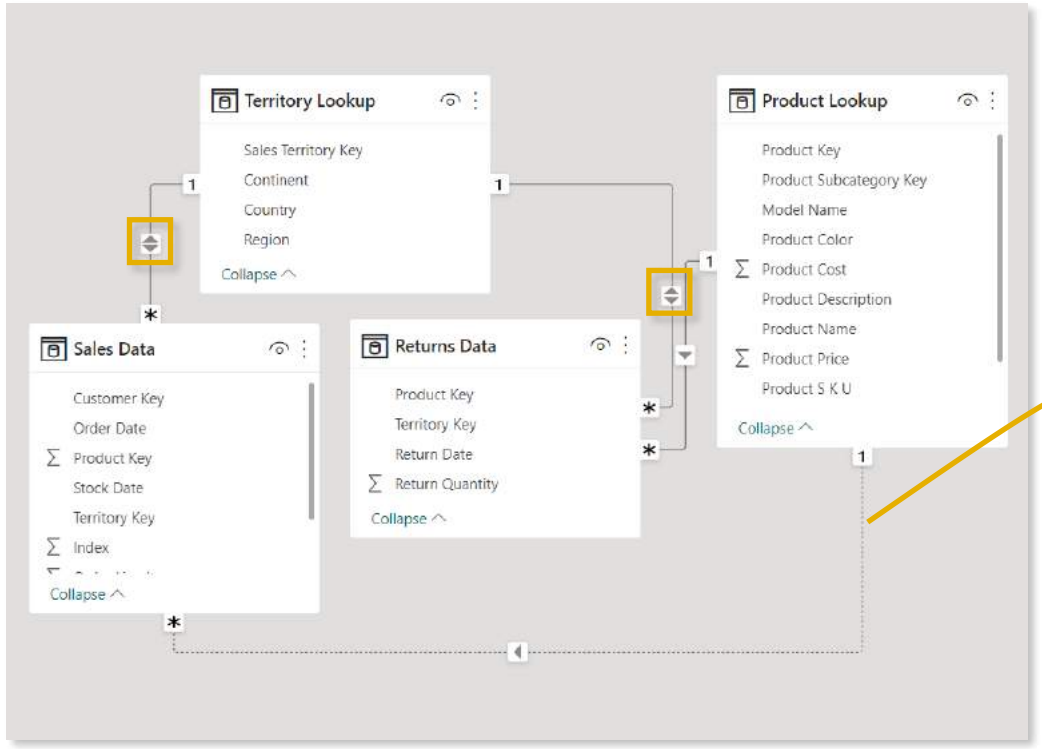
*Filtering by **Sales Data**[Territory Key]*

TerritoryKey	OrderQuantity	ReturnQuantity
1	12,513	270
4	17,191	362
5	49	1
6	10,894	238
7	7,862	186
8	7,950	163
9	17,951	404
10	9,694	204
Total	**84,174**	**1,828**

*Filtering by **Returns Data**[Territory Key]*

*Territories 2 & 3 don't exist in the **Returns** table, so they aren't included in the filter context that passes to **Territory Lookup** and **Sales***

AMBIGUITY



Use two-way filters carefully, and **only when necessary**

- Using multiple two-way filters can cause **ambiguity** by introducing multiple filter paths between tables

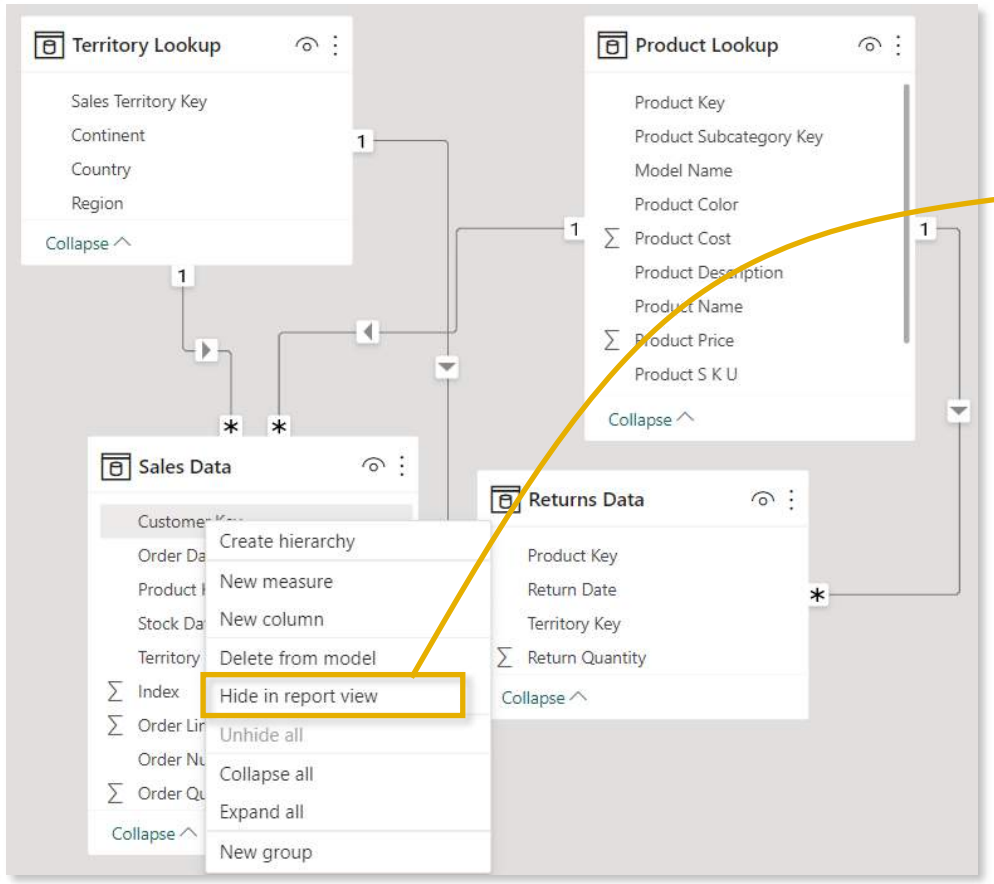
> You can't create a direct active relationship between Sales_Data and Product_Lookup because that would introduce ambiguity between tables Product_Lookup and Territory_Lookup. To make this relationship active, deactivate or delete one of the relationships between Product_Lookup and Territory_Lookup first.

*In this example, filter context from the **Product** table can pass down to **Returns** and up to **Territory Lookup**, which would be filtered based on the Territory Keys passed from the Returns table*

*With an active relationship between **Product** and **Sales** as well, filter context could pass through **either the Sales or Returns table to reach the Territory Lookup table**, which could yield conflicting filter context*

PRO TIP: Design your models with **one-way filters** and **1:many cardinality** unless more complex relationships are absolutely necessary

HIDING FIELDS



Hide in Report View makes fields inaccessible from the Report tab, but still available in **Data** and **Model** views

- This can be controlled by right-clicking a field in the Data or Model view, or by selecting "**Is hidden**" in the Properties pane
- This is commonly used to prevent users from filtering using invalid fields, reduce clutter, or to hide irrelevant metrics from view

PRO TIP: Hide the **foreign keys** in fact tables to force users to filter using **primary keys** in dimension tables

ASSIGNMENT: FILTER FLOW

NEW MESSAGE

From: **Dana Modelle** *(Analyst)*

Subject: **Larry's gone rogue!**

Hey there, we've got another problem.

Larry from Sales just sent me this screenshot. I think he must have downloaded our Power BI model and messed with some relationships, because I KNOW we had sales for product 338.

Can you help diagnose what's going on, and prevent him from doing this again?

-Dana

P.S. Kevin says hi

Reply Forward

Key Objectives

1. Replicate Larry's matrix below to diagnose what he must have done to the model*

Product Key	Sum of Order Quantity	Sum of Return Quantity
324	72	3
326	65	3
328	75	4
330	51	6
332	64	2
334	63	2
336	50	1
340	56	1
342	72	1
346	24	2

   - Which product is #338?
   - Why didn't Larry's matrix show any orders?

2. Hide any remaining foreign keys to prevent other users from making the same mistake

***Hint**: you may need to temporarily change a relationship to bi-directional*

SOLUTION: FILTER FLOW

NEW MESSAGE

From: **Dana Modelle** *(Analyst)*

Subject: **Larry's gone rogue!**

Hey there, we've got another problem.

Larry from Sales just sent me this screenshot. I think he must have downloaded our Power BI model and messed with some relationships, because I KNOW we had sales for product 338.

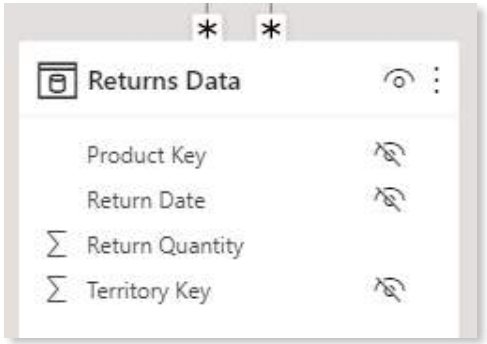
Can you help diagnose what's going on, and prevent him from doing this again?

-Dana

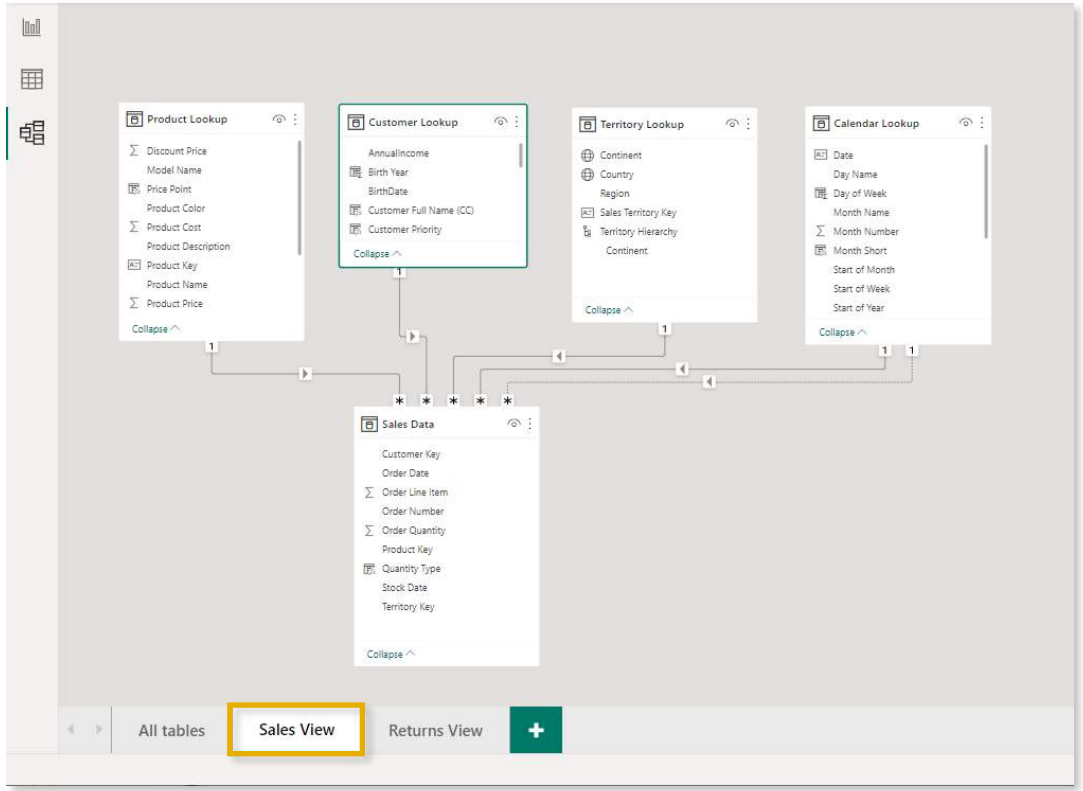
P.S. Kevin says hi

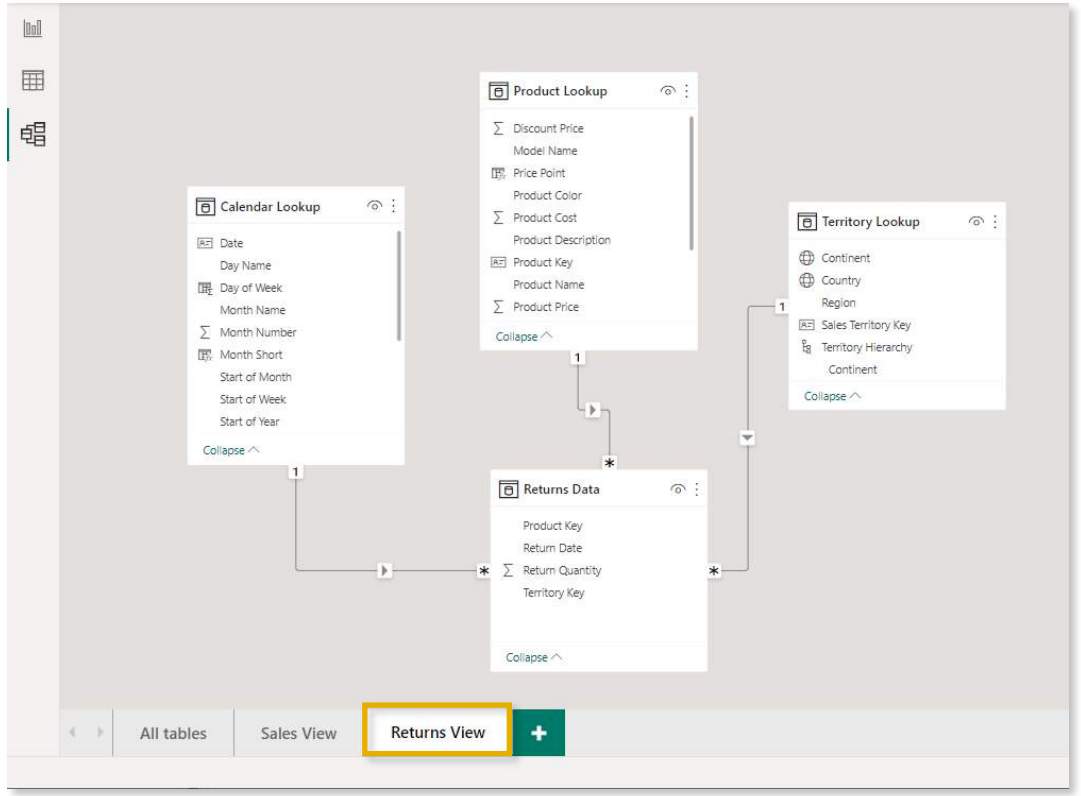
Reply Forward

Solution Preview

1. Larry must have changed the relationship between **Returns Data** and **Product Lookup** to **bi-directional**, and filtered his matrix using product_id from the Returns table
   - Road bike (Road-650 Black, 44)
   - Product 338 doesn't exist in the Returns table, so it was excluded when that filter context passed to the Sales table
2. 

PRO TIP: MODEL LAYOUTS



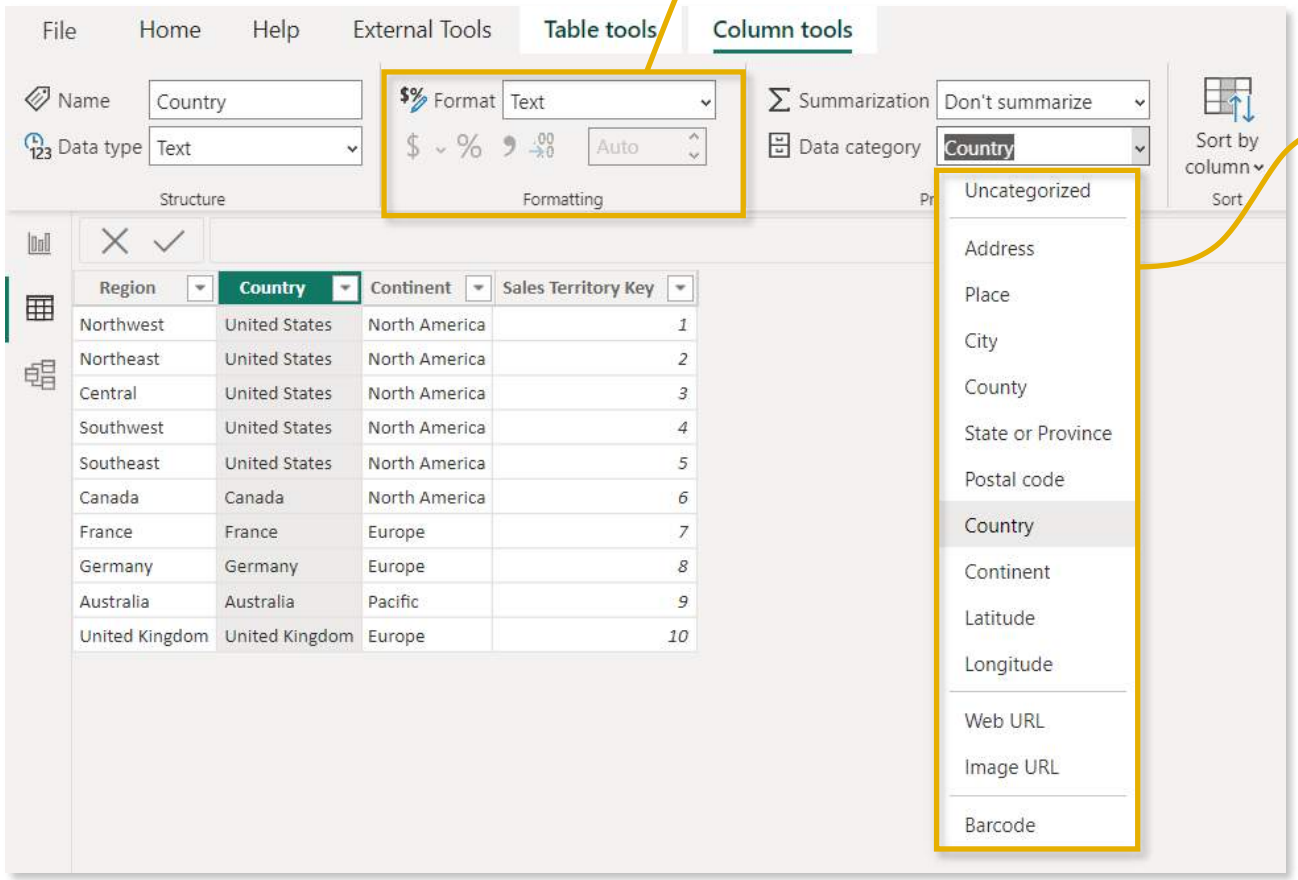


Model layouts allow you to create custom views to show specific portions of large, complex models

- Here we've created a **Sales View** displaying only tables related to sales, and a **Returns View** displaying only tables related to returns *(**Note**: this doesn't actually create duplicate tables)*

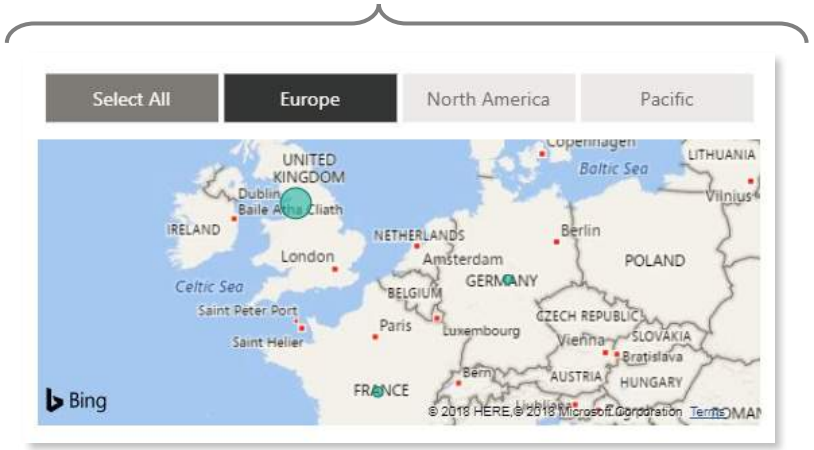
DATA FORMATS & CATEGORIES

Customize **data formats** from the Column tools menu in the **Data** view or the Properties pane in the **Model** view



Assign **data categories** for geospatial fields, URLs or barcodes

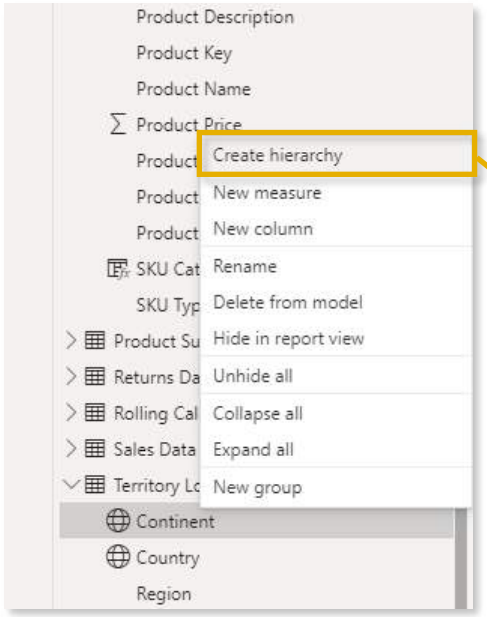
- This is commonly used to help Power BI map location-based fields like addresses, countries, cities, coordinates, zip codes, etc.



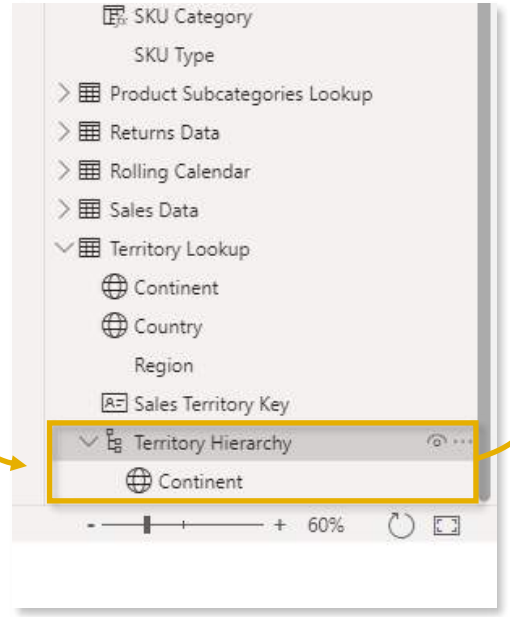
HIERARCHIES

Hierarchies are groups of columns that reflect multiple levels of granularity

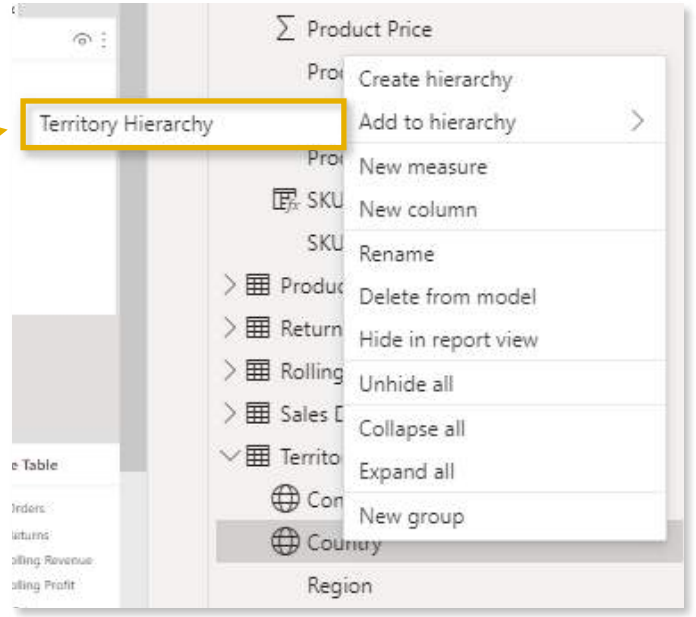
- For example, a **Geography hierarchy** might include **Country**, **State** and **City** fields
- Hierarchies are treated as a **single item** in tables and reports, allowing users to "drill up" and "drill down" through each level



*In the **Data** pane, right-click a field and select **Create hierarchy***



*This hierarchy contains "Continent", and is named "**Territory Hierarchy**"*



*Right-click another field (like "Country") and select **Add to Hierarchy** (or drag it in!)*

ASSIGNMENT: HIERARCHIES

NEW MESSAGE

From: **Dana Modelle** *(Analyst)*

Subject: **Adding a date hierarchy**

Good morning!

Hoping you can help with a quick request.

Since we'll be doing a lot of time-series analysis, Ethan asked us to add a date hierarchy to the model so that users can quickly view trends at any level of granularity (year, month, day, etc.)

Please get that added before our afternoon call. Thanks!

-Dana

Reply Forward

Key Objectives

1. Create a new hierarchy based on the **Start of Year** field, and name it "**Date Hierarchy"**

2. Right-click or drag to add fields until your hierarchy contains the following (in this order):
    - **Start of Year**
    - **Start of Month**
    - **Start of Week**
    - **Date**

3. Add your new hierarchy to the matrix visual (on rows) and practice drilling up and down between each level of granularity

SOLUTION: HIERARCHIES

NEW MESSAGE

From: **Dana Modelle** *(Analyst)*

Subject: **Adding a date hierarchy**

Good morning!

Hoping you can help with a quick request.

Since we'll be doing a lot of time-series analysis, Ethan asked us to add a date hierarchy to the model so that users can quickly view trends at any level of granularity (year, month, day, etc.)

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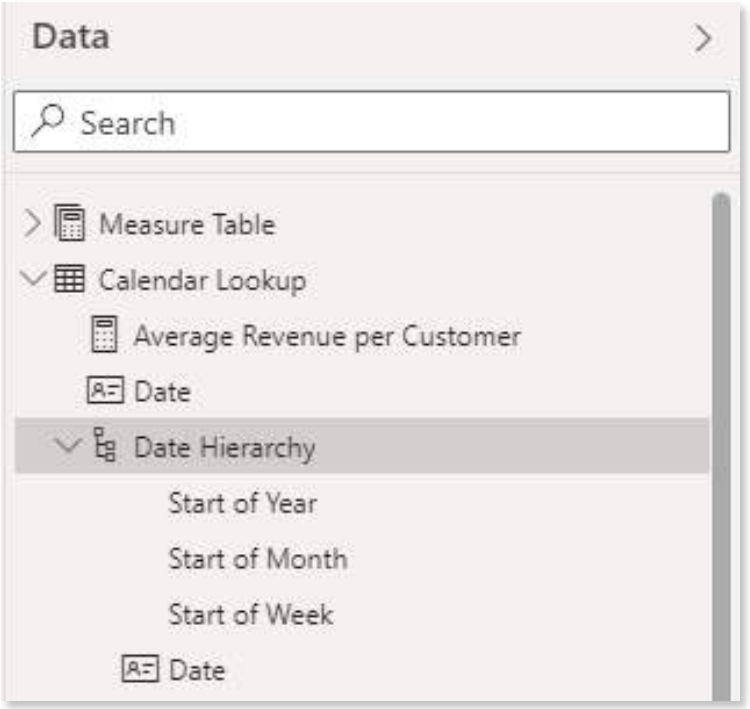
-Dana

Reply Forward

Solution Preview



DATA MODEL BEST PRACTICES

Focus on building a normalized model from the start

- *Leverage relationships and make sure that each table serves a clear, distinct purpose*

Organize dimension tables above data tables in your model

- *This serves as a visual reminder that filters always flow "downstream"*

Avoid complex relationships unless absolutely necessary

- *Aim to use 1-to-many table relationships and one-way filters whenever possible*

Hide fields from report view to prevent invalid filter context

- *This forces report users to filter using primary keys from dimension tables*

CALCULATED FIELDS WITH DAX

CALCULATED FIELDS WITH DAX

In this section we'll use **Data Analysis Expressions (DAX)** to add calculated columns & measures to our model, and introduce topics like row & filter context, iterators and more

TOPICS WE'LL COVER:

- DAX 101
- Columns & Measures
- Row & Filter Context
- DAX Syntax
- Common Functions
- Calculate
- Iterators
- Time Intelligence

GOALS FOR THIS SECTION:

- Introduce DAX fundamentals and learn when to use calculated columns and measures
- Understand the difference between row context and filter context, and how they impact DAX calculations
- Learn DAX formula syntax, basic operators and common function categories *(math, logical, text, date/time, filter, etc.)*
- Explore nested functions, and more complex topics like iterators and time intelligence patterns

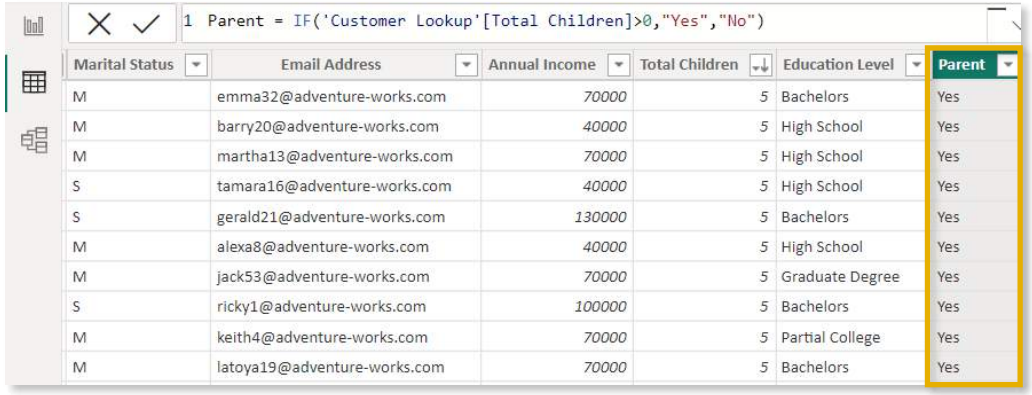
MEET DAX

Data Analysis Expressions (commonly known as **DAX**) is the formula language that drives the Power BI front-end. With DAX, you can:

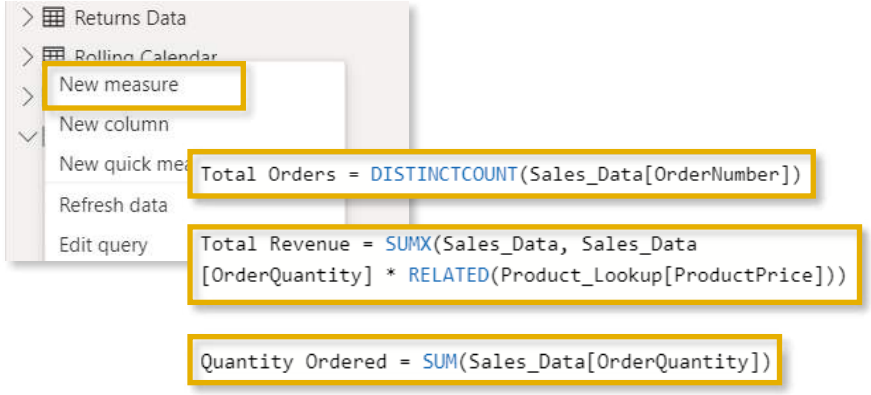
- Go beyond the capabilities of traditional spreadsheet formulas, with powerful and flexible functions built specifically to work with relational data models
- Add **calculated columns** *(for filtering)* and **measures** *(for aggregation)* to enhance data models

Two ways to use DAX

Calculated Columns



Measures



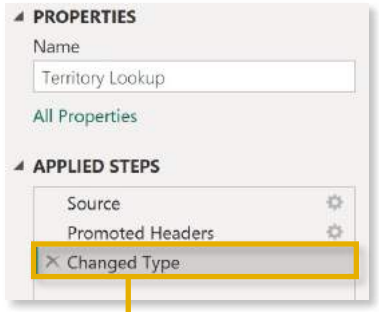
M VS. DAX

M and **DAX** are two distinct functional languages used within Power BI Desktop:

- **M** is used in the Power Query editor, and is designed specifically for extracting, transforming and loading data
- **DAX** is used in the Power BI front-end, and is designed specifically for analyzing relational data models

M

Query Editor:




```
#"Changed Type" = Table.TransformColumnTypes(    // Adding a new step
  #"Promoted Headers",                           // after we promoted headers
  {
    {"SalesTerritoryKey", Int64.Type},           // that changes column datatypes
    {"Region", type text},
    {"Country", type text},
    {"Continent", type text}
  }
)
```

DAX

Report View:

Category Name	Total Returns	Bike Returns
Accessories	1,115	
Bikes	427	427
Clothing	267	
Total	**1,809**	**427**

```
1 Bike Returns =
2 CALCULATE(
3     [Total Returns],                                  // Counting total returns
4     'Product Categories Lookup'[Category Name] = "Bikes"    // filtered for bikes only
5 )
```

CALCULATED COLUMNS

Calculated columns allow you to add new, formula-based columns to tables in a model

- Calculated columns refer to **entire tables** or **columns** *(no A1-style cell references)*
- Calculated columns **generate values for each row**, which are visible within tables in the Data view
- Calculated columns understand **row context**; they're great for defining properties based on information in each row, but generally useless for aggregation *(sum, count, etc.)*

HEY THIS IS IMPORTANT!

