

GETTING STARTED USING DATA TO TELL YOUR STORY

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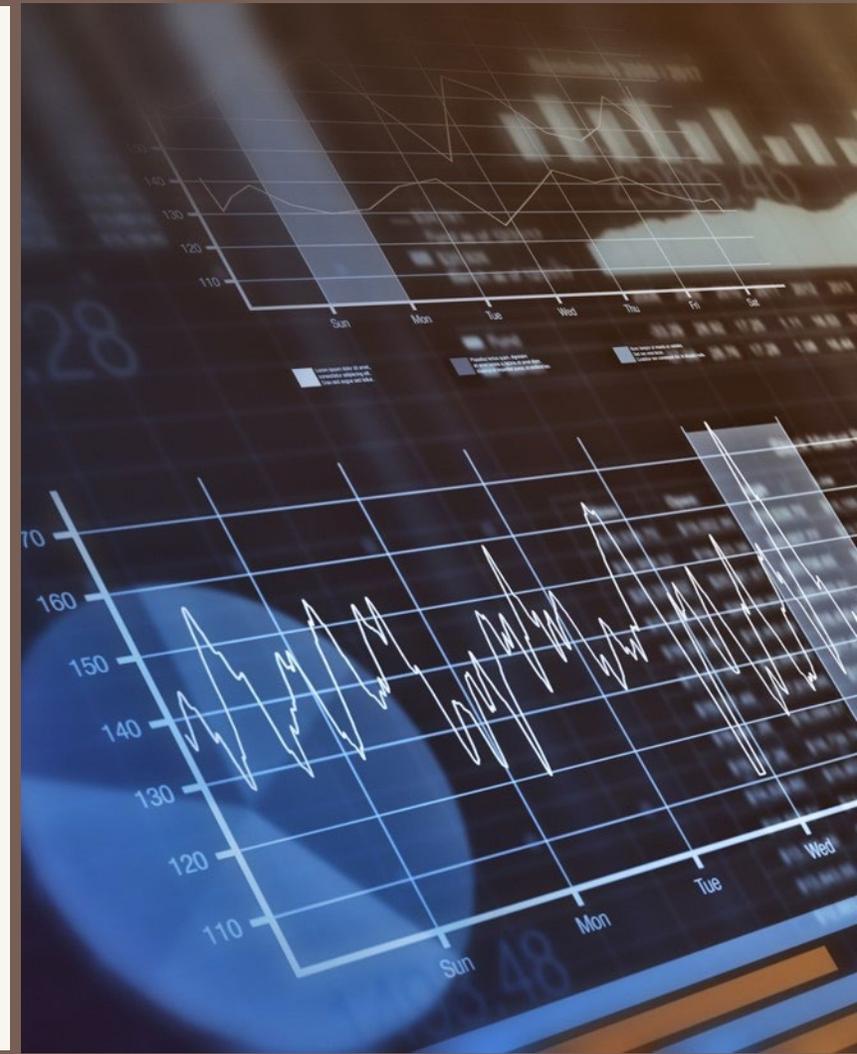
Haworth College of Business

Center for Business Analytics



Agenda

- ❑ Popular Tools for Data Visualization
- ❑ Case Study : Understanding state level indicators that influence food recall events
 - ❑ Challenges in data import and connections
 - ❑ ETL using Power Query
 - ❑ Advanced AI enabled visuals
 - ❑ Integrating third party scripts
- ❑ More tools, resources and training





Two popular visualization tools

Power BI

- Strong integration with Microsoft products.
- [Specialized versions for government use available](#)
- Cheaper than Tableau
- Faster on smaller data sets.
- [Higher number of default and advanced visuals](#)

Tableau

- Can create more complex visuals
- Steeper learning curve
- Handles large datasets better





Key Power BI products and services

Power BI Desktop

- Free product can be installed on PC
- Data modeling and visualization capabilities

Power BI Service

- Cloud or internet-based service where users can collaborate, share and work on reports and dashboards.
- These come with Power BI pro or premium subscriptions
- Subscription brings dedicated resources, more data capacity and enhanced performance.

Power BI Visuals Marketplace

- Developers can contribute visuals usable for free or at a cost.



Case Study

Goal : To explore state level indicators that influence Food recall events.

Key Steps :

- 1) Gather food recall data, state economic and demographic data in Power BI.
- 2) Compile a cross-sectional table with state level indicators and aggregate recall data for a year.
- 3) Develop visuals to understand factors related to food recalls.



Data Source for Recall Information

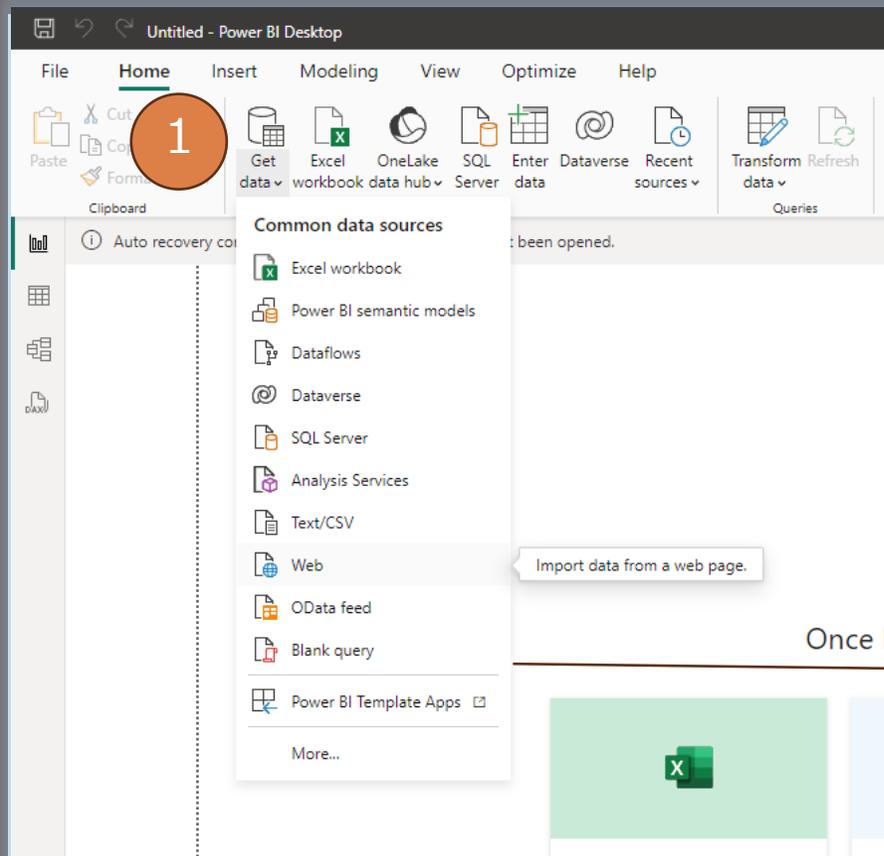
DATA SOURCE : OPEN.FDA.GOV

- **FDA Recall Enterprise System (RES)** – A database of information on recall events submitted to FDA
- An enforcement report contains information on actions taken in connection with FDA regulatory activities.
- **An API (Application Programming Interface)** protocol is used to interact with RES.
- **URL to fetch the data from RES using API:**

