



**Andrii Kopp, Ph.D.**



**Dmytro Orlovskyi, Ph.D.**

# “Advanced Informative and Understandable Data Visualization Techniques”

**Andrii Kopp, Ph.D., Senior Lecturer**

[kopp93@gmail.com](mailto:kopp93@gmail.com)

**Dmytro Orlovskyi, Ph.D., Associate Professor**

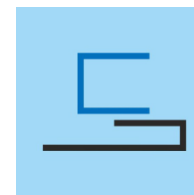
[orlovskyi.dm@gmail.com](mailto:orlovskyi.dm@gmail.com)

National Technical University “Kharkiv Polytechnic Institute”

Department of Software Engineering and Management  
Information Technologies

Kharkiv, Ukraine

# SEMIT

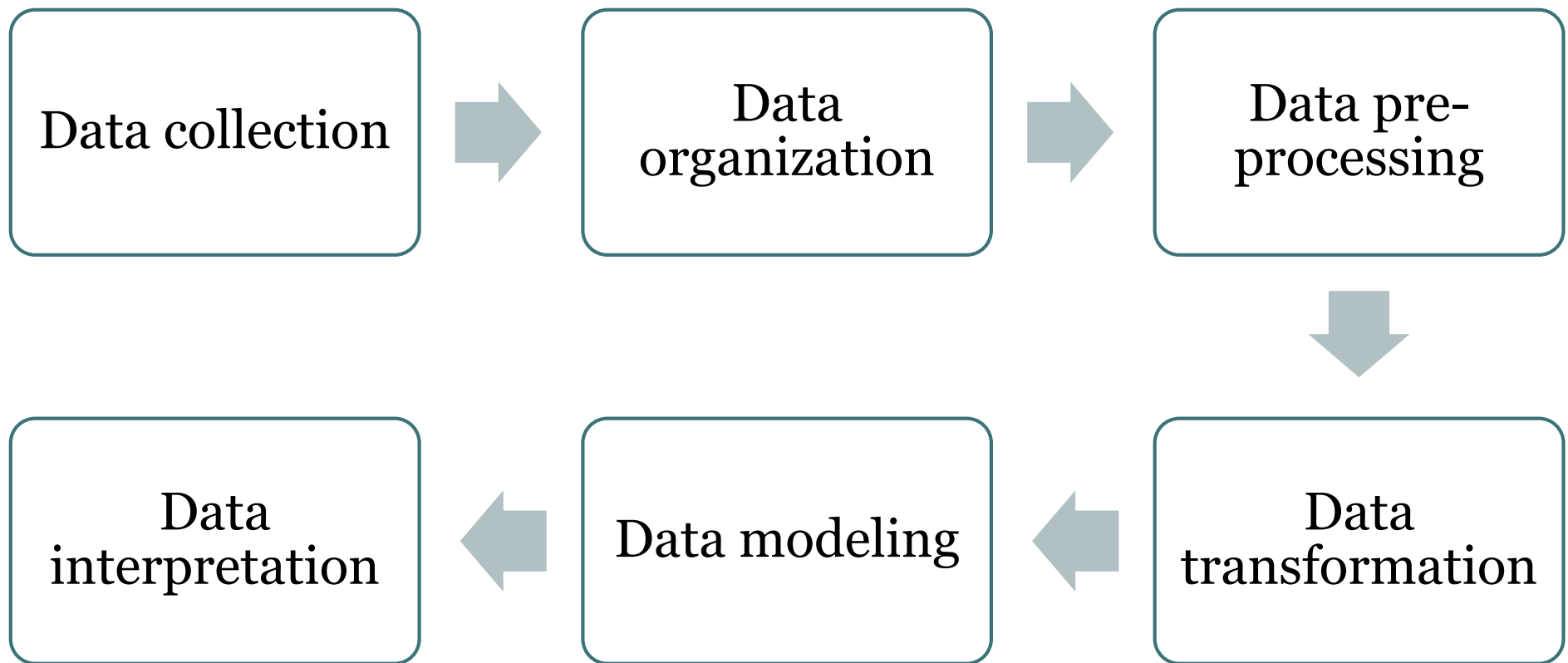


Computer Science  
& Software  
Engineering Faculty

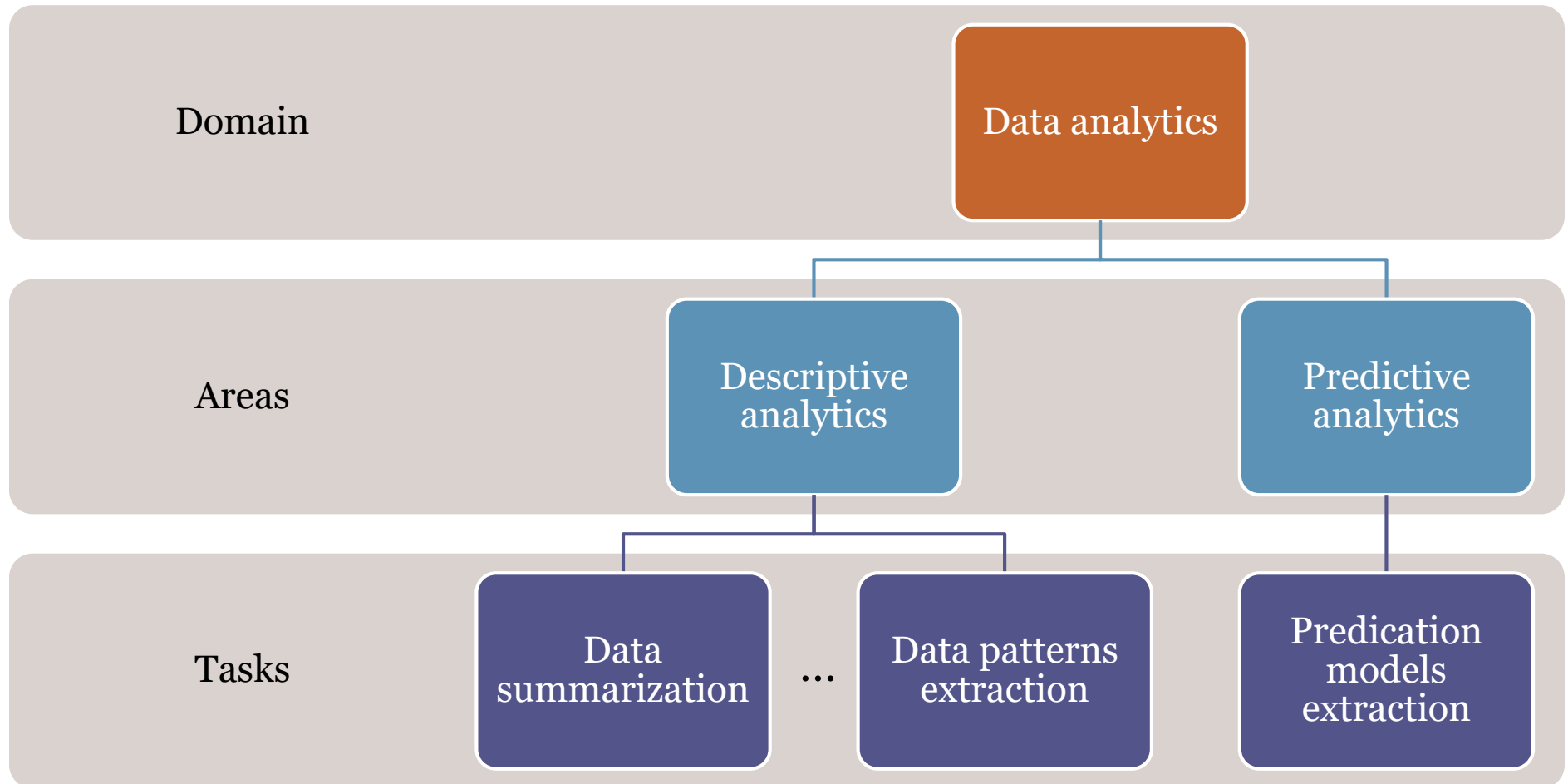
# Relevance

- Small companies and large corporations, government institutions and municipal administrations should have permanent access to analytical reports in order to analyze organizational performance and make necessary decisions
- Therefore, IT (Information Technology) solutions that may help to design software applications for data analytics, visualization, and data-driven decision making are in high demand nowadays

# Data Analytics Process



# Data Analytics Areas



# Data-driven Decision Making



# Business Intelligence (BI)

- Business Intelligence (BI) is an umbrella term, which covers reports, scorecards, dashboards, notification alerts, predefined user-specified queries, ad hoc queries, multidimensional analyses, statistical analyses, prediction, and simulation models
- All of these are BI capabilities that help business users to make vital business decisions in order to reduce costs, increase revenues, etc.