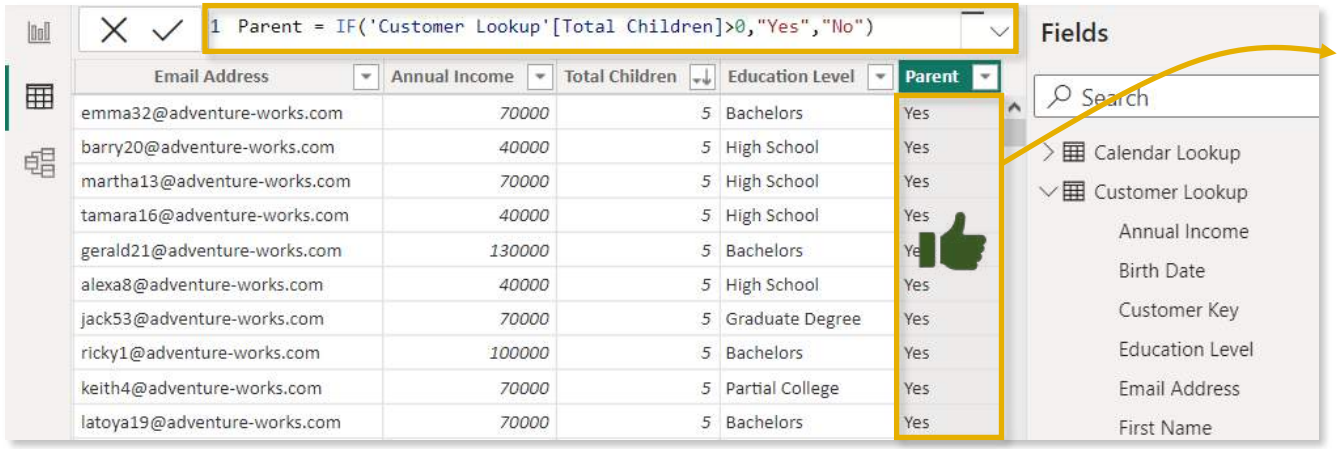
As a rule of thumb, use calculated columns to "stamp" static, fixed values to each row in a table (*or go upstream and use the Query Editor!*)

DO NOT use calculated columns for aggregation – this is what **measures** are for!

PRO TIP:

Calculated columns are typically used for **filtering** & **grouping** data, rather than creating aggregate numerical values

EXAMPLE: CALCULATED COLUMNS

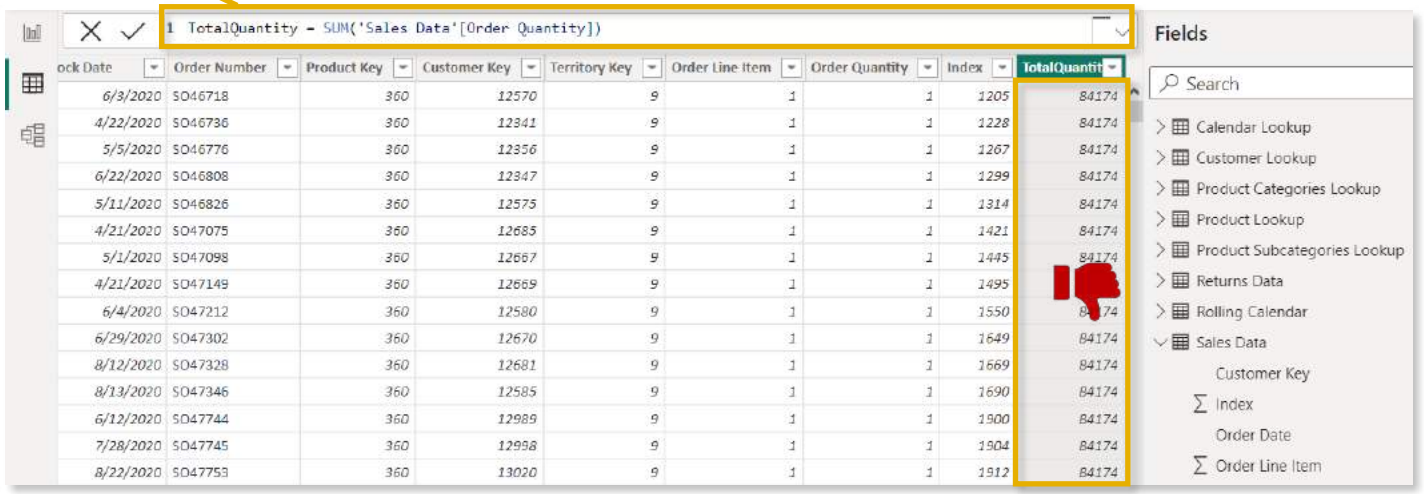


In this case we've added a **calculated column** named **Parent**, which equals "***Yes***" if the [Total Children] field is greater than 0, and "***No***" otherwise

- Since calculated columns understand **row context**, a new value is calculated in each row based on the value in the [Total Children] column
- This is a **valid use** of calculated columns; it creates a new row "property" that we can use to filter or segment any related data within the model

Here we're using an aggregation function (SUM) to calculate a new column named **TotalQuantity**

- Since this is an aggregation function, **the same grand total** is returned in *every row* of the table
- This is **not a valid use** of calculated columns; these values are statically "stamped" onto the table and can't be filtered, sliced, etc.



DAX MEASURES

Measures are DAX formulas used to generate new calculated values

- Like calculated columns, measures reference **entire tables** or **columns** *(no A1-style cell references)*
- Unlike calculated columns, **measures** aren't visible within tables; they can only be "seen" within a visualization like a chart or matrix (*similar to a calculated field in a PivotTable*)
- Measures evaluate based on **filter context**, which means they recalculate when the fields or filters around them change

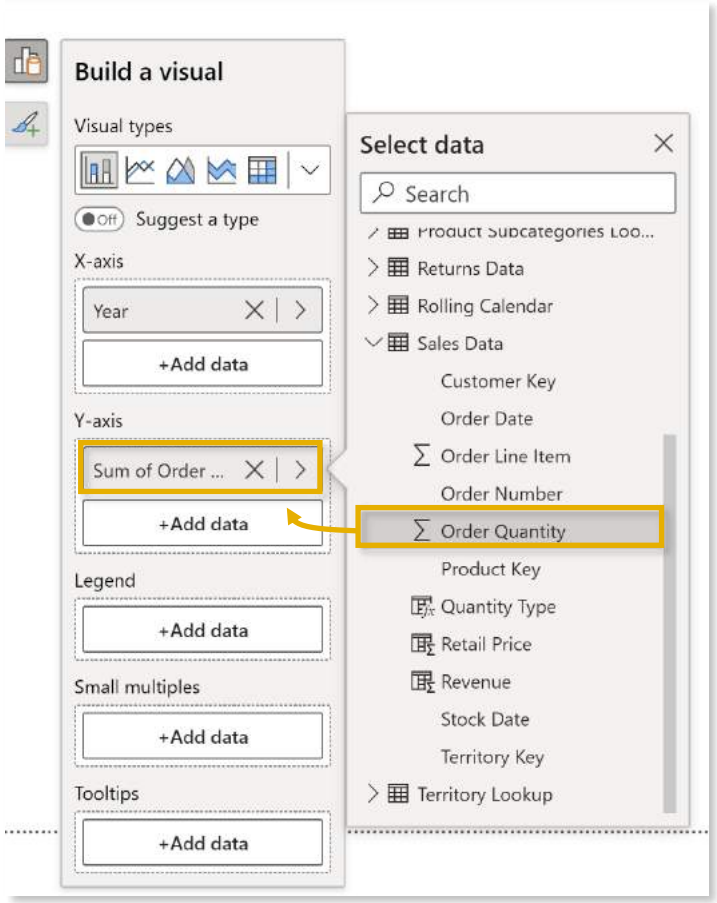
HEY THIS IS IMPORTANT!

As a rule of thumb, use measures when a single row can't give you the answer, or when you need to **aggregate** values across multiple rows in a table

PRO TIP:

Use measures to create **numerical, calculated values** that can be analyzed in the "**values**" field of a report visual

IMPLICIT VS. EXPLICIT MEASURES



*Example of an **implicit measure***

Implicit measures are created when you drag raw numerical fields into a report visual and manually select an aggregation mode (*Sum, Average, Min, Max, Count, etc.*)

Explicit measures are created when you actually write a DAX formula and define a new measure that can be used within the model

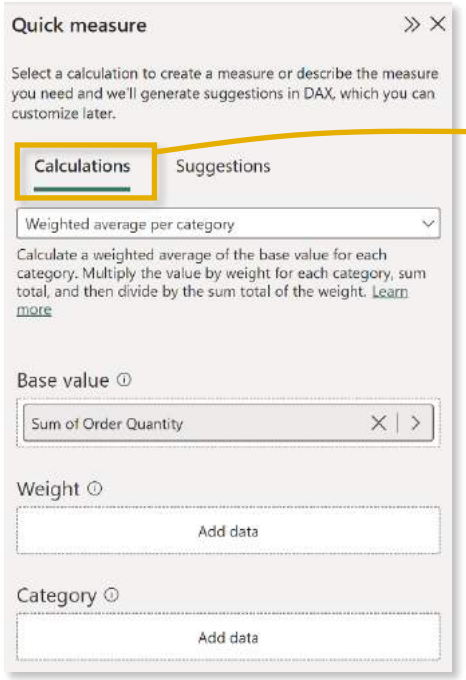
HEY THIS IS IMPORTANT!

Implicit measures are only accessible within the **specific visualization** in which they were created, and cannot be referenced elsewhere

Explicit measures can be used **anywhere in the report**, and referenced by other DAX calculations to create "measure trees"

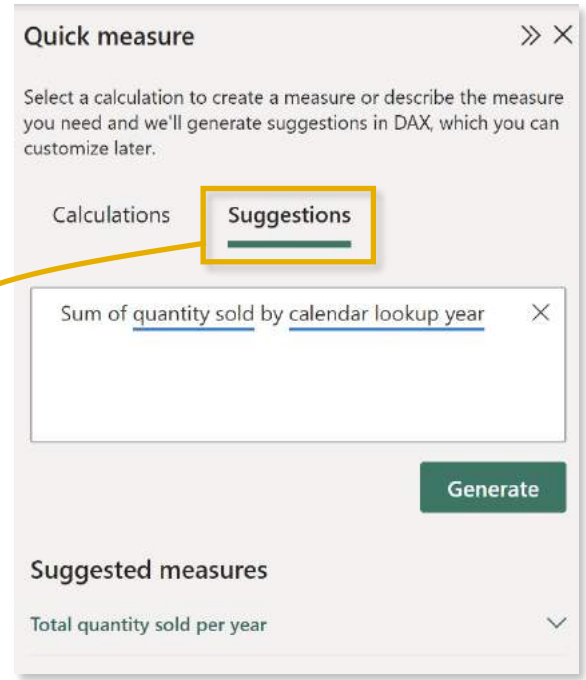
QUICK MEASURES

Quick measures automatically create formulas based on pre-built templates or natural language prompts



Quick measure **calculations** can be used to build measures using **predefined templates** *(weighted averages, percent difference, time intelligence, etc.)*

Quick measure **suggestions** can be used to find suggested measures based on **natural language queries** *(i.e. "sum of quantity sold by calendar year")*

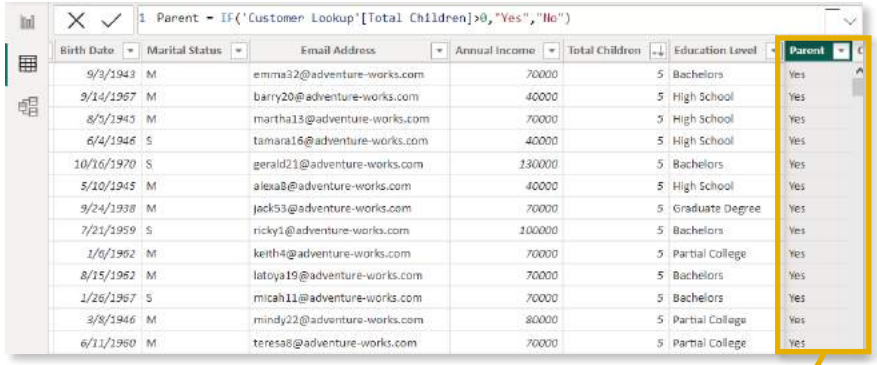


PRO TIP:
Quick measures can be a great learning tool for beginners or for building more complex formulas but use them with caution; **mastering DAX requires a deep understanding of the underlying theory**!

RECAP: CALCULATED COLUMNS VS. MEASURES

CALCULATED COLUMNS

- Values are calculated based on information from each row of a table (**row context**)
- Appends static values to each row in a table and stores them in the model (*which increases file size*)
- Recalculate on data source refresh or when changes are made to component columns
- Primarily used for **filtering** data in reports



*Calculated columns "live" in **tables***

MEASURES

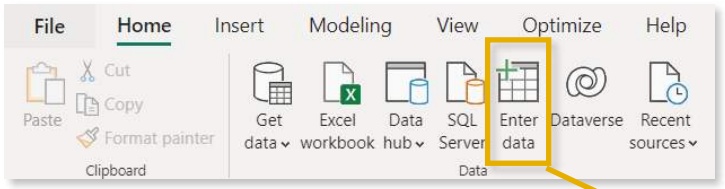
- Values are calculated based on information from any filters in the report (**filter context**)
- Does not create new data in the tables themselves (*doesn't increase file size*)
- Recalculate in response to any change to filters within the report
- Primarily used for **aggregating values** in report visuals

*Measures "live" in **visuals***

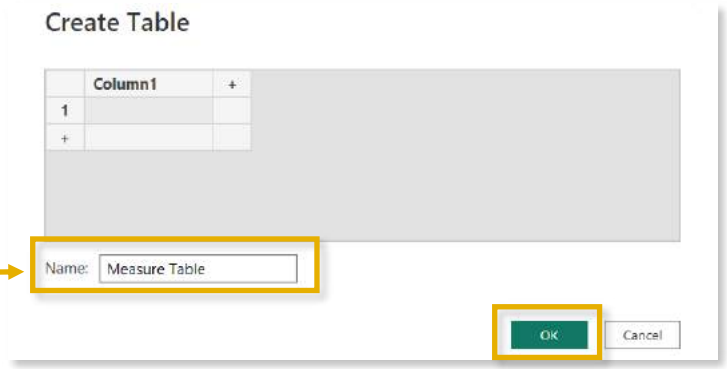
PRO TIP: MEASURE TABLES

It's a common best practice to **create a dedicated table to store your measures**; this will help you stay organized, find measures quickly, and allow you to group related measures into folders

Option 1: **Enter Data** into **Power Query** (loads the table to the data model – table is visible in Power Query)



**from the Report view*



Add a table Name and **click OK** to load the table to the data model

Option 2: Create a **calculated table** using **DAX** directly in the model (table is not visible in Power Query)

**from the Data view*

Create new table & use a table constructor { } to **add a single column**

FILTER CONTEXT

Measures are evaluated based on **filter context**, which means that they recalculate whenever the fields or filters around them change

Top 10 Products	Orders	Revenue	Return %
Water Bottle - 30 oz.	3,983	$39,755	1.95%
Patch Kit/8 Patches	2,952	$13,506	1.61%
Mountain Tire Tube	2,846	$28,333	1.64%
Road Tire Tube	2,173	$17,265	1.55%
Sport-100 Helmet, Red	2,099	$73,444	3.33%
AWC Logo Cap	2,062	$35,865	1.11%
Sport-100 Helmet, Blue	1,995	$67,112	3.31%
Fender Set - Mountain	1,975	$87,041	1.36%
Sport-100 Helmet, Black	1,940	$65,262	2.68%
Mountain Bottle Cage	1,896	$38,062	2.02%
Total	**15,587**	**$465,644**	**1.85%**

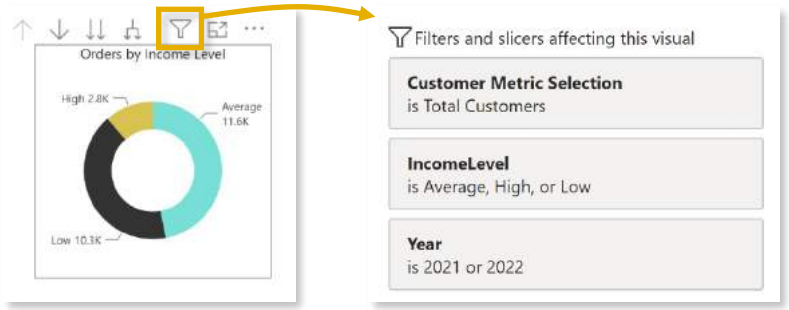
For this value in the matrix (2,846), the **Orders** measure is calculated based on the following filter context: *Products[**Product Name**] = "**Mountain Tire Tube**"*

- This allows the measure to return the total order quantity for each product specifically *(or whatever context the row and column labels dictate – years, countries, categories, customer names, etc.)*

This total (15,587) does **NOT** calculate by summing the values above; it evaluates as an independent measure with **no filter context** applied

- **IMPORTANT**: Every measure value in a report evaluates **independently** (like an island) and calculates based on its own filter context

PRO TIP: Clicking the **filter icon** will show you the filters currently applied to a selected visual



EXAMPLE: FILTER CONTEXT

MEASURE: Revenue Per Customer

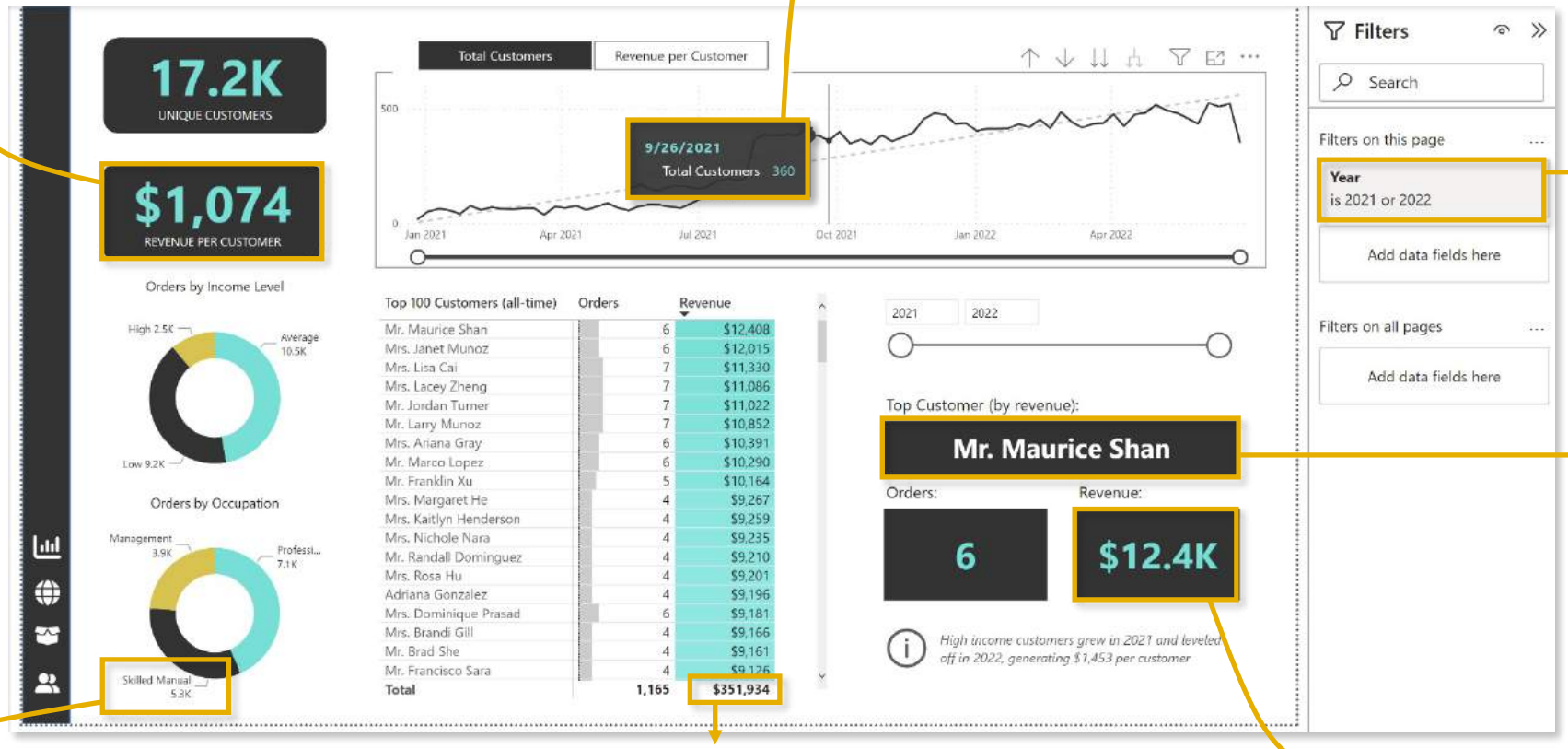
FILTER CONTEXT:

- *Calendar[**Year**]* = 2021 *or* 2022

MEASURE: Total Customers

FILTER CONTEXT:

- *Calendar[**Date**]* = September 26, 2021



This is **a page-level filter**, which impacts **ALL** visuals on this report page *(more on this later!)*

COLUMN: Customer Full Name

FILTER CONTEXT:

- *Calendar[**Year**]* = 2021 *or* 2022
- *Customer[**Full Name**]* = Top 1 by Total Revenue

MEASURE: Total Orders

FILTER CONTEXT:

- *Calendar[**Year**]* = 2021 *or* 2022
- *Customers[**Occupation**]* = Skilled Manual

MEASURE: Total Revenue

FILTER CONTEXT:

- *Calendar[**Year**]* = 2021 *or* 2022
- *Customer[**Full Name**]* = Top 100 by Total Orders

MEASURE: Total Revenue

FILTER CONTEXT:

- *Calendar[**Year**]* = 2021 *or* 2022
- *Customer[**Full Name**]* = Mr. Maurice Shan

STEP-BY-STEP MEASURE CALCULATION

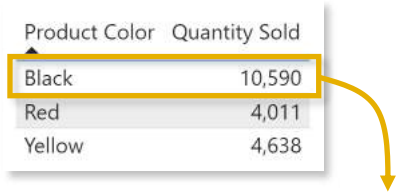
Product Color	Quantity Sold
Black	10,590
Red	4,011
Yellow	4,638

How *exactly* is this measure value calculated?

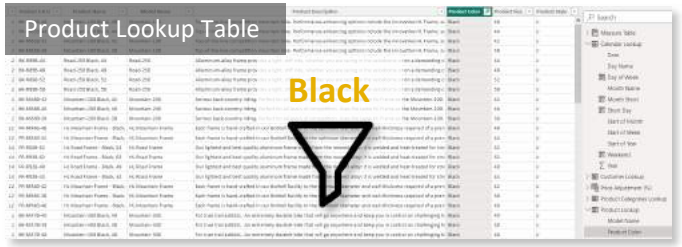
- **NOTE**: This all happens *instantly* behind the scenes, every time the filter context changes

STEP 1

Filter context is detected & applied

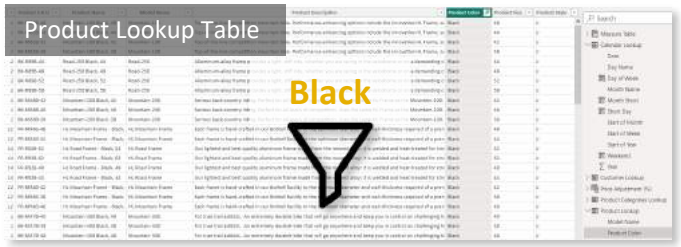


'Product Lookup'[Product Color] = "**Black**"



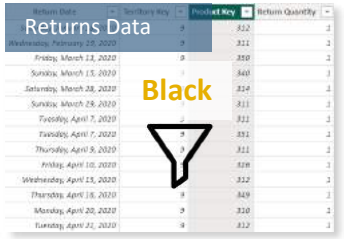
STEP 2

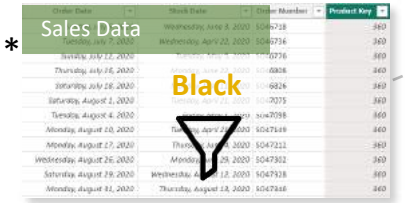
Filters flow "downstream" to related tables



1 1

* *





STEP 3

Measure evaluates against the filtered table

```
1 Quantity Sold =
2 SUM(
3     'Sales Data'[Order Quantity]
4 )
```

*Sum of values in the **Order Quantity** column of the **Sales Data** table, filtered to rows where the product color is "**Black**"*

= 10,590

DAX SYNTAX

MEASURE NAME

- Measures are always surrounded by brackets (i.e. **[Total Quantity]**) when referenced in formulas, so spaces are OK

Referenced **TABLE NAME**

Referenced **COLUMN NAME**

```
Total Quantity: = SUM(Transactions[quantity])
```

FUNCTION NAME

- Calculated columns don't always use functions, but measures do:
  - In a **Calculated Column**, **=Transactions[quantity]** returns the value from the quantity column in each row (*since it evaluates one row at a time*)
  - In a **Measure**, **=Transactions[quantity]** will return an ***error*** since Power BI doesn't know how to translate that as a single value – you need some sort of aggregation

This is a **"fully qualified"** column, since it's preceded by the table name.
NOTE: Table names with spaces must be surrounded by **single quotes**:

- *Without a space:* ***Transactions****[quantity]*
- *With a space:* ***'Transactions Table'****[quantity]*

PRO TIP:

Column references use fully qualified names (i.e. **'Table'[Column]**)

Measure references just use the measure name (i.e. **[Measure]**) and can be called by typing an open square bracket " ["

DAX OPERATORS

Arithmetic Operator	Meaning	Example
+	Addition	2 + 7
-	Subtraction	5 – 3
*	Multiplication	2 * 6
/	Division	4 / 2
^	Exponent	2 ^ 5

Comparison Operator	Meaning	Example
=	Equal to	[City]=“Boston”
>	Greater than	[Quantity]>10
<	Less than	[Quantity]<10
>=	Greater than or equal to	[Unit Price]>=2.5
<=	Less than or equal to	[Unit Price]<=2.5
<>	Not equal to	[Country]<>”Mexico”

Pay attention to these!

