Working with Power BI

Student Guide – April 2025

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Course Overview

This two-day course provides an introduction to the fundamentals of Microsoft Power BI.

1. Introduction to Power BI

2. Getting & Shaping Data

3. Modeling Data

4. Visualizations

5. Exploring Data

6. Publishing and Sharing

1 *Introduction to Power BI*

Big Picture: Data and Business Intelligence

The Power BI Ecosystem

Power BI Desktop Demonstration

Big Picture: Data and Business Intelligence

- What is data?

- Types of data sources

- What is business intelligence?

Working with Power BI

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Data is simply information

- Can be structured or unstructured

- Comes from all kinds of sources

- Often represents attributes of thing that exists or a particular event that occurred

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Common origins of business data:

  + Customer Relationship Management

  + Point-Of-Sale Retail Software

  + E-Commerce Retail Software

  + Financial & Accounting Software

  + Warehouse Management Systems

  + Enterprise Resource Planning

  + Content Management Systems

  + Employee Timecard Software

  + HR Hiring Software

- External sources may also be used

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Flat files like spreadsheets or text files

- Databases

- Online services (Salesforce, Google Analytics, etc.)

- Websites

- Many other options!

  + One advantage of working with Power BI: it enables you to combine data from different sources and of different types

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- **Databases** store information in a structured manner
  + There are many DBMSs (MS SQL Server, Oracle, MySQL, PostgreSQL, etc.)
  + Commonly accessed using SQL ("structured query language")
  + Helps to understand the DB's **schema** and which **primary and foreign keys** are used to define **relationships** between tables
  + May be highly **normalized** to optimize for density of storage and minimize duplication, with many **fact** and **dimension** tables, or flattened to optimize reporting / analysis

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

Example: MS SQL Server Mgt Studio

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Common options for accessing data in an application database:
  + Querying the database directly
  + Export using reporting features
  + Accessing via an application's API
- Talk to the system or database administrator about your options

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Databases kinda look like a set of spreadsheets, but they do not behave the same
  - + If you try to approach using a database as if it's just a big old spreadsheet, you are likely to become very frustrated!
- Users of Excel are likely to find some Power BI interactions very familiar, but a lot is also likely to feel very new

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Spreadsheets are a VERY common source of business information as well

- May be created from database reporting tools, but you may only have access to the resulting spreadsheet output and not the original database

- Power BI offers some helpful tools to reformat flattened data from spreadsheets, or to pull together multiple spreadsheets (or other sources) into one dataset

Working with Power BI

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- The "BI" in "Power BI"

- **Business intelligence** refers to the process of analyzing historical and current data to generate insights and make better decisions

- The term was popularized in the 1990s but has since taken on new significance in the Big Data era

Working with Power BI

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Enterprise BI is the business tooling that brings an org's data into a controlled structure, improving analysis capabilities and reducing duplicate efforts

- Data governance is also more readily managed through enterprise-level tooling

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Analyzing data is the goal, but a lot of thought and work needs to go into **getting & transforming data** in order to get there:
  + Collecting data
  + Cleaning data
  + Consolidating data
  + Augmenting data
  + Shaping data
  + Visualizing data

Working with Power BI

Big Picture: Data and Business Intelligence

What is data?

Types of data sources

What is business intelligence?

- Microsoft's Power BI is a compact, powerful tool for analysis
  + Pulls together all the tooling needed to ingest and prepare data for analysis
  + Enables users to create highly interactive, shareable reports to explore data and identify insights
- Power BI is part of a robust ecosystem including multiple products, tools, and technologies

Introduction to Power BI –
The Power BI Ecosystem

↓ *Focus of this course*

- **Power BI Desktop**
  + **Power Query Editor**
  + **DAX (Data Analysis eXpression) Language**
- **Power BI Service**
  + **Microsoft Fabric**

↓ *You may also encounter*

- SQL Server Analysis Services
- Power BI Report Server
- Power BI Mobile
- Power BI Embedded
- Power BI On-Premises Data Gateway
- Power Pivot / xVelocity Analytical Engine
- Direct Query
- Connect Live

The Power BI Ecosystem

Power BI Desktop

Power Query & M Language

DAX Language

Power BI Service

- A powerful and free application for creating Power BI data models and reports

- Hosts data in-memory using a powerful database engine called xVelocity
  + Also used by Power Pivot for Excel and SQL Server Analysis Services Tabular Engine

- Reports can be shared as PBIX files, though there are some limitations, or exported to PDF

The Power BI Ecosystem

Power BI Desktop

Power Query & M Language

DAX Language

Power BI Service

- Power Query is a tool embedded within Power BI for loading and transforming data

- Uses M language ("M" for mashup)
  + While it's helpful to get a handle on M, many transformations can easily be accomplished using the GUI, no coding required
  + Note that M is case-sensitive

The Power BI Ecosystem

Power BI Desktop

Power Query & M Language

DAX Language

Power BI Service

- Stands for **D**ata **A**nalysis e**X**pression
- Used to augment data with:
  + Measures
  + Calculated columns
  + Calculated tables
  + Row-level security
- <u>Not</u> case sensitive
- Beyond Power BI, also used by SQL Server Analytical Services and Power Pivot for Excel (which also use xVelocity analytical engine)

The Power BI Ecosystem

Power BI Desktop

Power Query & M Language

DAX Language

Power BI Service

- Online version of Power BI
- Enhanced capabilities in the service require Pro/Premium subscription
- Features include:
  + Creation and sharing of workspaces, reports, and dashboards
  + Ability to share and collaborate on datasets
  + AI-enabled Quick Insights
  + Deployment Pipelines
  + Metrics
  + More features and growing…

Introduction to Power BI –

Power BI Desktop Demonstration

- Let's take a tour of the Power BI desktop application by importing a data source, shaping our data, and creating a quick report.

- Power BI has many moving parts! The purpose of this demo is to help you start putting some of these concepts into context.

2 Getting & Shaping Data

Bringing data into Power BI Desktop

Data optimization

Transforming data with Power Query Editor

Getting & Shaping Data –
Bringing Data into Power BI Desktop

- Data sources & Get Data workflow

Bringing Data into Power BI Desktop

Data sources & Get Data workflow

- As we've discussed, many different data sources can be used
  + Databases (e.g. from SQL Server Analysis Services, Oracle, MySQL, Snowflake, etc.)
  + Excel and CSV files
  + XML and JSON
  + SharePoint, Azure, OneLake / Fabric (in preview)
  + Other third-party platforms
- Data can also be manually entered (less common)

Getting & Shaping Data

Bringing Data into Power BI Desktop

Data sources & Get Data workflow

- Also multiple ways of *connecting* to data
  + Importing a local copy
  + Connecting to a database server
  + Using your organization's Data Gateway
  + Connecting to a dataset hosted on another platform
  + Using dataset shared with you via Power BI service

- These offer different options for refreshing data, processing demands, and stability of data

Working with Power BI

Discussion & Exercise 1

- Let's import some data!

  + Pros/cons of downloading and using a local copy of a file?

  + Pros/cons of connecting to web address as a data source?

From the USDA's [Food and Nutrient Database for Dietary Studies (FNDDS)](#)

[FNDDS Nutrient Values.xlsx](#)
https://www.ars.usda.gov/ARSUserFiles/80400530/apps/2019-2020%20FNDDS%20At%20A%20Glance%20-%20FNDDS%20Nutrient%20Values.xlsx

[Ingredient Nutrient Values.xls](#)
https://www.ars.usda.gov/ARSUserFiles/80400530/apps/2019-2020%20FNDDS%20At%20A%20Glance%20-%20Ingredient%20Nutrient%20Values.xlsx

[FNDDS Ingredients.xlsx](#)
https://www.ars.usda.gov/ARSUserFiles/80400530/apps/2019-2020%20FNDDS%20At%20A%20Glance%20-%20FNDDS%20Ingredients.xlsx

Discussion & Exercise 1, continued

- What if you get a "Load error" message? What does that mean?

