



# **OLAP Analysis with PowerBI**

## **Fundamentals of Business Intelligence**

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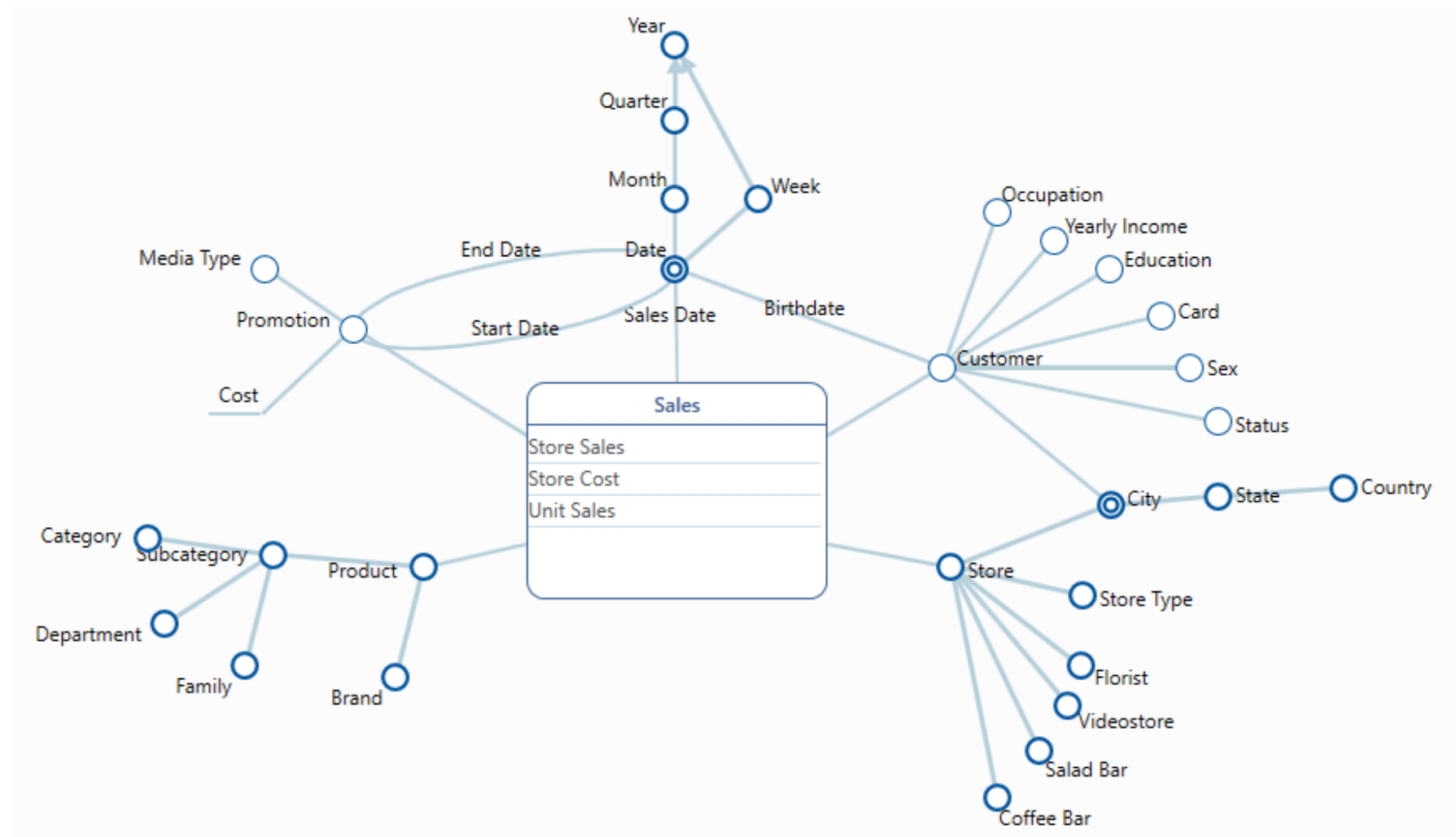
2024/2025