Text/Logical Operator	Meaning	Example
&	Concatenates two values to produce one text string	[City] & “ “ & [State]
&&	Create an AND condition between two logical expressions	([State]=“MA”) && ([Quantity]>10)
|| *(double pipe)*	Create an OR condition between two logical expressions	([State]=“MA”) || ([State]=“CT”)
IN	Creates a logical OR condition based on a given list (using curly brackets)	‘Store Lookup’[State] IN { “MA”, “CT”, “NY” }

Head to **https://learn.microsoft.com for more information about DAX syntax, operators, troubleshooting, etc.*

COMMON FUNCTION CATEGORIES

MATH & STATS Functions

*Functions used for **aggregation** or iterative, row-level calculations*

Common Examples:

- SUM
- AVERAGE
- MAX/MIN
- DIVIDE
- COUNT/COUNTA
- COUNTROWS
- DISTINCTCOUNT

Iterator Functions:

- SUMX
- AVERAGEX
- MAXX/MINX
- RANKX
- COUNTX

LOGICAL Functions

*Functions that use **conditional expressions** (IF/THEN statements)*

Common Examples:

- IF
- IFERROR
- AND
- OR
- NOT
- SWITCH
- TRUE
- FALSE

TEXT Functions

*Functions used to manipulate **text strings** or **value formats***

Common Examples:

- CONCATENATE
- COMBINEVALUES
- FORMAT
- LEFT/MID/RIGHT
- UPPER/LOWER
- LEN
- SEARCH/FIND
- REPLACE
- SUBSTITUTE
- TRIM

FILTER Functions

*Functions used to **manipulate table** and **filter contexts***

Common Examples:

- CALCULATE
- FILTER
- ALL
- ALLEXCEPT
- ALLSELECTED
- KEEPFILTERS
- REMOVEFILTERS
- SELECTEDVALUE

TABLE Functions

*Functions that **create** or **manipulate tables** and output tables vs. scalar values*

Common Examples:

- SUMMARIZE
- ADDCOLUMNS
- GENERATESERIES
- DISTINCT
- VALUES
- UNION
- INTERSECT
- TOPN

DATE & TIME Functions

*Functions used to manipulate **date & time values** or handle time intelligence calculations*

Common Examples:

- DATE
- DATEDIFF
- YEARFRAC
- YEAR/MONTH
- DAY/HOUR
- TODAY/NOW
- WEEKDAY
- WEEKNUM
- NETWORKDAYS

Time Intelligence:

- DATESYTD
- DATESMTD
- DATEADD
- DATESBETWEEN

RELATIONSHIP Functions

*Functions used to **manage & modify table relationships***

Common Examples:

- RELATED
- RELATEDTABLE
- CROSSFILTER
- USERELATIONSHIP

***Note:** This is NOT a comprehensive list. DAX contains more than 250 different functions!*

BASIC MATH & STATS FUNCTIONS

SUM	Evaluates the sum of a column	=**SUM**(ColumnName)
AVERAGE	Returns the average (arithmetic mean) of all the numbers in a column	=**AVERAGE**(ColumnName)
MAX	Returns the largest value in a column or between two scalar expressions	=**MAX**(ColumnNameOrScalar1, *[Scalar2]*)
MIN	Returns the smallest value in a column or between two scalar expressions	=**MIN**(ColumnNameOrScalar1, *[Scalar2]*)
DIVIDE	Performs division and returns the alternate result (or blank) if DIV/0	=**DIVIDE**(Numerator, Denominator, *[AlternateResult]*)

COUNTING FUNCTIONS

COUNT	Counts the number of non-empty cells in a column (excluding Boolean values)	=**COUNT**(ColumnName)
COUNTA	Counts the number of non-empty cells in a column (including Boolean values)	=**COUNTA**(ColumnName)
DISTINCTCOUNT	Counts the number of distinct values in a column	=**DISTINCTCOUNT**(ColumnName)
COUNTROWS	Counts the number of rows in the specified table, or a table defined by an expression	=**COUNTROWS**([Table])

ASSIGNMENT: MATH & STATS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Help with a few measures**

Hey there, excited to start working with you!

I'll need to pull some high-level metrics from our model to share with leadership, and I could use some help with the calculations.

For now, could you please create one measure to calculate the total number of distinct customers, and a second measure that we can use to calculate return rate (quantity returned / quantity sold)? Thank you!

-Dianne

Reply Forward

Key Objectives

1. Create a measure named **Total Customers**, to calculate the number of distinct AdventureWorks customers who made a transaction
2. Create a measure named **Return Rate**, defined as quantity returned divided by quantity sold

SOLUTION: MATH & STATS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Help with a few measures**

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I'll need to pull some high-level metrics from our model to share with leadership, and I could use some help with the calculations.

For now, could you please create one measure to calculate the total number of distinct customers, and a second measure that we can use to calculate return rate (quantity returned / quantity sold)? Thank you!

-Dianne

Reply Forward

Solution Preview

```
1 Total Customers =
2 DISTINCTCOUNT(
3     'Sales Data'[Customer Key]
4 )
```

```
1 Return Rate =
2 DIVIDE(
3     [Quantity Returned],
4     [Quantity Sold],
5     "No Sales"
6 )
```

BASIC LOGICAL FUNCTIONS

IF	Checks if a given condition is met and returns one value if the condition is TRUE, and another if the condition is FALSE	=**IF**(LogicalTest, ResultIfTrue, *[ResultIfFalse]*)
IFERROR	Evaluates an expression and returns a specified value if it returns an error, otherwise returns the expression itself	=**IFERROR**(Value, ValueIfError)
SWITCH	Evaluates an expression against a list of values and returns one of multiple possible expressions	=**SWITCH**(Expression, Value1, Result1, …, *[Else]*)
AND	Checks whether both arguments are TRUE to return TRUE, otherwise returns FALSE	=**AND**(Logical1, Logical2)
OR	Checks whether any argument is TRUE to return TRUE, otherwise returns FALSE	=**OR**(Logical1, Logical2)

***Note**: Use the **&&** and **||** operators to include more than two conditions*

SWITCH

SWITCH Evaluates an expression against a list of values and returns one of multiple possible expressions

=**SWITCH**(Expression, Value1, Result1, …, *[Else]*)

Any **DAX expression** that returns a single scalar value, evaluated multiples times

Examples:

- *Calendar[Month ID]*
- *'Product Lookup'[category]*

List of **values** produced by the expression, each paired with a result to return for rows/cases that match

Examples:

=**SWITCH**(*Calendar[Month ID],*
1, "January",
2, "February"

Value returned if the expression doesn't match any value argument

PRO TIP

SWITCH(TRUE) is a common DAX pattern to replace multiple nested IF statements

ASSIGNMENT: LOGICAL FUNCTIONS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Customer segmentation fields**

Hey there!

Ethan has been working with the DS team on a customer segmentation analysis, and came back to us with a few requests.

Could you please add some new columns in our customer table to identify "priority" customers, segment customers based on income level, and group some of the education categories?

I've attached the logic to use, but reach out with any questions!

-Dianne

Reply Forward

Key Objectives

1. Create a calculated column in the Customer Lookup table named **Customer Priority**:
   - If the customer is a parent and has an annual income > $100,000, Customer Priority = **Priority**
   - Otherwise, Customer Priority = **Standard**
2. Create a calculated column in the Customer Lookup table named **Income Level**:
   - If annual income is >= $150,000, **Very High**
   - If annual income is >= $100,000, **High**
   - If annual income is >= $50,000, **Average**
   - Otherwise, Income Level = **Low**

ASSIGNMENT: LOGICAL FUNCTIONS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Customer segmentation fields**

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Could you please add some new columns in our customer table to identify "priority" customers, segment customers based on income level, and group some of the education categories?

I've attached the logic to use, but reach out with any questions!

-Dianne

Reply Forward

Key Objectives

BONUS: Use a SWITCH function* to create another column named **Education Category**:

- If EducationLevel is High School or Partial High School, Education Category **= High School**
- If EducationLevel is Bachelors or Partial College, Education Category = **Undergrad**
- If EducationLevel is Graduate Degree, Education Category = **Graduate**

**You can use the "data groups" tool to do this too!*

SOLUTION: LOGICAL FUNCTIONS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Customer segmentation fields**

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Ethan has been working with the DS team on a customer segmentation analysis, and came back to us with a few requests.

Could you please add some new columns in our customer table to identify “priority” customers, segment customers based on income level, and group some of the education categories?

I’ve attached the logic to use, but reach out with any questions!

-Dianne

Reply Forward

Solution Preview

```
Customer Priority =
IF(
    'Customer Lookup'[AnnualIncome] > 100000 &&
    'Customer Lookup'[Is Parent?] = "Yes",
    "Priority",
    "Standard"
)
```

```
Income Level =
IF('Customer Lookup'[AnnualIncome] >= 150000, "Very High",
IF('Customer Lookup'[AnnualIncome] >= 100000, "High",
IF('Customer Lookup'[AnnualIncome] >= 50000, "Average",
"Low")))
```

```
Education Category =
SWITCH('Customer Lookup'[EducationLevel],
"High School","High School",
"Partial High School","High School",
"Bachelors","Undergrad",
"Partial College","Undergrad",
"Graduate Degree","Graduate")
```

TEXT FUNCTIONS

LEN	Returns the number of characters in a string	=**LEN**(Text)
CONCATENATE	Joins two text strings into one	=**CONCATENATE**(Text1, Text2)
UPPER/LOWER	Converts a string to upper or lower case	=**UPPER/LOWER** (Text)
LEFT/RIGHT/MID	Returns a number of characters from the start/middle/end of a text string	=**LEFT/RIGHT**(Text, *[NumChars]*) =**MID**(Text, StartPosition, NumChars)
SUBSTITUTE	Replaces an instance of existing text with new text in a string	=**SUBSTITUTE**(Text, OldText, NewText, *[InstanceNumber]*)
SEARCH	Returns the position where a specified string or character is found, reading left to right	=**SEARCH**(FindText, WithinText, *[StartPosition], [NotFoundValue]*)

Note: *Use the* ***&*** *operator as a shortcut, or to combine more than two strings*

ASSIGNMENT: TEXT

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Couple random requests**

Good morning!

Hoping you can help with a couple quick updates to the model:

1) Ethan wants to make the month abbreviations ALL CAPS to make them more readable in our reports.

2) The product team asked us to break out the SKU category into its own field, which we can define as any characters before the first hyphen ("-") in the ProductSKU column.

Thanks, reach out with any questions!

Reply Forward

Key Objectives

1. Update the **Month Short** column in the Calendar Lookup table to extract and capitalize the first 3 characters of the month name

2. Create a new column in the Product Lookup table named **SKU Category**, to return any number of characters before the first hyphen in the ProductSKU column

SOLUTION: TEXT

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Couple random requests**

Good morning!

Hoping you can help with a couple quick updates to the model:

1) Ethan wants to make the month abbreviations ALL CAPS to make them more readable in our reports.

2) The product team asked us to break out the SKU category into its own field, which we can define as any characters before the first hyphen (“-”) in the ProductSKU column.

Thanks, reach out with any questions!

Reply Forward

Solution Preview

```
1 Month Short =
2 UPPER(
3     LEFT(
4         'Calendar Lookup'[Month Name],
5         3
6     )
7 )
```

```
1 SKU Category =
2 LEFT(
3     'Product Lookup'[Product SKU],
4     SEARCH(
5         "-",
6         'Product Lookup'[Product SKU]
7     )
8     -1
9 )
```

BASIC DATE & TIME FUNCTIONS

TODAY/NOW	Returns the current date or exact time	=**TODAY/NOW**()
DAY/MONTH/YEAR	Returns the day of the month (1-31), month of the year (1-12), or year of a given date	=**DAY/MONTH/YEAR**(Date)
HOUR/MINUTE/ SECOND	Returns the hour (0-23), minute (0-59), or second (0-59) of a given datetime value	=**HOUR/MINUTE/SECOND**(Datetime)
WEEKDAY/ WEEKNUM	Returns a weekday number from 1 (Sunday) to 7 (Saturday), or the week # of the year	=**WEEKDAY/WEEKNUM**(Date, *[ReturnType]*)
EOMONTH	Returns the date of the last day of the month, +/- a specified number of months	=**EOMONTH**(StartDate, Months)
DATEDIFF	Returns the difference between two dates, based on a given interval (day, hour, year, etc.)	=**DATEDIFF**(Date1, Date2, Interval)

ASSIGNMENT: DATE & TIME

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Customer birth years**

Hey there, super easy one for you.

The customer segmentation project got me wondering if there are any interesting patterns or insights based on customer age.

Could you please add a field in our customer table to extract only the year from the birthdate field?

Thanks!
-Dianne

Reply Forward

Key Objectives

1. Create a new column in the Customer Lookup table named **Birth Year**, to extract only the year from the BirthDate column

SOLUTION: DATE & TIME

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Customer birth years**

Hey there, super easy one for you.

The customer segmentation project got me wondering if there are any interesting patterns or insights based on customer age.

Could you please add a field in our customer table to extract only the year from the birthdate field?

Thanks!
-Dianne

Reply Forward

Solution Preview

```
1 Birth Year =
2 YEAR(
3     'Customer Lookup'[BirthDate]
4 )
```

RELATED

RELATED() Returns related values in each row of a table based on relationships with other tables

=**RELATED**(ColumnName)

The **column** from a related table containing the values you want to retrieve

Examples:

- *'Product Lookup'[Product Name]*
- *'Territory Lookup'[Country]*

HEY THIS IS IMPORTANT!

RELATED works like a **VLOOKUP** function in Excel – it uses the relationship between tables (*defined by primary and foreign keys*) to pull values from one table into a new column of another.

Since this function requires row context, it can only be used as a **calculated column** or as part of an **iterator function** that cycles through all rows in a table (*FILTER, SUMX, MAXX, etc.*)

PRO TIP:

Instead of using RELATED to create extra columns (which increases file size), **nest it within measures like FILTER or SUMX**

CALCULATE

CALCULATE()

Evaluates an expression in a context that is modified by filters

=**CALCULATE**(Expression, *[Filter1], [Filter2],…*)

Name of an **existing measure** or a **DAX formula** for a valid measure

Examples:

- *[Total Orders]*
- *SUM('Returns Data'[Return Quantity])*

A Boolean (True/False) expression or a table expression that defines a filter

Note: these require fixed values or aggregation functions that return a scalar value (you cannot create filters based on measures)

Examples:

- *'Territory Lookup'[Country]* ***= "USA"***
- *Calendar[Year] <>* ***MAX****(Calendar[Year])*

PRO TIP:

Think of CALCULATE as a **filter modifier**; it allows you to overrule existing report filters and "force" new filter context

EXAMPLE: CALCULATE

```
1 Red Sales = CALCULATE( [Quantity Sold], 'Product Lookup'[Product Color] = "Red" )
```

Here we've defined a new measure named **Red Sales**, which evaluates the **Quantity Sold** measure under a filter context where the product color is "**Red**"

Product Color	Quantity Sold	Red Sales
Black	10,590	4,011
Multi	5,756	4,011
Red	4,011	4,011
Silver	3,257	4,011
Total	**23,614**	**4,011**

*Note how we see the **the same repeated values** for each product color, and even the total!*

HEY THIS IS IMPORTANT!

The CALCULATE function modifies and overrules any competing filter context!

In this matrix, the "Black" row has competing filter context: Product Color = **Black** (from the row label) and Product Color= "**Red**" (from the CALCULATE function)

Both can't be true at the same time, so the "**Red**" filter from CALCULATE takes priority

EXAMPLE: CALCULATE

CALCULATE

Filters are modified by CALCULATE

[**Product Color**] = **"Red"**

If the measure being evaluated contains a **CALCULATE** function, filter context is *overwritten* between **Step 1** & **Step 2**

STEP 1

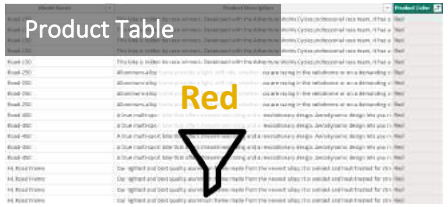
Filter context is detected & applied

Product Color	Quantity Sold	Red Sales
Black	10,590	4,011
Red	4,011	4,011
Silver	3,257	4,011

'Product Lookup'[**Product Color**] = **"Black"**

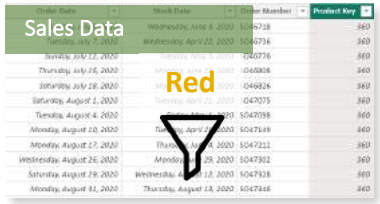
STEP 2

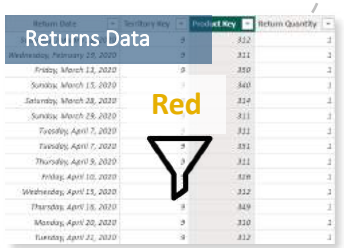
Filters flow "downstream" to related tables



1 1

* *





STEP 3

Measure evaluates against the filtered table

```
1 Quantity Sold =
2 SUM( 'Sales Data'[Order Quantity] )
```

*Sum of the **Order Quantity** column in the **Sales Data** table, filtered to rows where the product color is "**Red**"*

= 4,011

DAX MEASURE TOTALS

Measure totals may seem incorrect or inconsistent depending on how they are calculated, because they **don't simply add up the visible values in the report**

*Total Returns look right, but shouldn't Total Orders be **37,888**??*

-Anonymous confused man

Category Name	Total Returns	Total Orders
Accessories	1,115	16,983
Bikes	427	13,929
Clothing	267	6,976
Total	**1,809**	**25,164**

PRO TIP:

Understand EXACTLY how your measures calculate and **what they are designed to measure**

```
1 Total Orders =
2 DISTINCTCOUNT(
3     'Sales Data'[Order Number]
4 )
```

[Total Orders] counts **distinct orders** in the Sales Data table

Order Date	Stock Date	Order Number	Product Key
Thursday, June 30, 2022	Thursday, April 07, 2022	SO74140	568
Thursday, June 30, 2022	Friday, March 04, 2022	SO74140	477
Thursday, June 30, 2022	Monday, May 30, 2022	SO74140	223
Thursday, June 30, 2022	Friday, April 29, 2022	SO74141	604
Thursday, June 30, 2022	Wednesday, May 04, 2022	SO74141	471
Thursday, June 30, 2022	Monday, May 30, 2022	SO74142	383
Thursday, June 30, 2022	Friday, March 18, 2022	SO74142	490
Thursday, June 30, 2022	Tuesday, March 15, 2022	SO74143	479
Thursday, June 30, 2022	Friday, April 08, 2022	SO74143	606
Thursday, June 30, 2022	Tuesday, March 22, 2022	SO74143	477
Thursday, June 30, 2022	Thursday, June 02, 2022	SO74143	462
Thursday, June 30, 2022	Monday, April 25, 2022	SO74144	574
Thursday, June 30, 2022	Sunday, April 24, 2022	SO74144	220
Thursday, June 30, 2022	Monday, March 14, 2022	SO74145	561
Thursday, June 30, 2022	Tuesday, June 14, 2022	SO74146	584
Thursday, June 30, 2022	Friday, March 18, 2022	SO74147	605
Thursday, June 30, 2022	Sunday, May 29, 2022	SO74147	538
Thursday, June 30, 2022	Thursday, March 24, 2022	SO74147	490

Table: Sales Data (56,046 rows) Column: Order Numbe (25,164 distinct values)

Order **SO74144** included **two products**: a bike and a helmet.

That counts as **1** distinct order for the Total and **1** distinct order for BOTH **Accessories** & **Bikes**

With no filter context, there are **25,164** total distinct orders

ASSIGNMENT: CALCULATE

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **URGENT: Bike returns**

Hey there,

Apparently George (our Product VP) has been speaking with some of the store managers, and they've raised concerns about the number of bike returns they are seeing recently.

Can you please create a measure to calculate total returns for bikes specifically, and let me know what you see? Volume alone won't tell the full story, so let's calculate the return *rate* for bikes as well, and see how it's trending before responding to George.

Need this ASAP – thank you!

Reply Forward

Key Objectives

1. Create a new measure named **Bike Returns** to calculate the total quantity of bikes returned
2. Create a matrix to show **Bike Returns** (values) by **Start of Month** (rows). What do you notice about the volume of bike returns over time?
3. Create a new measure named **Bike Sales** to calculate the total quantity of bikes sold, and add it to the matrix. What do you notice?
4. Create a new measure named **Bike Return Rate** using either CALCULATE or DIVIDE, and add it to the matrix
5. How would you respond to the Product VP's concerns about rising bike returns?

SOLUTION: CALCULATE

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **URGENT: Bike returns**

Hey there,

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Can you please create a measure to calculate total returns for bikes specifically, and let me know what you see? Volume alone won't tell the full story, so let's calculate the return *rate* for bikes as well, and see how it's trending before responding to George.

Need this ASAP – thank you!

Reply Forward

Solution Preview

```
1 Bike Returns =
2 CALCULATE(
3     [Total Returns],
4     'Product Categories Lookup'[Category Name] = "Bikes"
5 )
```

```
1 Bike Sales =
2 CALCULATE(
3     [Quantity Sold],
4     'Product Categories Lookup'[Category Name] = "Bikes"
5 )
```

```
1 Bike Return Rate =
2 CALCULATE(
3     [Return Rate],
4     'Product Categories Lookup'[Category Name] = "Bikes"
5 )
```

(Solution continued on next slide)

SOLUTION: CALCULATE

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **URGENT: Bike returns**

Hey there,

Apparently George (our Product VP) has been speaking with some of the store managers, and they've raised concerns about the number of bike returns they are seeing recently.

Can you please create a measure to calculate total returns for bikes specifically, and let me know what you see? Volume alone won't tell the full story, so let's calculate the return *rate* for bikes as well, and see how it's trending before responding to George.

Need this ASAP – thank you!

Reply Forward

Solution Preview

6/1/2021	8	312	2.564%
7/1/2021	12	506	2.372%
8/1/2021	14	485	2.887%
9/1/2021	22	575	3.826%
10/1/2021	26	612	4.248%
11/1/2021	25	688	3.634%
12/1/2021	26	1038	2.505%
1/1/2022	14	766	1.828%
2/1/2022	22	806	2.730%
3/1/2022	27	888	3.041%
4/1/2022	38	956	3.975%
5/1/2022	36	1116	3.226%
6/1/2022	34	1157	2.939%
Total	**429**	**13929**	**3.080%**

The volume of bike returns has risen over time, but so has the number of bikes being sold.

When we look at the rate of returns as a percent of sales, we don't see a concerning trend.

ALL

ALL Returns all rows in a table, or all values in a column, ignoring any filters that have been applied

=**ALL**(Table *or* Column, *[Column2], [Column3],…*)

The **table** or **column** that you want to clear filters on

Examples:

- *Transactions*
- *Products[Category]*

Additional columns that you want to clear filters on (optional)

- Cannot specify columns if your first parameter is a **table**
- All columns must include the **table name** and come from the **same table**

Examples:

- *'Customer Lookup'[City], 'Customer Lookup'[Country]*
- *Products[Product Name]*

PRO TIP:

Instead of adding filter context, **the ALL function removes it**. This is often used in "**% of Total**" calculations, when the denominator needs to remain fixed regardless of filter context.

ASSIGNMENT: CALCULATE & ALL

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Return analysis follow-up**

Hey again,

Thanks for the quick turnaround on that bike return analysis – crisis averted!

That got me thinking about how we could start analyzing the return data in our reports. Could you please help me create two new measures, one to calculate ALL returns (regardless of filter context), and another that divides Total Returns by All Returns?

That should allow us to see the % of returns by different products and product categories.

Reply Forward

Key Objectives

1. Create a new measure named **All Returns** to calculate the total number of returns, regardless of filter context
2. Create a new measure named **% of All Returns** that divides Total Returns by All Returns
3. Create a matrix to show % of All Returns (values) by product Category Name (rows). Which category accounts for the largest percentage of returns? The smallest?

SOLUTION: CALCULATE & ALL

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Return analysis follow-up**

Hey again,

Thanks for the quick turnaround on that bike return analysis – crisis averted!

That got me thinking about how we could start analyzing the return data in our reports. Could you please help me create two new measures, one to calculate ALL returns (regardless of filter context), and another that divides Total Returns by All Returns?

That should allow us to see the % of returns by different products and product categories.

Reply Forward

Solution Preview

```
All Returns =
CALCULATE(
    [Total Returns],
    ALL(
        'Returns Data'
    )
)
```

```
% of All Returns =
DIVIDE(
    [Total Returns],
    [All Returns]
)
```

Category Name	% of All Returns
Bikes	23.60%
Clothing	14.76%
Accessories	61.64%
Total	**100.00%**

FILTER

FILTER — Returns a table that represents a subset of another table or expression

=**FILTER**(Table, FilterExpression)

Table to be filtered

Examples:

- *Territory Lookup*
- *Customer Lookup*

A Boolean (True/False) filter expression to be evaluated for each row of the table

Examples:

- *'Territory Lookup'[Country]* = ***"USA"***
- *Calendar[Year]* = ***1998***
- *Products[Price]* > ***[Overall Avg Price]***

HEY THIS IS IMPORTANT!

FILTER is used to add new filter context, and can handle **more complex filter expressions** than CALCULATE (*by referencing measures, for example*)

Since FILTER returns an entire table, it's often **nested within other functions**, like CALCULATE or SUMX

PRO TIP:

Since FILTER **iterates through each row in a table**, it can be slow and computationally expensive; only use FILTER if a simple CALCULATE function won't get the job done!

ITERATOR FUNCTIONS

Iterator (or "**X**") **functions** allow you to loop through the same expression on each row of a table, then apply some sort of aggregation to the results (SUM, MAX, etc.)

=**SUMX**(Table, Expression)

Aggregation to apply to calculated rows*

Examples:

- *SUMX*
- *COUNTX*
- *AVERAGEX*
- *RANKX*
- *MAXX/MINX*

Table in which the expression will be evaluated

Examples:

- *Sales*
- *FILTER(Sales, RELATED(Products[Category])="Clothing")*

Expression to be evaluated for each row of the given table

Examples:

- *[Total Orders]*
- *Sales[Retail Price] * Sales[Quantity]*

PRO TIP:

Imagine that iterator functions **add a temporary new column** to a table, calculate a value in each row based on the given expression, then aggregate the values within that temporary column (similar to **SUMPRODUCT** in Excel)

In this example we're looking at **SUMX, but other iterator functions follow a similar syntax*

ASSIGNMENT: ITERATORS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Profit calculation – HELP!**

Hey,

Ethan asked for a quick analysis of company profit over the past few years, but I'm struggling with the calculation.

We need a measure that multiplies order quantity by product cost, but I'd like to do it without adding redundant columns to our Sales table.

Could you take a stab at this please?

-Dianne

Reply Forward

Key Objectives

1. Create a new measure named **Total Cost** that multiplies the order quantities in the Sales Data table by the product cost in the Product Lookup table, then calculates the sum
2. Create a new measure named **Total Profit** (revenue minus cost)
3. Create a matrix to show Total Profit (values) by Year (rows). How much profit has AdventureWorks earned so far in 2022?

SOLUTION: ITERATORS

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Profit calculation – HELP!**

Hey,

Ethan asked for a quick analysis of company profit over the past few years, but I'm struggling with the calculation.

We need a measure that multiplies order quantity by product cost, but I'd like to do it without adding redundant columns to our Sales table.

Could you take a stab at this please?

-Dianne

Reply Forward

Solution Preview

```
1 Total Cost =
2 SUMX(
3     'Sales Data',
4     'Sales Data'[Order Quantity]
5     *
6     RELATED(
7         'Product Lookup'[Product Cost]
8     )
9 )
```

```
1 Total Profit =
2 [Total Revenue] - [Total Cost]
```

Year	Total Profit
2020	$2,601,606
2021	$3,967,023
2022	$3,888,952
Total	**$10,457,581**

TIME INTELLIGENCE

Time Intelligence patterns are used to calculate common date-based comparisons

Performance To-Date

```
=CALCULATE(Measure, DATESYTD(Calendar[Date]))
```

*Use **DATESYTD** for Years, **DATESQTD** for Quarters, **DATESMTD** for Months*

Previous Period

```
=CALCULATE(Measure, DATEADD(Calendar[Date], -1, MONTH))
```

*Select an interval (**DAY**, **MONTH**, **QUARTER**, or **YEAR**) and the # of intervals to compare (e.g. previous month, rolling 10-day)*

Running Total

```
=CALCULATE(Measure,
 DATESINPERIOD(Calendar[Date], MAX(Calendar[Date]), -10, DAY))
```

PRO TIP:
To calculate a **moving average**, use the running total calculation above and **divide by the number of intervals**

ASSIGNMENT: TIME INTELLIGENCE

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Time Intelligence Measures**

Hey there, need a big favor!

The leadership team has been asking a lot of questions about month-over-month and year-over-year comparisons, and I've been pulling the numbers pretty manually.

Could you please add the following list of measures, to make these metrics easier to track and share with stakeholders?

Thank you!

-Dianne

Reply Forward

Key Objectives

Add the following measures to the model:

1. **Previous Month Returns**
2. **Previous Month Orders**
3. **Previous Month Profit**
4. **Order Target** (10% increase over previous month)
5. **Profit Target** (10% increase over previous month)
6. **90-day Rolling Profit**

SOLUTION: TIME INTELLIGENCE

NEW MESSAGE

From: **Dianne A. Xu** *(Senior Analyst)*

Subject: **Time Intelligence Measures**

Hey there, need a big favor!