Load   ×

⚠ Ingredient Nutrient Values

Model object name 'Ingredient Nutrient Values2019-2020 Food and Nutrient Database for Dietary Studies - At A Glance ' is longer than the allowed 512 characters.

Close
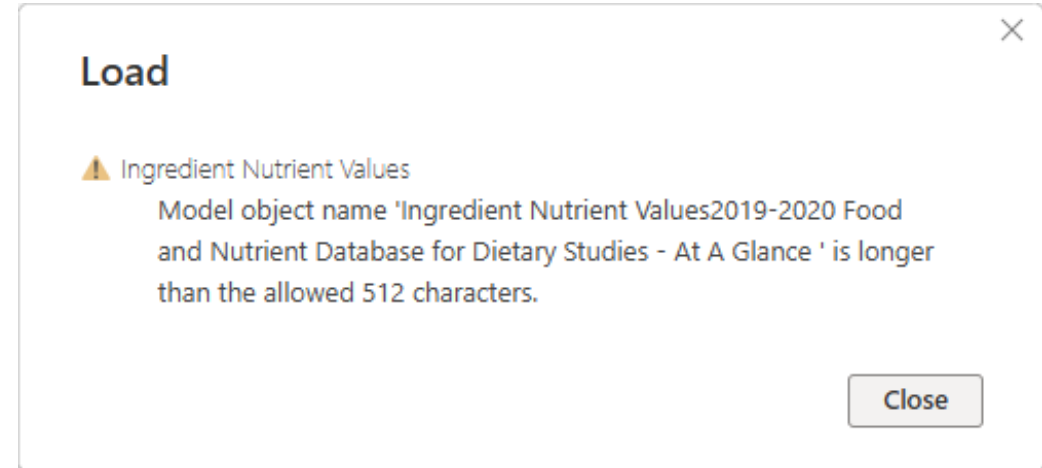
+ Click on Transform Data to open Power Query to find all your *connected* data sources (including those with errors)

+ You'll need to fix any "Load error" issues before those data sources can be loaded to your Power BI *semantic model*

Working with Power BI

Discussion & Exercise 1, continued

- In Power Query, for each:
  + Ingredient Nutrient Values
  + FNDDS Ingredients

- Notice how the header labels are stuck in row 1, while the current header data uses the name of the table, then Column2, Column3, etc. – not helpful!

- Go to the Transform tab
  + Click **Use First Row as Headers**
  + Notice this adds 2 steps at right
    - Promoted Headers1
    - Changed Type1

Discussion & Exercise 1, continued

- Rename your queries:
  + FNDDS Nutrient Values
    → **Food Nutrient Values**
  + Ingredient Nutrient Values
    → no change, this name is good
  + FNDDS Ingredients
    → **Food-Ingredient Correlation**

- Finally, in the ribbon Home tab, click **Close & Apply**

- Save project as **nutrition_data_Exercise1.pbix**

- M Language under the hood

- Manage queries, functions, and parameters

- Shape and transform data

- Apply formatting

Transforming Data with Power Query Editor

M Language under the hood

Manage queries, functions, and parameters

Shape and transform data

Apply formatting

- Power Query uses M language
  + GUI conveniently tracks "Applied Steps" which can be edited or rolled back
  + "Advanced editor" also allows you to directly write changes in M language

- Structured as a **let** expression:

```
let
    Variablename = expression,
    #"Variable name" = expression2
in
    #"Variable name"
```

  + Each step is defined by a variable name
  + Each step builds upon previous
  + Output with the concluding **in** statement

Getting & Shaping Data

Transforming Data with Power Query Editor

M Language under the hood

Manage queries, functions, and parameters

Shape and transform data

Apply formatting

- Manage tables created from your imported data using queries
- Duplicate or reference a query to create a modified table from the same starting point
- Create a function from a query to automate a repeated set of steps
- Create a parameter to establish a user-defined value for use in queries

Getting & Shaping Data

Transforming Data with Power Query Editor

M Language under the hood

Manage queries, functions, and parameters

Shape and transform data

Apply formatting

- Add, remove, combine or split columns

- Eliminate duplicates and nulls

- Rename and reorder columns

- Transpose and pivot/unpivot

  + Transpose = swap horizontal/vertical

  + Pivot = moves row values into separate columns (*flattening – tall to wide*)

  + Unpivot = moves values from selected columns into rows (*unflattening*)

Getting & Shaping Data

Transforming Data with Power Query Editor

M Language under the hood

Manage queries, functions, and parameters

Shape and transform data

Apply formatting

- Set data types (e.g. text, numbers, dates)
  + Date / time formatting
  + Number formatting (e.g. currency, percentage, whole number)
- Apply text formatting (e.g. change case, trim extra spaces)

Getting & Shaping Data

Getting & Shaping Data: Transforming Data with Power Query Editor

Exercise 2

In your Nutrition Data project, using Power Query (launch with **Transform Data**):

- In the **Food Nutrient Values** table:
  - + Change column names
    - Main food description → *Food*
    - WWEIA Category description → *Category*

- In the **Ingredient Nutrient Values** table:
  - + Change column name
    - Ingredient description → *Ingredient*
  - + Keep columns
    - Ingredient code
    - Ingredient
    - Nutrient description
    - Nutrient value
      - + Ctrl+click to select, then Remove Columns > **Remove Other Columns**

- What do you notice about columns versus rows between these two tables?
  - + In Ingredient Nutrient Values, pivot data:
    - Select the Nutrient description column. In the Transform tab, click **Pivot Column**. Set the Values Column drop-down to Nutrient value and click OK.

- In both Nutrient Values queries, delete columns:
  - + All columns with num headers, 4:0(g) through 22:6 n-3 (g)

- Save project as **nutrition_data_Exercise2.pbix**

3 Modeling Data

- Data relationships

- Time-based data

- Using DAX

Modeling Data –
Data Relationships

- Attributes of relationships

- Primary & foreign keys

- Creating relationships

Data Relationships

Attributes of relationships

Primary & foreign keys

Creating relationships

- Cardinality
  + One-to-one (1:1) – unique matching
  + One-to-many (1:N) – unique rows in one table might match many rows in another
  + Many-to-many (N:N) – many rows in one table match many rows in another
    - This is problematic!
    - Resolved using a bridge or junction table

- Granularity
  + Refers to the level of detail or specificity at which data is stored
  + When tables are at different granularity, you will need to be creative about how to create a relationship that is useful.

Data Relationships

Attributes of relationships

Primary & foreign keys

Creating relationships

- **Primary key** = the column that contains a unique identifier for every row/record in a table
  + Sometimes your data source does not include a unique identifier, in which case you might add an **index column** or **create a composite key** using a combination of existing column values

- **Foreign key** = a column used to create a relationship with another table's primary key
  + Primary key is the "one" and foreign key is the "many" in a one-to-many relationship

Data Relationships

Attributes of relationships

Primary & foreign keys

Creating relationships

- Power BI can detect and create relationships based on the primary and foreign keys present in the data

- Sometimes you may have to manually create or modify relationships in the Model View

Modeling Data: Data Relationships
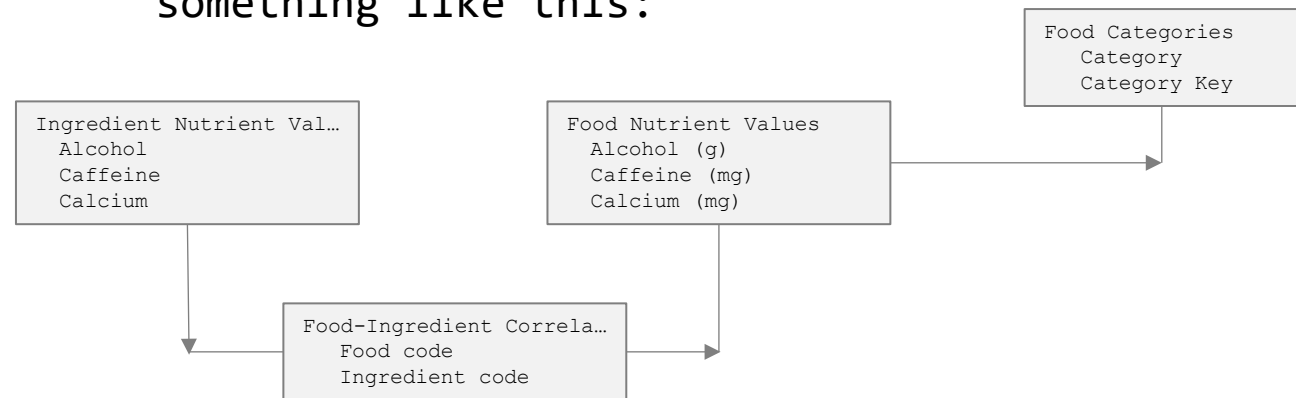
Exercise 3