**BOLOGNA BUSINESS SCHOOL**  
Alma Mater Studiorum Università di Bologna

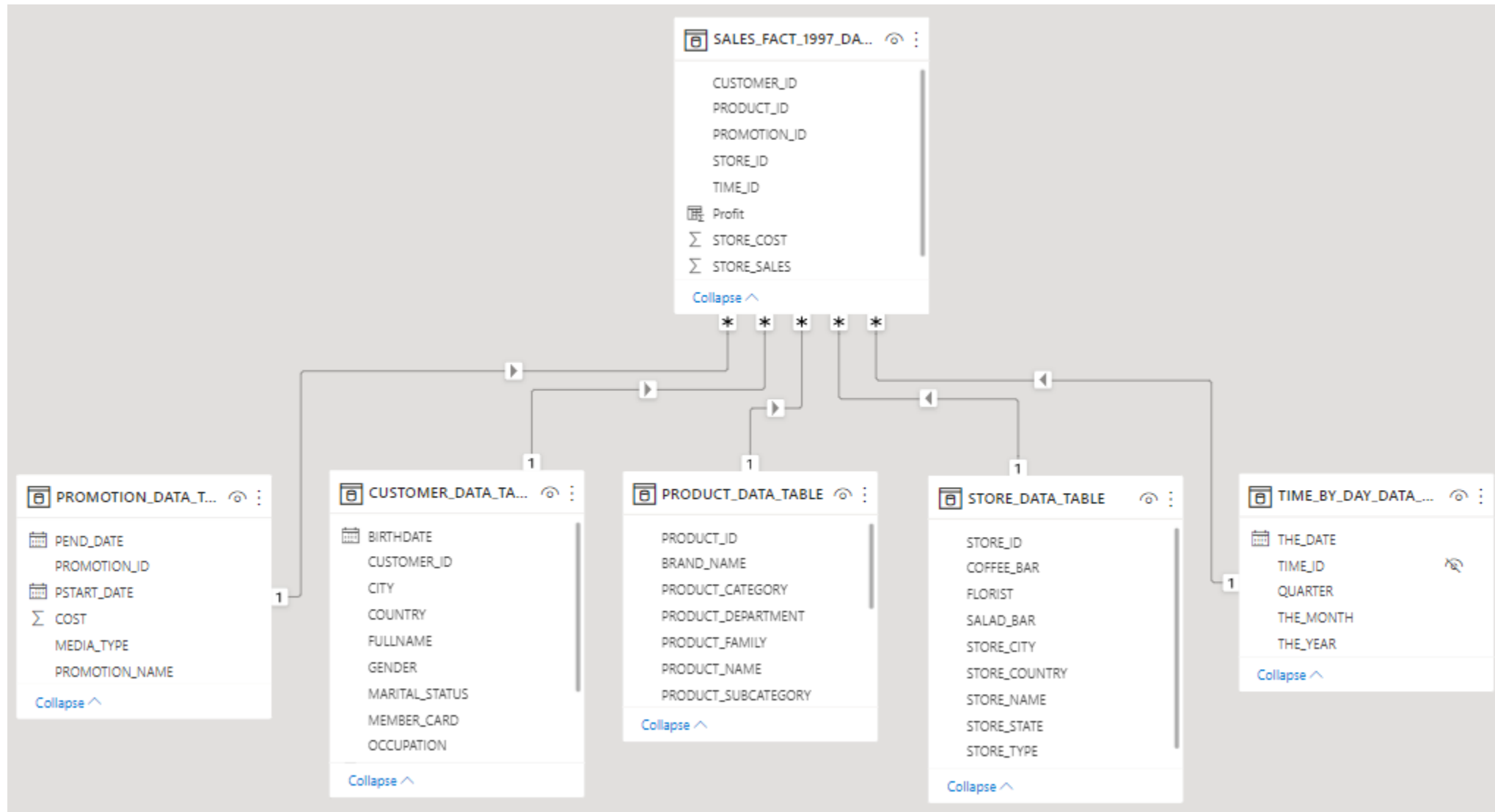
# Use case

Foodmart

# DFM – Foodmart



# Database Structure – Foodmart (Sales)



# Database Structure – Foodmart (Sales)

	PROMOTION_ID	PROMOTION_NAME	MEDIA_TYPE	COST	PSTART_DATE	PEND_DATE
1	532	Weekend Markdown	Bulk Mail	14997	1998-03-10 00:00:00	1998-03-13 00:00:00
2	533	Shelf Clearing Days	Sunday Paper, Radio, TV	10196	1998-03-24 00:00:00	1998-03-27 00:00:00
3	534	Mystery Sale	Daily Paper, Radio	6884	1998-04-07 00:00:00	1998-04-10 00:00:00
4	535	Mystery Sale	Street Handout	8527	1998-04-22 00:00:00	1998-04-23 00:00:00
5	536	Bye Bye Baby	Daily Paper, Radio, TV	5816	1998-05-06 00:00:00	1998-05-09 00:00:00
6	537	Big Time Discounts	Daily Paper, Radio, TV	14641	1998-05-21 00:00:00	1998-05-23 00:00:00
7	538	Saving Days	Sunday Paper, Radio, TV	6711	1998-06-04 00:00:00	1998-06-05 00:00:00
8	539	High Roller Savings	Sunday Paper, Radio, TV	9555	1998-06-17 00:00:00	1998-06-19 00:00:00
9	540	Mystery Sale	Cash Register Handout	8553	1998-07-02 00:00:00	1998-07-04 00:00:00
10	541	Price Winners	Sunday Paper, Radio	12251	1998-07-17 00:00:00	1998-07-18 00:00:00
11	542	Green Light Special	Street Handout	12358	1998-07-31 00:00:00	1998-08-01 00:00:00
12	543	Fantastic Discounts	Radio	13746	1998-08-12 00:00:00	1998-08-14 00:00:00
13	544	Saving Days	Product Attachment	8326	1998-08-28 00:00:00	1998-08-29 00:00:00
14	545	Two for One	Daily Paper	6887	1998-08-11 00:00:00	1998-08-14 00:00:00