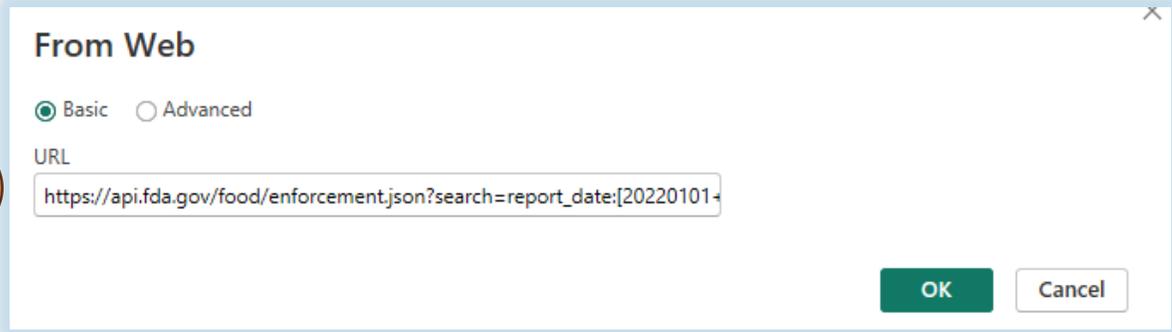
[https://api.fda.gov/food/enforcement.json?search=report_date:\[20230101+TO+20231231\]&limit=1000](https://api.fda.gov/food/enforcement.json?search=report_date:[20230101+TO+20231231]&limit=1000)



Connecting to RES using Power BI Desktop



Power BI desktop opening window



List of Data sources that can be imported



Imported data opens in power query editor

In Query editor you can transform data before analysis. It is an ETL supported by other Microsoft applications as well.

The screenshot displays the Power Query Editor window. The ribbon at the top includes tabs for File, Home, Transform, Add Column, View, Tools, and Help. The Transform tab is active, showing various options like Transpose, Reverse Rows, Detect Data Type, Fill, Pivot Column, Split Column, Format, Merge Columns, Statistics, Standard Scientific, Trigonometry, Rounding, Date, Time, Duration, Run R script, and Run Python script. The main area shows a table with 14 rows and 6 columns. The columns are: meta.disclaimer, meta.terms, meta.license, meta.last_updated, meta.results.skip, and meta.results. The data in the table is as follows:

| | meta.disclaimer | meta.terms | meta.license | meta.last_updated | meta.results.skip | meta.results |
|----|--|-----------------------------|-------------------------------|-------------------|-------------------|--------------|
| 1 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 2 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 3 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 4 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 5 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 6 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 7 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 8 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 9 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 10 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 11 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 12 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 13 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |
| 14 | Do not rely on openFDA to make decisions regarding medical care. Wh... | https://open.fda.gov/terms/ | https://open.fda.gov/license/ | 5/22/2024 | 0 | |

The right-hand pane shows the Query Settings for the query [20230101+TO+20231231]&limit=1000. It includes sections for PROPERTIES (Name: [20230101+TO+20231231]&limit=1000) and APPLIED STEPS (Source, Converted to Table, Expanded meta, Expanded meta.results, Expanded results, Expanded results1, Expanded results.openfda, and Changed Type).

Power Query, Editor Window



Transforming Data

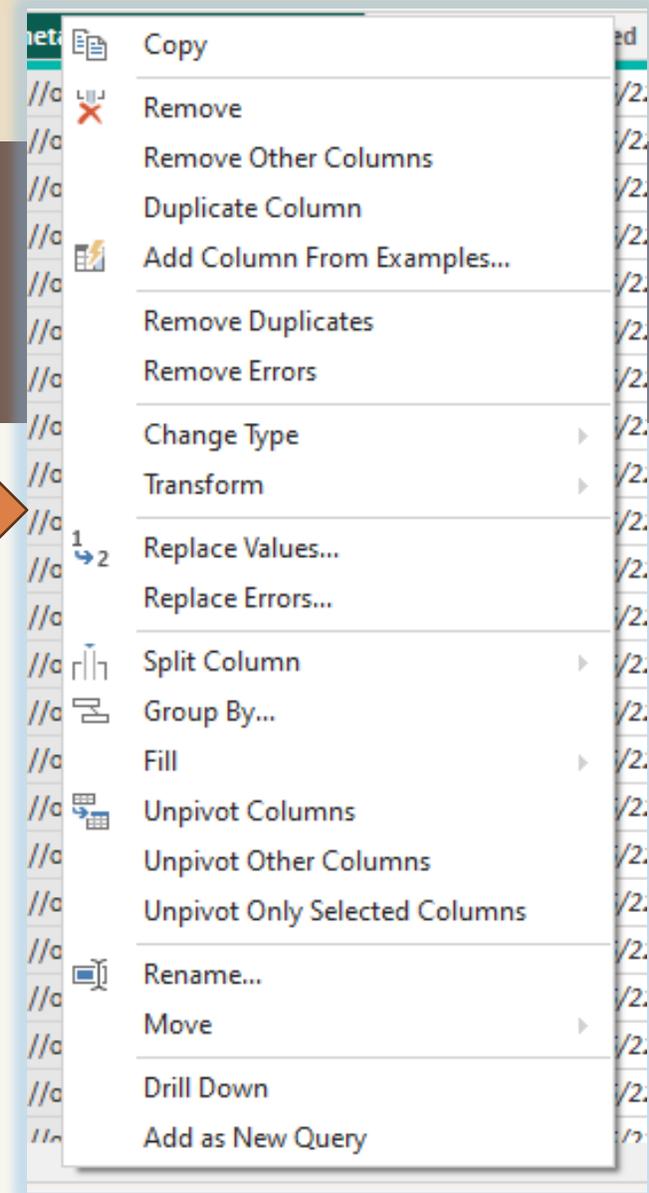
Transformations to Consider

- Delete columns
- Create new columns (State Full Names)
- Replace missing values
- Change Format of a Column (e.g. Dates)
- Relevant Column Selection
- Rename Columns if required
- Rename the table
- Load the Table in the Data Model

Potential operations that can be executed on a column in power query editor.