The leadership team has been asking a lot of questions about month-over-month and year-over-year comparisons, and I've been pulling the numbers pretty manually.

Could you please add the following list of measures, to make these metrics easier to track and share with stakeholders?

Thank you!

-Dianne

Reply Forward

Solution Preview

```
1 Previous Month Orders =
2 CALCULATE(
3     [Total Orders],
4     DATEADD(
5         'Calendar Lookup'[Date],
6         -1,
7         MONTH
8     )
9 )
```

```
1 90-day Rolling Profit =
2 CALCULATE(
3     [Total Profit],
4     DATESINPERIOD(
5         'Calendar Lookup'[Date],
6         LASTDATE(
7             'Calendar Lookup'[Date]
8         ),
9         -90,
10        DAY
11    )
12 )
```

```
1 Order Target =
2 [Previous Month Orders] * 1.1
```

DAX BEST PRACTICES

Know when to use calculated columns vs. measures

- *Use calculated columns for filtering, and measures for aggregating values*

Use explicit measures, even for simple calculations

- *Explicit measures can be referenced anywhere, and nested within other measures*

Use fully-qualified column references in measures

- *This makes your DAX more readable, and differentiates column references from measure references*

Move column calculations “upstream” when possible

- *Adding calculated columns at the source or in Power Query improves report speed and efficiency*

Minimize the use of “expensive” iterator functions

- *Use iterators with caution, especially if you are working with large tables or complex models*

VISUALIZING DATA

VISUALIZING DATA

In this section we'll **build dynamic interactive reports**, introduce visualization best practices, and explore features like bookmarks, drillthrough filters, parameters, tooltips, and more

TOPICS WE'LL COVER:

- **Data Viz Best Practices**
- **Formatting & Filtering**
- **Bookmarks**
- **Report Interactions**
- **User Roles**
- **Parameters**
- **Custom Tooltips**
- **Mobile Layouts**

GOALS FOR THIS SECTION:

- Review frameworks and best practices for visualizing data and designing effective reports and dashboards
- Explore tools and techniques for inserting, formatting and filtering visuals in the Power BI Report view
- Add interactivity using tools like bookmarks, slicer panels, parameters, tooltips, and report navigation
- Learn how to configure row-level security with user roles
- Optimize reports for mobile viewing using custom layouts

THREE KEY QUESTIONS

1 What **TYPE OF DATA** are you working with?

- Geospatial? Time-series? Hierarchical? Financial?

2 What do you want to **COMMUNICATE**?

- Comparison? Composition? Relationship? Distribution?

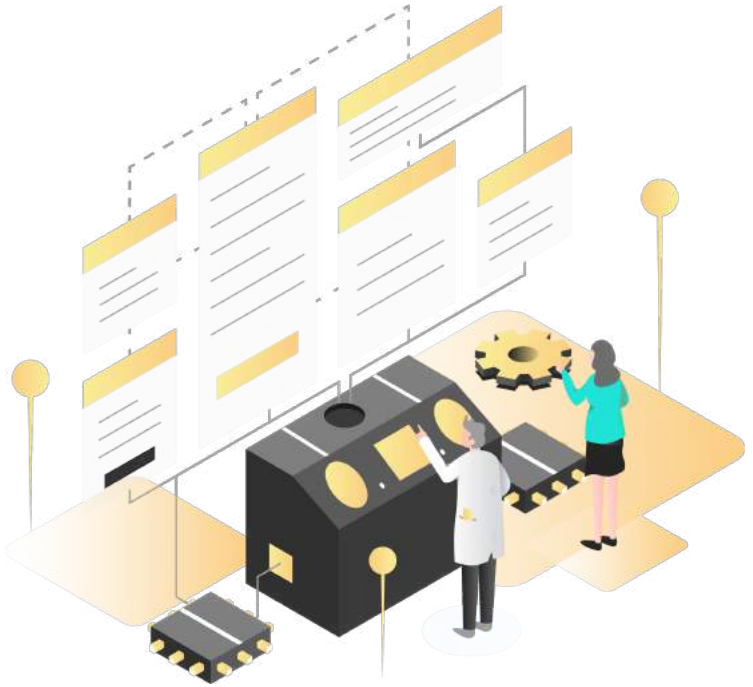
3 Who is the **END USER** and what do they need?

- Analyst? Manager? Executive? General public?

THREE KEY QUESTIONS

1 What **TYPE OF DATA** are you working with?

- Time-series
- Financial
- Geospatial
- Textual
- Categorical
- Funnel
- Hierarchical
- Survey

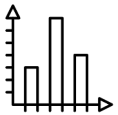


The type of data you're working with often determines **which type of visual will best represent it**; for example, using maps to represent geospatial data, line charts for time-series data, or tree maps for hierarchical data

THREE KEY QUESTIONS

2 What do you want to **COMMUNICATE**?

COMPARISON



Used to **compare values over time or across categories**

Common visuals:

- Column/Bar Chart
- Clustered Column/Bar
- Data Table/Heat Map
- Radar Chart
- Line Chart *(time series)*
- Area Chart *(time series)*

COMPOSITION

Used to **break down the component parts of a whole**

Common visuals:

- Stacked Bar/Column Chart
- Pie/Donut Chart
- Stacked Area *(time series)*
- Waterfall Chart *(gains/losses)*
- Funnel Chart *(stages)*
- Tree Map/sunburst *(hierarchies)*

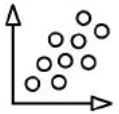
DISTRIBUTION

Used to **show the frequency of values within a series**

Common visuals:

- Histogram
- Density Plot
- Box & Whisker
- Scatter Plot
- Data Table/Heat Map
- Map/Choropleth *(geospatial)*

RELATIONSHIP



Used to **show correlation between multiple variables**

Common visuals:

- Scatter Plot
- Bubble Chart
- Data Table/Heat Map
- Correlation Matrix

Keep it simple! While there are *hundreds* of charts to choose from, basic options like bars and columns, line charts, histograms and scatterplots often tell the simplest and clearest story

THREE KEY QUESTIONS

3 Who is the **END USER** and what do they need?

THE **ANALYST**

Likes to see details and understand exactly what's happening at a granular level

- Tables or combo charts
- Granular detail to support root-cause analysis

THE **MANAGER**

Wants summarized data with clear, actionable insights to help operate the business

- Common charts & graphs
- Some detail, but only when it supports a specific insight

THE **EXECUTIVE**

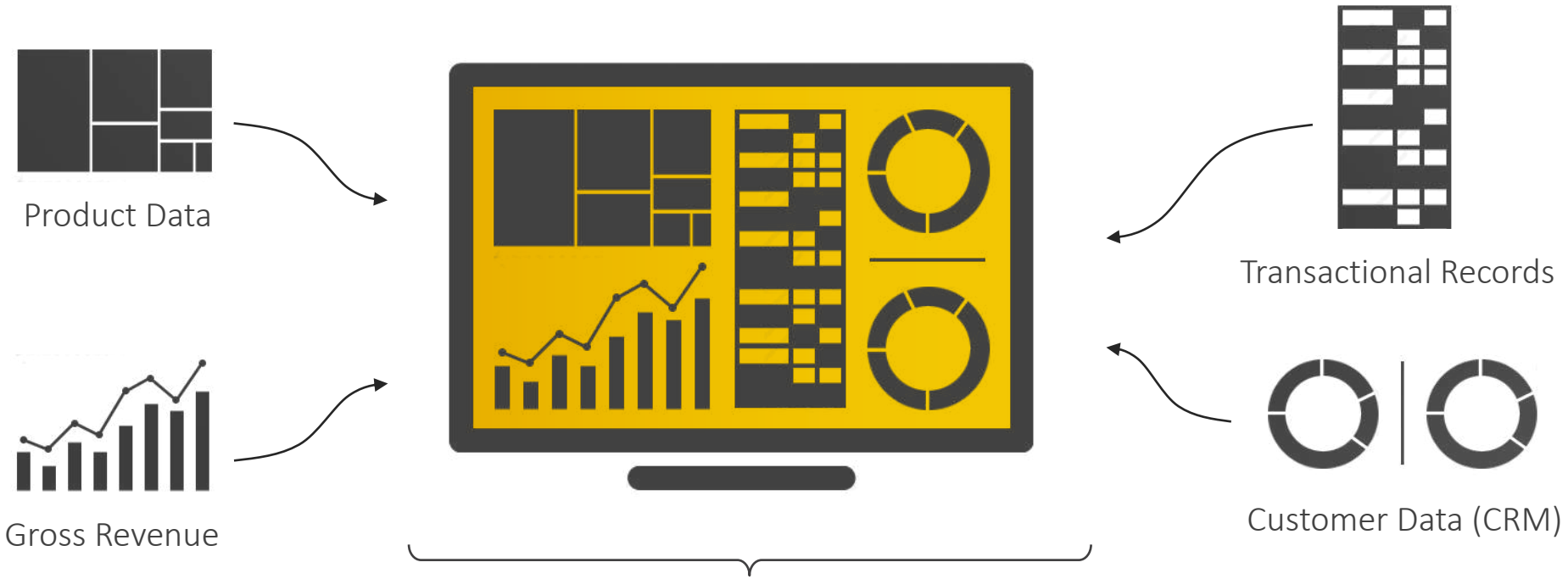
Needs high-level, crystal clear KPIs to track business health and topline performance

- KPI cards or simple charts
- Minimal detail, unless it adds critical context to KPIs

How you visualize and present your data is a function of **who will be consuming it**; a fellow analyst may want to see granular details, while managers and executives often prefer topline KPIs and clear, data-driven insights

ANALYTICS DASHBOARDS

Dashboards are analytics tools designed to consolidate data from multiple sources, track key metrics at a glance, and facilitate data-driven storytelling and decision making



DASHBOARD DESIGN FRAMEWORK

1. Define the purpose
2. Choose the right metrics
3. Present the data effectively
4. Eliminate clutter & noise
5. Use layout to focus attention
6. Tell a clear story

A well-designed dashboard should **serve a distinct purpose for a distinct audience**, use **clear and effective metrics and visuals**, and **provide a simple, intuitive user experience**.

Key questions to consider:

- *Who are the **end-users** of your dashboard?*
- *What are their **key business goals** and objectives?*
- *What are the **most important questions** they need answers to?*
- *How can I present information **as clearly as possible**?*

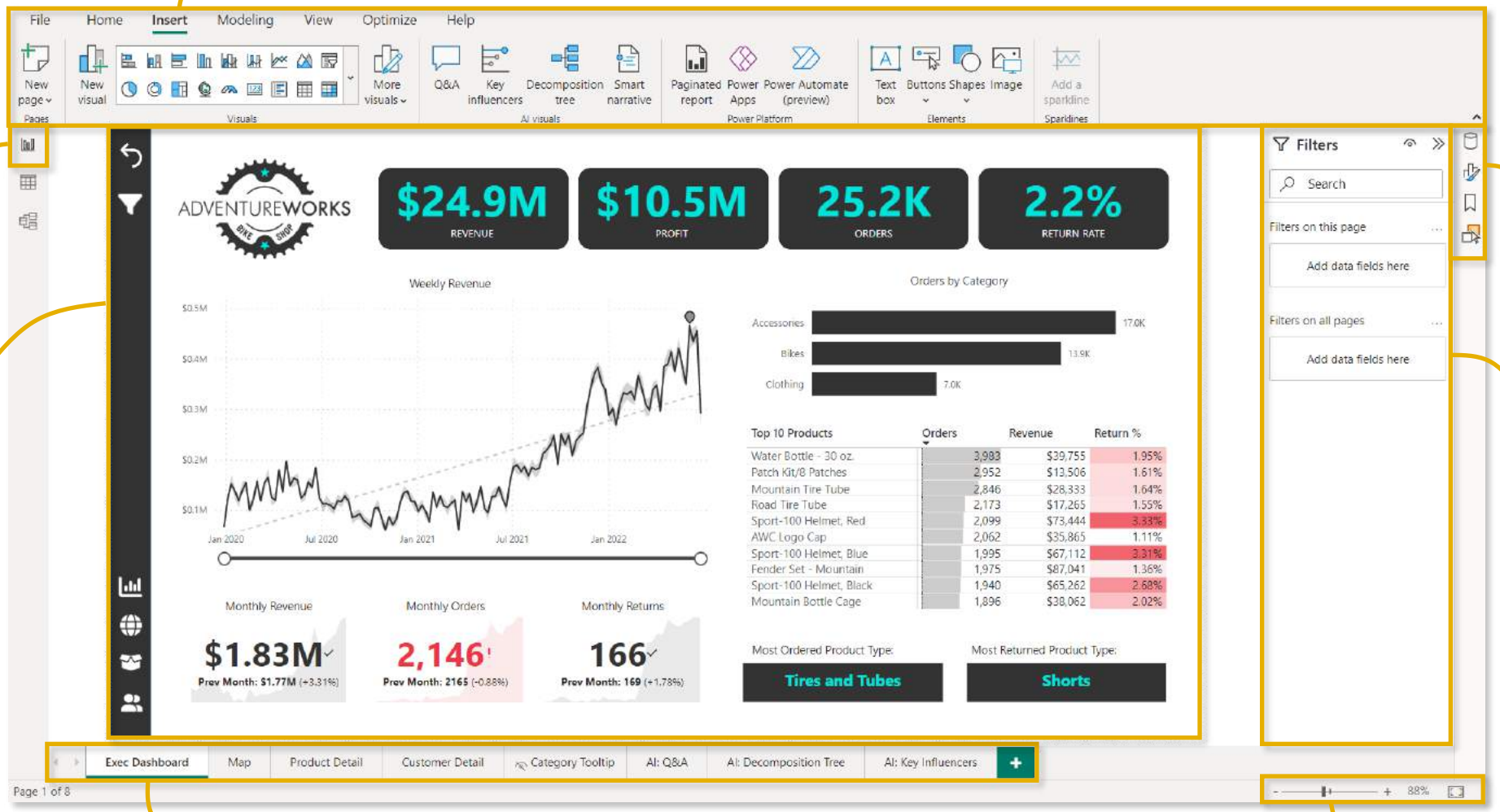
> *"Perfection is achieved not when there is nothing more to add, **but when there is nothing left to take away**"*
>
> *Antoine de Saint-Exupery*

THE REPORT VIEW

Insert Menu *(Add pages, visuals, buttons, shapes, images, etc.)*

Report View

Report Canvas



Panes

(Data, Format, Bookmarks, Selection)

Filter Pane

(Page-level, report-level, visual-level filters)

Report Pages *(each tab is a blank report canvas)*

View Options *(Zoom, fit to page)*

ASSIGNMENT: CARDS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Let's get visual!**

Hey there!

We've kicked off the visualization work for our Power BI dashboard, and I'm hoping you can help.

For now I'd love for you to focus on building out the **Customer Detail** report. Can you start by adding some KPIs to show total customers and revenue per customer?

-Vic

Reply Forward

Key Objectives

1. Insert a **card** in the **Customer Detail** report page to show **Total Customers**, and rename the field "UNIQUE CUSTOMERS"
2. Add a background shape and match the formatting of the cards in the **Exec Dashboard** tab
3. Copy and paste to create a second card showing **Average Revenue per Customer**, and rename the field "REVENUE PER CUSTOMER"

SOLUTION: CARDS

NEW MESSAGE

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Subject: **Let's get visual!**

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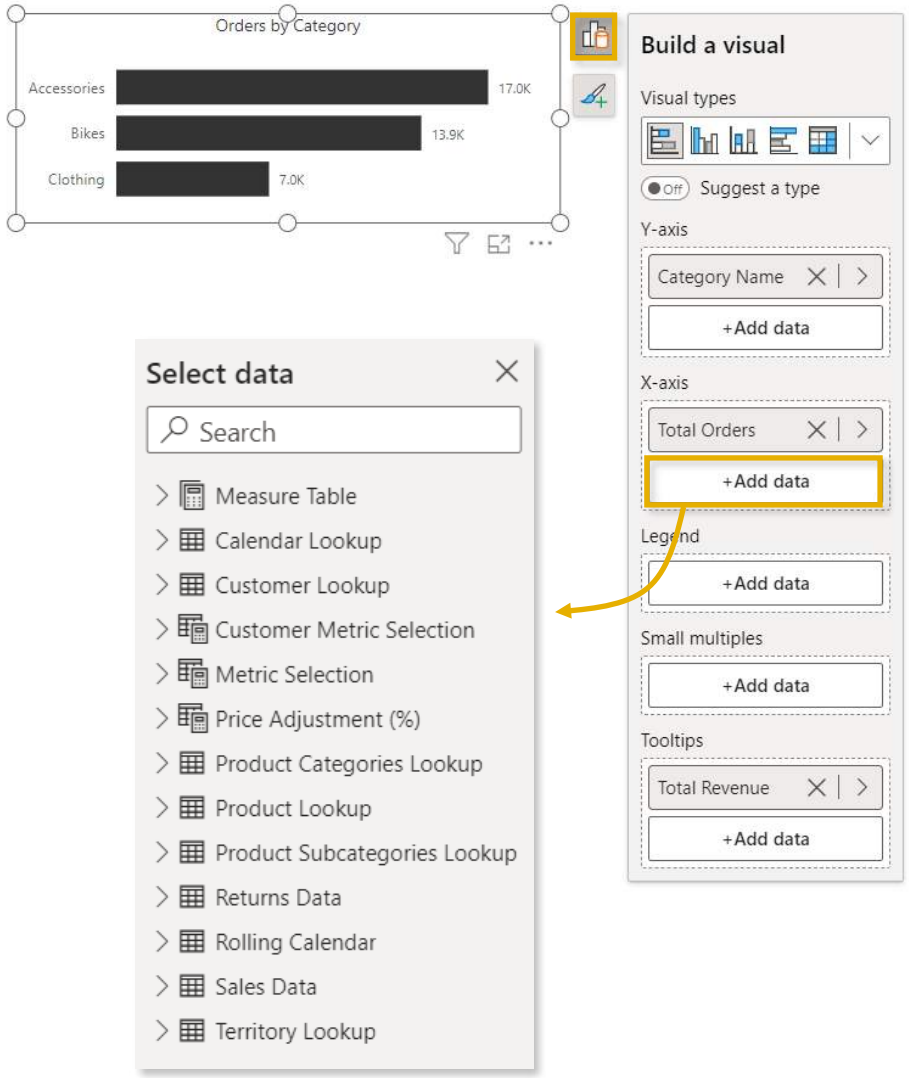
For now I'd love for you to focus on building out the **Customer Detail** report. Can you start by adding some KPIs to show total customers and revenue per customer?

-Vic

Reply Forward

Solution Preview

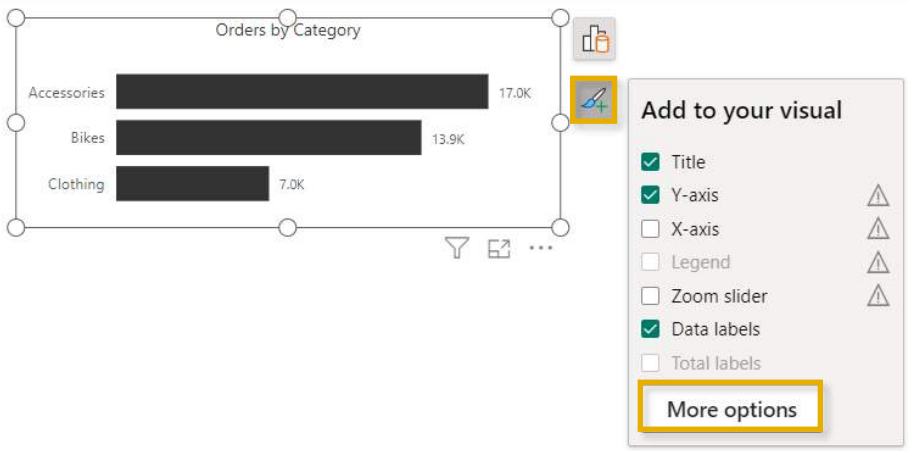
BUILDING & FORMATTING CHARTS



The **Build** menu allows you to change the visual type, auto-suggest visuals, and add data to customize chart components *(x-axis, y-axis, legend, tooltips, etc.)*

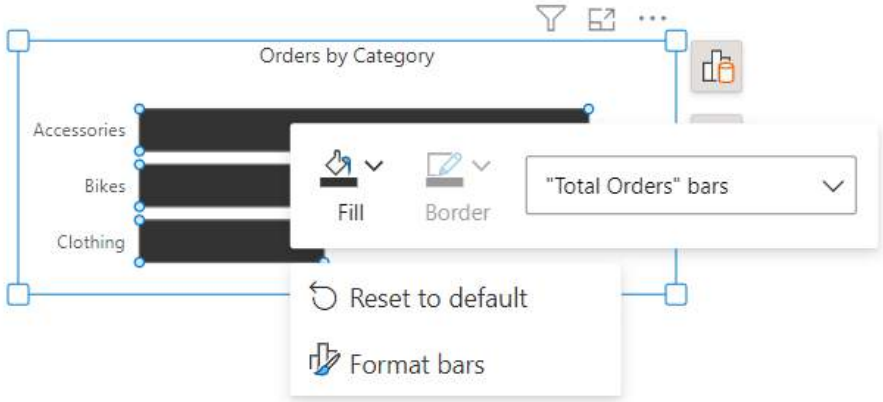
- This is a **contextual menu**, so you will only see options which are relevant to the selected visual
- You can build visuals by either inserting a specific chart type and adding data, or by dragging a field from the Data pane onto the canvas

BUILDING & FORMATTING CHARTS



The **Format** menu allows you to quickly add common chart elements *(title, axis labels, data labels, legends, etc.)* and access additional options and properties in the Format pane

- This is a **contextual menu**, so you will only see options which are relevant to the selected visual



Enable **on-object formatting** by double-clicking the chart object *(or right-click > format)*, which allows you to select and edit individual chart elements

- On-object formatting is only available for certain visuals (bar, column, line, area, combo & scatter)

ASSIGNMENT: LINE CHARTS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Customer count by week**

Nice work on those cards!

Next up let's add a weekly line chart to show how our customer base is trending over time.

Please add a zoom bar to make it interactive, and format the tooltips to match the line chart in the Exec Dashboard.

Thanks!

-Vic

Reply Forward

Key Objectives

1. Add a **line chart** to the **Customer Detail** report showing **Total Customers** by week
2. Add a **trend line** and a **zoom slider** to the x-axis
3. Enable **tooltips**, and format to match line chart in the **Exec Dashboard** tab

SOLUTION: LINE CHARTS

NEW MESSAGE

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Subject: **Customer count by week**

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Next up let's add a weekly line chart to show how our customer base is trending over time.

Please add a zoom bar to make it interactive, and format the tooltips to match the line chart in the Exec Dashboard.

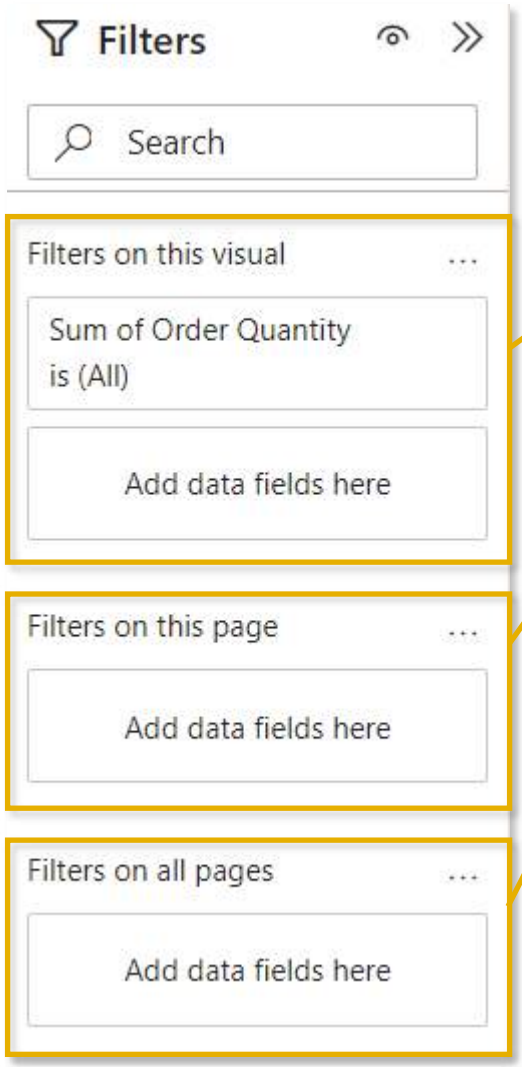
Thanks!

-Vic

Reply Forward

Solution Preview

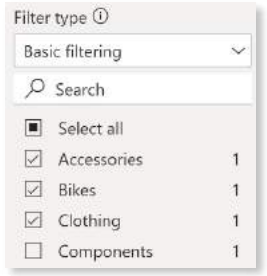
FILTERING OPTIONS



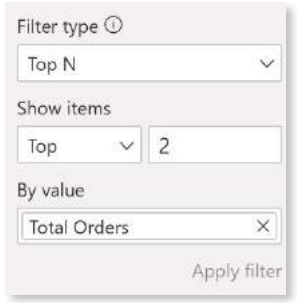
There are **3 types of filters** accessible from the **Filters** pane*:

1. **Visual-level** filters apply to specific visuals
2. **Page-level** filters apply to all visuals on the report page
3. **Report-level** filters apply to all visuals across all report pages

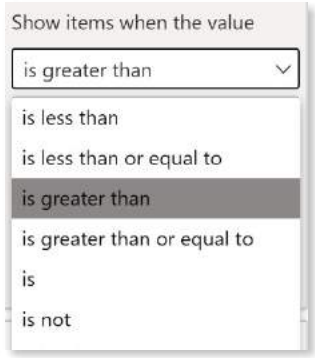
Drillthrough *filters can be configured in the page formatting pane – more on that later!*



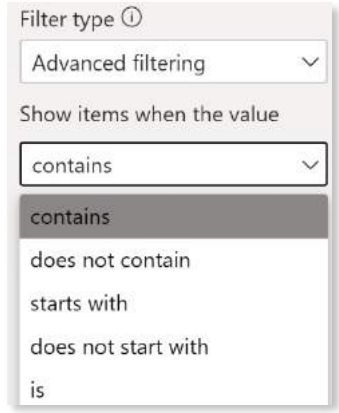
Basic Options



Top N Options



Advanced (Values)



Advanced (Text)

Filters can be configured using basic **selections**, **logical operators**, or **Top N** conditions

ASSIGNMENT: DONUT CHARTS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Customer demographics**

Good morning!

Just got a note from Ethan to see if we can build some demographic info into the customer report.

Let's add a couple donut charts to show the composition of customers by income level and occupation. We'll want to limit to just a few segments (maybe 3?) and do some formatting to match the rest of the dashboard.

Thanks, you rock!

-Vic

Reply Forward

Key Objectives

1. Add a **donut chart** to the **Customer Detail** report showing **Total Orders** by **Income Level**
2. Add a **chart title**, turn off the **legend**, and update the **data labels** to show the category and value (font size 8, 1 decimal place)
3. Update the colors of the slices to match the screenshot in the solution preview
4. Add a **visual-level filter** to exclude customers with a "Very High" income level
5. Copy the chart to show **Total Orders** by **Occupation**, and add a **visual-level filter** to display the three occupations with the most orders *(bonus points if you use a Top N filter!)*

SOLUTION: DONUT CHARTS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Customer demographics**

Good morning!

Just got a note from Ethan to see if we can build some demographic info into the customer report.

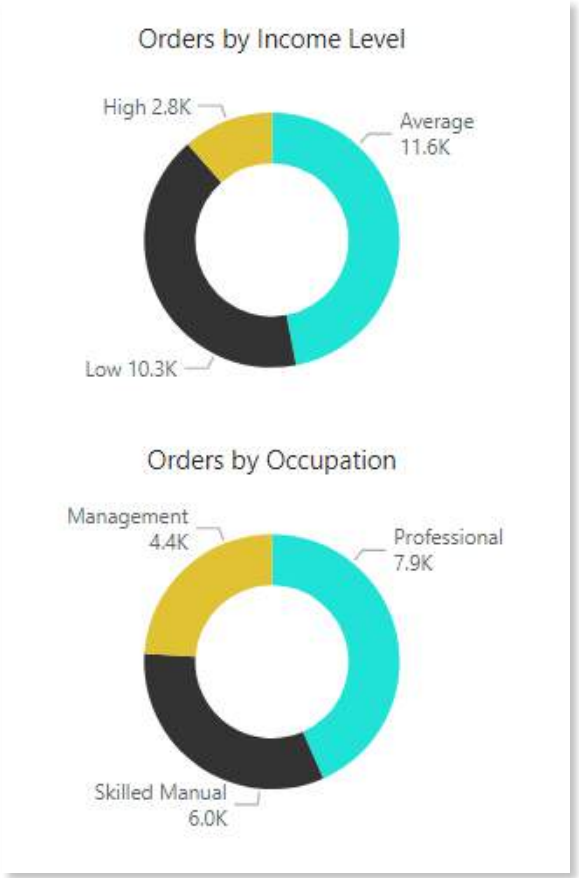
Let's add a couple donut charts to show the composition of customers by income level and occupation. We'll want to limit to just a few segments (maybe 3?) and do some formatting to match the rest of the dashboard.

Thanks, you rock!