In your Nutrition Data project file:

- Our third table is a correlation table to connect the first two tables, so it can be greatly simplified:
  + Select Food code and Ingredient code, and remove all other columns

- We can also break out Category from the main foods table to its own related table:
  + Right-click query FNDDS Nutrient Values and select **Duplicate**. Rename as Food Categories.
  + Select WWEIA Category number and Category, and remove all other columns
  + Right-click column header for WWEIA Category number, and select **Remove Duplicates**

- Go back to FNDDS table and delete column Category

- Click Close & Apply to return to Power BI, then go to the Model view.

Modeling Data: Data Relationships

Exercise 3, continued

In your Nutrition Data project file:

- Rearrange tables to fit the page (or adjust zoom).
- Note that Power BI has detected two relationships.
  + What key is used for each relationship?
  + What's the cardinality? How can you tell?
- Create a relationship between Ingredient Nutrient Values and Food-Ingredient Correlation
  + Locate the Ingredient code field in each card
  + Drag Ingredient code from one card onto the same field in the other to create the relationship
- Adjust the arrangement of your tables to look something like this:

```
Food Categories
   Category
   Category Key
```

```
Ingredient Nutrient Val…        Food Nutrient Values
   Alcohol                         Alcohol (g)
   Caffeine                        Caffeine (mg)
   Calcium                         Calcium (mg)
```

```
Food-Ingredient Correla…
   Food code
   Ingredient code
```

- Save project as **nutrition_data_Exercise3.pbix**

Modeling Data –
Time-based Data

- Date and Time Intelligence

- Adding a date table

Time-based Data

Date and Time Intelligence

Adding a date table

- Time Intelligence is the feature set designed to support analysis over time-based dimensions like year-over-year or year-to-date, or comparison of relative periods like this quarter vs. last year this quarter
  + Auto date/time supports calendar year calculations only, not fiscal years
  + If not using, Auto date/time can be turned off for new files in Options

Time-based Data

Date and Time Intelligence

Adding a date table

- Auto Date/Time creates a calculated table when enabled; however the table is hidden from the model, and is limited only to calendar year periods

- If your data does not contain an explicit date table, there are multiple strategies for creating one

  + There are many Power BI community resources for creation of custom date tables

  + You can also use a simple technique in Power Query to build a date table:

    - In a blank query, use the formula
      `= List.Dates(#date(YYYY,MM,DD),NNN,#duration(1,0,0,0))`

      - YYYY is the Year, MM is the Month, and DD is the Day of the **first date** to include

      - NNN is the **number of days** to include in the table (e.g. 365 for a full year)

Modeling Data: Data Relationships

Exercise 4

In your Nutrition Data project file:

- Right now, none of the tables in our data model include dates. We just have dimension tables. Let's add a fact table:
  + **Import from folder** Food Journal Data (two files)
  + Use Combine > **Combine & Transform Data** to combine the .csv files. On preview, click OK.

- In Power Query, take a look at the columns in this new table
  + We will not use Source.Name in this exercise, so this column can be deleted
    • When do you think you might use such information?
  + Also note the "Transform File" helper queries added

- Click Close & Apply, and return to the Model View. Expand the table Food Journal Data in the Data panel at the far right.
  + Review the Date Hierarchy created by auto date/time (*if no hierarchy present, go to Options and **turn on** "auto date/time" before proceeding*)
  + Revisit our schema. What's the main fact table?

Getting & Shaping Data

Modeling Data:
Data Relationships

Exercise 4, continued

In your Nutrition Data project file:

- Click Transform Data to head back to Power Query, and let's create a quick date table starting from M language.

- Right-click in the blank area of the queries panel on the left, and choose **New Query** > **Blank Query**. Rename it to Date.

- In the query box at the top center, type in:

  = List.Dates(#date(**2022,11,25**),**160**,#duration(1,0,0,0))

- Click **To Table** to convert this list to a table (using delimiter: None).

  + Rename the column to Date.

  + Change column **data type** to Date.

  + In the Add Column tab of ribbon, use the **Date** drop-down to add columns for **Year**, **Month**, **Name of Month**, **Day of Week**, and **Name of Day**.

    - Note: Date column must be re-selected each time.

- Rename columns from default values:

  + Month → **Month Number**

  + Month Name → **Month**

  + Day of Week → **Day of Week Number**

  + Day Name → **Day of Week**

Getting & Shaping Data

Working with Power BI

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Exercise 4, continued

In your Nutrition Data project file:

- Click Close & Apply, and return to the Model View.
  + Add a relationship between Food Journal Data and Date tables using the Date field

- In Data panel at the right, expand the Date table
  + Select Month. In Properties panel, expand Advanced options. Change **Sort by column** to Month Number.
  + Similarly, change sort order for column Day of Week to use Day of Week Number

- If not auto-generated: Create a new Date hierarchy from Date field (right-click or ... menu)
  + Select newly created Date Hierarchy field. Using Properties panel, add Year and Month. Order should be Year on top, then Month, then Date. Finally click **Apply Level Changes**.

- Save project as **nutrition_data_Exercise4.pbix**

Getting & Shaping Data

Modeling Data – Using DAX

- DAX resources

- Measures

- Calculated columns

- Calculated tables

- Row-level security

Working with Power BI

Using DAX

DAX resources

Measures

Calculated columns

Calculated tables

Row-level security

- DAX reference (bookmark!)
  + https://learn.microsoft.com/en-us/dax/
- Includes library of functions and statements, organized by category
  + e.g. Aggregation, Date/time, Filter, Financial, Information, Logical, Math/trig, Statistical, etc.

Using DAX

DAX resources

Measures

Calculated columns

Calculated tables

Row-level security

- Measures are dynamic calculations which depend on context
  + Measures are calculated on the fly, unlike static values in a table
- A measure might be used to:
  + calculate a value you wish to use directly in your report, and/or
  + create a calculation to be passed as an argument for use in other measures
- The name of a measure appears in the Fields list for the table with which it is associated (along with column names for that table)

Using DAX

DAX resources

Measures

Calculated columns

Calculated tables

Row-level security

- DAX can also be used to add a column to an existing table
  + A column name is created, and the value for each row in the table is immediately calculated (not context-dependent)
  + Row values can be reviewed in Table View
- When might you add a column using DAX versus using Power Query?
  + Complexity: Power Query primarily focused on basic transformation tasks, while DAX enables more complex calculations
  + Performance / Efficiency: Power Query transformations applied during data load, versus DAX calculations at analysis phase
  + Reusability: Do you want to add the column to the underlying dataset, or just the report you're working on?