Date Issues

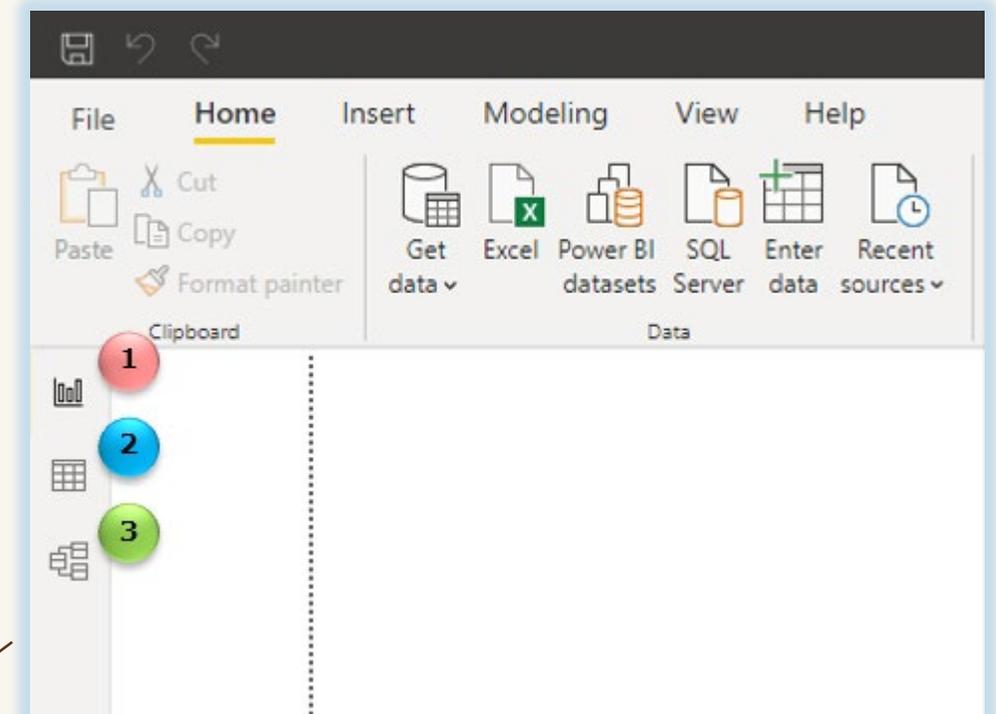
| 1 ² 3 results.report_date |
|--------------------------------------|
| 20230809 |
| 20231227 |
| 20230712 |
| 20230322 |
| 20230517 |



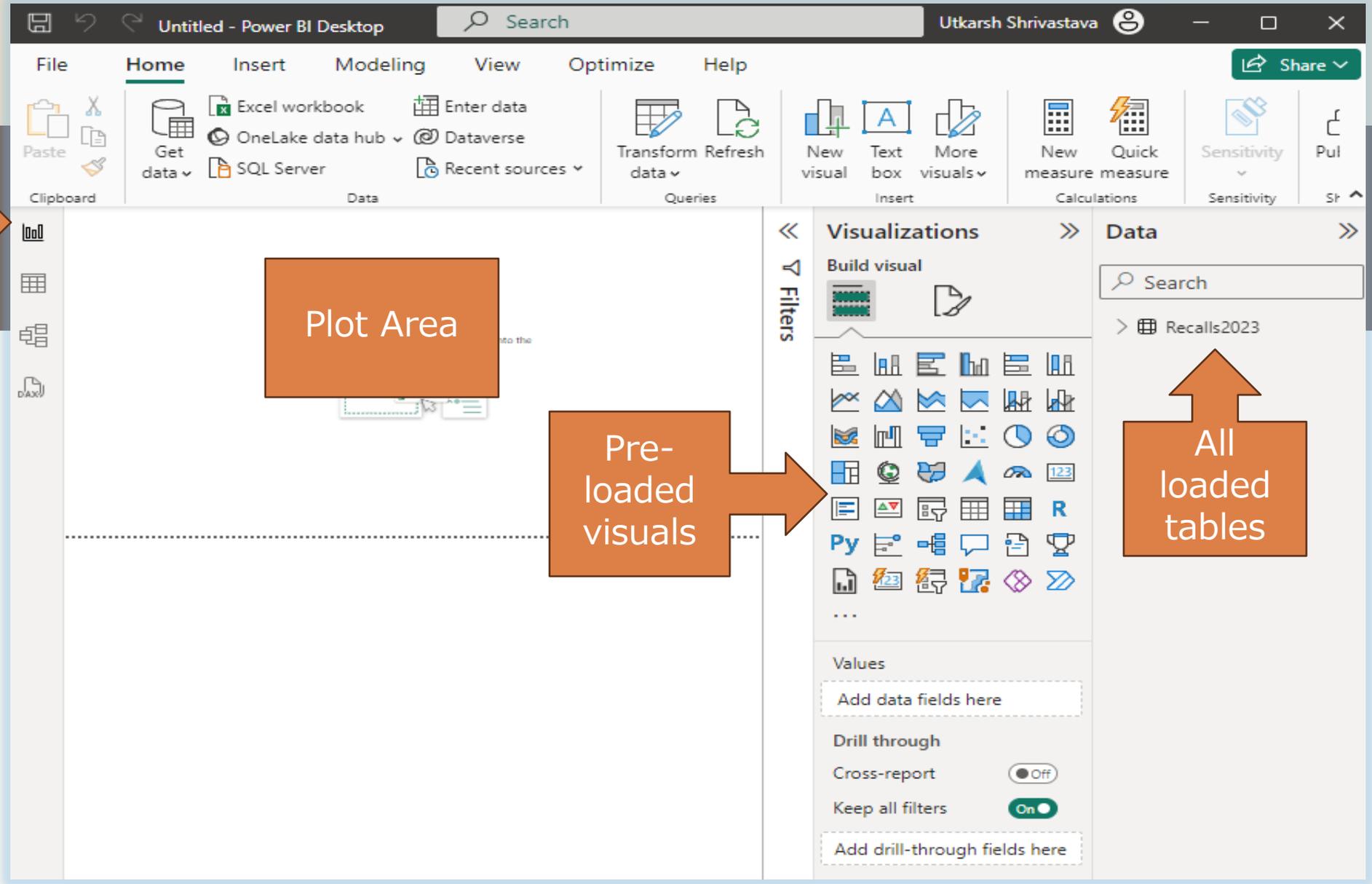
Load the Transformed Data for Analysis

Three Basic Views in Power BI

1. **Report View:** this is where most of your time is going to be spent on to create visualizations.
2. **Data View:** this is where the raw data are shown.
3. **Model View:** this is where relationships among data sets are displayed.