PROMOTION_DATA_T...
PEND_DATE
PROMOTION_ID
PSTART_DATE
COST
MEDIA_TYPE
PROMOTION_NAME
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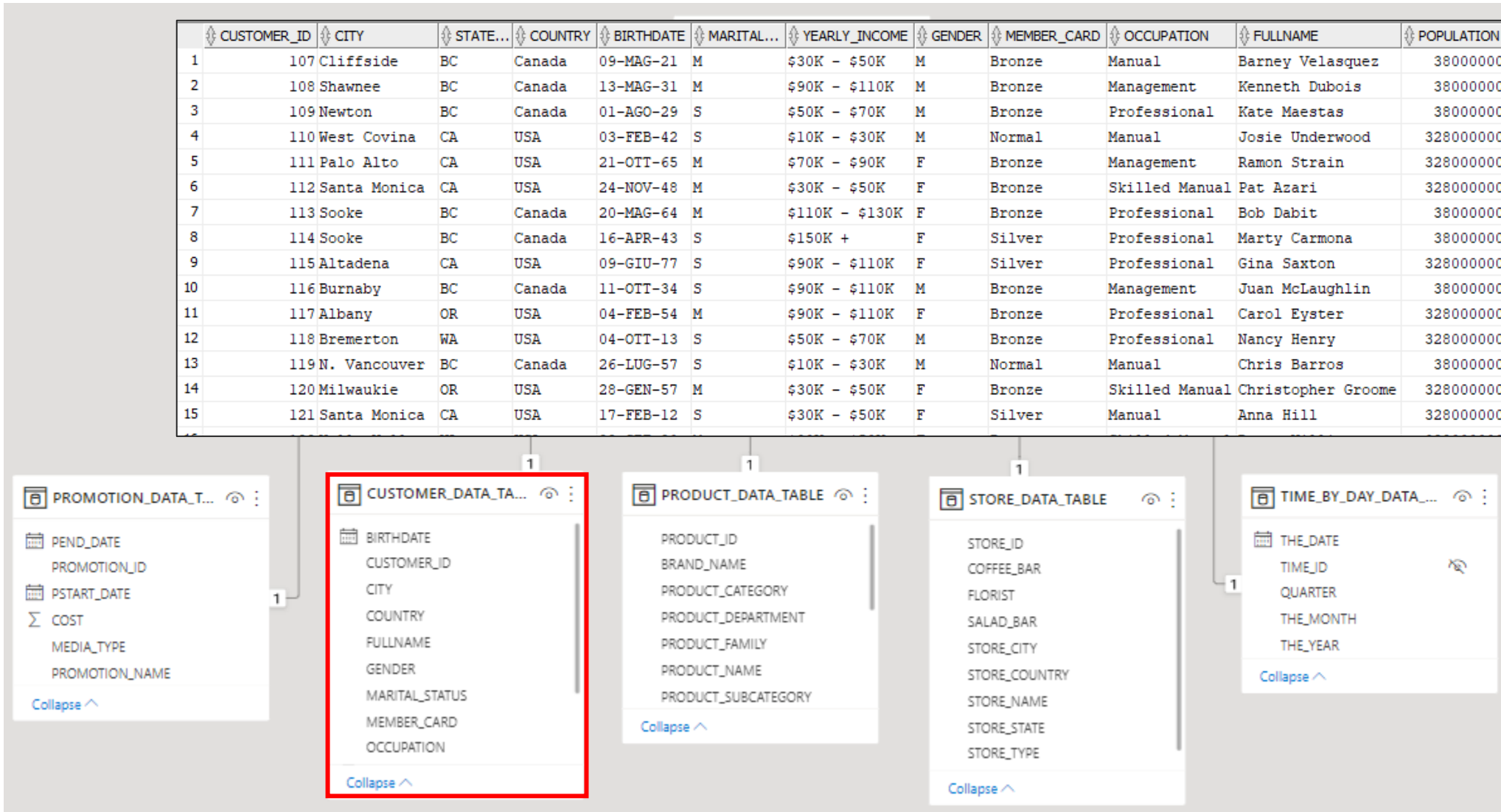
CUSTOMER_DATA_TA...
BIRTHDATE
CUSTOMER_ID
CITY
COUNTRY
FULLNAME
GENDER
MARITAL_STATUS
MEMBER_CARD
OCCUPATION
<a href="#">Collapse ^</a>

PRODUCT_DATA_TABLE
PRODUCT_ID
BRAND_NAME
PRODUCT_CATEGORY
PRODUCT_DEPARTMENT
PRODUCT_FAMILY
PRODUCT_NAME
PRODUCT_SUBCATEGORY
<a href="#">Collapse ^</a>

STORE_DATA_TABLE
STORE_ID
COFFEE_BAR
FLORIST
SALAD_BAR
STORE_CITY
STORE_COUNTRY
STORE_NAME
STORE_STATE
STORE_TYPE
<a href="#">Collapse ^</a>

TIME_BY_DAY_DATA...
THE_DATE
TIME_ID
QUARTER
THE_MONTH
THE_YEAR
<a href="#">Collapse ^</a>

# Database Structure – Foodmart (Sales)



# Database Structure – Foodmart (Sales)

	PRODUCT_ID	BRAND_NAME	PRODUCT_NAME	PRODUCT_SUBCATEGORY	PRODUCT_CATEGORY	PRODUCT_DEPARTMENT	PRODUCT_FAMILY
1	1	Washington	Washington Berry Juice	Juice	Pure Juice Beverages	Beverages	Drink
2	2	Washington	Washington Mango Drink	Flavored Drinks	Drinks	Beverages	Drink
3	3	Washington	Washington Strawberry Drink	Flavored Drinks	Drinks	Beverages	Drink
4	4	Washington	Washington Cream Soda	Soda	Carbonated Beverages	Beverages	Drink
5	5	Washington	Washington Diet Soda	Soda	Carbonated Beverages	Beverages	Drink
6	6	Washington	Washington Cola	Soda	Carbonated Beverages	Beverages	Drink
7	7	Washington	Washington Diet Cola	Soda	Carbonated Beverages	Beverages	Drink
8	8	Washington	Washington Orange Juice	Juice	Pure Juice Beverages	Beverages	Drink
9	9	Washington	Washington Cranberry Juice	Juice	Pure Juice Beverages	Beverages	Drink
10	10	Washington	Washington Apple Juice	Juice	Pure Juice Beverages	Beverages	Drink
11	11	Washington	Washington Apple Drink	Flavored Drinks	Drinks	Beverages	Drink
12	12	Jeffers	Jeffers Oatmeal	Cereal	Breakfast Foods	Breakfast Foods	Food
13	13	Jeffers	Jeffers Corn Puffs	Cereal	Breakfast Foods	Breakfast Foods	Food
14	14	Jeffers	Jeffers Wheat Puffs	Cereal	Breakfast Foods	Breakfast Foods	Food
15	15	Jeffers	Jeffers Grits	Cereal	Breakfast Foods	Breakfast Foods	Food

PROMOTION_DATA_T...
PEND_DATE
PROMOTION_ID
PSTART_DATE
COST
MEDIA_TYPE
PROMOTION_NAME
Collapse ^

CUSTOMER_DATA_TA...
BIRTHDATE
CUSTOMER_ID
CITY
COUNTRY
FULLNAME
GENDER
MARITAL_STATUS
MEMBER_CARD
OCCUPATION
Collapse ^

PRODUCT_DATA_TABLE
PRODUCT_ID
BRAND_NAME
PRODUCT_CATEGORY
PRODUCT_DEPARTMENT
PRODUCT_FAMILY
PRODUCT_NAME
PRODUCT_SUBCATEGORY
Collapse ^