Using DAX

DAX resources

Measures

Calculated columns

Calculated tables

Row-level security

- A calculated table is a calculated object derived from existing tables in the same model, with a DAX formula defining the new table's values

- Often used to generate a filtered row-set, or a subset/superset of columns from existing tables, keeping original intact while creating variations to support a particular scenario

- Similar considerations apply re: using DAX to create a calculated table versus adding with Power Query

Using DAX

DAX resources

Measures

Calculated columns

Calculated tables

Row-level security

- Uses a Boolean TRUE/FALSE condition to define which rows may be viewable by users who have a particular role
- For instance, might limit records viewable by users with a certain role to a specific country/region
- Applies both to specified rows and related rows

Exercise 5

In your Nutrition Data
project file:

- Let's add one more supporting table: Food
  Journal Administration.csv
  + In the Model View, draw a relationship from
    this new table to the Date table

- Now switch over to Table View

- Expand the Food Journal Data table
  + New measure #1:

```
Unique Foods Eaten = DISTINCTCOUNT('Food Journal Data'[Foods])
```

  + New measure #2 (rolling total):

```
Total Foods Tried =
CALCULATE(
    DISTINCTCOUNT('Food Journal Data'[Foods]),
    FILTER(
        ALL('Food Journal Data'),
        'Food Journal Data'[Date] <= MAX ('Food Journal Data'[Date])
    )
)
```

Exercise 5, continued

In your Nutrition Data project file:

- Try adding a calculated column to Food Journal Data

  + Currently, the `Meal` column describes the meal when a food was consumed by its text name

  + Let's create a column using the **logical function SWITCH** to convert the names of each mealtime to a number value, to give us an alternative option for sorting/labeling.

  + Use the Column Tools > New Column to add a column with the following formula:

```
Meal Number = SWITCH(
    'Food Journal Data'[Meal],
    "Breakfast", 1,
    "Lunch", 2,
    "Dinner", 3,
    "Snack", 4)
```

- *BONUS: What happens if you head to the Model View and try to adjust the "sort by" order for the Meal column to use Meal Number? What other alternative approach might you use instead?*

Modeling Data: Using DAX

Exercise 5, continued

In your Nutrition Data project file:

- Still in the Table View, expand and review the Food Journal Administration table
  + If you scroll down, you'll see multiple different roles listed in the Role column (may have to scroll to bottom)

- We'll use this data to add Row-Level Security
  + In the ribbon Home tab, go to **Manage Roles**.
  + Create 2 new roles called **Patient** and **Admin**
  + For the **Patient** role:
    - Under Select Tables, select Food Journal Administration
    - Under Filter Data, click +New
    - Set Column to Role, Condition to Equals, and Value enter Patient
  + For the **Admin** role:
    - Again select table Food Journal Administration
    - Under **Filter Data**, click **+New**
    - Set Column to Role and for Condition enter Is Not Blank
  + Click **Save**.

- Back in the Table View, click **View As** in the ribbon, and check the box for Patient.
  + You'll see the banner "Now viewing as: Patient"
  + If you scroll through the Food Journal Administration table again, this time you'll only see the rows with a Role value of Patient.
  + Click **Stop viewing** to turn off RLS view

- Save project as **nutrition_data_Exercise5.pbix**

4 Visualizations & Data Storytelling

- [Data Storytelling with Visualizations](#)

- [Create and Customize Visualizations](#)

- [Using Hierarchies, Groups, and Clusters](#)

- [Drill down and drill through Interactions](#)

Visualizations & Data Storytelling –

Data storytelling with visualizations

- Why "storytelling"?

- Using visualizations to tell a story

- Accessibility: Don't undermine your story!

Working with Power BI

Data storytelling with visualizations

Why "storytelling"?

Using visualizations to tell a story

Accessibility: Don't undermine your story!

- **Data storytelling** is using selected data points and visualizations to communicate a story about that data
- A story **engages your audience** and brings **sense and structure** to complex data
- What might be your story's theme?
  + A hero overcomes a challenge
  + A plot twist leads to a surprising result
  + Imminent risk of danger, and a path to avert or mitigate it

Data storytelling with visualizations

Why "storytelling"?

Using visualizations to tell a story

Accessibility: Don't undermine your story!

- The format and shape of the visualization should support the story (we'll talk more about this!)

- Consider the level of detail needed on the page

  + Keep visuals focused on the most impactful insights

- Incorporate interactive features like filtering into your report

  + If presenting your results live, demonstrate interactive features as you share the story

Data storytelling with visualizations

Why "storytelling"?

Using visualizations to tell a story

Accessibility: Don't undermine your story!

- Prioritize clarity of presentation and interaction
- Consider your audience's needs and how they will be accessing the report

  1) **Assume end users will be viewing on a smaller screen than yours**

  2) **Use accessible color schemes**

  3) **Consider using labels, icons, or textures to augment the meaning of colors in your report design**

- Remember: *If your end-users can't read your report, then it doesn't matter how good your data is!*

Visualizations –

Create and customize visualizations

- Charts

- Slicers

- Tables and matrices

- Custom visualizations

Create and customize visualizations

Charts

Slicers

Tables and matrices

Custom visualizations

- Used to aggregate or compare data
  + bar and column charts
  + donut and pie charts
  + line and area charts
  + scatter charts
  + maps
- Also may highlight a specific data point or progress against a goal
  + cards
  + gauge charts
  + KPIs

Create and customize visualizations

Charts

Slicers

Tables and matrices

Custom visualizations

- **Bar/column**: compare values across categories
- **Line/area**: trace shape of a series of values over time to show trends
- **Pie/donut/treemap**: compare parts of a whole
- **Scatter/bubble**: plots data points against an X and Y axis that are both numerical values
- **Cards**: highlight a data point or multiple data points
- **Guage and KPI charts**: show progress toward a designated goal or business KPI

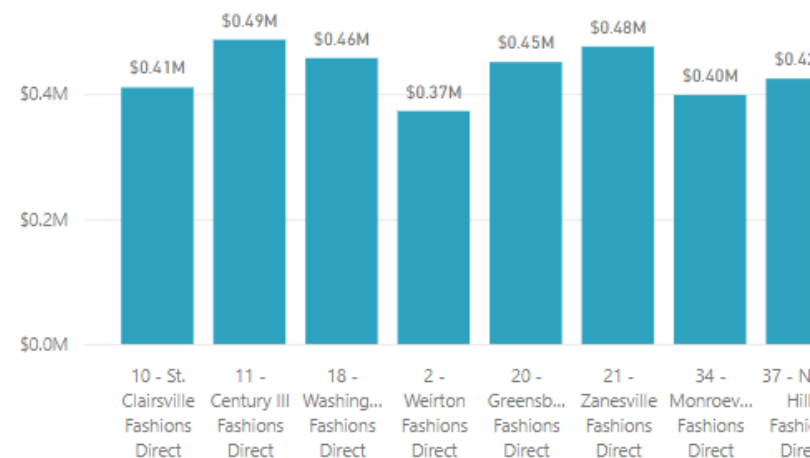# *Create and customize visualizations*

Charts

Slicers

Tables and matrices

Custom visualizations

• Slicers make it easy for the user to **see** and **apply** filtering
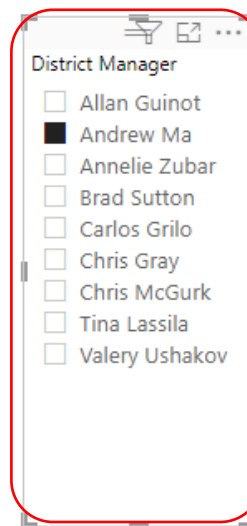
Create and customize visualizations

Charts

Slicers

Tables and matrices

Custom visualizations

- A table visualization is a way to quickly see and compare detailed data by category

- Mix and match fields to construct a custom table visualization
  + You are not limited to the underlying tables in your dataset!