Power BI desktop window after loading the data and closing the Power Query Editor



Report View

Plot Area

Pre-loaded visuals

All loaded tables





Bring More Data to the Model

- To understand the association between food recalls in 2023 and other state level indicators (e.g. population, per capital income, healthcare expenses etc.) are needed.
- Goal is to create a cross-sectional table containing all relevant state level economic and demographic variables for analysis.
- Import relevant data from other Data Sources





Other Data Sources

- **State level consumer expenditure data available from**
[Bureau of Economic Analysis](#)
- **State GDP, personal income and population data from.**
[BEA Interactive Data Application](#)

Above data can be imported as .CSV file into the model



Problems with consumer expenditure data

- **Per-capita consumer expenditures metrics for a state are clustered over several rows.**
- **In cross sectional data each metric for a state should be represented in a column.**
- **Duplicate the table and filter relevant metric to create a new table. Use appropriate name and rename metric**

| Description | Unit | 2021 |
|---|---------|-------|
| Per capita personal consumption expenditures | Dollars | 39657 |
| Goods | Dollars | 15388 |
| Durable goods | Dollars | 5336 |
| Motor vehicles and parts | Dollars | 2243 |
| Furnishings and durable household equipment | Dollars | 1251 |
| Recreational goods and vehicles | Dollars | 1217 |
| Other durable goods | Dollars | 625 |
| Nondurable goods | Dollars | 10052 |
| Food and beverages purchased for off-premises consumption | Dollars | 3261 |
| Clothing and footwear | Dollars | 1209 |
| Gasoline and other energy goods | Dollars | 1215 |
| Other nondurable goods | Dollars | 4367 |



All tables in the model view

The screenshot displays a 'Model view' interface with a list of tables and their fields. The 'Recalls2023' table is expanded, showing the following fields:

- Date
- results.city
- results.classification
- results.code_info
- results.distribution_pattern
- Σ results.event_id
- results.initial_firm_notification
- results.postal_code
- results.product_description
- results.product_quantity
- results.reason_for_recall
- Σ results.recall_initiation_date
- results.recall_number
- results.recalling_firm
- Σ results.report_date
- results.status
- Σ results.termination_date
- results.voluntary_mandated
- State

Other tables shown include:

- Food_purchases**: Description, Σ food_purchases, S_Name, TableName, Unit, Collapse ^
- Insurance**: Description, Σ Insurance, S_Name, TableName, Unit, Collapse ^
- Expenditures_all**: Σ 2021, Description, GeoName, TableName, Unit, Collapse ^
- Healthcare** (highlighted): Description, Σ healthcare, S_name, TableName, Unit, Collapse ^
- Personal_consumption**: Description, Σ personal_consumption, S_Name, TableName, Unit, Collapse ^
- Populaton**: Description, Σ population, S_Name, TableName, Unit, Collapse ^
- Income_percapita**: Description, Σ income_percapita, S_Name, TableName, Unit, Collapse ^



ESTABLISH CONNECTIONS BETWEEN TABLES

Problem (State names do not match for linking)

File Home Help **Table tools**

Name Recalls2023

Structure Calendars Relationships Calculations

Table view

| | results.city | State | results.classification | results.event_id | results |
|---------|--------------|-------|------------------------|------------------|---------|
| | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |
| Ongoing | Chicago | IL | Class I | 92423 | Newly |

Name Healthcare

Name your table.

Structure Calendars Relationships Calculations

| S_name | TableName | Description | Unit | healthcare |
|----------------------|-----------|-------------|---------|------------|
| Alabama | SAPCE2 | Health care | Dollars | 6545 |
| Alaska | SAPCE2 | Health care | Dollars | 11473 |
| Arizona | SAPCE2 | Health care | Dollars | 6828 |
| Arkansas | SAPCE2 | Health care | Dollars | 6943 |
| California | SAPCE2 | Health care | Dollars | 8501 |
| Colorado | SAPCE2 | Health care | Dollars | 7364 |
| Connecticut | SAPCE2 | Health care | Dollars | 8606 |
| Delaware | SAPCE2 | Health care | Dollars | 9064 |
| District of Columbia | SAPCE2 | Health care | Dollars | 12201 |
| Florida | SAPCE2 | Health care | Dollars | 7676 |
| Georgia | SAPCE2 | Health care | Dollars | 6595 |



One table uses IL other users Indiana as state name



Load states names and two letter abbreviations from USPS website

1. Create a new table (States) containing states full names and their two letter abbreviations.
2. Data available on USPS website
3. Link Recalls2023 table and states table in Model view
4. Create a new column (in Recall table) such that it takes states abbreviations in each row (of Recall table) and fetches corresponding full name from S_Name column of linked States table.



Create Relationship

New relationship

Select tables and columns that are related.

From table

Recalls2023

| recall_... | results.recalli... | results.report... | results.status | results.termin... | results.volunt... | State |
|------------|--------------------|-------------------|----------------|-------------------|-------------------|-------|
| 2023 | Newly Weds ... | 20230712 | Ongoing | null | Voluntary: Fir... | IL |
| 2023 | Newly Weds ... | 20230712 | Ongoing | null | Voluntary: Fir... | IL |
| 2023 | Newly Weds ... | 20230712 | Ongoing | null | Voluntary: Fir... | IL |

Recall Data Table

To table

States

| S_Name | State |
|---------|-------|
| Alabama | AL |
| Alaska | AK |
| Arizona | AZ |

Table from USPS

Cardinality

Many to one (*:1)