STORE_DATA_TABLE
STORE_ID
COFFEE_BAR
FLORIST
SALAD_BAR
STORE_CITY
STORE_COUNTRY
STORE_NAME
STORE_STATE
STORE_TYPE
Collapse ^

TIME_BY_DAY_DATA...
THE_DATE
TIME_ID
QUARTER
THE_MONTH
THE_YEAR
Collapse ^

# Database Structure – Foodmart (Sales)

	STORE_ID	STORE_TYPE	STORE_NAME	STORE_CITY	STORE_STATE	STORE_COUNTRY	COFFEE_BAR	VIDEO_STORE	SALAD_BAR	FLORIST
1	1	Supermarket	Store 1	Acapulco	Guerrero	Mexico	0	0	0	0
2	2	Small Grocery	Store 2	Bellingham	WA	USA	1	0	0	0
3	3	Supermarket	Store 3	Bremerton	WA	USA	0	0	1	0
4	4	Gourmet Supermarket	Store 4	Camacho	Zacatecas	Mexico	1	0	1	1
5	5	Small Grocery	Store 5	Guadalajara	Jalisco	Mexico	1	0	0	0
6	6	Gourmet Supermarket	Store 6	Beverly Hills	CA	USA	1	1	1	1
7	7	Supermarket	Store 7	Los Angeles	CA	USA	0	0	0	1
8	8	Deluxe Supermarket	Store 8	Merida	Yucatan	Mexico	1	1	1	1
9	9	Mid-Size Grocery	Store 9	Mexico City	DF	Mexico	0	0	0	0
10	10	Supermarket	Store 10	Orizaba	Veracruz	Mexico	0	0	1	0
11	11	Supermarket	Store 11	Portland	OR	USA	0	0	0	0
12	12	Deluxe Supermarket	Store 12	Hidalgo	Zacatecas	Mexico	1	1	1	1
13	13	Deluxe Supermarket	Store 13	Salem	OR	USA	1	1	1	1
14	14	Small Grocery	Store 14	San Francisco	CA	USA	1	0	0	0
15	15	Supermarket	Store 15	Seattle	WA	USA	1	0	0	0
16	16	Supermarket	Store 16	Spokane	WA	USA	0	0	0	0

PROMOTION_DATA_TABLE
PEND_DATE
PROMOTION_ID
PSTART_DATE
COST
MEDIA_TYPE
PROMOTION_NAME
<a href="#">Collapse ^</a>

CUSTOMER_DATA_TABLE
BIRTHDATE
CUSTOMER_ID
CITY
COUNTRY
FULLNAME
GENDER
MARITAL_STATUS
MEMBER_CARD
OCCUPATION
<a href="#">Collapse ^</a>

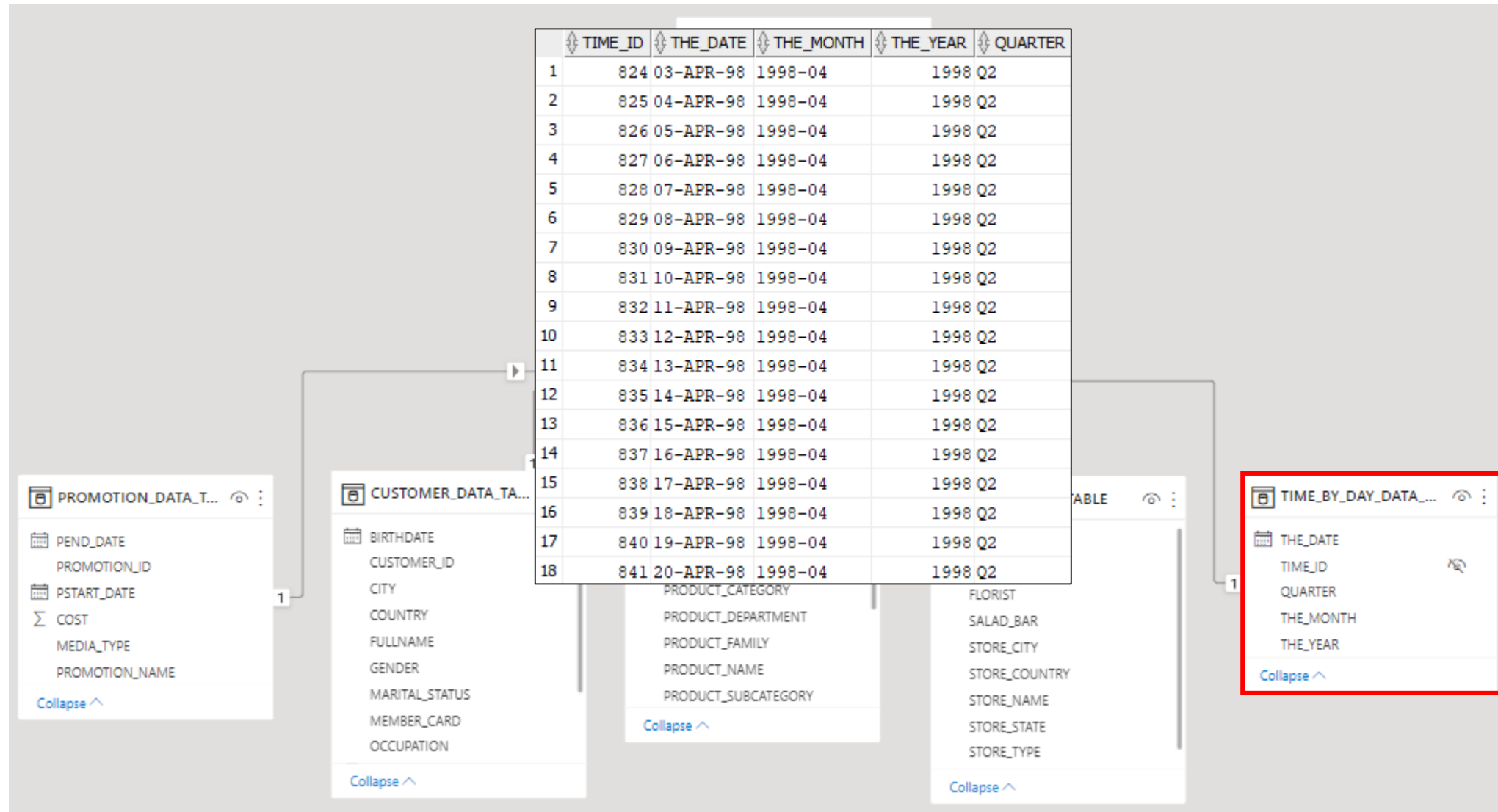
PRODUCT_DATA_TABLE
PRODUCT_ID
BRAND_NAME
PRODUCT_CATEGORY
PRODUCT_DEPARTMENT
PRODUCT_FAMILY
PRODUCT_NAME
PRODUCT_SUBCATEGORY
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STORE_DATA_TABLE
STORE_ID
COFFEE_BAR
FLORIST
SALAD_BAR
STORE_CITY
STORE_COUNTRY
STORE_NAME
STORE_STATE
STORE_TYPE
<a href="#">Collapse ^</a>