Create and customize visualizations

Charts

Slicers

Tables and matrices

Custom visualizations

- A matrix is a multidimensional table
- Use a matrix to show the breakdown and subtotals of data across dimensions

Create and customize visualizations

Charts

Slicers

Tables and matrices

Custom visualizations

- Table:

Category	Sub Category	Total Invoice
Direct	Contracting & Services	$3,556,021.52
Direct	Hardware	$140,732,213.09
Direct	Outsourced	$29,429,955.04
Direct	Raw Materials	$42,965,010.75
Indirect	Indirect Goods & Services	$156,848,846.62
Logistics	Logistics	$23,939,576.96
Other	Other	$119,863,903.91
Total		**$517,335,527.89**

- Matrix:

Category	Contracting & Services	Hardware	Indirect Goods & Services	Logistics	Other	Outsourced	Raw Materials	Total
Direct	$3,556,021.52	$140,732,213.09				$29,429,955.04	$42,965,010.75	**$216,683,200.40**
Indirect			$156,848,846.62					**$156,848,846.62**
Logistics				$23,939,576.96				**$23,939,576.96**
Other					$119,863,903.91			**$119,863,903.91**
Total	$3,556,021.52	$140,732,213.09	$156,848,846.62	$23,939,576.96	$119,863,903.91	$29,429,955.04	$42,965,010.75	**$517,335,527.89**

Create and customize visualizations

Charts

Slicers

Tables

Matrices

Custom visualizations

- Custom visualization options are available via AppSource, from Microsoft and other providers

- Some offerings include:
  + Chiclet slicer (using custom images)
  + Gantt, Sankey, sunburst, tornado, and other charts
  + Enhanced KPIs and gauges
 + Animated charts and slicers to add visual engagement

Visualizations & Data Storytelling: Create & Customize Visualizations

Exercise 6

Add the following visualizations in the Report View, and use the Format ✎ options to adjust each visual's display settings:

- Text box (via Insert tab of ribbon)
  + Goldilocks Food Summary, Nov 29 2022 through Apr 30 2023

- Line chart 📈
  + X-axis: Date > Date Hierarchy
  + Y-axis: Food Journal Data > Total Foods Tried
  + Secondary y-axis: Food Journal Data > Unique Foods Eaten

- Donut chart ⊙
  + Legend: Food Categories > Category
  + Values: Food Journal Data > Unique Foods Eaten

- Stacked column chart 📊
  + X-axis: Food Journal Data > Meal
  + Y-axis: Food Journal Data > Unique Foods Eaten
  + Legend: Food Categories > Category
  + Also try changing this to a 100% stacked column chart – why might you use either?

- Matrix ▦
  + Rows: Food Journal Data > Meal
  + Rows: Food Journal Data > Foods
  + Columns: <none>

- Slicer 🗒
  + Field: Food Journal Data > Meal

- Optional: Experiment with changing themes using the View tab

- Save project as **nutrition_data_Exercise6.pbix**
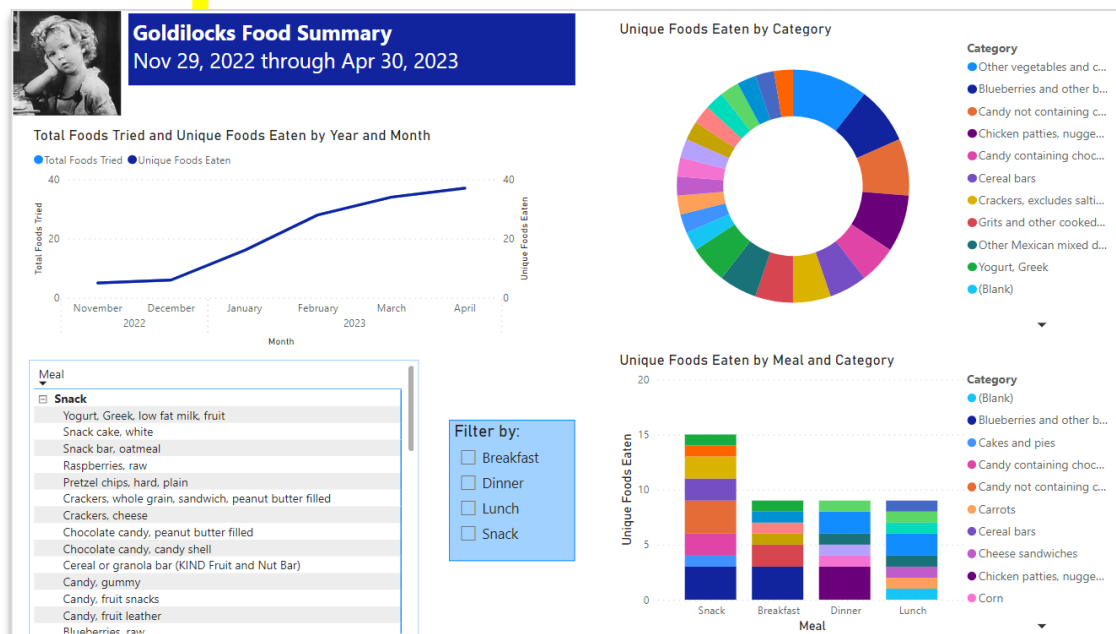
Visualizations –
Using hierarchies, groups, & clusters

- Hierarchies

- Grouping and binning

- Clustering

Using hierarchies, groups, & clusters

Hierarchies

Grouping and binning

Clustering

- We've touched on hierarchies a little
  + Auto date/time generates a date hierarchy by default where applicable
  + Hierarchies can also be created for other categories of information
- In a visualization, use the ⬇ icon to expand down a hierarchy and ↑ to drill up

Using hierarchies, groups, & clusters

Hierarchies

Grouping and binning

Clustering

- Grouping and binning simplify complex data sets by reducing the number of categories or values displayed

- **Grouping** allows you to combine data based on common attributes or characteristics

- **Binning** allows you to set a bin size for numeric or time fields

  + Number and size of bins can be customized, as well as the ranges and labels for each bin

- Both groups and bins are created and managed with the Groups dialog

Using hierarchies, groups, & clusters

Hierarchies

Grouping and binning

Clustering

- Clustering is machine learning technique that groups data points with similar characteristics or behaviors

- This can help identify patterns and insights in complex data sets that may not be immediately apparent

- You can customize parameters, such as the number of clusters to be identified, in order to refine the clustering results

Visualizations –

Drill down and drill through Interactions

- Drill down functionality

- Drill through pages

Drill down and drill through Interactions

Drill down functionality

Drill through pages

- Turning on Drill Mode for a visualization applies a drill down interaction when clicking on a data point

- Drill Mode can be turned on using the down arrow ↓ in the top right corner of a visualization

- Once drill down is applied, user can drill up with the same up arrow ↑ used for hierarchy navigation

Drill down and drill through Interactions

Drill down functionality

Drill through pages

- Provide a means for report users to explore specific data points in more depth without cluttering the main report page

- Can be customized to display different visualizations or information based on the selected data point

- Filters applied at the starting page will pass through to the drill-through page unless other behavior is specified

Wrap-Up: Visualizations & Data Storytelling

Exercise 7

- Select your donut chart, Unique Foods Eaten by Category:

  + Under Legend, click the down-chevron by Category and select **New Group**

  + Use the pick-list of Category values to create four groups:

    - In **Ungrouped values,** use ctrl+click to select multiple lines, then click Group to create the group

    - Double-click to rename group under **Groups and members**

Fruits & Vegetables	*Sweets*
Blueberries and other berries	Cakes and pies
Carrots	Candy containing chocolate
Corn	Candy not containing
Other fruits and fruit salads	chocolate
Other vegetables and	
combinations	*Breads & Grains*
Peaches and nectarines	Cereal bars
	Cheese sandwiches
Proteins	Crackers, excludes saltines
Chicken patties, nuggets and	Grits and other cooked
tenders	cereals
Dips, gravies, other sauces	Oatmeal
Other Mexican mixed dishes	Pasta mixed dishes, excludes
Yogurt, Greek	macaroni and cheese
	Pasta, noodles, cooked grains
	Pizza
	Pretzels/snack mix

Wrap-Up: Visualizations & Data Storytelling

Exercise 7, continued

- Create a drill through page:
  + Add a new report page using the + tab at the bottom of the canvas
  + Rename your new page Food Groups
    - While you're at it, rename your first page Summary
  + Add a table visualization ⊞ to the Food Groups page using two values for Columns:
    - Food Categories > Category
    - Food Journal Data > Foods
  + Into the field marked **Add drill-through fields here**, drag:
    - Food Categories > Category (groups)
    - Note that Power BI will automatically add a back arrow button to the top left corner of your page
- Try it! On the Summary page, right click a segment of the donut chart and select **Drill through** > Food Groups
- Save project as **nutrition_data_Exercise7.pbix**

5 *Exploring Data*

- [Incorporating Natural Language](#)

- [Quick Insights with Power BI service](#)

Exploring Data –
Incorporating Natural Language

- What is Natural Language?