Cross-filter direction

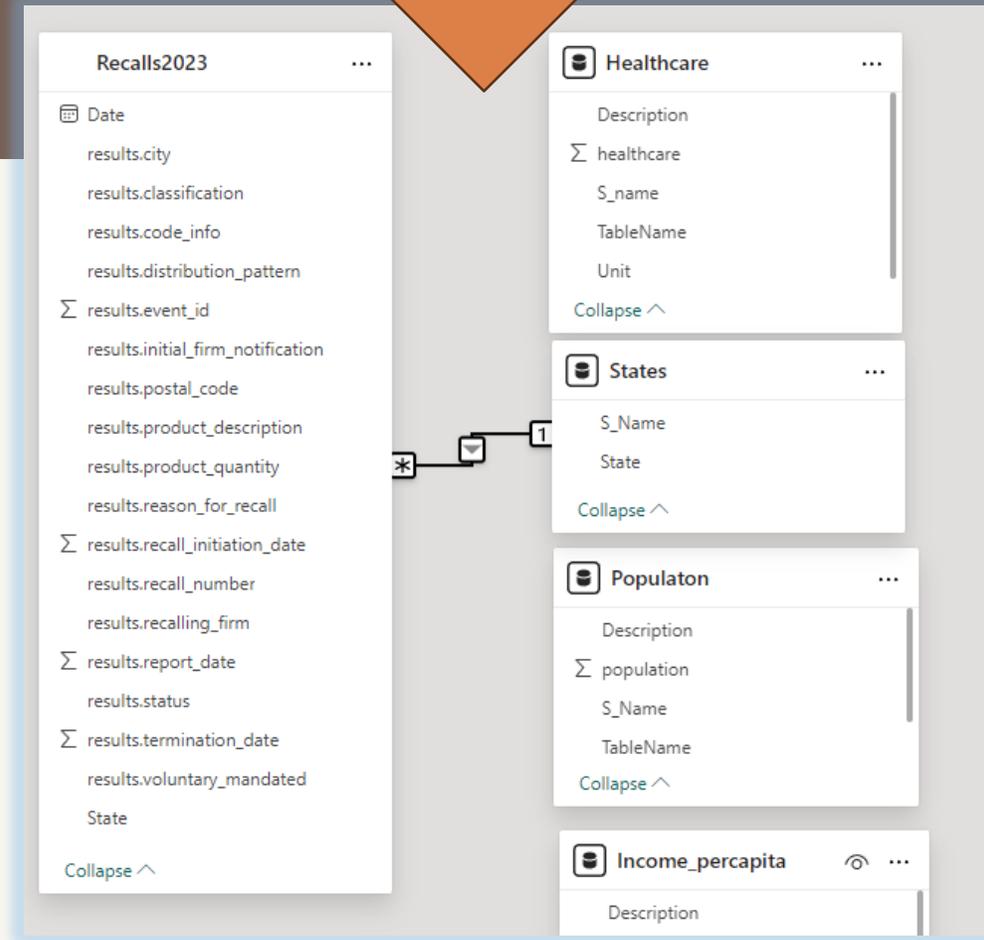
Single

Make this relationship active

Apply security filter in both directions

Assume referential integrity

Connect matching columns to establish relationship between two tables



Add New S_Name column to Recall Table

- Better to create full state name column in one table than creating abbreviation column in rest other tables.
- Copilot integrated to powerBI can also help you write DAX queries.

1

Write a DAX expression that creates a new column in the selected table and calculates values for each row.

| ts.termination_date | results.report_date | |
|---------------------|---------------------|---------------------|
| | 20230712 | SE102922A SE110722A |
| | 20230712 | YE674634 YE674635 |
| | 20230712 | ME240520 |

3

| Date | S_Name |
|-------------------|----------|
| ay, July 12, 2023 | Illinois |

2

S_Name

Format Text

Summarization Don't summarize

Data category Uncategorized

Structure

Formatting

Properties

1 S_Name = RELATED(States[S_Name])

| results.termination_date | results.report_date | |
|--------------------------|---------------------|---------------------|
| | 20230712 | SE102922A SE110722A |

DAX is formula language used in Power BI, Excel Power Pivot. Allows for calculated columns and measures.



All Tables

The screenshot displays a data modeling interface with a table list on the left and detailed views for several tables on the right. The table list includes: Recalls2023, Expenditures_all, Personal_consumption, Healthcare, Insurance, Food_purchases, Income_all, Income_percapita, Populaton, and States. The detailed views show the following fields for each table:

- Food_purchases:** Description, food_purchases (sum), S_Name, TableName, Unit.
- Personal_consumption:** Description, personal_consumption (sum), S_Name, TableName, Unit.
- Insurance:** Description, Insurance (sum), S_Name, TableName, Unit.
- Recalls2023:** Date, results.city, results.classification, results.code_info, results.distribution_pattern, results.event_id (sum), results.initial_firm_notification, results.postal_code, results.product_description, results.product_quantity, results.reason_for_recall, results.recall_initiation_date (sum), results.recall_number, results.recalling_firm, results.report_date (sum), results.status, results.termination_date (sum), results.voluntary_mandated, State.
- Healthcare:** Description, healthcare (sum), S_name, TableName, Unit.
- States:** S_Name, State.
- Populaton:** Description, population (sum), S_Name, TableName.
- Income_percapita:** Description, income_percapita (sum), S_Name, TableName, Unit.

| A ^B C | S_Name | A ^B C | State |
|------------------|----------------------|------------------|-------|
| 1 | Alabama | AL | |
| 2 | Alaska | AK | |
| 3 | Arizona | AZ | |
| 4 | Arkansas | AR | |
| 5 | California | CA | |
| 6 | Colorado | CO | |
| 7 | Connecticut | CT | |
| 8 | Delaware | DE | |
| 9 | District of Columbia | DC | |
| 10 | Florida | FL | |
| 11 | Georgia | GA | |
| 12 | Hawaii | HI | |
| 13 | Idaho | ID | |
| 14 | Illinois | IL | |

- Recall table has multiple observations for a state over the year. Other tables have one observation for each state as other metrics are annually observed.
- Need to aggregate recalls for 2023 across each state in a cross-sectional table as dependent variable is recalls per state over the year.