TIME_BY_DAY_DATA_TABLE
THE_DATE
TIME_ID
QUARTER
THE_MONTH
THE_YEAR
<a href="#">Collapse ^</a>



# Database Structure – Foodmart (Sales)



# Database Structure – Foodmart (Sales)

**SALES\_FACT\_1997\_DA...**

- CUSTOMER\_ID
- PRODUCT\_ID
- PROMOTION\_ID
- STORE\_ID
- TIME\_ID
- Profit
- Σ STORE\_COST
- Σ STORE\_SALES
- [Collapse ^](#)

	PRODUCT_ID	TIME_ID	CUSTOMER_ID	PROMOTION_ID	STORE_ID	STORE_SALES	STORE_COST	UNIT_SALES
1	1	369	4728	501	7	11,4	3,99	4
2	1	377	9788	1547	13	8,55	4,0185	3
3	1	414	6666	34	17	8,55	4,1895	3
4	1	440	5313	413	24	8,55	3,762	3
5	1	463	916	302	7	11,4	4,902	4
6	1	474	4461	1839	11	8,55	2,9925	3
7	1	489	1312	162	3	8,55	3,6765	3
8	1	500	9169	1435	23	11,4	5,358	4
9	1	529	5607	501	6	11,4	4,902	4
10	1	534	456	828	15	11,4	4,332	4
11	1	570	923	30	15	8,55	2,736	3
12	1	574	9358	1097	15	8,55	4,275	3
13	1	576	7704	486	3	5,7	2,508	2
14	1	590	3441	131	3	8,55	3,42	3
15	1	594	6248	1860	24	11,4	3,876	4
16	1	596	5929	496	15	14,25	5,5575	5
17	1	616	1565	116	24	8,55	4,1895	3
18	1	617	638	1038	11	8,55	2,9925	3