- Natural Language with Q&A

Incorporating Natural Language

What is Natural Language?

Natural Language with Q&A

- Natural Language can process synonyms and other variations of words, allowing data to be queried in a more intuitive way

Incorporating Natural Language

What is Natural Language?

Natural Language with Q&A

- The Q&A visual allows users to ask questions about the report data in natural language

- Synonyms can also be added, especially helpful if your data contains specialized vocabulary

- Q&A can be used to generate a variety of visualizations, including tables, charts, maps, and timelines

Exploring Data –
Quick Insights with Power BI Service

- What is the Quick Insights feature?

- Types of Quick Insights

- Generating Quick Insights

Quick Insights with Power BI Service

What is the Quick Insights feature?

Types of Quick Insights

Generating Quick Insights

- Quick Insights is an **online** feature of the Power BI service

  + We'll talk more about Power BI service in the next unit!

- Uses advanced analytics and machine learning algorithms to automatically analyze your data and generate insights

- Provides a convenient way to kickstart exploration or identify areas where further analysis is needed

- Can help uncover hidden patterns and trends in data

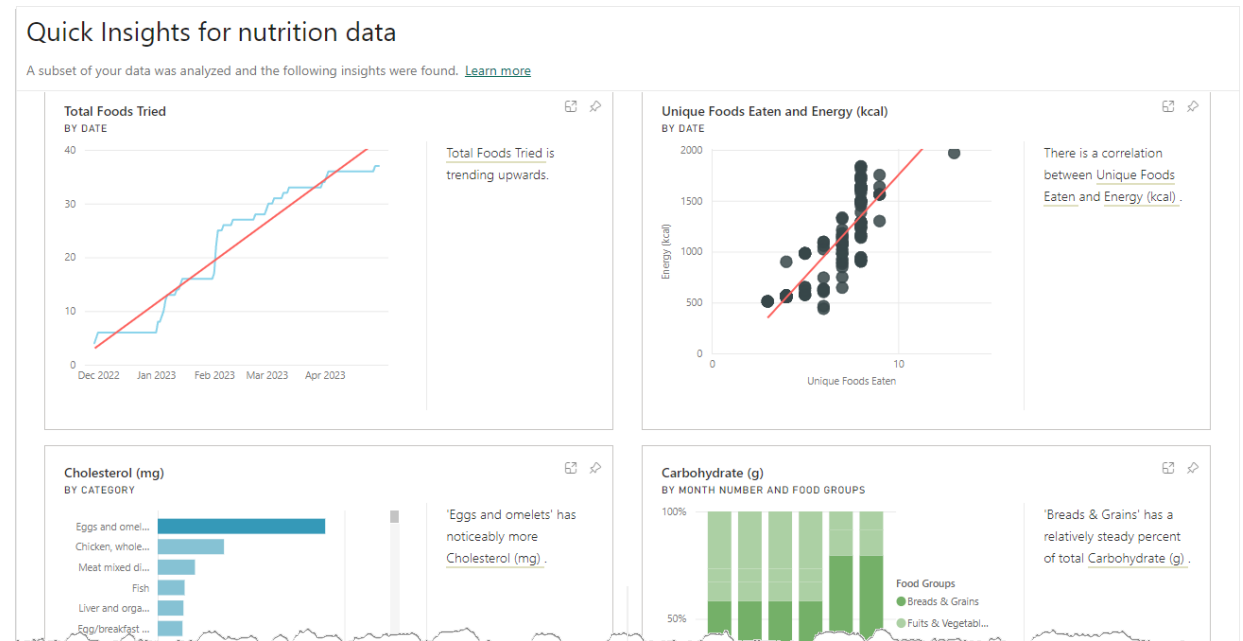- Also helps you identify outliers and anomalies in your data that might be indicative of errors or other issues

Quick Insights with Power BI Service

What is the Quick Insights feature?

Types of Quick Insights

Generating Quick Insights

- Category outliers (top or bottom)

- Outliers based on clustering

- Correlation

- Low variance

- Steady share (% of T)

- Majority / Major factors

- Change points in a time series

- Overall trends in time series

- Seasonality in time series

- Time series outliers

Quick Insights for nutrition data

A subset of your data was analyzed and the following insights were found. Learn more

Total Foods Tried BY DATE — Total Foods Tried is trending upwards.

Unique Foods Eaten and Energy (kcal) BY DATE — There is a correlation between Unique Foods Eaten and Energy (kcal).

Cholesterol (mg) BY CATEGORY — 'Eggs and omelets' has noticeably more Cholesterol (mg).

Carbohydrate (g) BY MONTH NUMBER AND FOOD GROUPS — 'Breads & Grains' has a relatively steady percent of total Carbohydrate (g).

Quick Insights with Power BI Service

What is the Quick Insights feature?

Types of Quick Insights

Generating Quick Insights

- Available from the three-dots menu for dataset in an online workspace
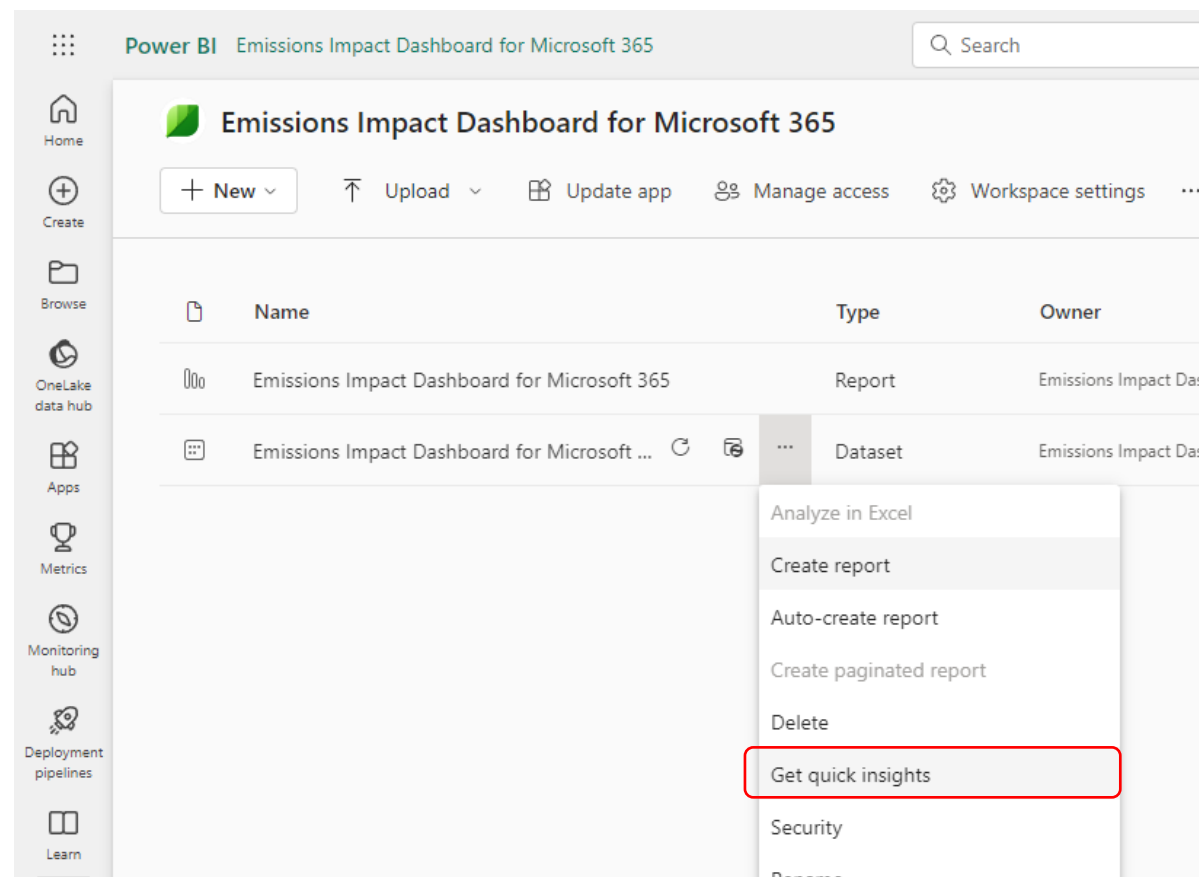
Wrap-up:

Exploring Data

Exercise 8

- On a new report page, try adding one or more of the following visualizations:

  + Q&A visualization 💬
    - What kinds of questions are suggested by Power BI? How are results portrayed?