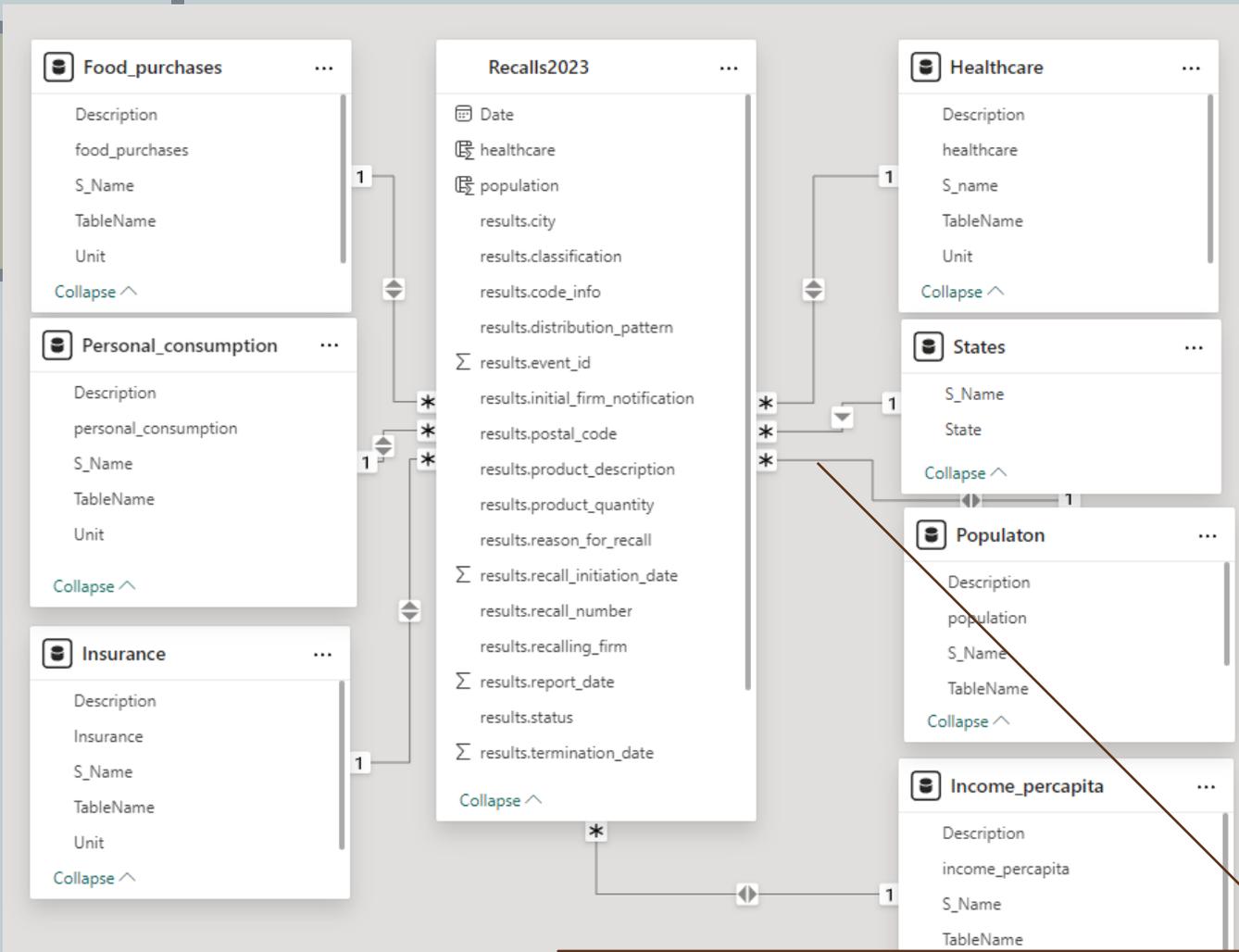


Establish relationship between tables (Data Modelling)

- 1. All tables have S_Name column which contains full names of states.**
- 2. Recalls2023 has multiple observations for a state while rest other tables one unique observation for each state.**
- 3. S_Name column can be primary key for all tables except in Recalls2023 where it can be a foreign key.**



Final Data Model and Relationships



• Right click on any relationship to get the following window.

Edit relationship

Select tables and columns that are related.

From table
Recalls2023

| recalli... | results.report... | results.status | results.termin... | results.volunt... | S_Name | State |
|------------|-------------------|----------------|-------------------|-------------------|----------|-------|
| Veds ... | 20230712 | Ongoing | null | Voluntary: Fir... | Illinois | IL |
| Veds ... | 20230712 | Ongoing | null | Voluntary: Fir... | Illinois | IL |
| Veds ... | 20230712 | Ongoing | null | Voluntary: Fir... | Illinois | IL |

To table
Healthcare

| Description | healthcare | S_name | TableName | Unit |
|-------------|------------|---------|-----------|---------|
| Health care | 6545 | Alabama | SAPCE2 | Dollars |
| Health care | 11473 | Alaska | SAPCE2 | Dollars |
| Health care | 6828 | Arizona | SAPCE2 | Dollars |

Cardinality
Many to one (*:1)

Cross-filter direction
Both

Make this relationship active Apply security filter in both directions

- Connect S_Name in all tables (except States) with S_Name in recall table to establish the relationship.
- One to may relationships are established.

Visual : Cross-Sectional Data Table

This Table visual can be exported for further analysis

| S_Name | Total Recalls | population | personal_consumption | | |
|----------------|---------------|---------------|----------------------|------|--|
| Maryland | 226 | 6,164,830.00 | 48650 | 3504 | |
| California | 125 | 38,915,992.00 | 53082 | 4233 | |
| Illinois | 99 | 12,488,984.00 | 49558 | 3955 | |
| New York | 65 | 19,513,472.00 | 53255 | 5080 | |
| Florida | 56 | 22,770,881.00 | 50689 | 5057 | |
| Washington | 55 | 7,842,949.00 | 51751 | 3837 | |
| Minnesota | 40 | 5,731,859.00 | 48615 | 4263 | |
| Texas | 36 | 30,623,333.00 | 45114 | 3547 | |
| New Mexico | 26 | 2,114,195.00 | 40028 | 3009 | |
| Georgia | 25 | 11,065,867.00 | 43482 | 3029 | |
| Michigan | 25 | 10,040,455.00 | 45591 | 4708 | |
| Vermont | 25 | 648,312.00 | 50761 | 2965 | |
| New Jersey | 23 | 9,271,324.00 | 54700 | 4338 | |
| Wisconsin | 21 | 5,911,541.00 | 45165 | 3552 | |
| Indiana | 19 | 6,868,078.00 | 42697 | 2724 | |
| Ohio | 17 | 11,763,240.00 | 44089 | 3066 | |
| Oregon | 17 | 4,230,219.00 | 47779 | 3115 | |
| Pennsylvania | 13 | 12,952,561.00 | 49040 | 4148 | |
| Missouri | 11 | 6,199,993.00 | 44990 | 3517 | |
| Massachusetts | 8 | 6,984,445.00 | 58532 | 5317 | |
| Utah | 8 | 3,432,626.00 | 42653 | 3209 | |
| New Hampshire | 5 | 1,406,478.00 | 56727 | 5401 | |
| North Carolina | 5 | 10,870,629.00 | 43959 | 3193 | |
| Virginia | 5 | 8,728,827.00 | 48249 | 3362 | |
| Idaho | 4 | 1,982,401.00 | 39739 | 3071 | |
| Iowa | 4 | 3,209,684.00 | 41758 | 2879 | |
| Louisiana | 3 | 4,560,111.00 | 42294 | 3322 | |
| Maine | 3 | 1,397,283.00 | 50559 | 2846 | |
| Tennessee | 3 | 7,157,568.00 | 42469 | 3152 | |
| Arizona | 2 | 7,475,343.00 | 44875 | 2851 | |
| Nebraska | 2 | 1,976,058.00 | 46190 | 4215 | |
| Puerto Rico | 2 | | | | |
| South Carolina | 2 | 5,394,491.00 | 43305 | 3024 | |
| Total | 986 | | | | |

Select appropriate column from Tables in Data Model



Visual: Key Influencers (Food Recall Events)

Key influencers | Top segments

What influences total_events to ?