-Vic

Reply Forward

Solution Preview

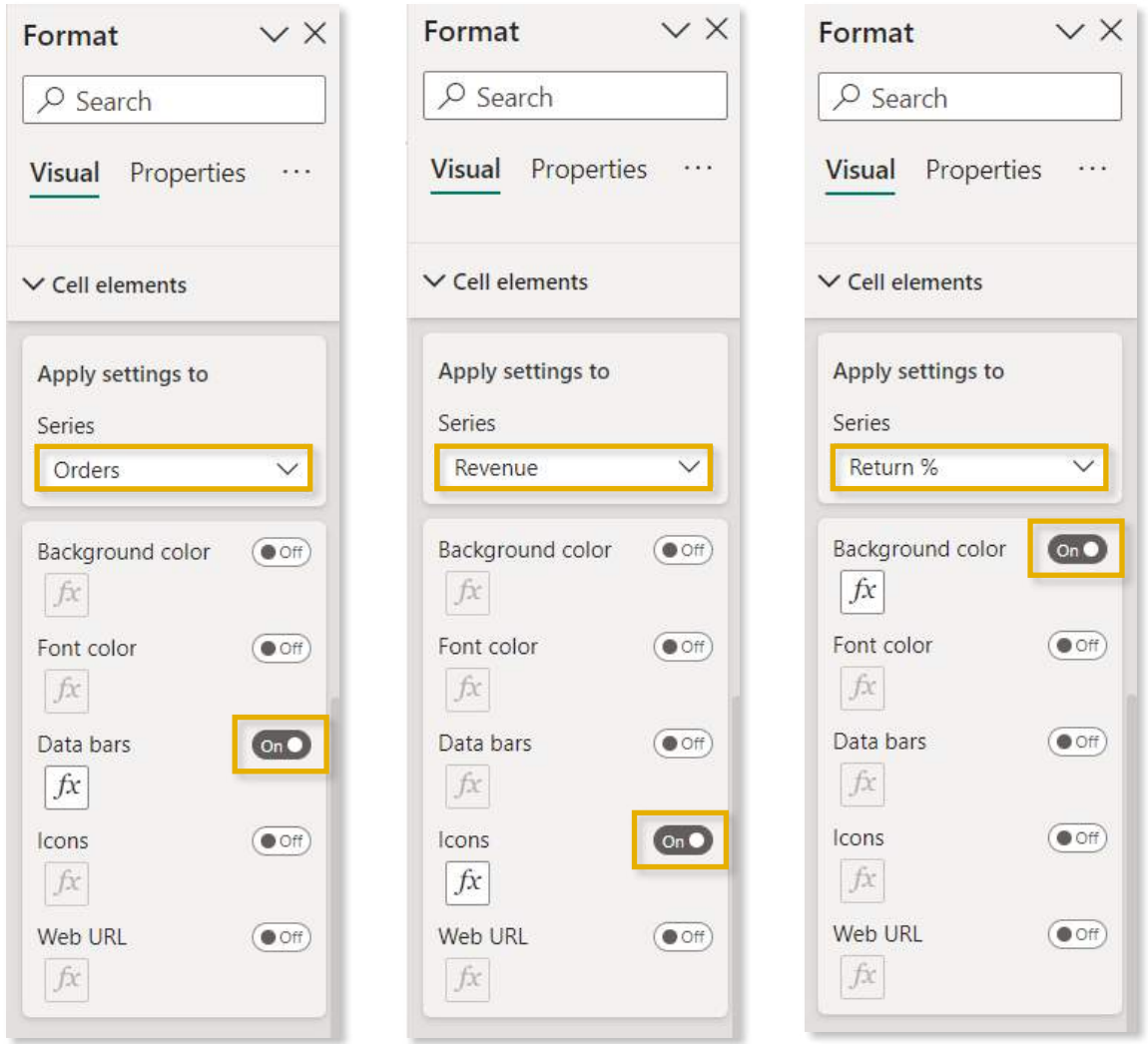


CONDITIONAL FORMATTING

Top 10 Products	Orders	Revenue	Return %
Water Bottle - 30 oz.	3,983	$39,755	1.95%
Patch Kit/8 Patches	2,952	$13,506	1.61%
Mountain Tire Tube	2,846	$28,333	1.64%
Road Tire Tube	2,173	$17,265	1.55%
Sport-100 Helmet, Red	2,099	$73,444	3.33%
AWC Logo Cap	2,062	$35,865	1.11%
Sport-100 Helmet, Blue	1,995	$67,112	3.31%
Fender Set - Mountain	1,975	$87,041	1.36%
Sport-100 Helmet, Black	1,940	$65,262	2.68%
Mountain Bottle Cage	1,896	$38,062	2.02%

Conditional formatting allows you to dynamically format Table or Matrix visuals based on cell values

- Conditionally formatting options can be found in the **Format** pane, under **Cell elements**
- Options include background color, font color, data bars, icons, or Web URL



ASSIGNMENT: TABLES

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Top customer table**

Hey there, this customer report is really coming together!

Since the management team needs a way to identify high-value customers, let's add a table to our report showing customer keys, full names, orders, and revenue.

Probably makes sense to add some conditional formatting and limit to the top 100 customers for now.

Thanks!

-Vic

Reply Forward

Key Objectives

1. Add a **table** to the **Customer Detail** report to show **Customer Key, Full Name**, **Total Orders** (as "Orders") and **Total Revenue** (as "Revenue")
2. Use conditional formatting to add light gray **data bars** to the orders column and a white > blue **color scale** to the revenue column
3. Add a **visual-level filter (Top N)** to show the 100 customers with the most orders, and add a **chart title** ("Top 100 Customers")
4. **Sort** the table descending by orders

SOLUTION: TABLES

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Top customer table**

Hey there, this customer report is really coming together!

Since the management team needs a way to identify high-value customers, let's add a table to our report showing customer keys, full names, orders, and revenue.

Probably makes sense to add some conditional formatting and limit to the top 100 customers for now.

Thanks!

-Vic

Reply Forward

Solution Preview

Top 100 Customers

Customer Key	Full Name	Orders	Revenue
11091	Mr. Dalton Perez	26	$1,513
11223	Mrs. Hailey Patterson	26	$1,616
11300	Mr. Fernando Barnes	26	$1,839
11330	Mr. Ryan Thompson	26	$1,597
11331	Mrs. Samantha Jenkins	26	$1,740
11185	Mrs. Ashley Henderson	25	$1,717
11200	Mr. Jason Griffin	25	$1,614
11176	Mr. Mason Roberts	24	$1,526
11262	Mrs. Jennifer Simmons	24	$1,465
11277	Mr. Charles Jackson	24	$1,777
11287	Mr. Henry Garcia	24	$1,443
11566	Ms. April Shan	24	$1,424
11711	Mr. Daniel Davis	24	$1,404
11276	Mrs. Nancy Chapman	23	$1,111
11203	Mr. Luis Diaz	17	$1,002
11215	Mrs. Ana Perry	17	$1,336
11078	Ms. Gina Martin	16	$991
Total		**1,272**	**$615,328**

ASSIGNMENT: TOP N TEXT CARDS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Top customers by revenue**

Hey,

Ethan is loving the customer report so far – great job!

He mentioned that he'd like to highlight top customers based on *revenue* as well, so I'm thinking we could add some text cards to show the top customer name, along with total revenue and the number of orders placed.

We'll be offering some coupons based on how much customers have spent in the past, so accuracy is critical here!

-Vic

Reply Forward

Key Objectives

1. Add a **card** to the **Customer Detail** report to show **Full Name**
2. Add a **visual-level filter (Top N)** to show the top customer (Full Name) in terms of **Total Revenue**
   - What do you notice when you filter the report for low income customers? *(**Hint**: check your value against the table)*
   - How could you modify the Top N filter to correct this?
3. Copy and paste the card (x2) to show **Total Orders** and **Total Revenue** for the top customer
4. Add **text boxes** for titles and adjust formatting to match the solution preview

SOLUTION: TOP N TEXT CARDS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Top customers by revenue**

Hey,

Ethan is loving the customer report so far – great job!

He mentioned that he'd like to highlight top customers based on *revenue* as well, so I'm thinking we could add some text cards to show the top customer name, along with total revenue and the number of orders placed.

We'll be offering some coupons based on how much customers have spent in the past, so accuracy is critical here!

-Vic

Reply Forward

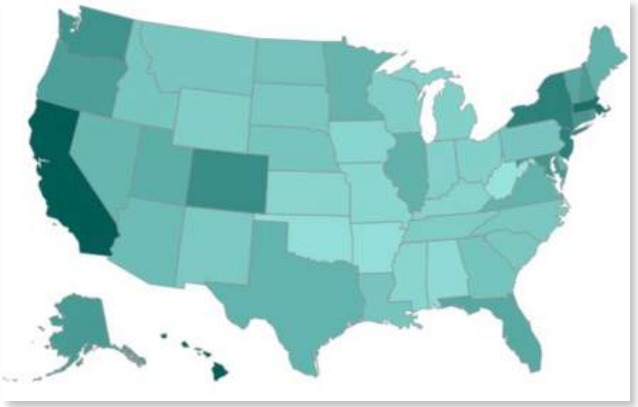
Solution Preview

MAP VISUALS

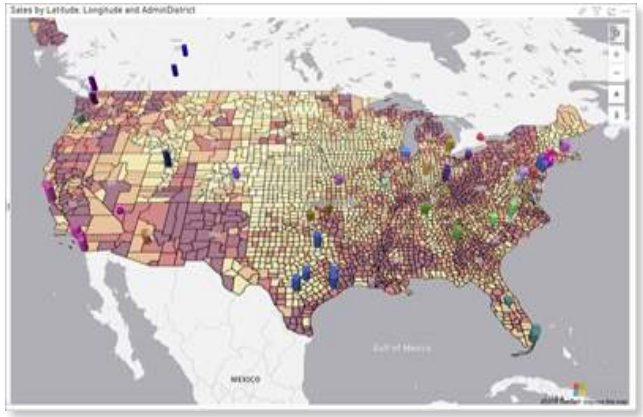
Map

Filled map

Shape map



Azure map



Power BI includes several types of **map visuals** powered by Bing Maps

Tips for creating accurate maps:

1. Assign **categories** to geospatial fields
2. Add **multiple location** fields
3. Use **latitude/longitude** when possible

HEY THIS IS IMPORTANT!

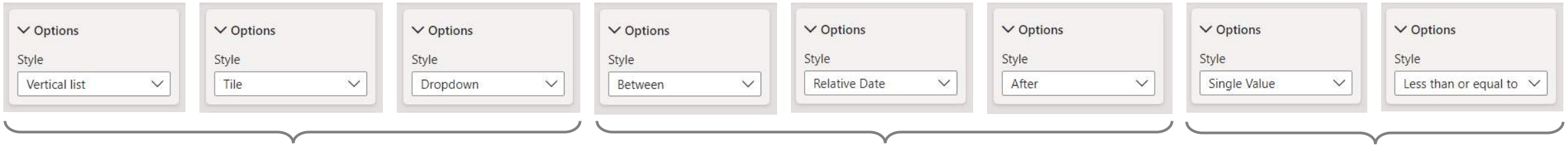
An administrator may need to **enable maps in your tenant settings** in order to use them in Power BI Service

**ArcGIS maps require a separate account, and are not pictured here*

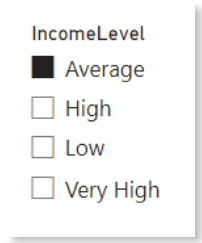
SLICERS

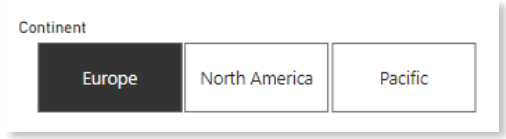
Slicers are visual filters which affect all other visuals on a report page (by default)

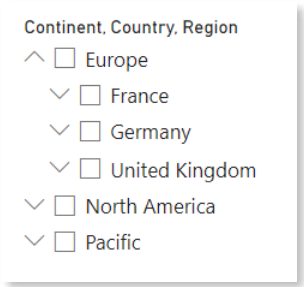
- Slicers can take many formats depending on the data type, including **lists**, **dropdowns**, **tiles**, **ranges**, and more



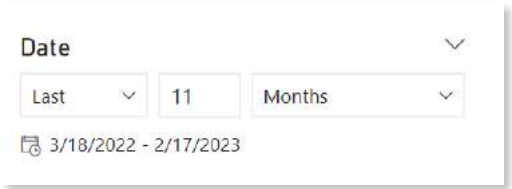
***Categorical/Text** options*



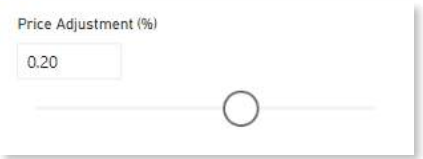


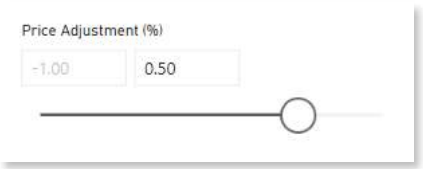


***Date/Time** options*



***Numeric Range** options*





PRO TIP:
Use **Apply/Clear All Slicers** buttons for more filtering control

ASSIGNMENT: SLICERS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Year slicer for customer report**

Hey there, quick request when you get a sec…

Could you please add a slicer to the customer report, so that users can filter the entire page by year?

No preference for which specific type of slicer you use, as long as managers can filter customers for a specific year or across multiple years.

Thanks!

-Vic

Reply Forward

Key Objectives

1. Add a **slicer** to filter the **Customer Detail** report page by **Year**
2. Add a **visual-level filter** to exclude blanks
3. Choose any **slicer style** that allows users to filter individual years or across multiple years

SOLUTION: SLICERS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Year slicer for customer report**

Hey there, quick request when you get a sec…

Could you please add a slicer to the customer report, so that users can filter the entire page by year?

No preference for which specific type of slicer you use, as long as managers can filter customers for a specific year or across multiple years.

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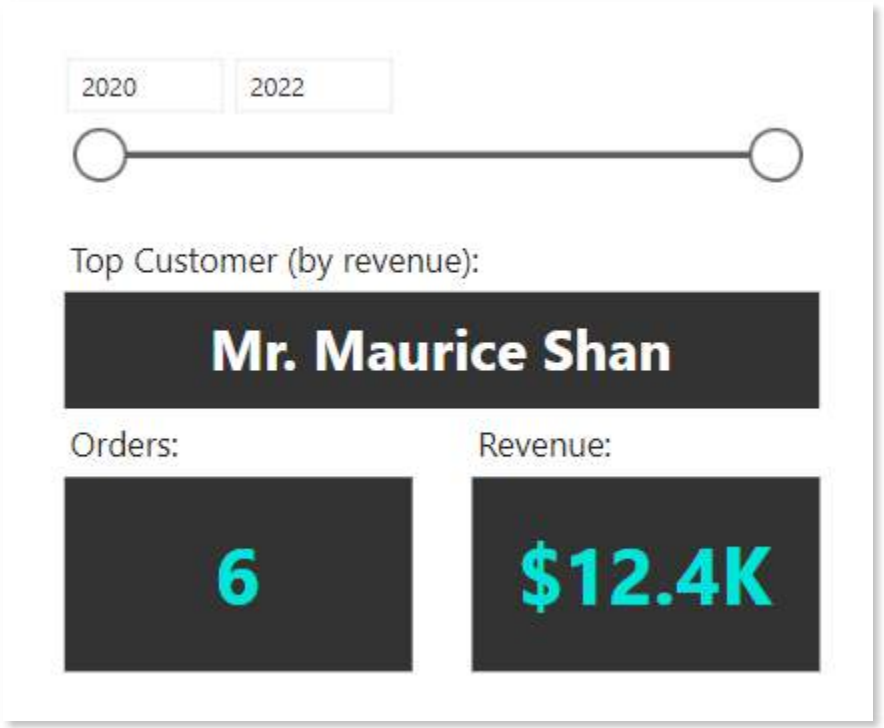
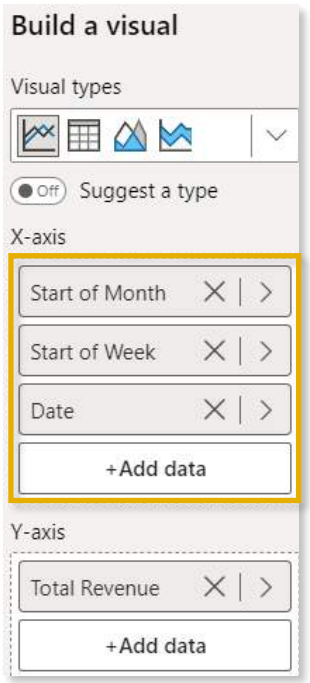
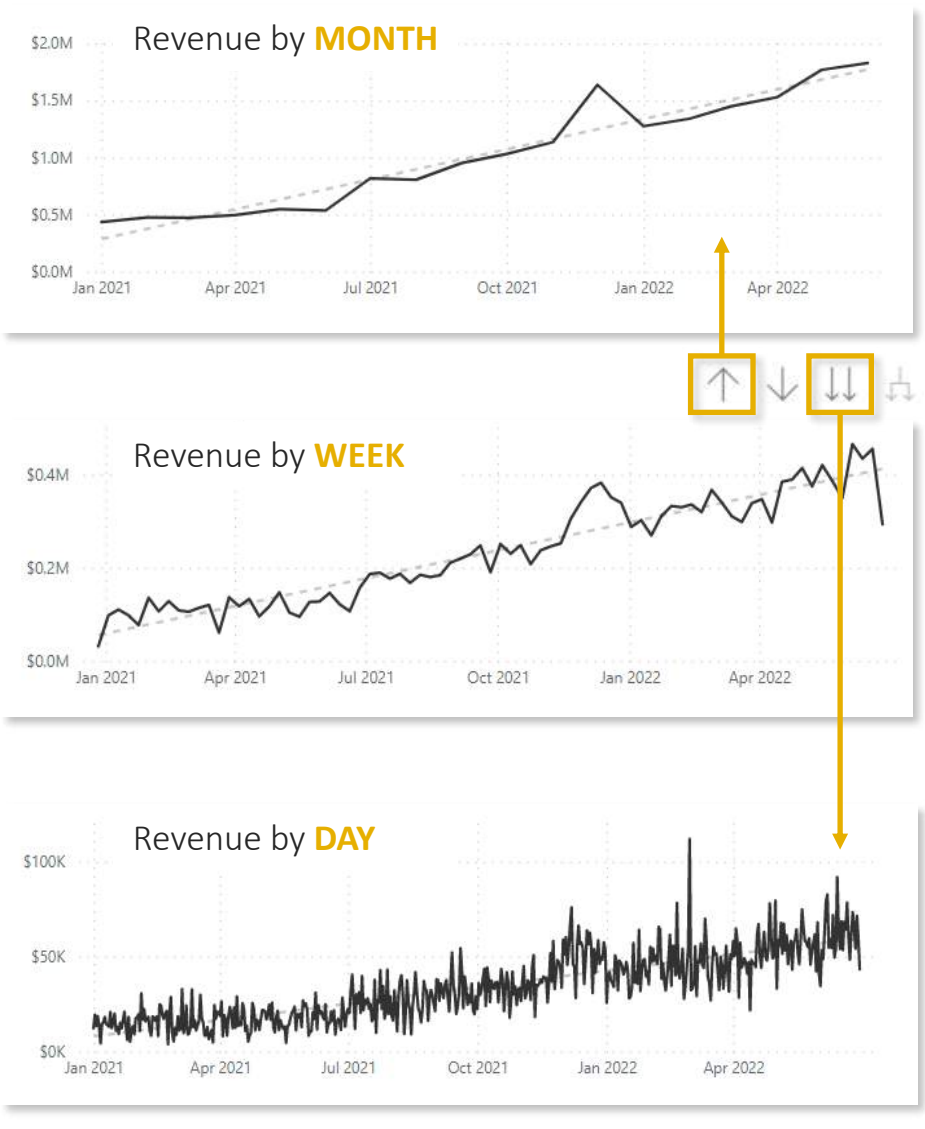
Reply Forward

Solution Preview



DRILL UP & DRILL DOWN





Drill Up and **Drill Down** tools allow you to switch between different levels of granularity

- In this example users can "drill up" from **weekly** to **monthly**, or "drill down" to **daily**
- The single down arrow activates **drill mode**, allowing users to drill by clicking data points
- The forked down arrow **expands each level** of the hierarchy (used in matrix visuals)

PRO TIP:
Use **location hierarchies** and enable drill mode to create interactive map visuals

ASSIGNMENT: DRILL DOWN

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Dynamic time periods**

Hey again, just got some feedback from the managers about our customer report.

Chad loves the weekly trending chart, but Thad wants to see the data by *day* and Vlad was hoping for an *annual* breakdown.

Instead of building multiple versions of the same line chart, could you please make it interactive so that Chad, Thad and Vlad get the views they want?

Thanks!

-Vic

Reply Forward

Key Objectives

1. In the **Customer Detail** report, update the X-axis of the line chart to pull in **Date Hierarchy**
2. Use the chart header to **drill up** and **drill down** to explore trends at each level of granularity
3. Test **drill mode** to change the granularity by selecting individual data points in the chart
    - Why do some weeks look very low?
4. Turn off drill mode and show the chart at a weekly level of granularity by default

SOLUTION: DRILL DOWN

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Dynamic time periods**

Hey again, just got some feedback from the managers about our customer report.

Chad loves the weekly trending chart, but Thad wants to see the data by *day* and Vlad was hoping for an *annual* breakdown.

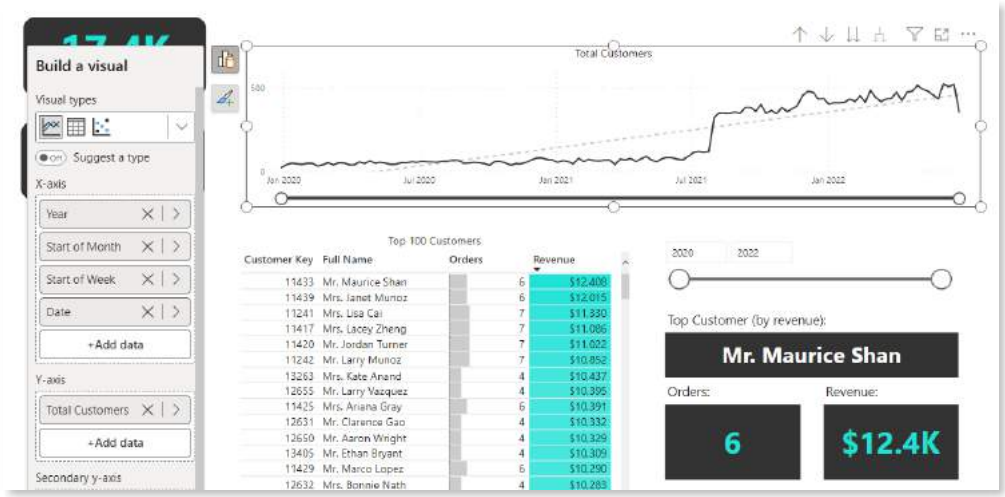
Instead of building multiple versions of the same line chart, could you please make it interactive so that Chad, Thad and Vlad get the views they want?

Thanks!

-Vic

Reply Forward

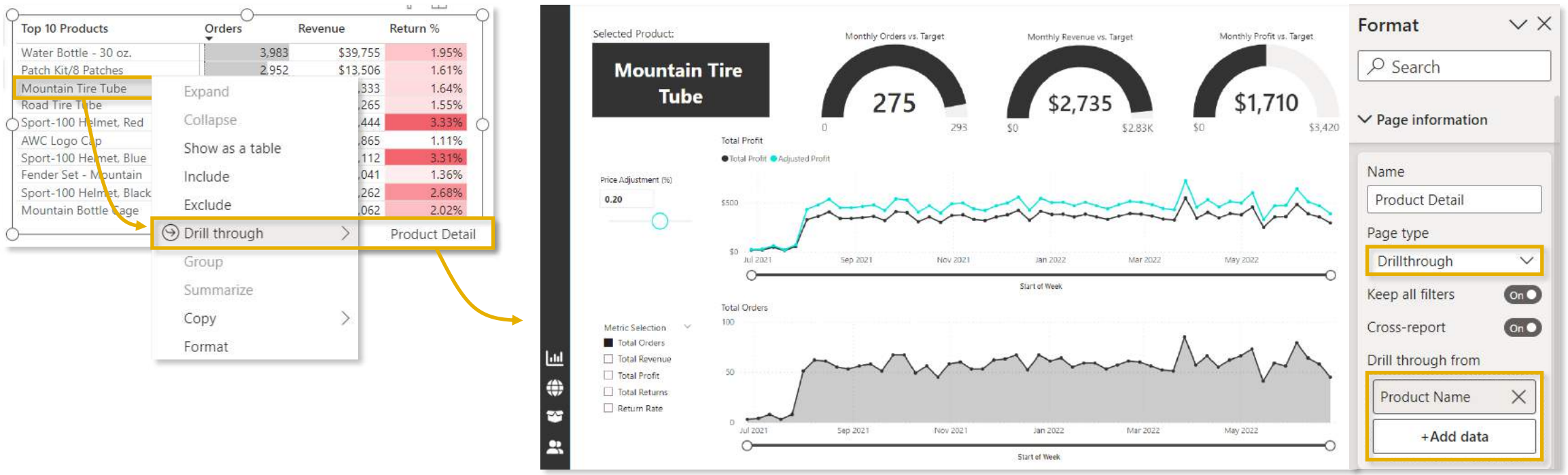
Solution Preview



DRILL THROUGH FILTERS

Drill through filters allow users to navigate to a specific report page, pre-filtered on the item selected

- Here we've created a **Product Detail** page, set the type to **Drillthrough**, and configured drill through from **Product Name**
- This means that users can right-click any instance of product name (i.e. in a matrix visual) and use the Drill through option to navigate straight to the Product Detail report filtered on that product (in this case "Mountain Tire Tube")

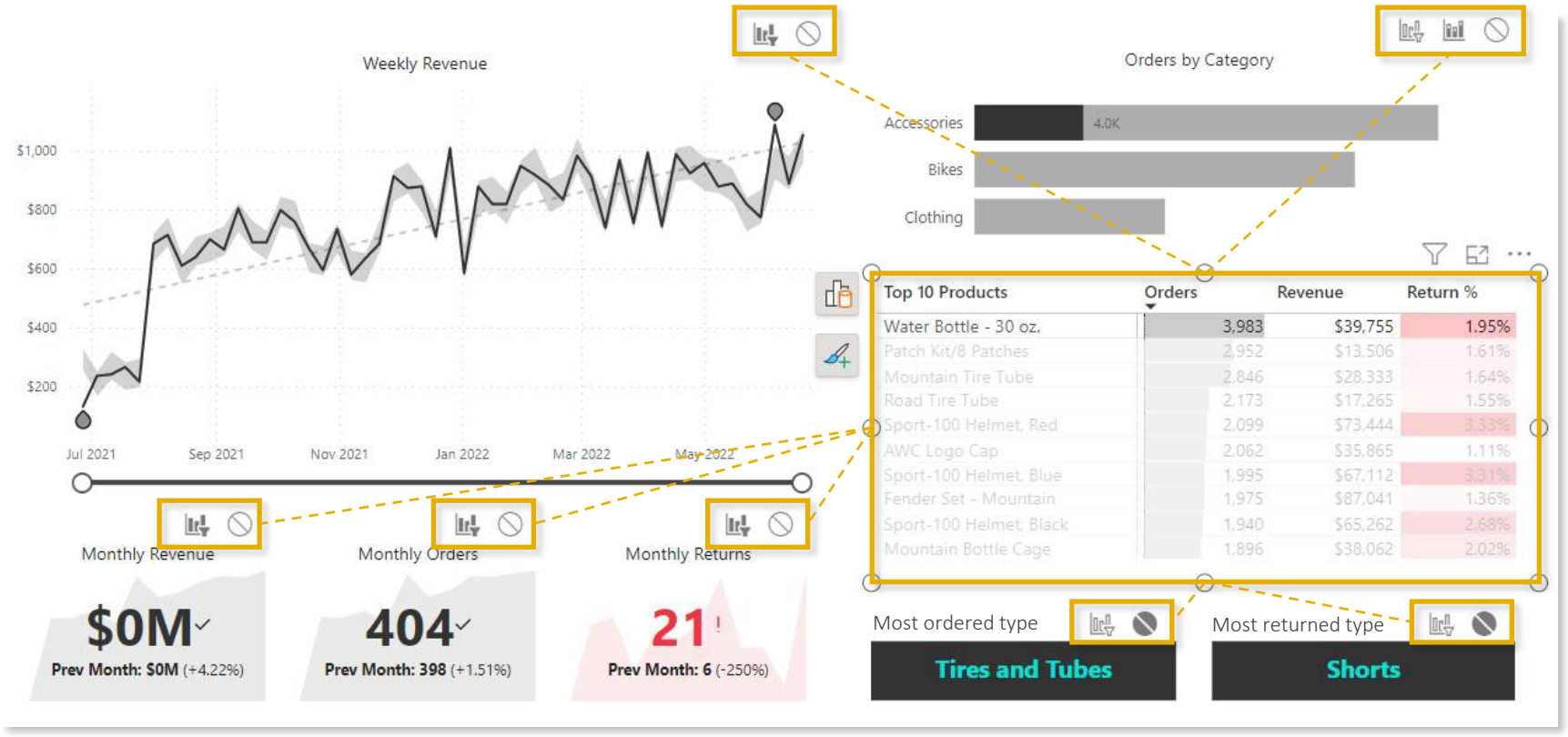


REPORT INTERACTIONS

Edit **report interactions** to customize how filters applied to one visual impact other visuals on the page

- Cross-filter options include **filter** ( ), **highlight** ( ) and **none** ( ), depending on the visual type

Format > ***Edit Interactions***



In this example, selecting a product in the matrix visual:

- **Filters** the line chart & KPIs
- **Highlights** the bar chart
- **Doesn't impact** the text cards

ASSIGNMENT: REPORT INTERACTIONS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Weird report interactions**

Hey there,

I was playing with the customer report this morning and noticed some odd visual interactions. For example, selecting a specific customer shouldn't filter the line chart, and probably shouldn't filter the donut charts either.