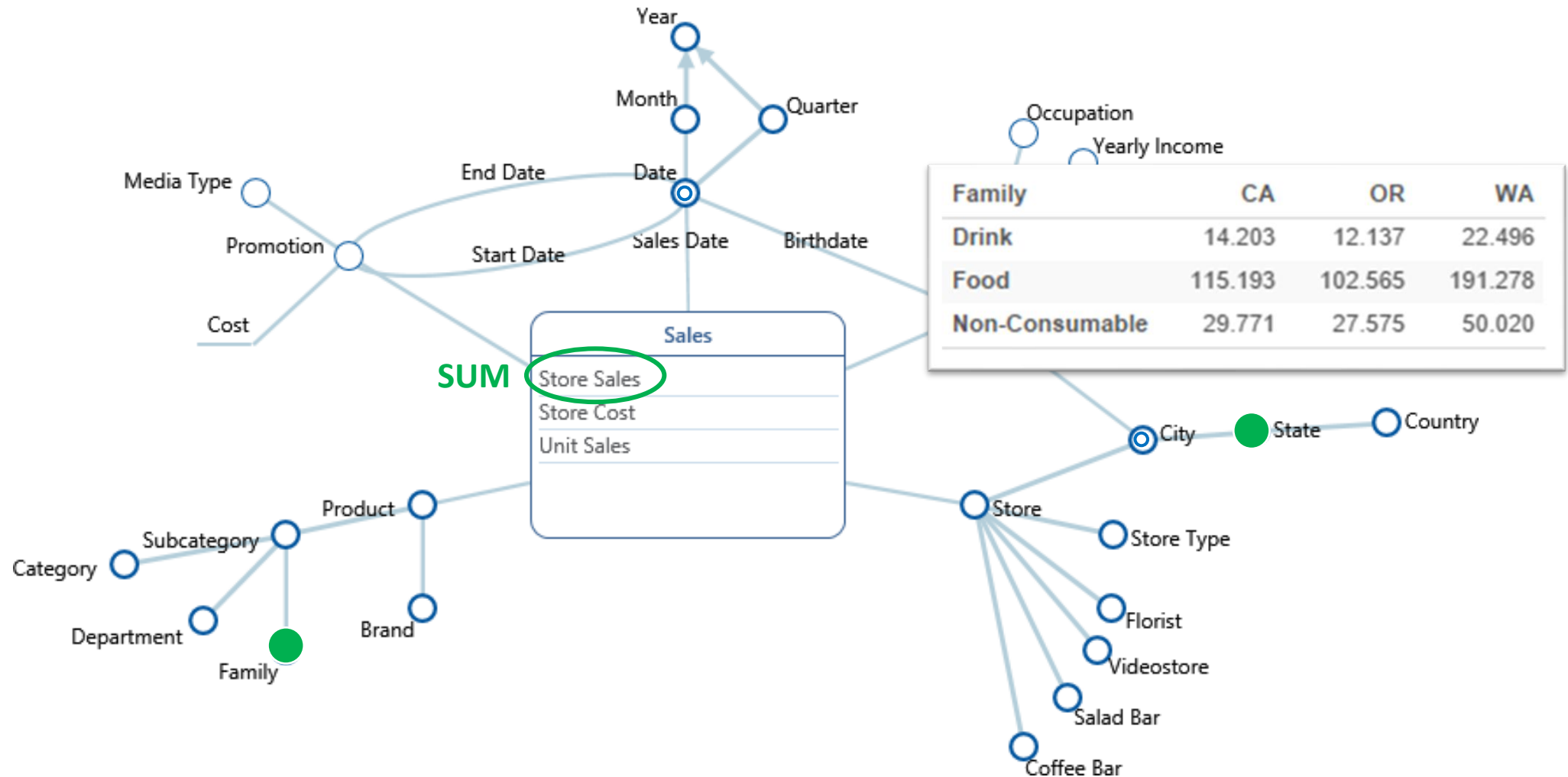
**PROMOTION\_DATA\_T...**

- PEND\_DATE
- PROMOTION\_ID
- PSTART\_DATE
- Σ COST
- MEDIA\_TYPE
- PROMOTION\_NAME
- [Collapse ^](#)

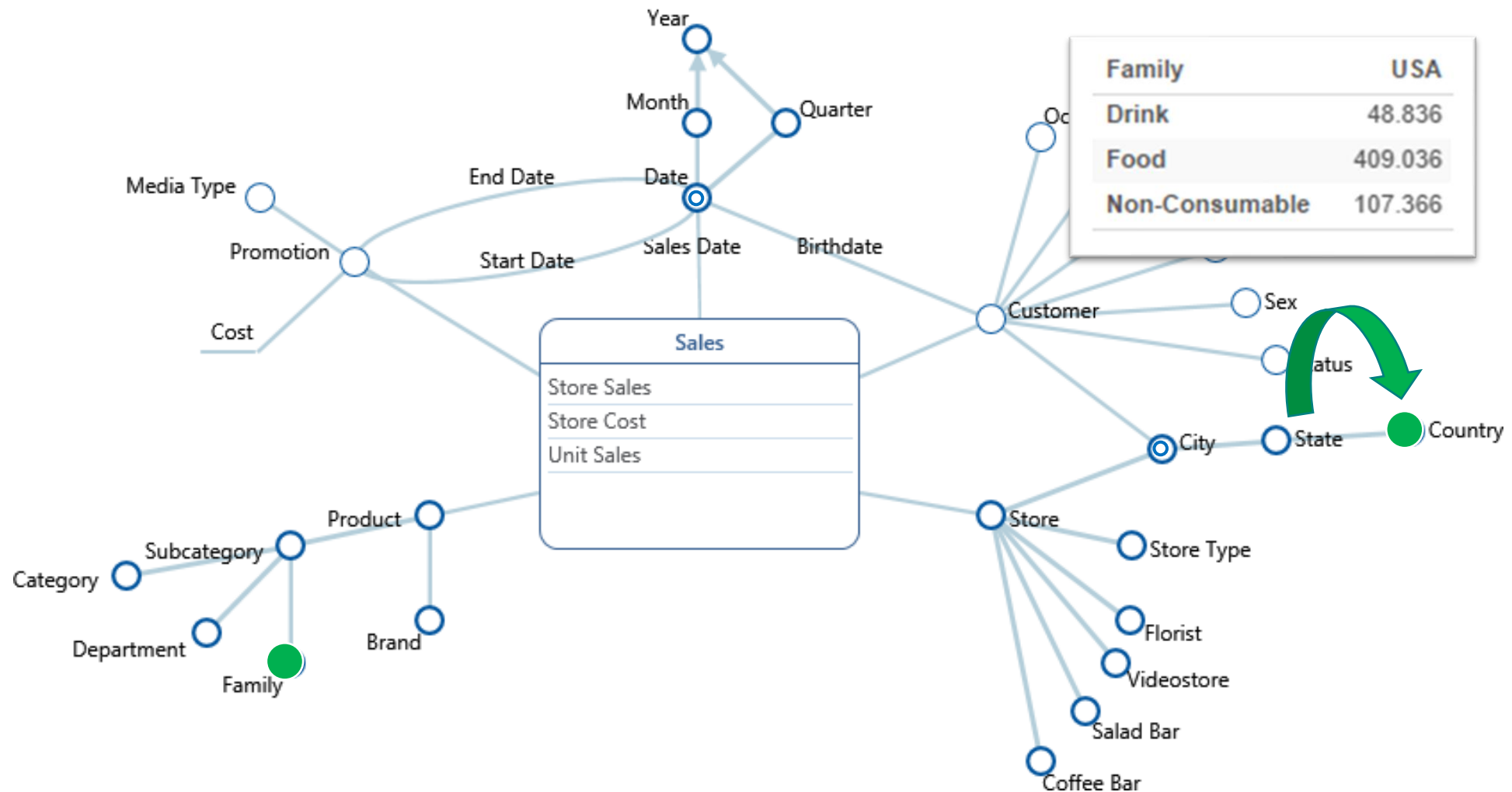
**TIME\_BY\_DAY\_DATA...**

- THE\_DATE
- TIME\_ID
- QUARTER
- THE\_MONTH
- THE\_YEAR
- [Collapse ^](#)