  + Key Influencers 📊
    - Try using **Analyze:** `Meal` and **Explain by:** `Foods.` Is this useful? What might make this more useful?

  + Decomposition Tree 🔸
    - Again try **Analyze:** `Meal` and **Explain by:** `Foods`, then experiment with expanding `Count of Meal` by High value vs. Low value. What else might make this more useful?

- Save project as **nutrition_data_Exercise8.pbix**

6 Publishing and Sharing

- [Publishing Options from Power BI Desktop](#)

- [Publishing with Power BI Service](#)

- [Sharing and refreshing data](#)

Publishing and Sharing –
Publishing Options from Power BI Desktop

- Save and share a PBIX file

- Export to PDF

- Publish to Power BI service

Publishing Options from Power BI Desktop

Save and share a PBIX file

Export to PDF

Publish to Power BI service

- While you can send someone a copy of your .pbix file, they will likely need to fix/refresh the data sources for the report to work correctly

- Try opening **nutrition data.pbix** from the Student Files folder
  + What kind of error messages do you get when you try to explore the tables using Transform Data / Power Query?
  + You can "fix" the report by connecting to your local copy of the source files

Publishing Options from Power BI Desktop

Save and share a PBIX file

Export to PDF

Publish to Power BI service

- **Export to PDF** is a one-click step that generates a flat PDF image of your report
  + Includes any applied filters or drill-downs
  + Any scrollable visuals are cut off as they appear at time of export
  + No filtering or other interaction is possible
  + Underlying data is not shared
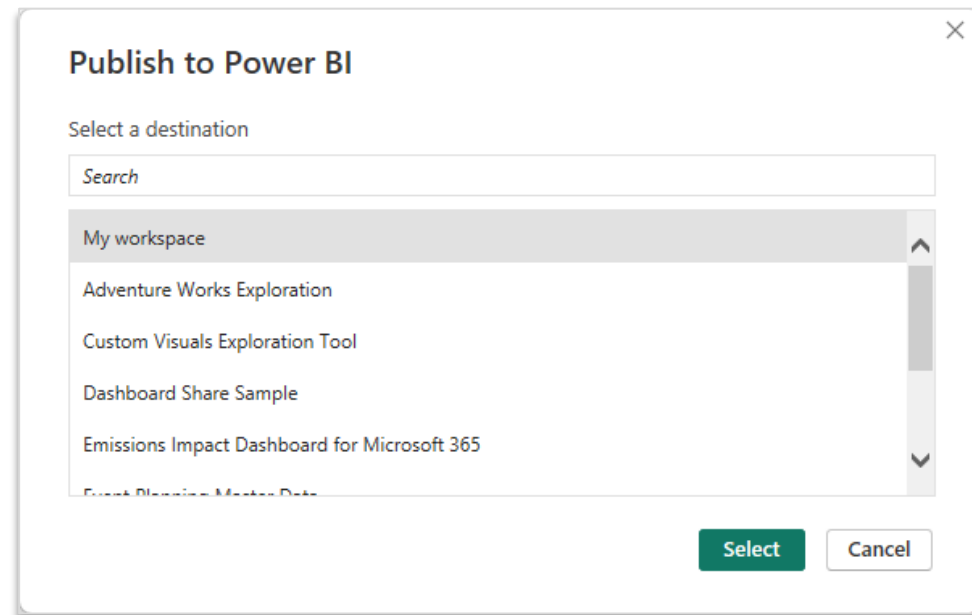- Good option for situations where a **static report** is desirable

Publishing Options from Power BI Desktop

Save and share a PBIX file

Export to PDF

Publish to Power BI service

- The Publish button in the Home tab allows quick means to upload your report to a workspace in Power BI service

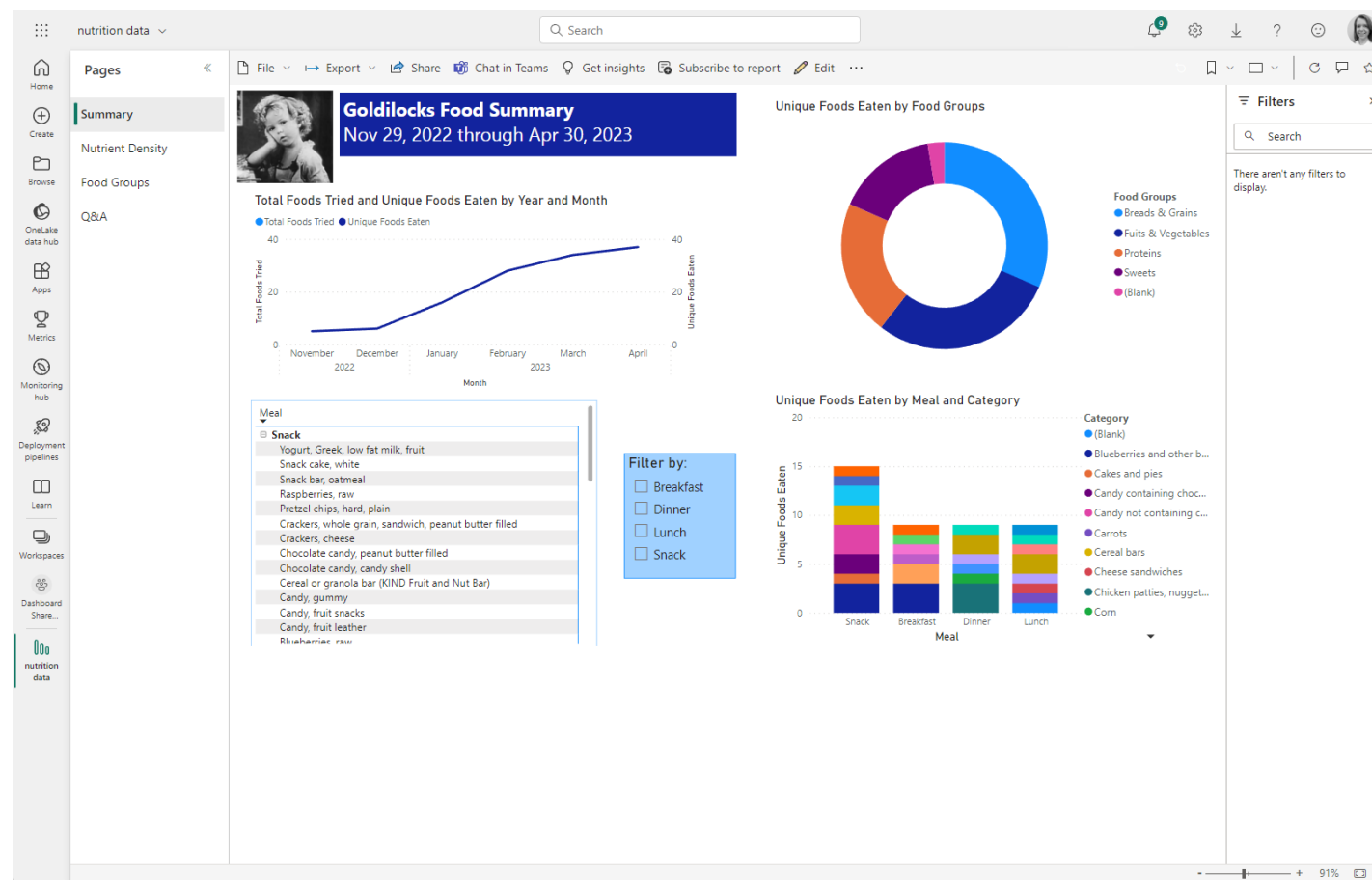# Publishing and Sharing – Publishing with Power BI Service