Could you please take a pass through the report interactions and update any that seem off?

Thanks!

-Vic

Reply Forward

Key Objectives

1. On the **Customer Detail** tab, edit the **report interactions** based on the following logic:
   - When a filter is applied to the line chart, the donut charts should **filter** (not highlight)
   - When a filter is applied to the table, the line chart and donuts should **not filter**
   - The slicer should **filter all visuals** on the report page

SOLUTION: REPORT INTERACTIONS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Weird report interactions**

Hey there,

I was playing with the customer report this morning and noticed some odd visual interactions. For example, selecting a specific customer shouldn't filter the line chart, and probably shouldn't filter the donut charts either.

Could you please take a pass through the report interactions and update any that seem off?

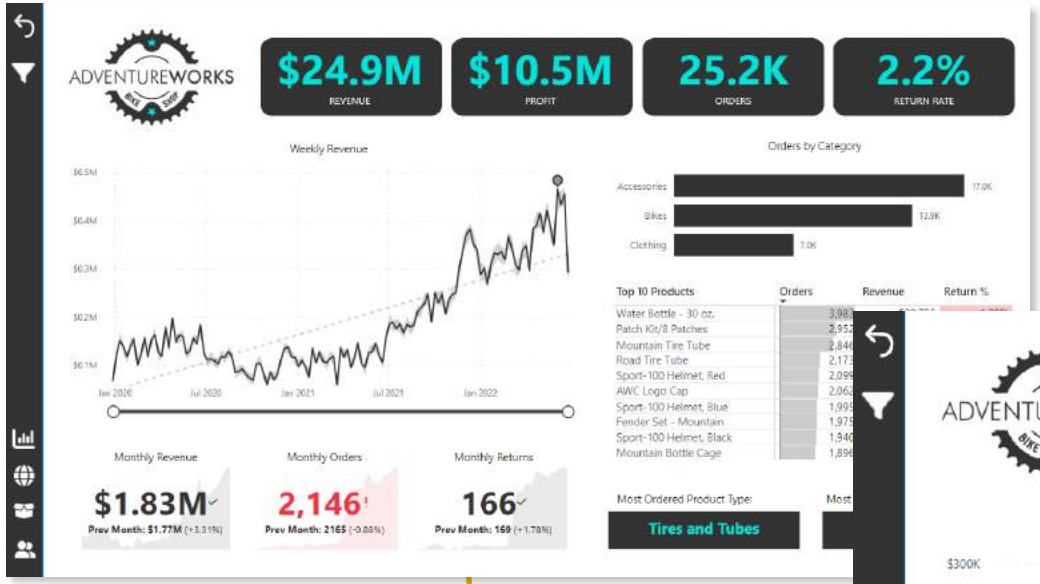
Thanks!

-Vic

Reply Forward

Solution Preview

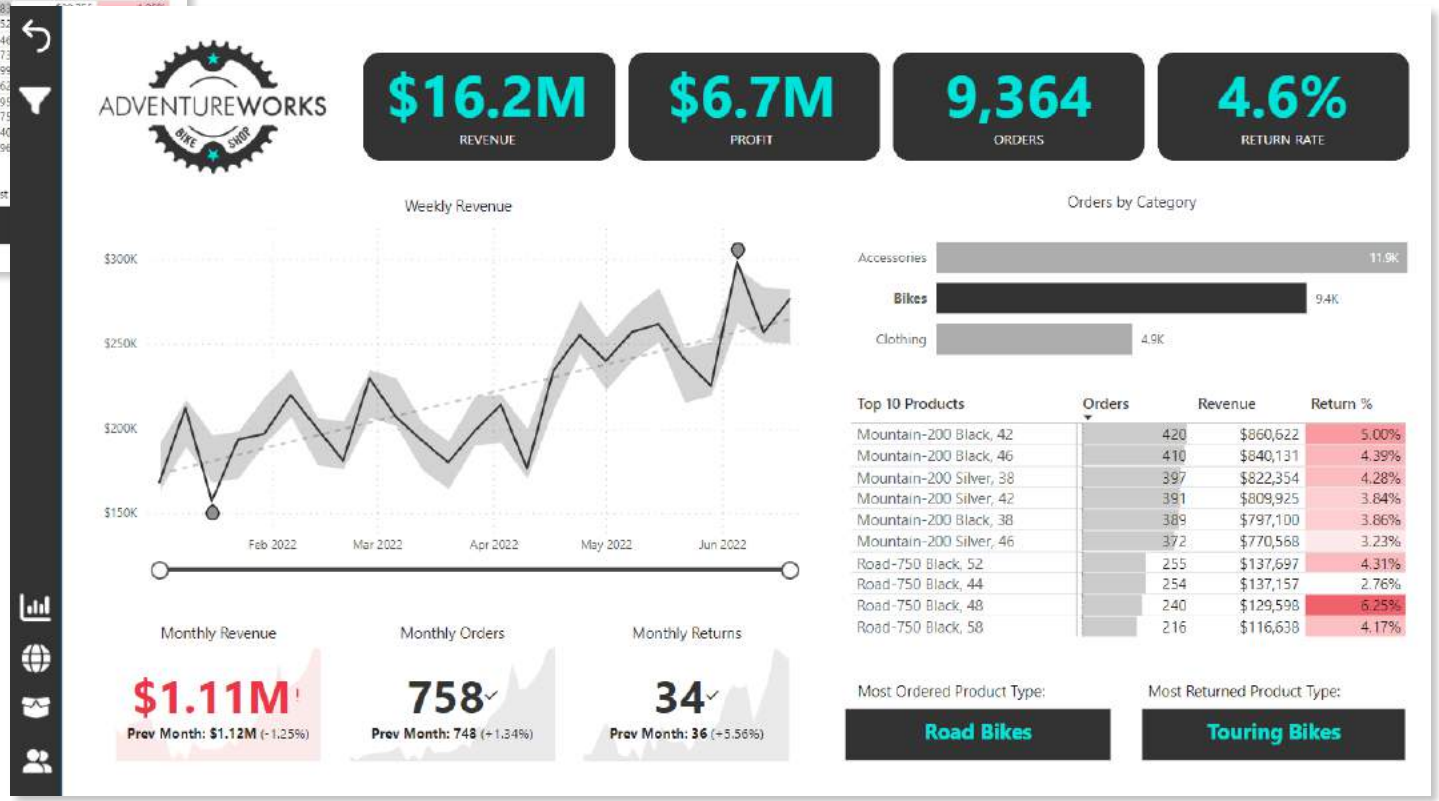
BOOKMARKS



Bookmarks capture the current state of a page, and allow users to return to that state using report actions

- Bookmarks are commonly used for clearing filters, highlighting specific insights, navigating reports, etc.

Bike sales in Europe (1H 2022)



ASSIGNMENT: BOOKMARKS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Finding anything interesting?**

Hey,

Now that you're getting pretty familiar with our customer data, are you noticing any interesting insights or trends that might be worth explicitly calling out in the report?

This could be a great way for us to use bookmarks to draw attention to some specific stories in the dashboard. While we're at it, let's add another one to clear all filters from the page.

Let me know what you think!

-Vic

Reply Forward

Key Objectives

1. Explore the **Customer Detail** report by adjusting filters until you find an interesting insight or trend *(this can be anything you choose!)*
2. Add a new **bookmark** to capture the current state of the report, and name it "Customer Insight"
3. Insert an **Information button** and add text to the button style to summarize what you've found
4. Assign a **bookmark action** to the button, and link to the Customer Insight bookmark you created
5. Create a second bookmark named "Clear all Customer Filters" which returns the page to an unfiltered state, and link it to a **Reset button**
6. Test both bookmarks using **CTRL-click**

SOLUTION: BOOKMARKS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **Finding anything interesting?**

Hey,

Now that you're getting pretty familiar with our customer data, are you noticing any interesting insights or trends that might be worth explicitly calling out in the report?

This could be a great way for us to use bookmarks to draw attention to some specific stories in the dashboard. While we're at it, let's add another one to clear all filters from the page.

Let me know what you think!

-Vic

Reply Forward

Solution Preview

Example: *Among customers in Skilled Manual roles in 2022, Ruben Suarez drove the most revenue at $4,683*

PARAMETERS

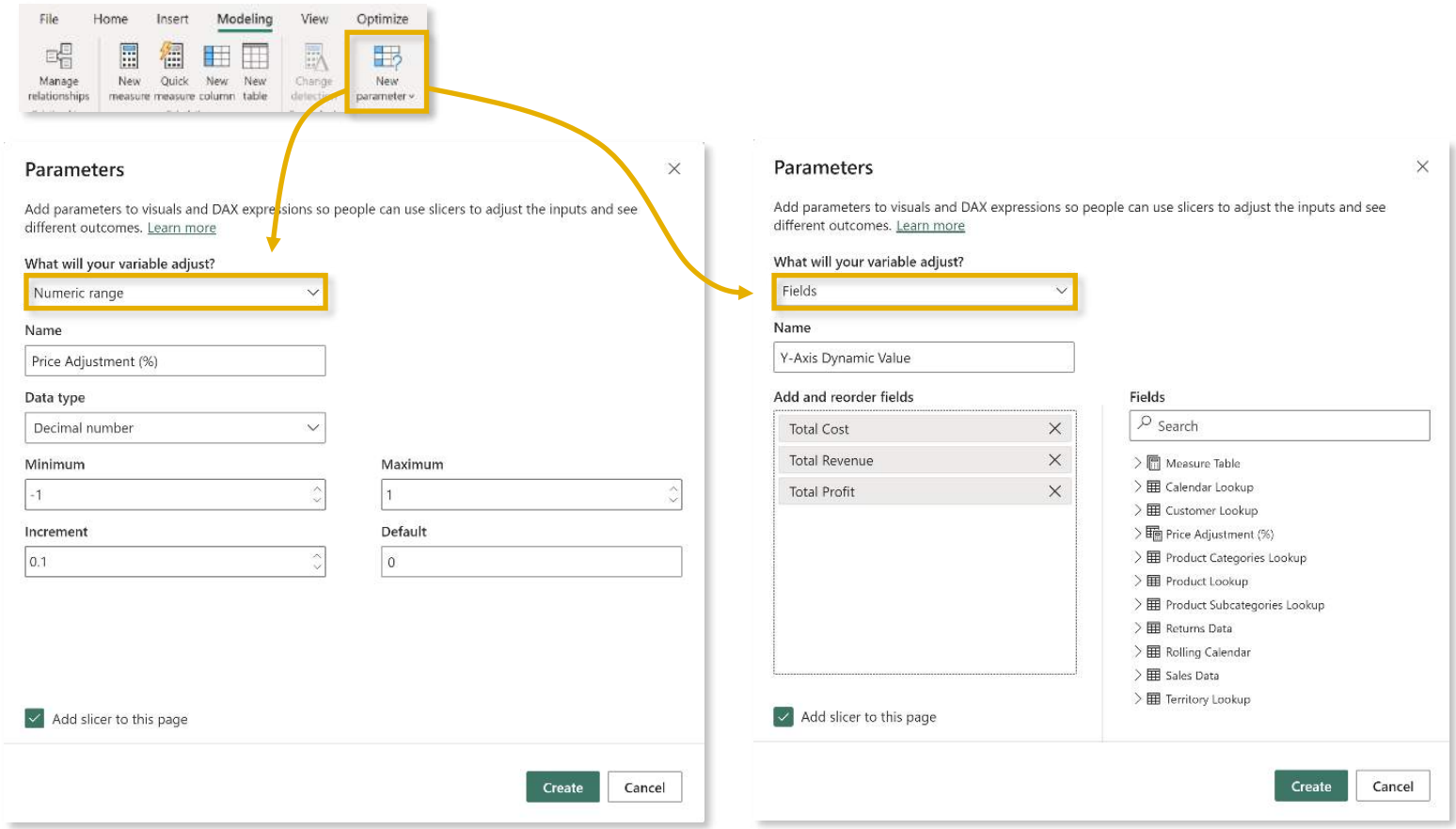
Parameters allow you to create variables which can be referenced in measures and controlled via slicers

Numeric range parameters

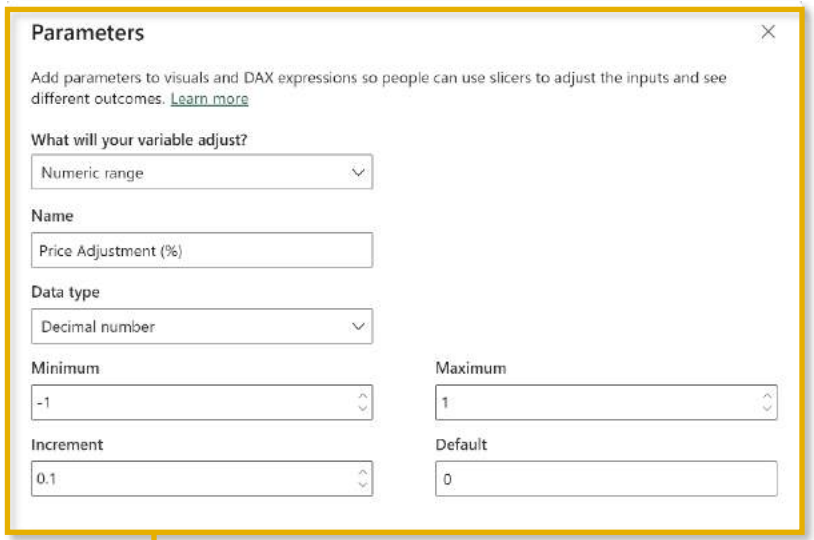
Typically used for scenario testing, where users adjust numerical inputs to see the impact on a given output

Fields parameters

Typically used to allow users to dynamically change the metrics or dimensions displayed in a report visual



EXAMPLE: NUMERIC RANGE PARAMETER

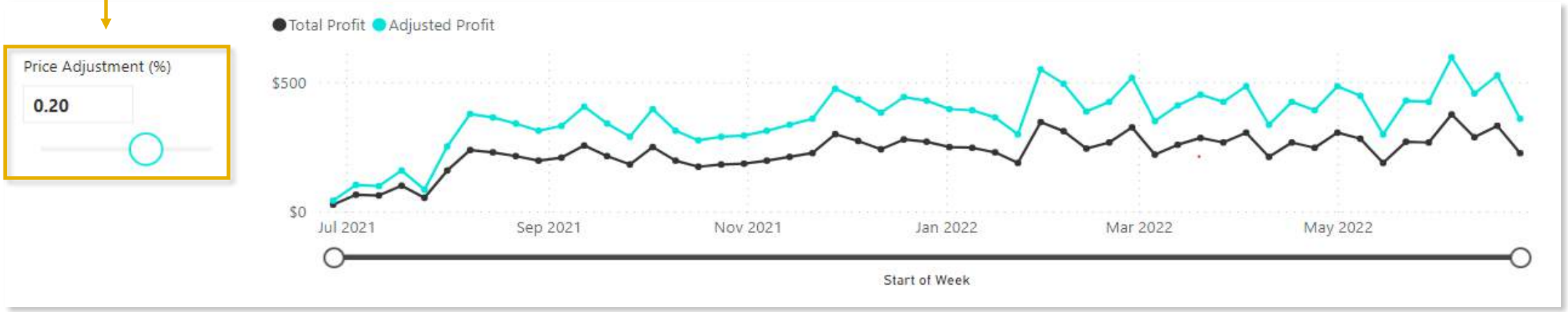


When you create a numeric parameter, Power BI generates **two new measures**: one to define the parameter and another to capture the selected value:

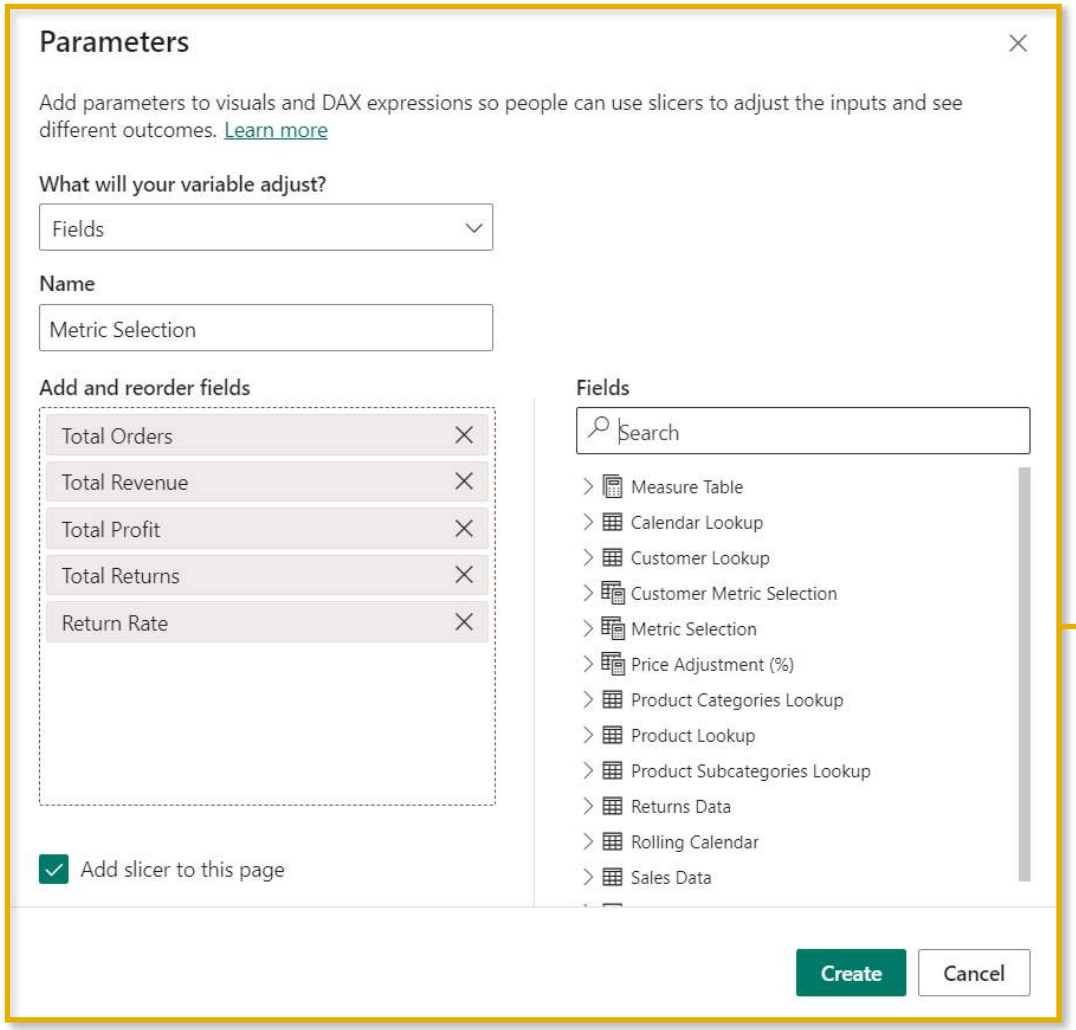
```
Parameter = GENERATESERIES(-1, 1, 0.1)
```

```
Parameter Value = SELECTEDVALUE(Parameter[Parameter], 0)
```

Here we've created a parameter named **Price Adjustment %**, added it as a slicer, and created measures to calculate **Adjusted Profit** based on the parameter value



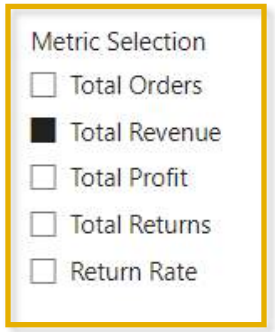
EXAMPLE: FIELDS PARAMETER

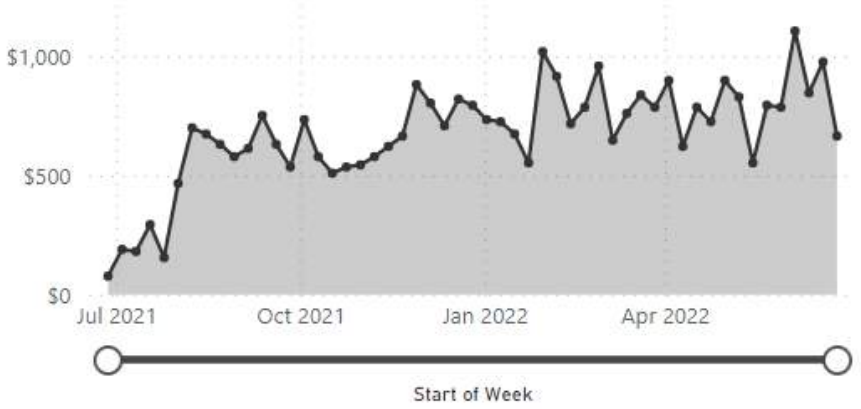


When you create a fields parameter, Power BI **adds a report slicer** and **generates a new measure** to capture the selected value:

```
Metric Selection = {
    ("Total Orders", NAMEOF('Measure Table'[Total Orders]), 0),
    ("Total Revenue", NAMEOF('Measure Table'[Total Revenue]), 1),
    ("Total Profit", NAMEOF('Measure Table'[Total Profit]), 2),
    ("Total Returns", NAMEOF('Measure Table'[Total Returns]), 3),
    ("Return Rate", NAMEOF('Measure Table'[Return Rate]), 4)
}
```

Here we've created a parameter named **Metric Selection** and added it to the Y-axis to let users dynamically change the metric shown





ASSIGNMENT: FIELDS PARAMETERS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **More line chart updates**

Good news and bad news…

The good news is that Chad, Thad and Vlad LOVE the drill options in the line chart – nice work!

The bad news is that now they can't align on what's the best metric to show. Chad likes seeing total customers, but Vlad is pushing for revenue per customer.

What do you think we should do?

-Vic

Reply Forward

Key Objectives

1. Add a new **Fields parameter** named "Customer Metric Selection", which includes **Total Customers** and **Average Revenue per Customer**
2. Add the parameter as a slicer to the **Customer Detail** report, change the slicer style to **Tile**, turn off the **header**, update to **single select**, and resize to create a horizontal layout
3. Select the DAX measure automatically created, and update the text from "Average Revenue per Customer" to "Revenue per Customer"
4. Update the line chart Y-Axis to use the **Customer Metric Selection** parameter, remove the chart title, and update the line colors to match the solution preview

SOLUTION: FIELDS PARAMETERS

NEW MESSAGE

From: **Victor Ignatius Zabel** *(BI Analyst)*

Subject: **More line chart updates**

Good news and bad news…

The good news is that Chad, Thad and Vlad LOVE the drill options in the line chart – nice work!

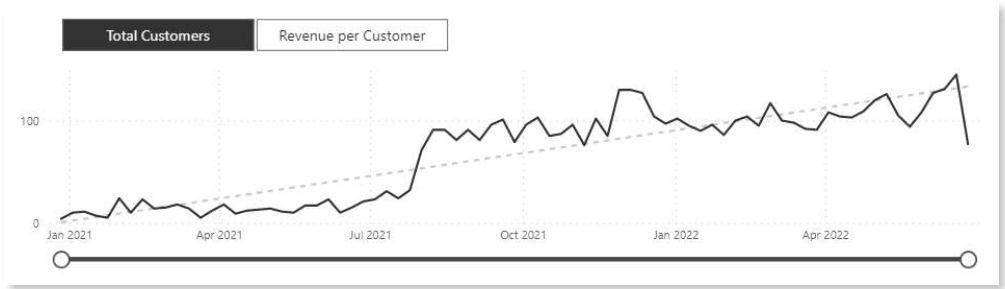
The bad news is that now they can't align on what's the best metric to show. Chad likes seeing total customers, but Vlad is pushing for revenue per customer.

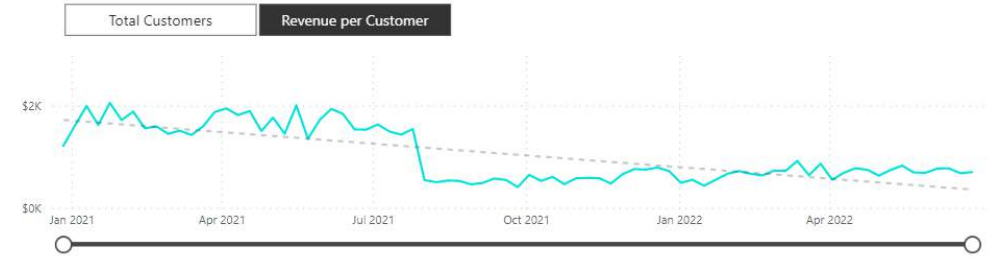
What do you think we should do?

-Vic

Reply Forward

Solution Preview

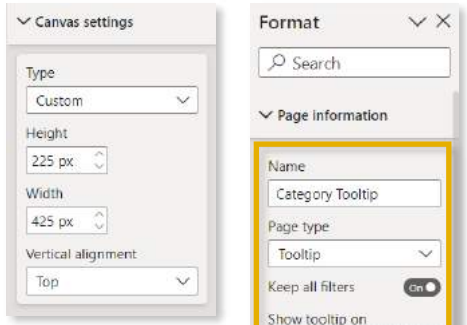


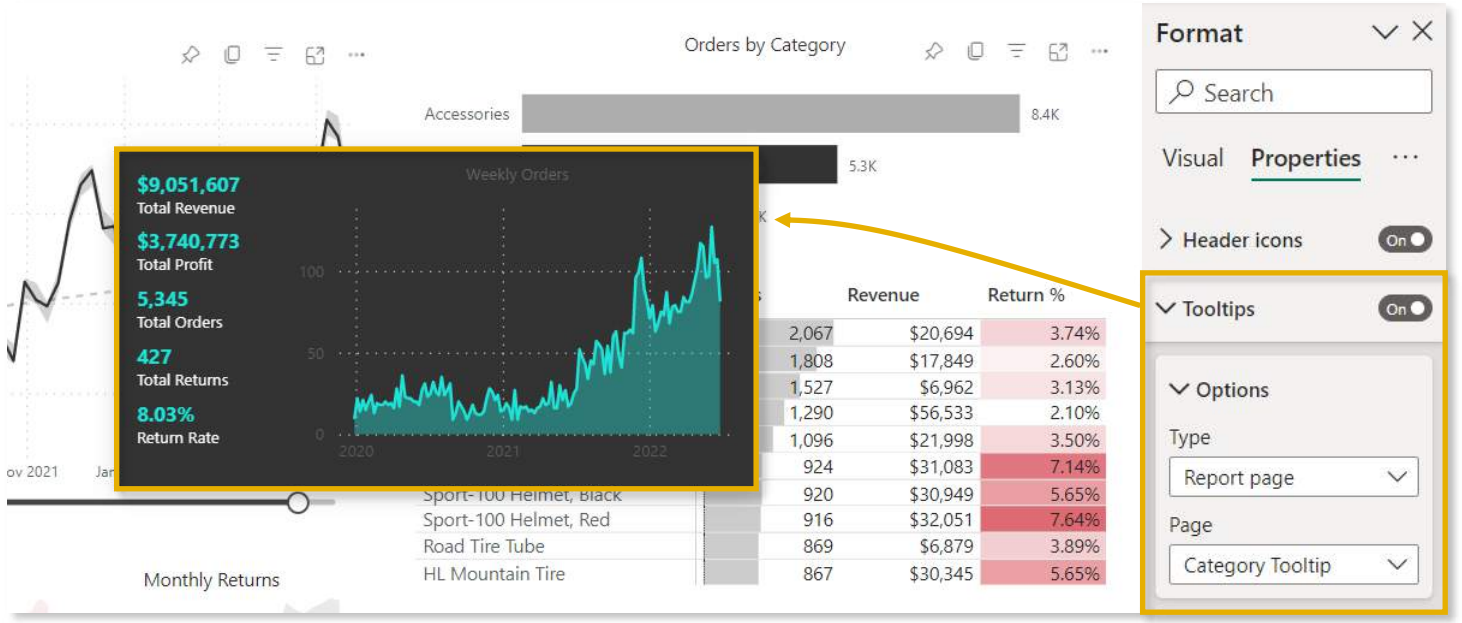


PRO TIP: CUSTOM TOOLTIPS

Create **custom tooltips** by designing a new report page, setting the page type to **Tooltip**, and configuring a visual to use the “Report page” tooltip type