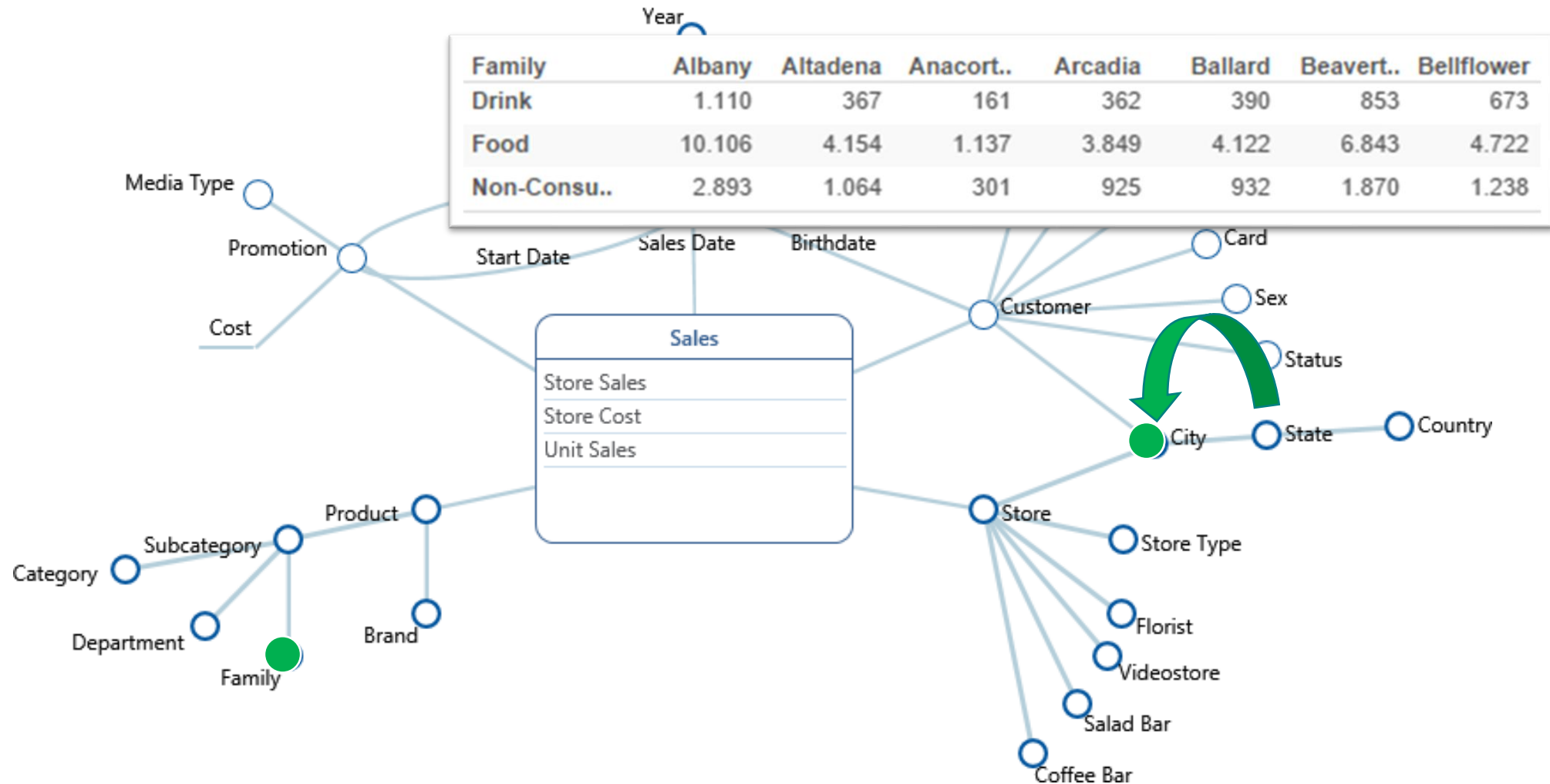
# OLAP query



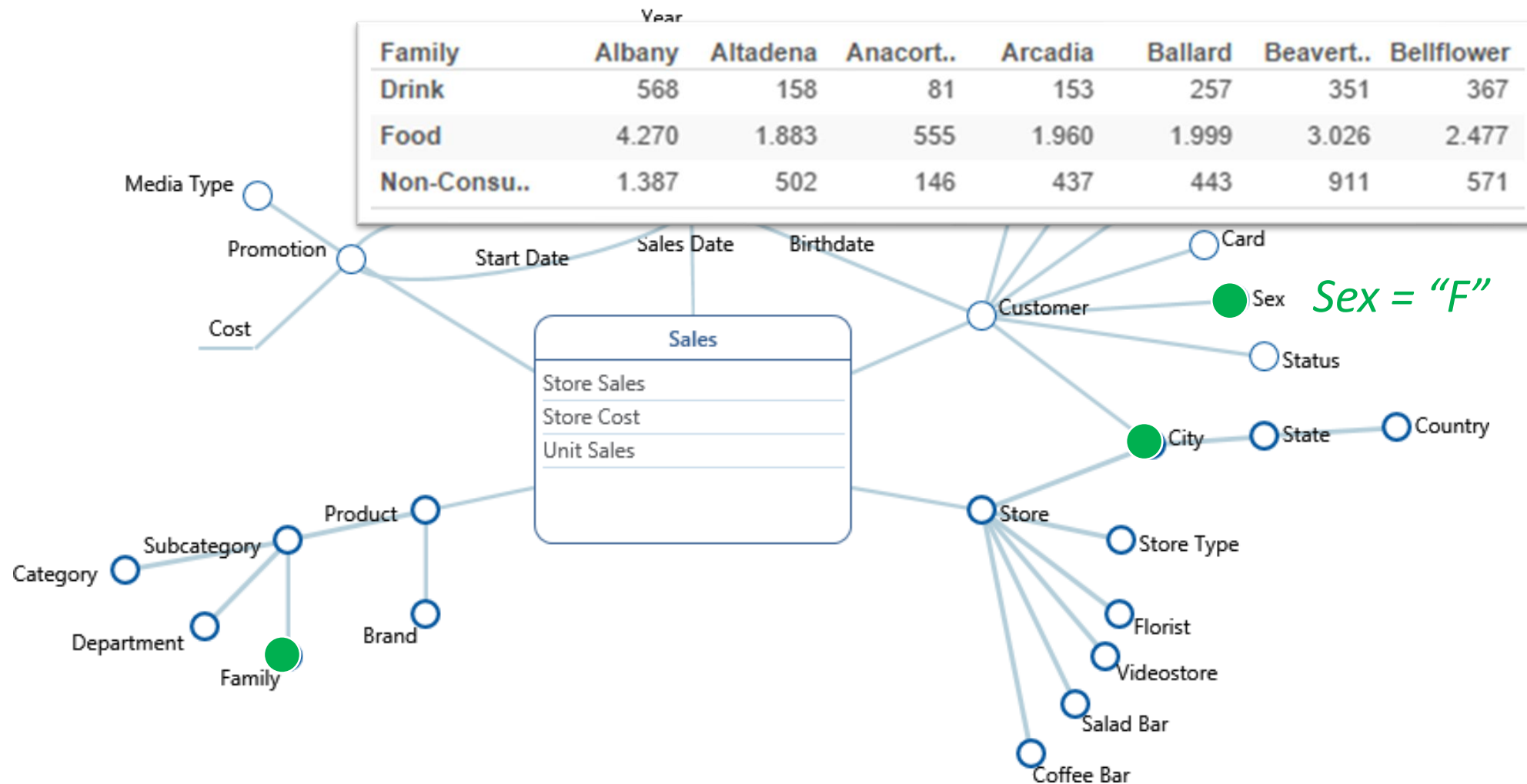
# OLAP Operators: Roll-Up



# OLAP Operators: Drill-down



# OLAP Operators: Slice & Dice



# Exercises - Part I

Setup the data on PowerBI

# Exercise 0

- Open the CSV files on PowerBI
- Setup the relationships between the files
- Clean the data
  - Check the month
  - Remove wrong sales
  - IDs or names?
  - Hide unused fields
- Create hierarchies



# Exercises - Part II

Familiarize with PowerBI querying functionalities

# Exercise 1

- Use a bar chart to plot the total sum of *STORE\_SALES* for each *STORE\_STATE*
  - Which one is the state with the highest sales?
- Apply a drill-down operation to show the sales at the *STORE\_CITY* level
  - Are there cities whose sales are much lower than the others'?
- How many stores are there in each *STORE\_STATE*? In each *STORE\_CITY*?
  - Color the bars based on the *Count(Distinct)* summarization function over the *STORE\_NAME* attribute
  - Would it be reasonable to say that cities with fewer stores also have lower total sales?

## Exercise 2

- Use a bar chart to plot the total sum of *STORE\_SALES* by *STORE\_CITY* and assign the *STORE\_TYPE* to the Legend property
  - Can you notice any interesting pattern?
- Use a bar chart to plot the total sum of *STORE\_SALES* by *STORE\_TYPE*
  - Assign the number of stores to the color property
  - Is the result surprising/expected?

# Exercise 3

- Use a line chart to plot the monthly sales trend
  - Any interesting pattern?
- Split the previous chart by *STORE\_STATE*
  - Put the *STORE\_STATE* in the Legend
  - Does the previous pattern hold for each state?
- Visualise the impact of each *STORE\_FAMILY* on the total sales while still showing the monthly trends
  - Use a Stacked area chart, where the *STORE\_STATE* is in the Small multiples and the *PRODUCT\_FAMILY* in the Legend

# Exercise 4

- Analyze sales by *STORE\_TYPE* (sorted by descending order)
- Drill-down to the stores
- Add the number of customers
  - Use the *Count(Distinct)* summarization function
  - In case of wrong calculation (i.e., if you get the same value in all rows):
    - Go back to the Model
    - Double-click the relationships between CUSTOMER and SALES
    - Set the *Cross filter direction* to *Both*
- Add the average sales per customer
  - Create a new measure, calculated by dividing the sum of store sales by the count of distinct customers

# Exercise 5

- Create a table to visualize the sales for each *OCCUPATION* (*Customer* dimension)
- Exclude (i.e., filter out) the tuples where the value of *STORE\_SALES* is lower than 5