When... **population goes up** 7940225.43 → ...the average of total_events increases by **7.03**

Analyze
total_events

Explain by
healthcare
income_percapita
Insurance
population
food_purchases
personal_consumption

On average when population increases, total_events also increases.

| Population (M) | Average of total_events |
|----------------|-------------------------|
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |
| 10 | 10 |
| 11 | 11 |
| 12 | 12 |
| 13 | 13 |
| 14 | 14 |
| 15 | 15 |
| 16 | 16 |
| 17 | 17 |
| 18 | 18 |
| 19 | 19 |
| 20 | 20 |
| 21 | 21 |
| 22 | 22 |
| 23 | 23 |
| 24 | 24 |
| 25 | 25 |
| 26 | 26 |
| 27 | 27 |
| 28 | 28 |
| 29 | 29 |
| 30 | 30 |
| 31 | 31 |
| 32 | 32 |
| 33 | 33 |
| 34 | 34 |
| 35 | 35 |
| 36 | 36 |
| 37 | 37 |
| 38 | 38 |
| 39 | 39 |
| 40 | 40 |

Visualizations
Build visual
Key influencers

Data
Search
data_recall_event
food_purchases
healthcare
income_percapita
Insurance
personal_consumption
population
S_Name
Total Recalls
total_events
Food_purchases
Description
food_purchases
S_Name
TableName
Unit
Healthcare
Description
healthcare
S_name
TableName
Unit
Income_percapita
Insurance
Personal_consumption
Populaton
Recalls2023
Table_data
food purchases

Visual: Key Influencers (Personal Consumption)

Key influencers Top segments

What influences personal_consumption to Increase ?

When...

....the average of personal_consumption increases by

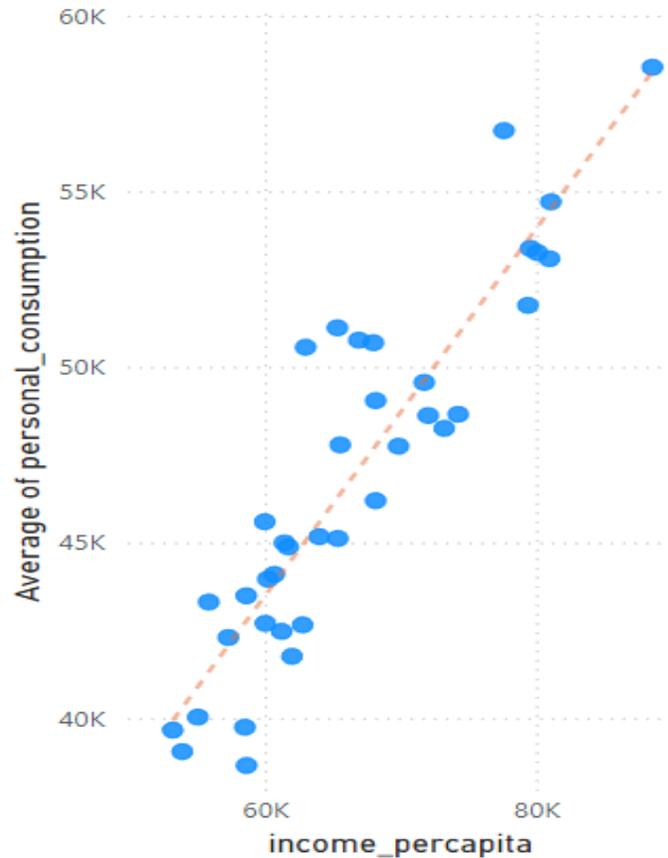
income_percapita goes up 8701.72

3.58K

Insurance goes up 742.05

589

← On average when income_percapita increases, personal_consumption also increases.



Visualizations

Build visual

Filters

Analyze

personal_consumption

Explain by

- healthcare
- income_percapita
- Insurance
- population

Expand by

Add data fields here

Drill through

Cross-report

Keep all filters

Add drill-through fields here

Visual: Smart Narratives (AI tool for explaining visual)

The image illustrates the process of generating a smart narrative in Power BI. It is divided into three numbered steps:

- 1**: The 'Visualizations' task pane is shown with the 'Narrative' icon selected under the 'Build visual' section.
- 2**: A dialog box titled 'Choose a narrative type' is displayed. It instructs the user to 'Use Copilot to create a narrative with AI, or choose Custom for more control.' and includes a link to 'Read Copilot terms'. Two buttons are present: 'Copilot (preview)' (highlighted in green) and 'Custom'.
- 3**: The 'Key influencers' visual is shown. A text box contains the generated narrative: 'personal_consumption increased the most (by 3,909.48) when income_per capita went up by 8701.72. 2 other factors also caused personal_consumption to increase, explore them in the key influencers visual.' Below the text box is a rich text editor toolbar with options for bold, italic, underline, and other formatting.



Decomposition Tree (AI based sequencing)

1

2

Visualizations >> **Data**

Build visual

Search

- Unit
- Income_percapita
- Insurance
- Personal_consumption
- Populaton
- Recalls2023
 - Date
 - Date Hierarchy
 - Year
 - Quarter
 - Month
 - Day