***Category Tooltip** report page*

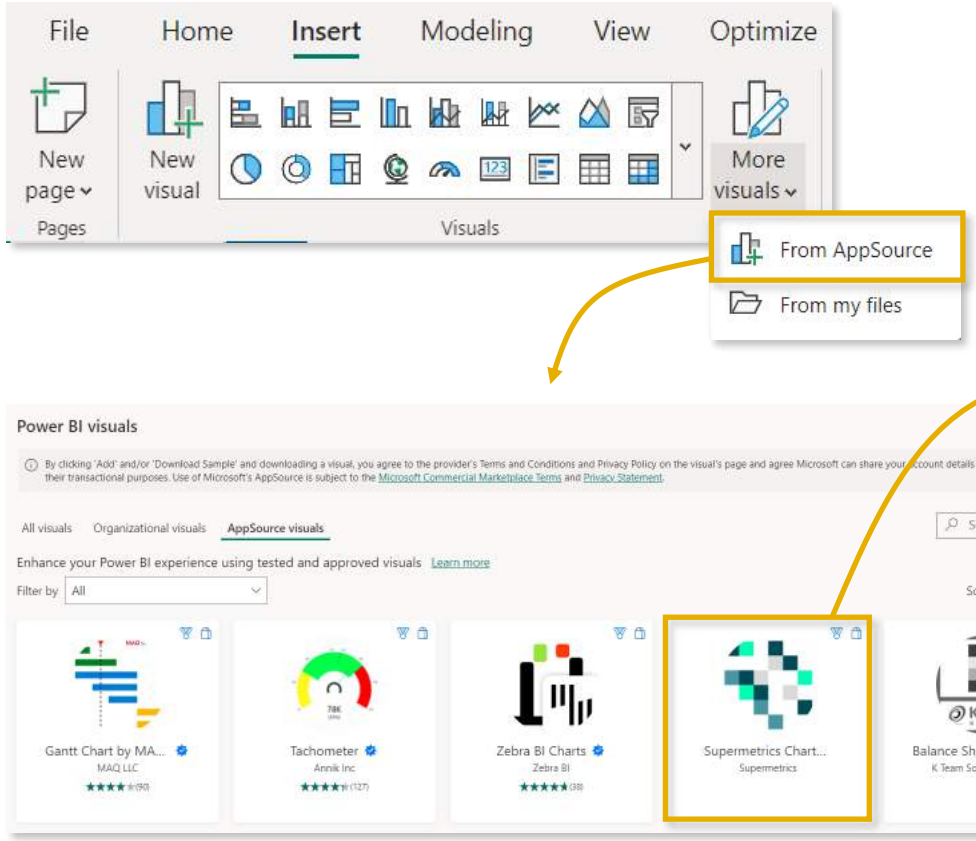


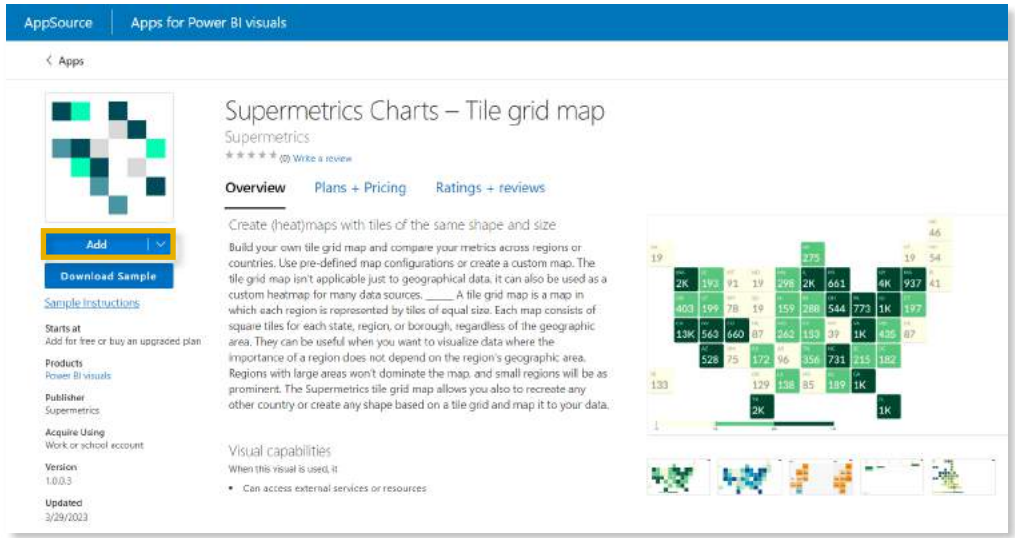


PRO TIP:
Keep your published reports clean by **hiding your tooltip pages**

IMPORTING CUSTOM VISUALS

Power BI offers a library of **custom visuals** (via **AppSource**) from Microsoft-certified partners and developers, which can be imported into the visualizations pane

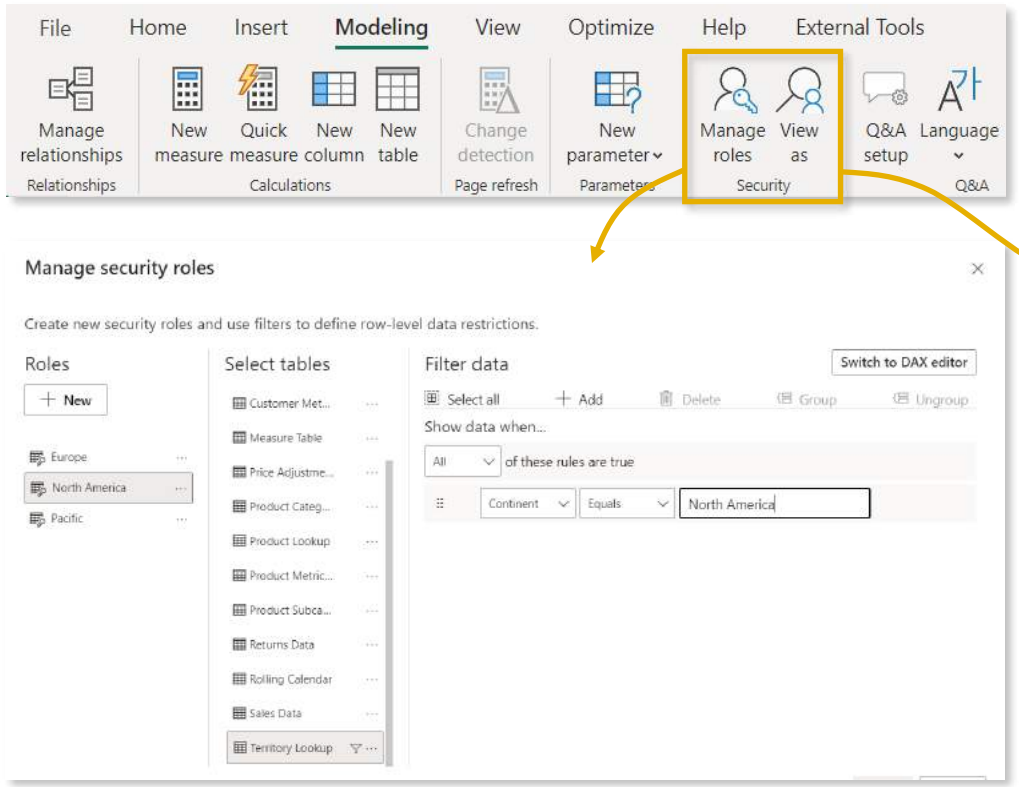


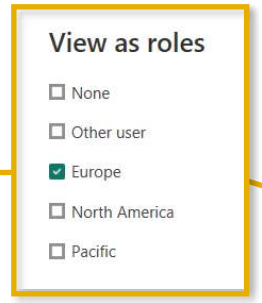


HEY THIS IS IMPORTANT!

You need a **Power BI account** to browse or import custom visuals from the AppSource marketplace

MANAGING & VIEWING ROLES





HEY THIS IS IMPORTANT!

Row-level security (RLS) rules are defined in Power BI Desktop, **but actually *applied* in Power BI Service**

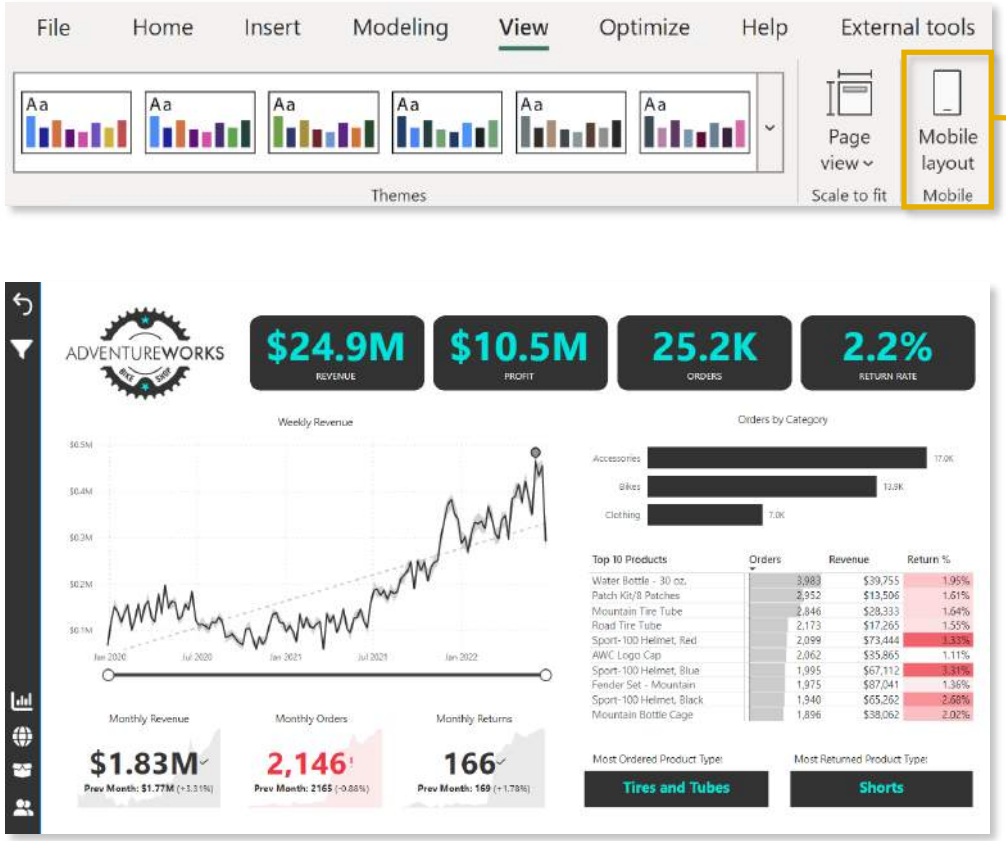
Roles allow you to define row-level security rules, and create filtered views to restrict access for specific audiences

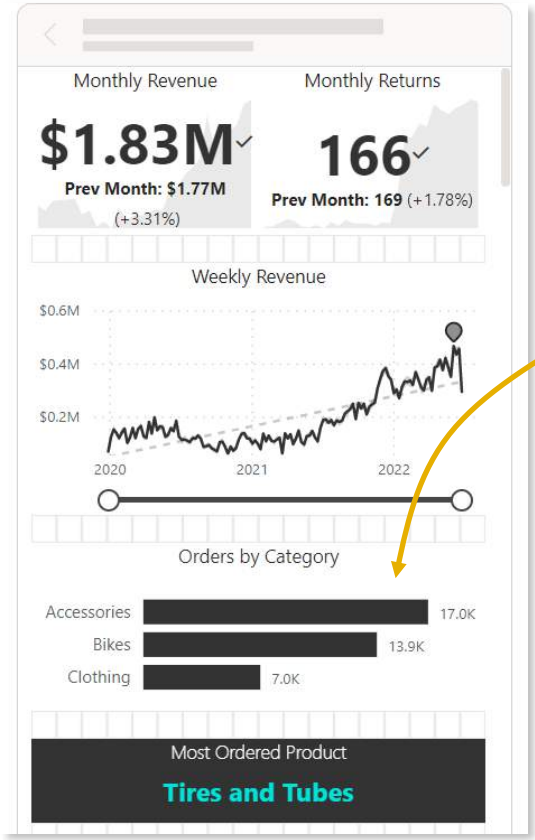
- Here we've created views for territory managers (**Europe**, **N. America**, **Pacific**), which filters records in the model

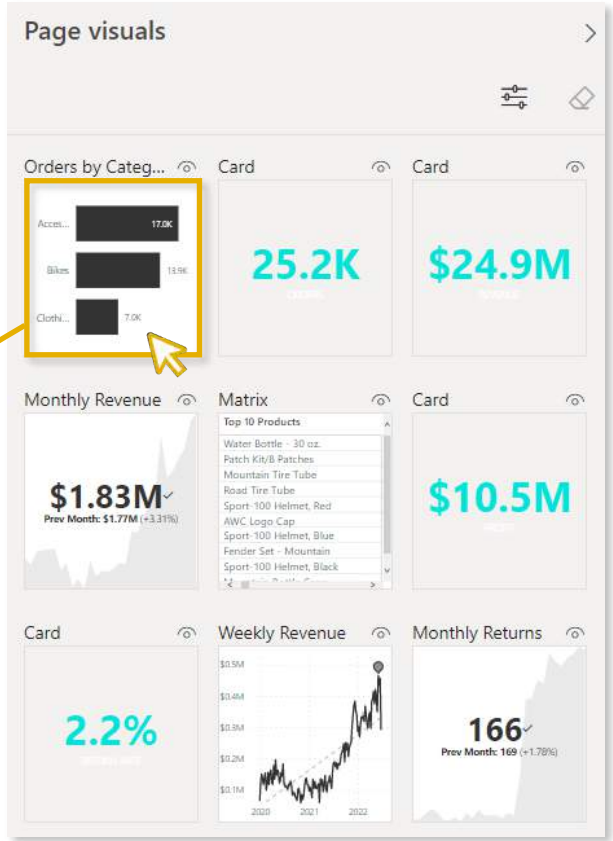
MOBILE LAYOUT

Mobile layout allows you to design mobile-specific versions of report pages by assembling visuals into new layouts

- **NOTE:** This is designed to optimize reports for viewing on the Power BI mobile app (after publishing to Power BI Service)







DATA VISUALIZATION BEST PRACTICES

Always ask yourself the three key questions

- *What type of data are you visualizing, what are you communicating, and who is the end user?*

Strive for clarity and simplicity above all else

- *"Perfection is achieved not when there's nothing more to add, but when there's nothing left to take away"*

Focus on creating clear narratives and intuitive user experiences

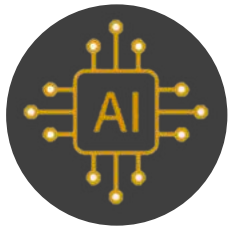
- *Use bookmarks, drillthroughs, tooltips and navigation buttons to seamlessly guide users through reports*

Create optimized layouts for mobile viewers

- *Create custom mobile layouts if you plan to publish reports to Power BI Service or use the Power BI app*

ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE



In this section we'll explore Power BI's artificial intelligence features, including anomaly detection, smart narratives, natural language Q&A, decomposition trees, and more

TOPICS WE'LL COVER:

- Anomaly Detection
- Smart Narrative
- Q&A Visual
- Decomposition Tree
- Key Influencers
- Top Segments

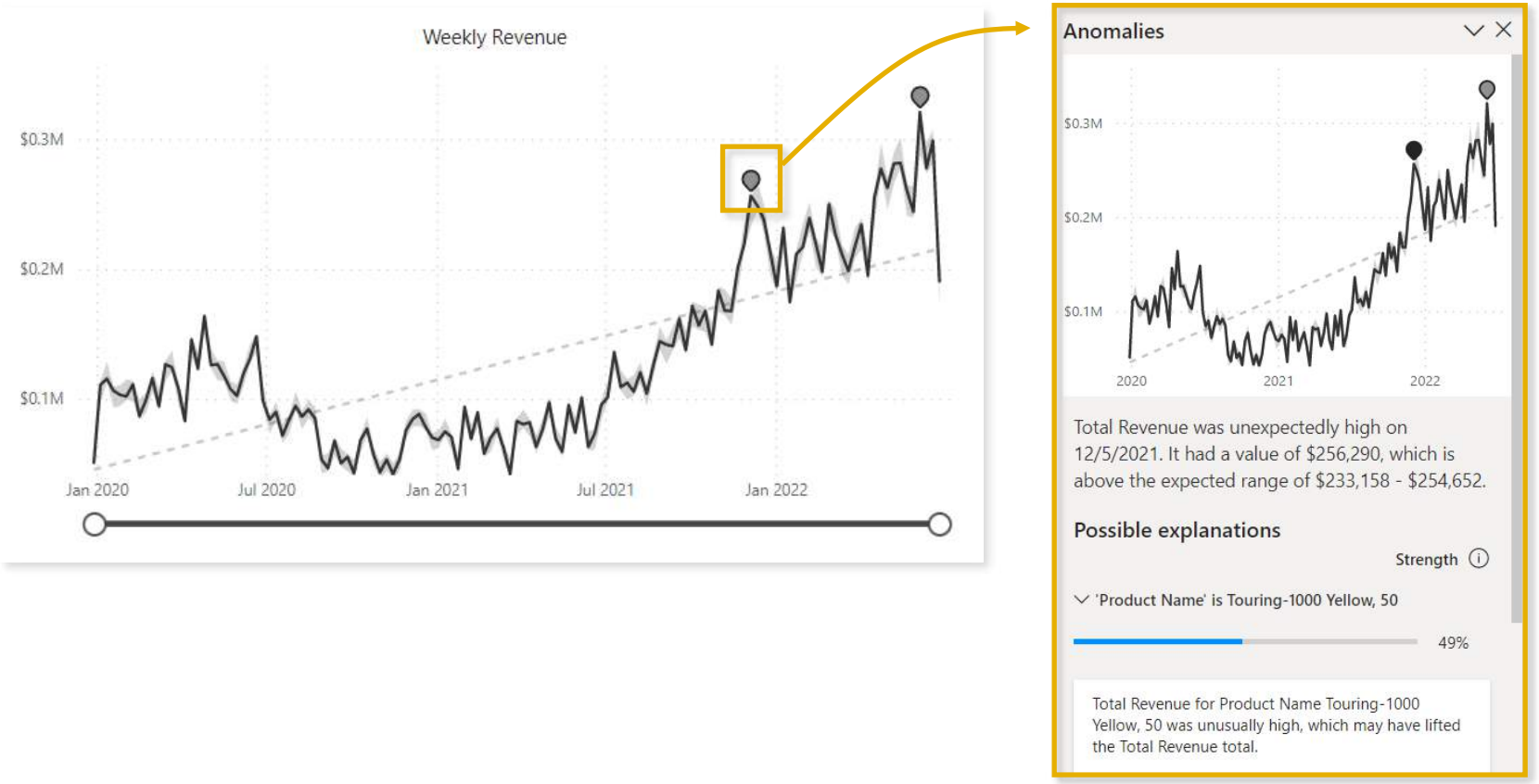
GOALS FOR THIS SECTION:

- Explore AI-generated insights using smart narratives and anomaly detection
- Build and train Q&A visuals to allow users to explore Power BI models using natural language queries
- Learn how to use decomposition trees for data exploration and root cause analysis
- Use key influencer visuals to identify the underlying factors that drive specific outcomes for the business

ANOMALY DETECTION

Anomaly detection is used to automatically detect and explain anomalies in time series data

- The anomaly detection feature adds “flags” to existing line charts, which link to AI-generated explanations and summaries



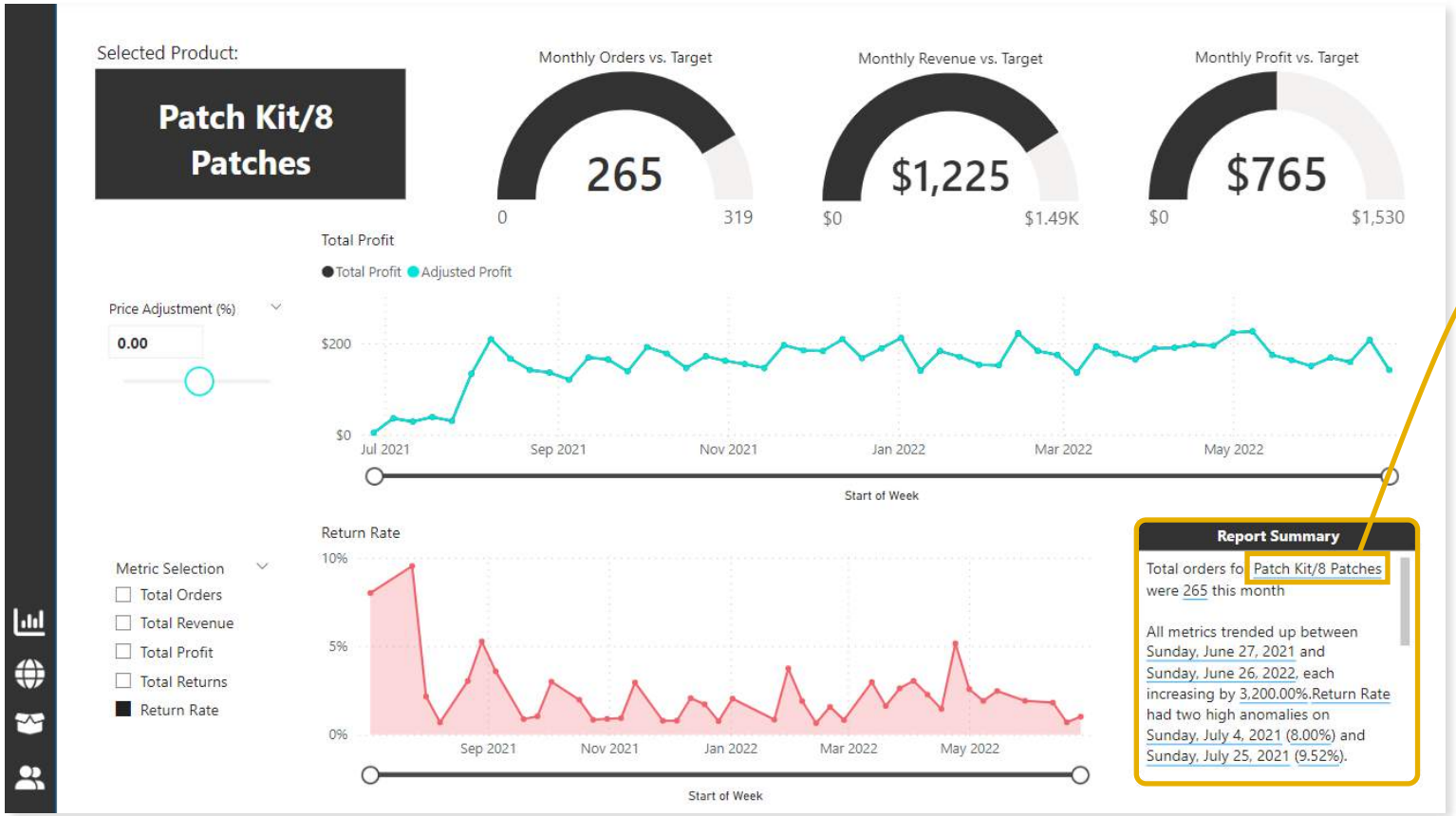
Limitations:

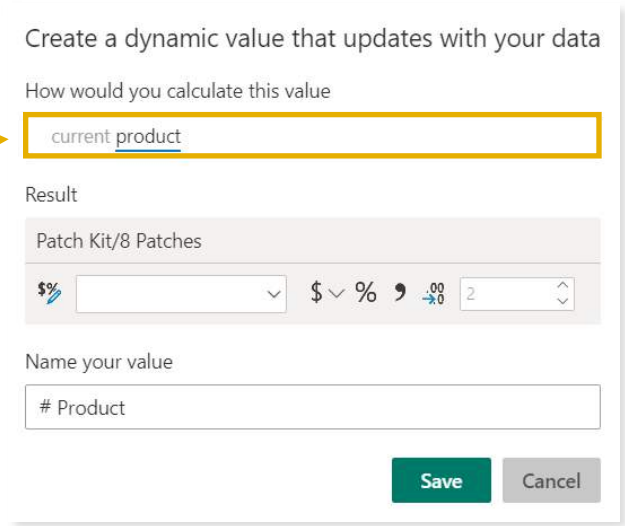
- Only supported for line charts with a time-series fields on the X-axis
- Does not support charts with legends, multiple values, or a secondary axis
- Cannot be applied at the same time as forecasts
- Not compatible with drill up/drill down
- Requires at least four data points

SMART NARRATIVES

Smart narratives create customizable, AI-generated text summaries based on report pages or visuals

- Smart narratives react to report filters like any other visual, and can be updated with custom, dynamic values

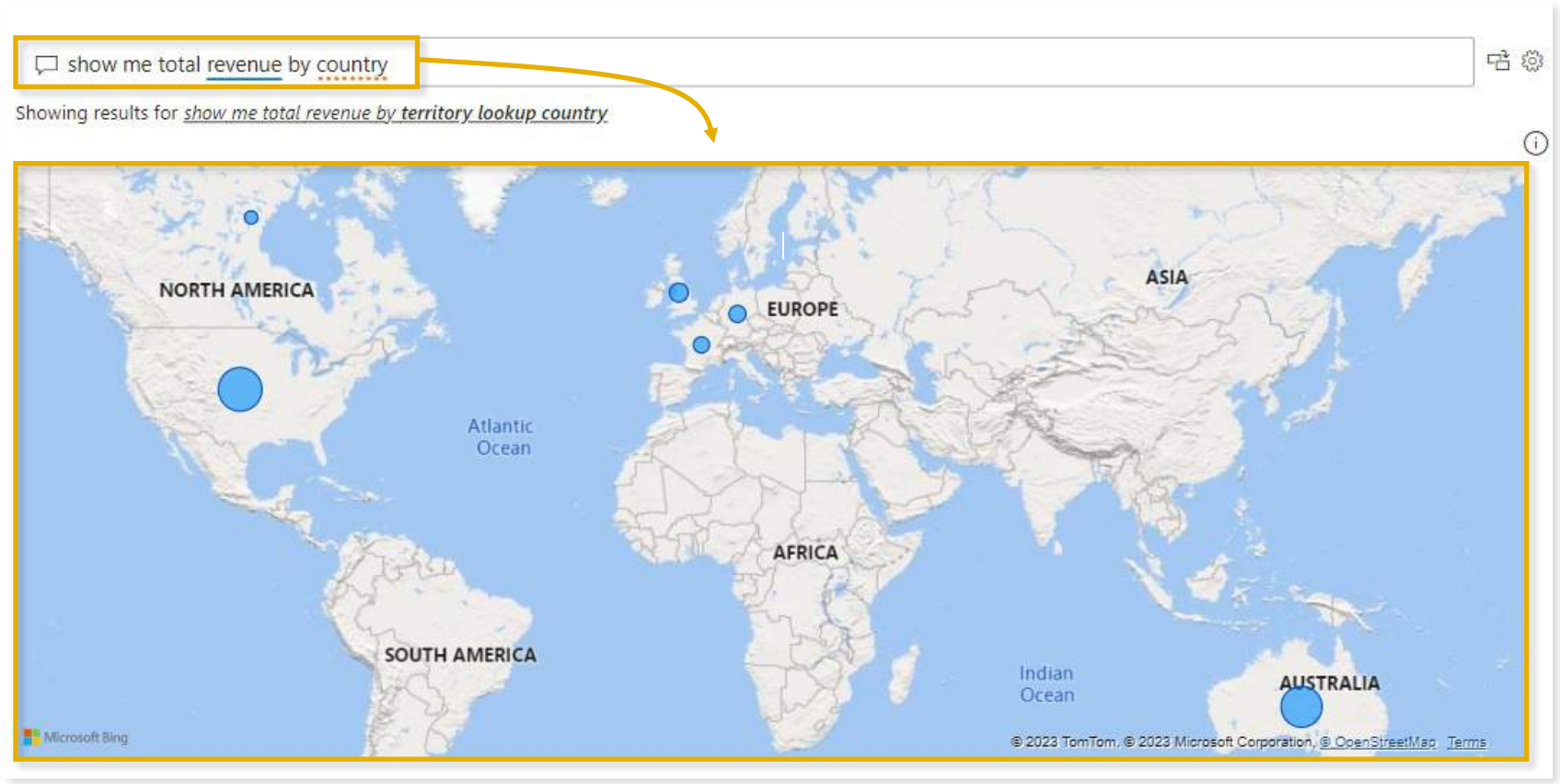




Q&A VISUALS

Q&A visuals allow users to explore and visualize data using intuitive, natural language prompts

- Q&A visuals are only as useful as the data model behind them, and typically require significant “training” to be effective



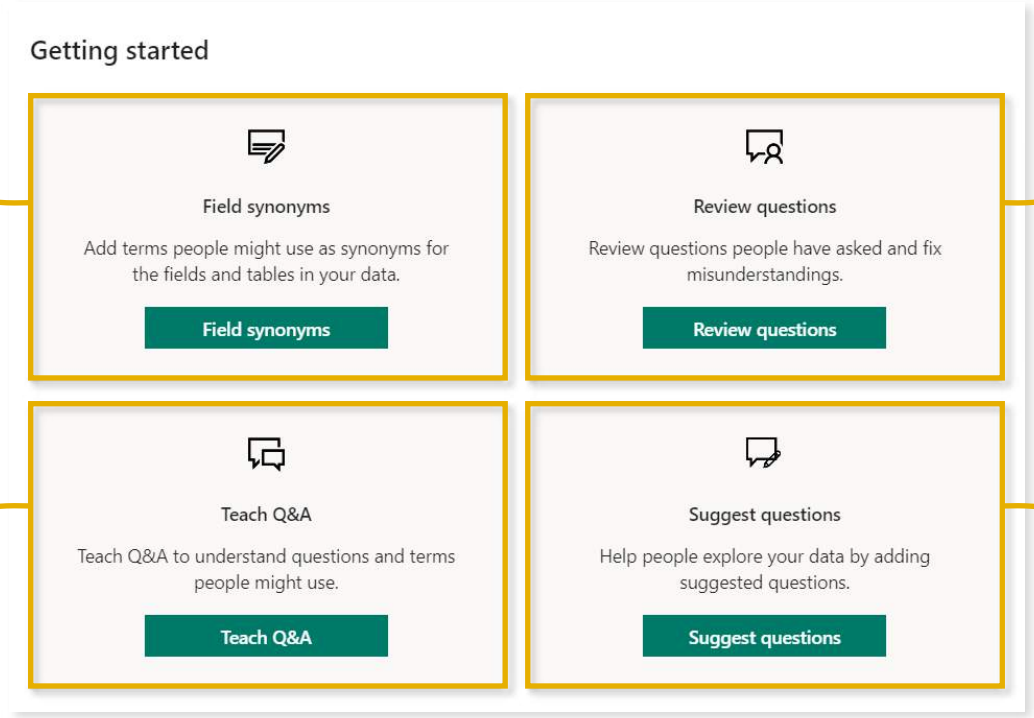
Q&A TRAINING

Q&A visuals allow users to explore and visualize data using intuitive, natural language prompts