- Apply another filter (in addition to the previous one) to exclude all occupations where the total sales is lower than 80K

# Exercise 6

- Create a table to visualize with the top ten customers by total sales
  - Show both *CUSTOMER\_ID* and *FULLNAME*
- Add the *Occupation* field
- Turn it into a matrix (without the *FULLNAME*)
- Add a measure on the Customer table calculating a ranking of customers
  - First, declare a new measure simply calculating the sum of *STORE\_SALES*
  - Then, declare a new measure calculating the RANKX, where
    - The 1st parameter is the attribute that we want to order, i.e., the *CUSTOMER\_ID*
    - The 2nd parameter is the measure to be used for ordering, i.e., the one declared above
- Take the first ten customers for each occupation by filtering on the rank

# Exercise 7

- Create a histogram of StoreSales
  - Right-click on *STORE\_SALES* > New group > Create bins of size 2
  - Create a bar chart showing the count of records for each bin
- Use the same binning to plot a bar chart with the average *STORE\_COST* for each bin
  - Do you see a correlation in the data?
- Plot the same result as a scatter chart
  - Find the chart in the list of visuals
  - Put *STORE\_COST* and *STORE\_SALES* on X and Y axis, respectively (without summarizing)



# Exercise 8

- Create a new column calculating the profits
  - $PROFIT = STORE\_SALES - STORE\_COST$
- Create a line chart showing the monthly trend of profits, sales, and costs

# Part III

Open exploration of the cube

# Exercise 9

- Goal: describe sales from the perspective of customers
- Some hints:
  - Check distribution of sales (or profits) with respect to different attributes
  - Are there correlations between sales and number of customers?
  - Create bins where necessary (e.g., population)
  - Try some combinations of attributes (e.g., with the stacked bar chart)
  - Calculate the age of customers from their birthdate
    - A new column must be defined
    - `<newColumn> = DATEDIFF(<date1>, <date2>, YEAR)`

# Exercise 10

- Goal: correlate sales between customer and product attributes
- Some hints:
  - Are sales of the different product families equally distributed among genders?
    - Explore the whole hierarchy using drill-down and roll-up functionalities
  - Rank brands by yearly income of customers
    - Show the top-3 brands for each yearly income
    - Plot ranks in a matrix
      - Possibly add "Background color" to "Cell elements" to make it a heatmap

# References

Doc: <https://docs.microsoft.com/en-us/power-bi/fundamentals/>

A *lot* of YouTube videos