- Create or upload a report

- Creating dashboards

Publishing with Power BI Service

Create or upload a report

Dashboards

• Let's take a look at viewing and editing a report online

Publishing with Power BI Service

Create or upload a report

Dashboards

- A **dashboard** is a one-page collection of report pages and/or image tiles
- Created by clicking the pin icon on a visualization or the three-dots menu from a report page (new or existing dashboard)
  + You can pin items from different reports to create a combined dashboard
  + Source reports must be part of the same workspace
  + Person creating the dashboard must have "creator" role for the report and on the workspace
- Pro or Premium Per User (PPU) license needed to create dashboards in shared workspaces
  + You can create dashboards in your own My Workspace even without a Pro or Premium license

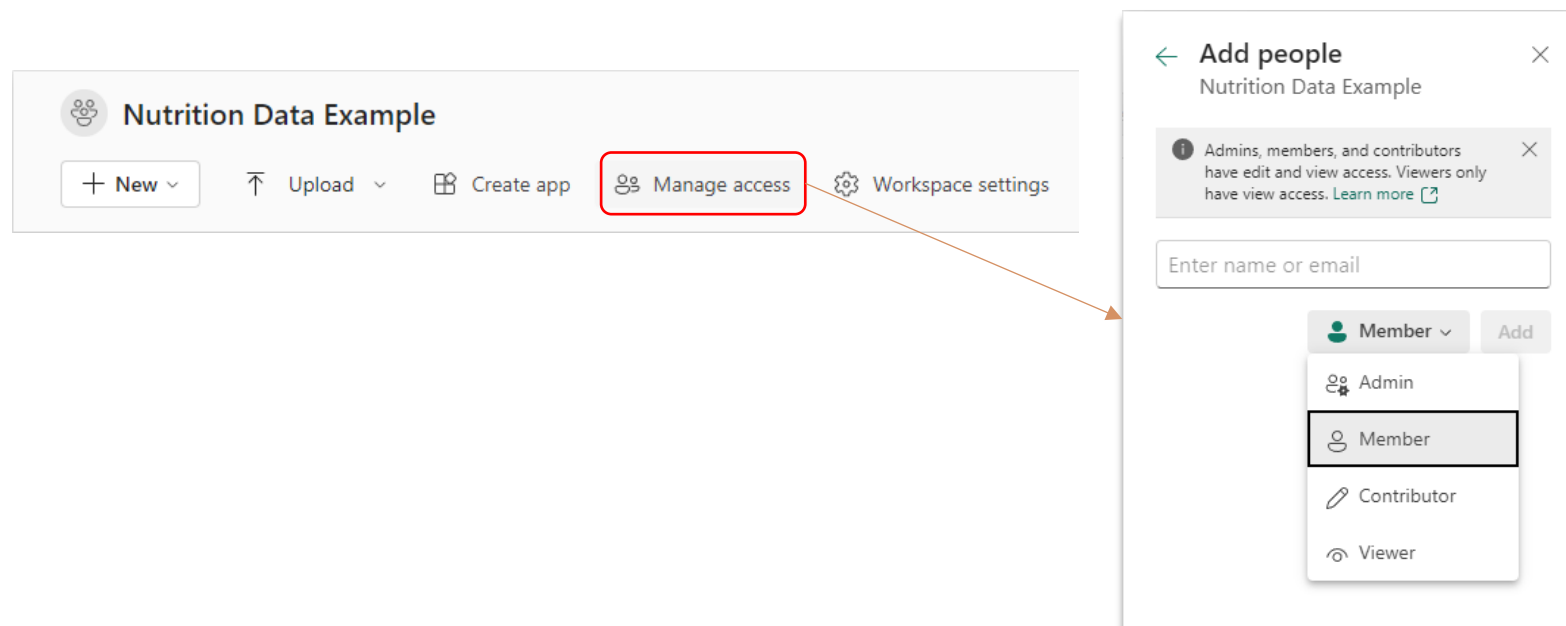# *Publishing and Sharing –*
Sharing and Refreshing Data

- Data share settings

- Refreshing report data

Working with Power BI

Sharing and Refreshing Data

Data share settings

Refreshing report data

- Datasets can be directly shared with team members via **Share** button
- A dataset in a shared workspace can be used / viewed by all members of the workspace, according to their role

100

Sharing and Refreshing Data

Data share settings

Refreshing report data

- An owner of a dataset can also **promote** that dataset (requires write permissions to workspace)
  + From the workspace, use gear icon to open Settings, then Power BI Settings
  + Find the dataset under the Datasets tab and expand **Endorsement and discovery**
    - <u>Promote</u>: share to your coworkers
    - <u>Certified</u>: request certification of the dataset by your organization

◁ Endorsement and discovery

Help coworkers find your quality content by endorsing this dataset and making it discoverable. Learn more

○ None
This dataset will appear in search results but isn't endorsed.

◉ Promoted
When you're ready to distribute the dataset to your coworkers, promote it to let them know.

○ Certified
Certify your dataset to show coworkers that it's been reviewed and meets your org's certification criteria. How do I get my dataset certified?

☑ Make discoverable
Allow users without access to this dataset to discover it and request permissions to access the data Learn more

ⓘ This dataset will be made discoverable. Others in your org will be able to find it by such details as name, tables, columns, etc. Learn more

Sharing and Refreshing Data

Data share settings

Refreshing report data

- In Power BI Desktop:
  + Refresh all data from current settings using Refresh button in the main ribbon
  + Use Power Query to refresh individual tables using Refresh Preview button

- In Power BI service (online):
  + From workspace, use circle-arrow refresh icon
  + In settings for dataset, set up a refresh schedule
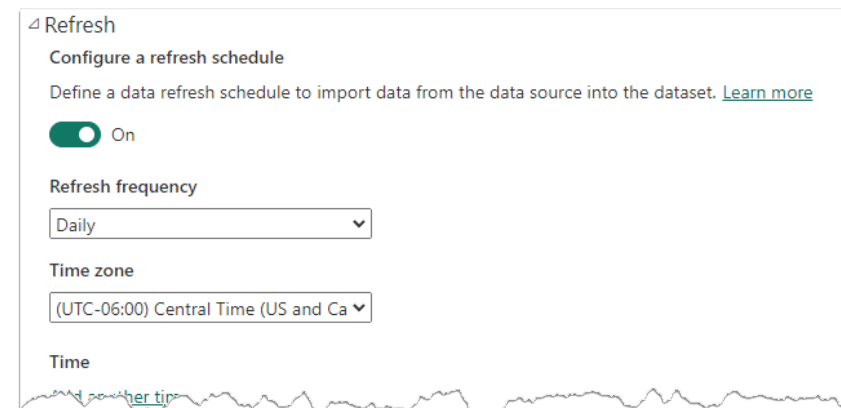
Wrap-up:

Publishing & Sharing

Exercise 9

- Export your Nutrition Data report
  + As a PDF file
  + To Power BI service

- In Power BI service (app.powerbi.com)
  + **Create a dashboard** using tiles based on your Nutrition Data report
  + Spend a little time exploring My Workspace (or the workspace where you have uploaded the report)
  + In the workspace, find your "nutrition data" dataset
    - Use the three-dots icon to select **Get quick insights** – once generated, these can also be pinned to your dashboard!
    - Then use the three-dots icon to open settings, and explore the options available for your dataset

Publishing and Sharing

Course Survey

Thank you for your time and attention the past two days! Please complete the survey at the link provided by your organization:

https://forms.office.com/r/Phia1JxWZS

Conclusion

Over the last two days, you have **developed a strong foundation in Power BI**. You have learned about **transforming data, creating visualizations, and sharing reports and dashboards** with others. I hope this course also sparked your enthusiasm to **continue exploring** Power BI's capabilities, especially as the world of data analysis and visualization continues to evolve!

Please feel free to reach out to me if you have any follow-up questions on Power BI, business analytics, or related topics.

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