- Q&A visuals are only as useful as the data model behind them, and typically require significant “training” to be effective

Add **human-readable synonyms** for tables, columns or measures in the model

Ask **example questions** to find missing or misunderstood terms and add new synonyms



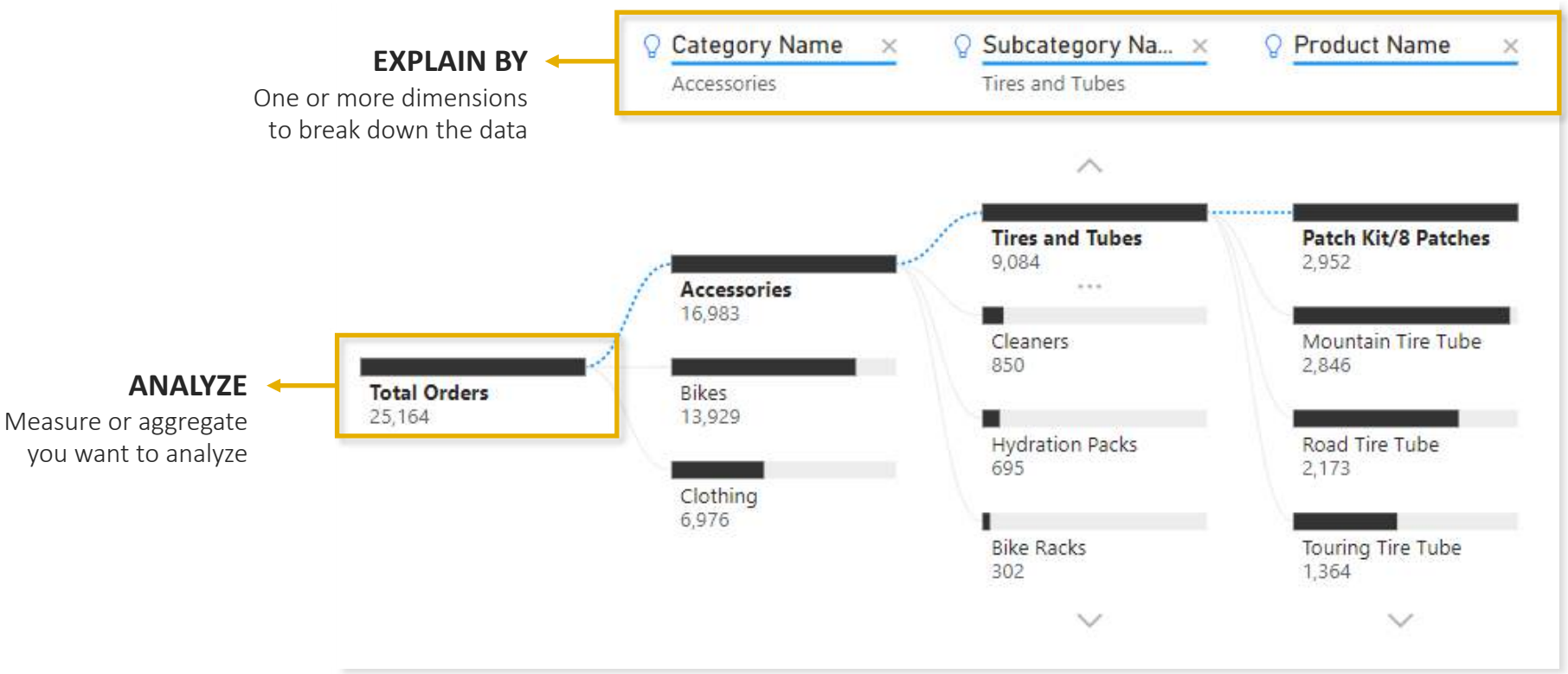
Review **actual prompts** from users to refine the model *(requires Power BI Service)*

Pre-populate a list of **suggested questions** that users can choose from

DECOMPOSITION TREES

Decomposition trees allow you to visualize how data is distributed across multiple dimensions

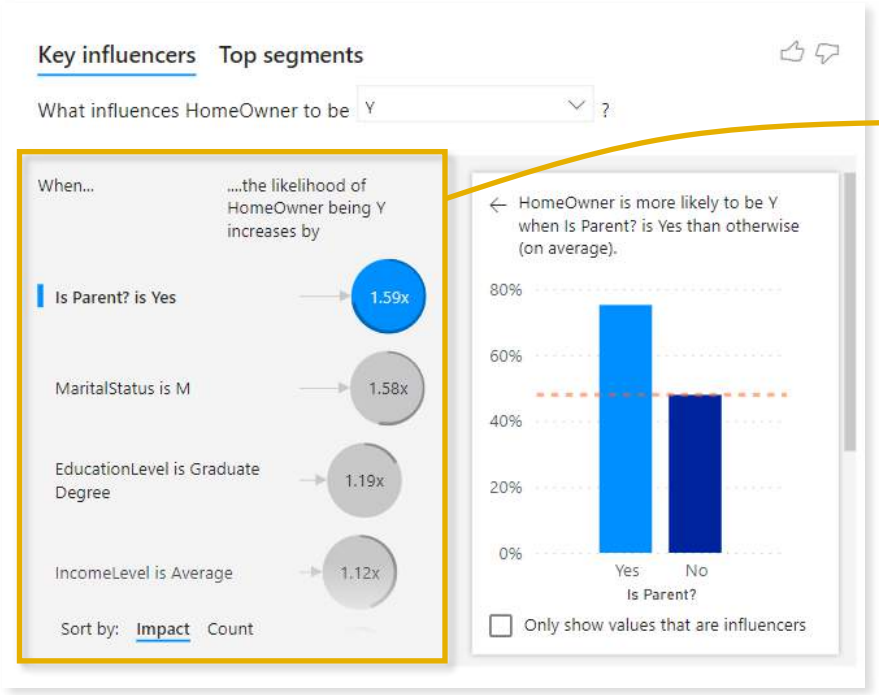
- Decomposition trees can be configured manually for data exploration, or leverage AI to support root cause analysis



KEY INFLUENCERS

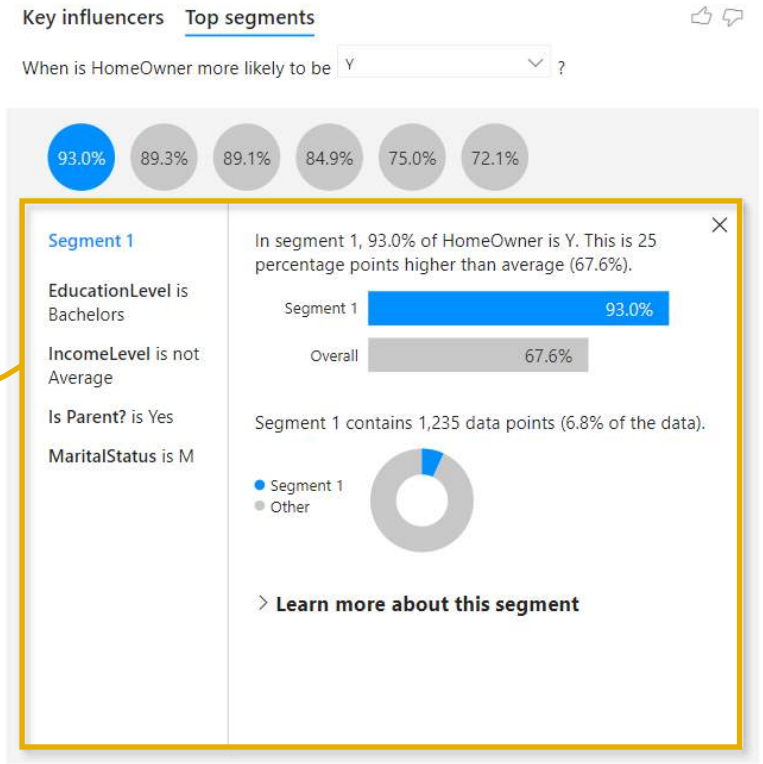
The **key influencer** visual helps you understand the factors that drive specific metrics or outcomes

- This can be used to analyze categorical or continuous outcomes, or identify top segments based on combinations of factors



Here we're identifying factors that are highly correlated with owning a home; for example, **parents are 1.59X more likely to be homeowners**, all else equal

We can also identify customer segments where this outcome is likely; for example, **93% of married customers with children and a Bachelors degree own a home** (vs. 67.6% overall)



OPTIMIZATION TOOLS

PREVIEW: POWER BI OPTIMIZATION

In this section, we'll investigate several native and external tools that can be used to optimize and enhance your Power BI reports

TOPICS WE'LL COVER:

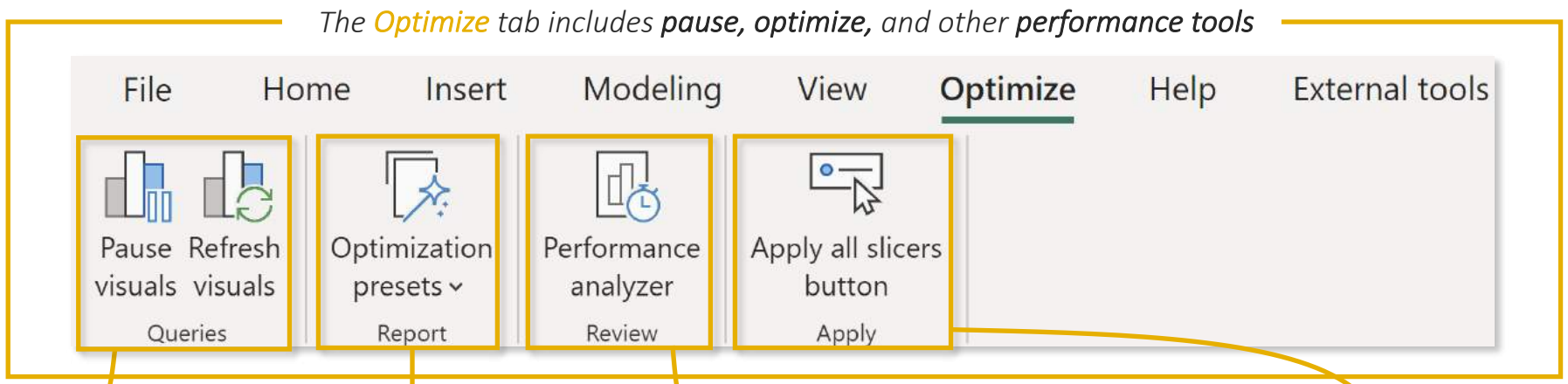
- **Optimize Ribbon**
- **Pause Visuals**
- **Optimization Presets**
- **Apply all Slicers**
- **Performance Analyzer**
- **External Tools**

GOALS FOR THIS SECTION:

- Explore the optimize ribbon tools, features, and use cases
- Understand how and when pausing visuals can aid in report development and creation
- Use Performance Analyzer to measure and compare the impact of report elements on speed and performance
- Explore external tools that can aid in report development, learning, and optimization

OPTIMIZE RIBBON

The **Optimize ribbon** helps report authoring by allowing developers to pause data source queries, apply preset settings, and view logs that measure report element performance



Pause *or* ***refresh queries*** *to make updates without processing changes*

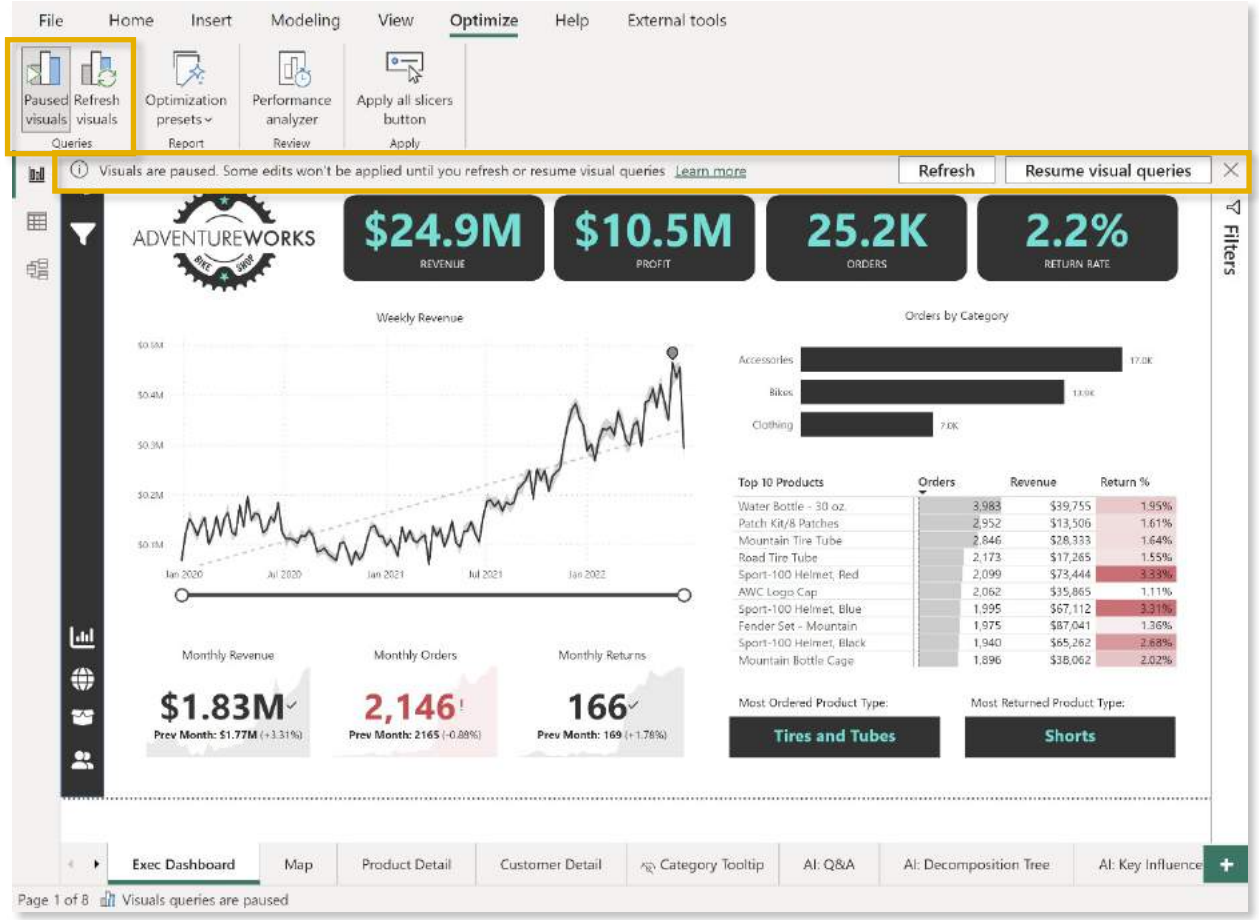
Predefined optimization presents *that can be applied based on your reporting scenario*

Show ***record logs*** *that measure each elements performance within a report*

Apply *and* ***clear multiple slicer selections*** *on a report page at once*

PAUSE VISUALS

Pause visuals stops queries from running and is used when you don't want to immediately apply additions or changes made to a report page or visual

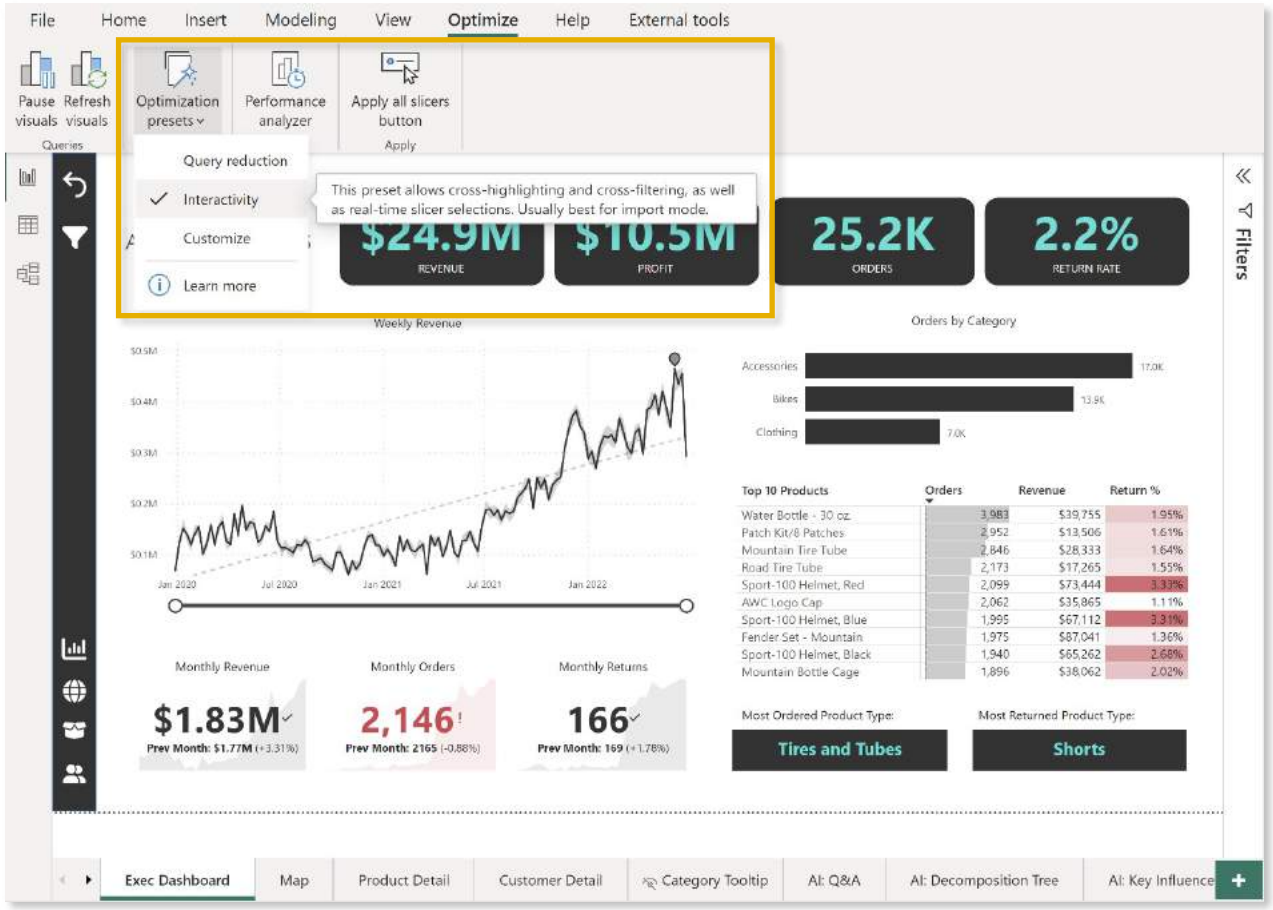


When paused, the report:

- Holds all changes & updates and sets them to a "**visual has pending changes**" state
- Shows a banner with **refresh** & **resume visual queries**
- Adds a **refresh button to individual visuals** allowing you to only refresh that visual
- Allows you to **add**, **move**, and **remove columns** and measures without having to wait for visuals to refresh
- **Blocks formatting actions**

OPTIMIZATION PRESETS

Optimization presets allow you to apply different predefined query optimization settings like query reduction, interactive, and custom



Query Reduction

- Is *best for DirectQuery connections* because it follows the best practices for DirectQuery optimization, turns off cross-highlighting, cross-filtering, and adds an Apply button to the filters pane

Interactivity

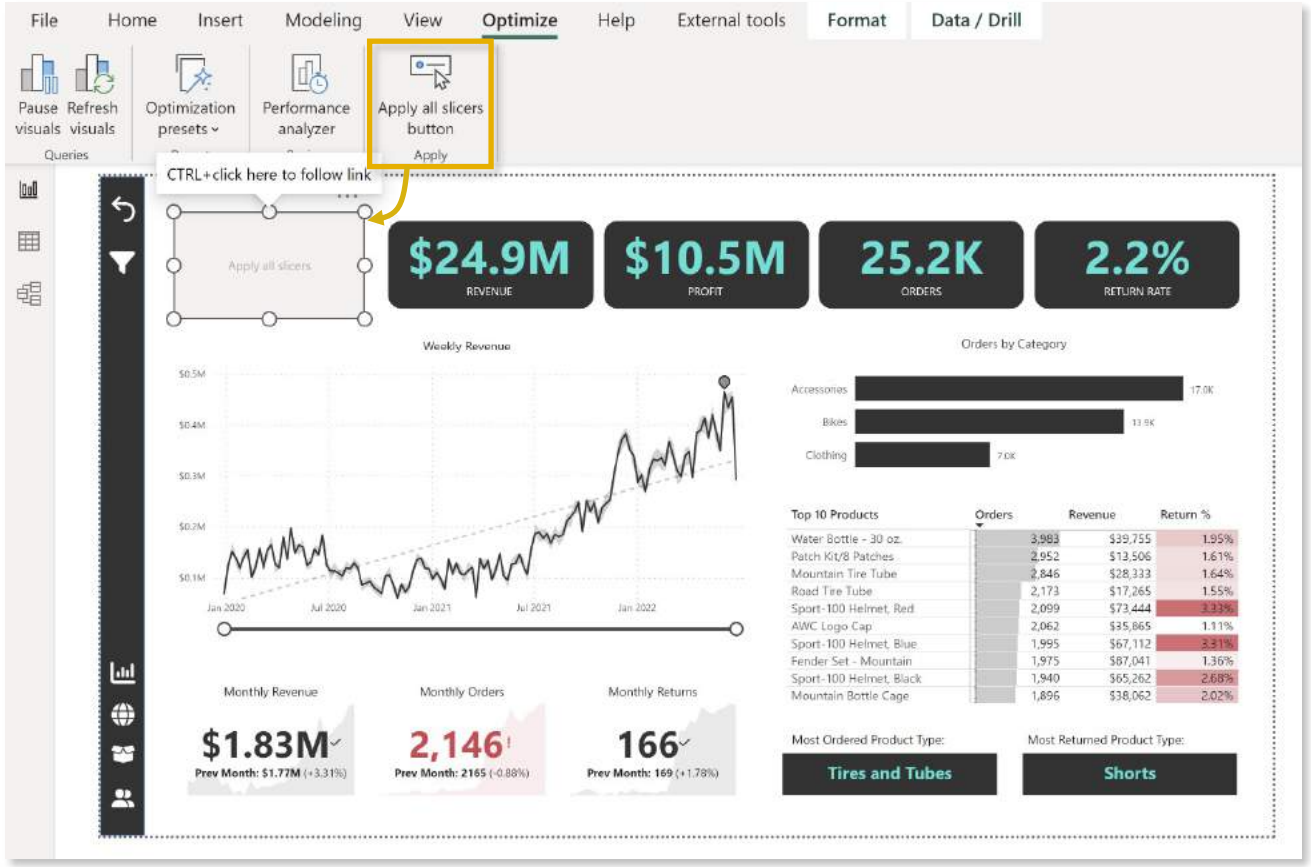
- Is the default setting and *best used for Import mode* because it allows cross-highlighting, cross-filtering, and real-time changes to slicers and filters

Customize

- Is best when you want to *choose which query reduction features to use*

APPLY ALL SLICERS BUTTON

Adding an **apply all slicers** button to your report page tracks all slicer selections and can be used to either apply or clear all slicers at once

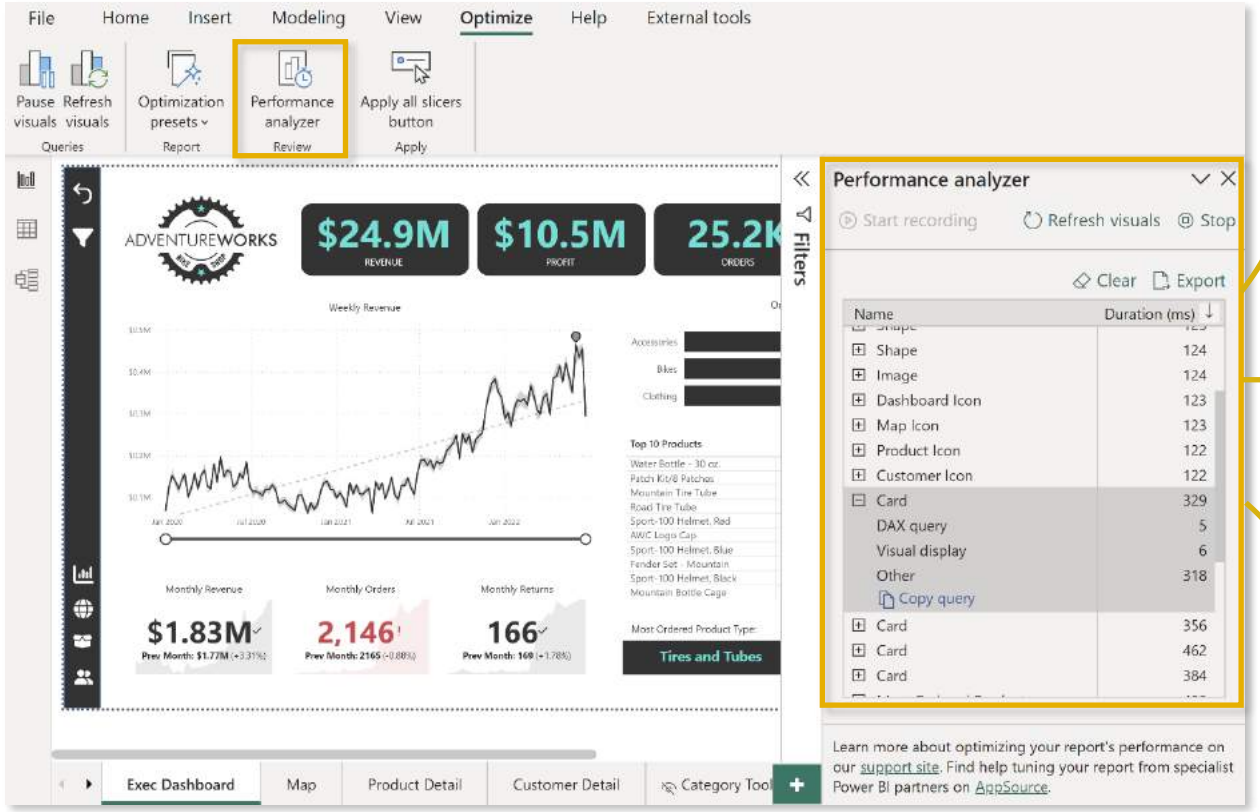


Common scenarios & **considerations**:

- **Apply multiple slicers** on a report page at once
- **Clear all slicers** on a report page at once
- Apply & clear all slicer buttons **impact all slicers** on the report page *(you can't pick and choose!)*
- You can have as **many of these buttons** as you'd like
- Button can be **added and formatted** just like other buttons in Power BI

PERFORMANCE ANALYZER

Performance Analyzer records user actions *(like Excel's macro recorder)*, and tracks the load time *(in milliseconds)* for each step in the process



DAX Query

- Shows the amount of time it takes for the visual to send the query to the engines, and for the engines to return the result (**Note:** DAX Studio can only help optimize this)

Visual Display

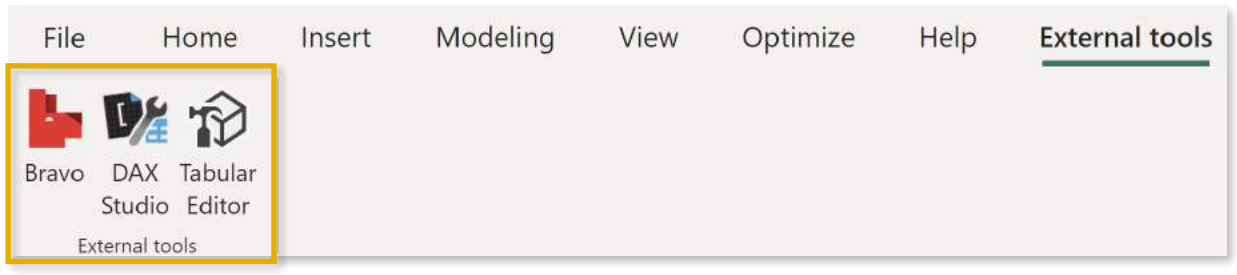
- Shows the amount of time it takes for the visual to populate, or "draw", on the screen. Includes time to retrieve web-based and geocoded images

Other

- Shows the amount of time required by the visual to prepare the query, wait for other visuals to complete their queries and perform other processing tasks

EXTERNAL TOOLS

External tools allows quick access to third-party built tools that are *locally installed* on your computer and *registered* with Power BI Desktop



External tools generally fall into one of the following categories:

Semantic Modeling

These tools extend Power BI's functionality for specific data modeling scenarios like DAX optimization, ALM, and metadata translation

- *DAX Studio*
- *ALM Toolkit*
- *Tabular Editor*
- *Bravo*

Data Analysis

Includes tools for connecting a PBI data model to a client application, in read-only mode, to query data and perform analysis tasks

- *Python*
- *Excel*
- *Power BI Report Builder*

Miscellaneous

Some tools are used to make Power BI more useful and accessible but don't connect to the data model

- *PBI.tips tutorials*
- *DAX Guide*
- *PowerBI.tips*

Featured open-source tools: *https://learn.microsoft.com/en-us/power-bi/transform-model/desktop-external-tools#featured-open-source-tools*