results.city

results.classification

results.code_info

results.distribution_pattern

Σ results.event_id

results.initial_firm_notification

results.postal_code

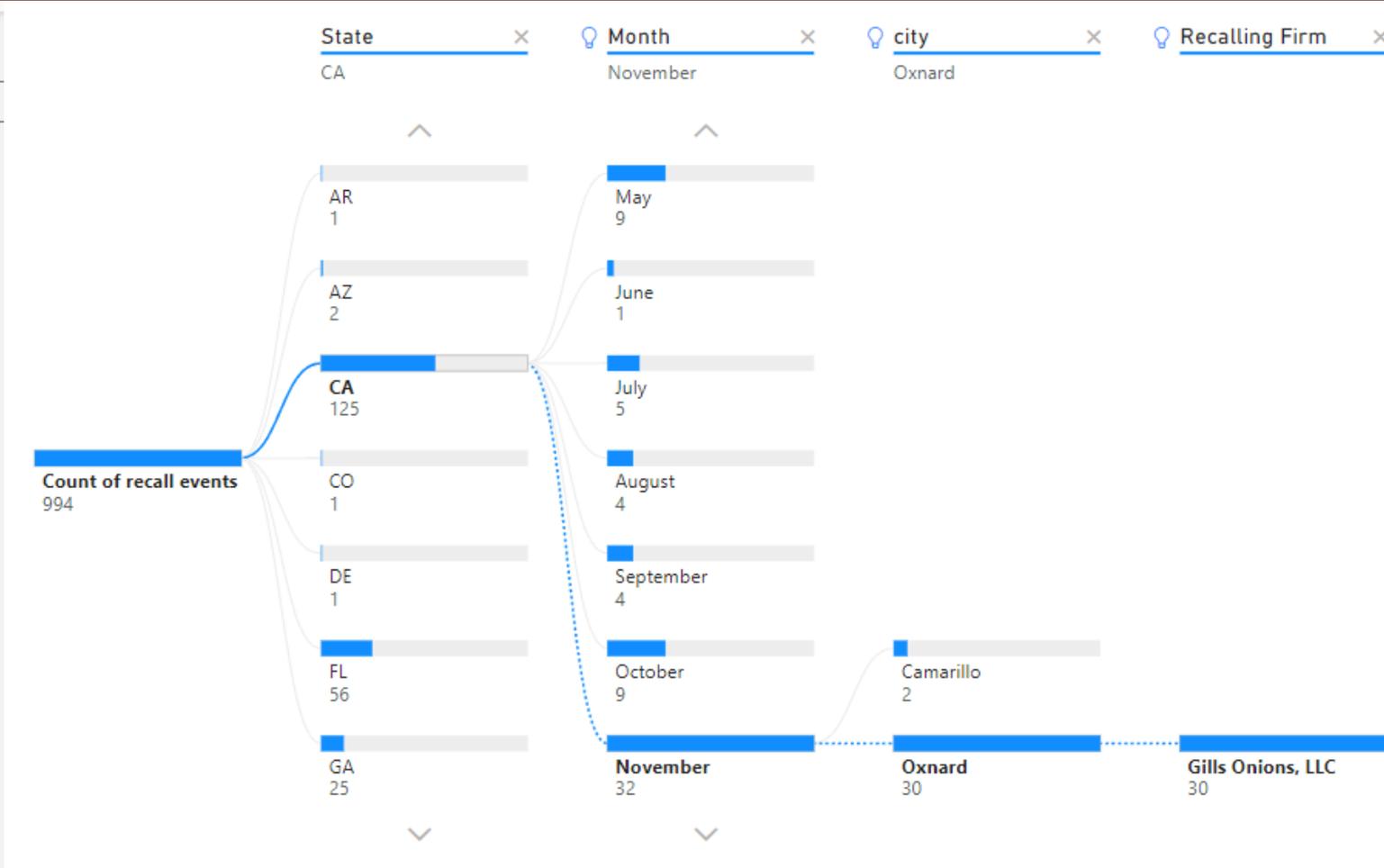
results.product_description

Analyze

Count of recall events

Explain by

- State
- Date
 - Month
- city
- Recalling Firm



Integrating Third Party Scripts (R) in Power BI

Create Correlation Heat Map

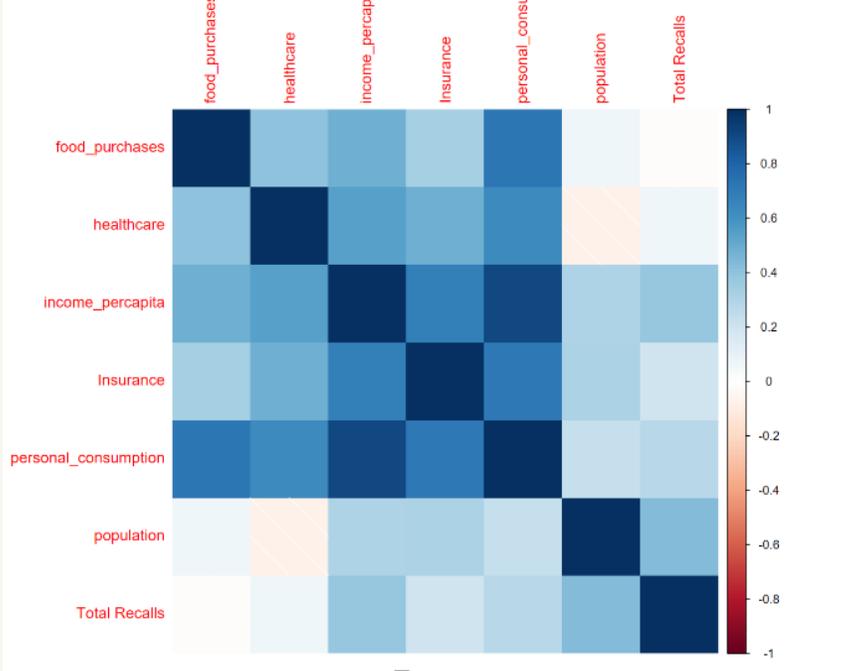
1

The screenshot shows the 'Visualizations' pane in Power BI. Under the 'Build visual' section, the 'R script visual' icon is highlighted with a tooltip that says 'R script visual'. Other visualization options like bar charts, line charts, and maps are also visible.

2

```
R script editor
⚠ Duplicate rows will be removed from the data.
1 # The following code to create a dataframe and remove duplicated rows is always executed and acts as a preamble for your script:
2
3 # dataset <- data.frame(food_purchases, healthcare, income_percapita, Insurance, personal_consumption, population)
4 # dataset <- unique(dataset)
5
6 # Paste or type your script code here:
7 #install.packages("corrplot")
8 library(corrplot)
9 corrplot(cor(dataset),
10 method = "shade", type = "full", diag = TRUE, t1.col = "black", bg = "white", title = "", col = NULL)
11
```

3





Visualization training and learning resources

POWER BI

- [Power BI Learning Overview | Microsoft Power BI](#)
- [Power BI documentation - Power BI | Microsoft Learn](#)
- [Microsoft Certified: Power BI Data Analyst Associate - Certifications | Microsoft Learn](#)
- [Power BI: Online Courses, Training and Tutorials | LinkedIn Learning](#)

TABLEAU

- [Free Training Videos - 2023.2 \(tableau.com\)](#)
- [Certification \(tableau.com\)](#)
- [eLearning: Tableau Web-Based Training](#)



THANK YOU



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