# Data Warehouses

- Data warehouses are specialized databases used to store records about transactions, products, customers, performance metrics, financial results, etc.
- Such business information is collected over multiple years in order to be used for analytical purposes
- Data analytics methods and models use data volumes stored in data warehouses to provide statistical analysis, predictions, and simulation results to stakeholders (business users that require such data insights)
- “A warehouse (Data Warehouse – DW) is a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management’s decision-making process”

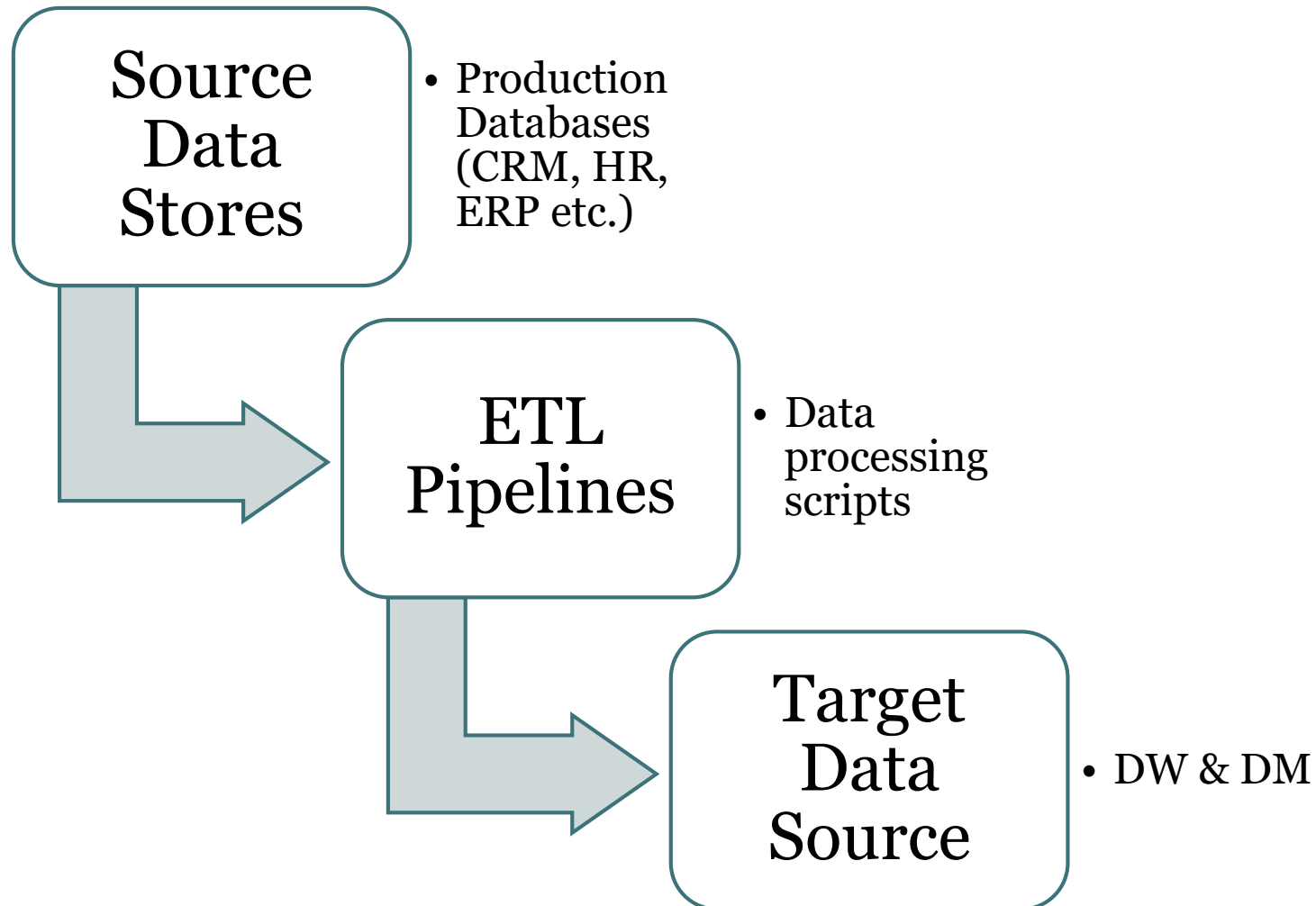
*Bill Inmon*

# Core BI Capabilities





# ETL Technology



# Data Marts (DM) vs. Data Warehouses (DW)

## DM



- Relational or Wide-column databases
- Dimensional data model
- Limited domains (e.g. “Sales”, “Marketing”, “Procurement” etc.)
- Depend on data warehouses

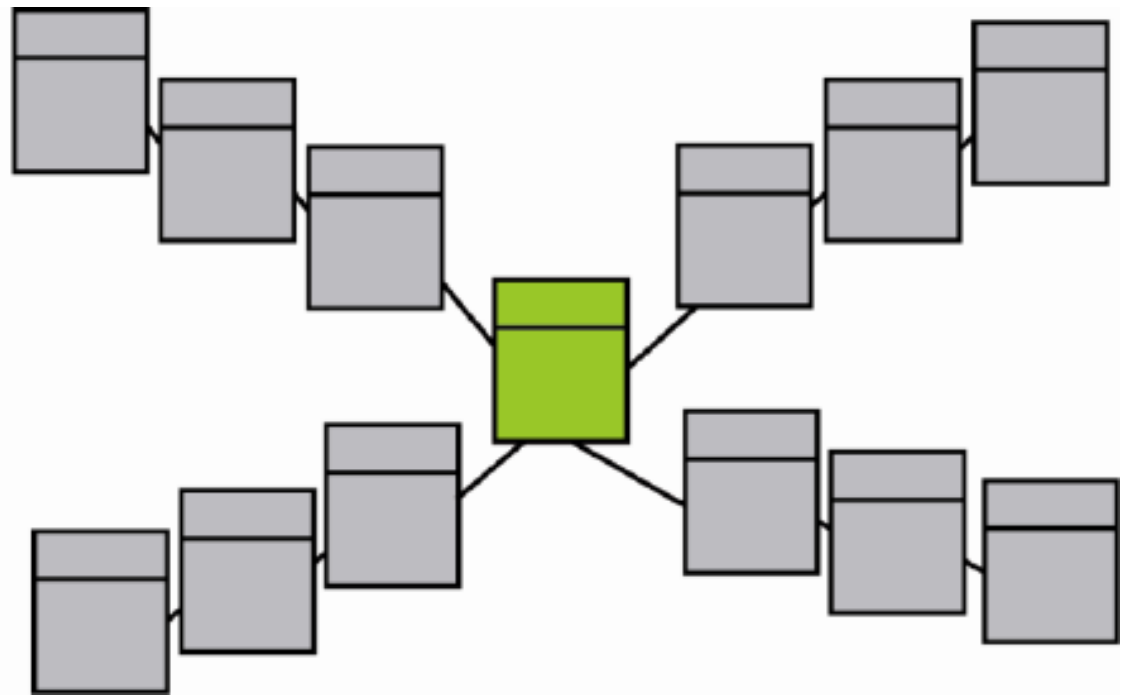
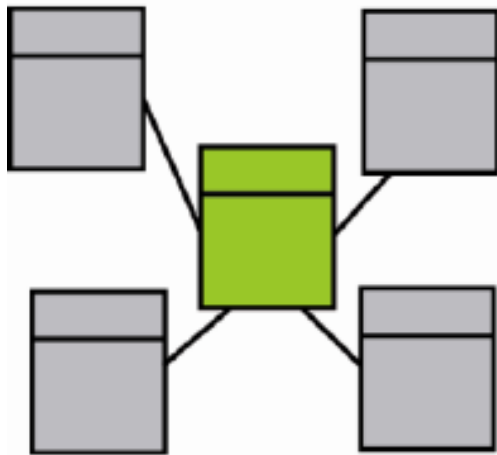
## DW



- Relational or Wide-column databases
- Dimensional data model

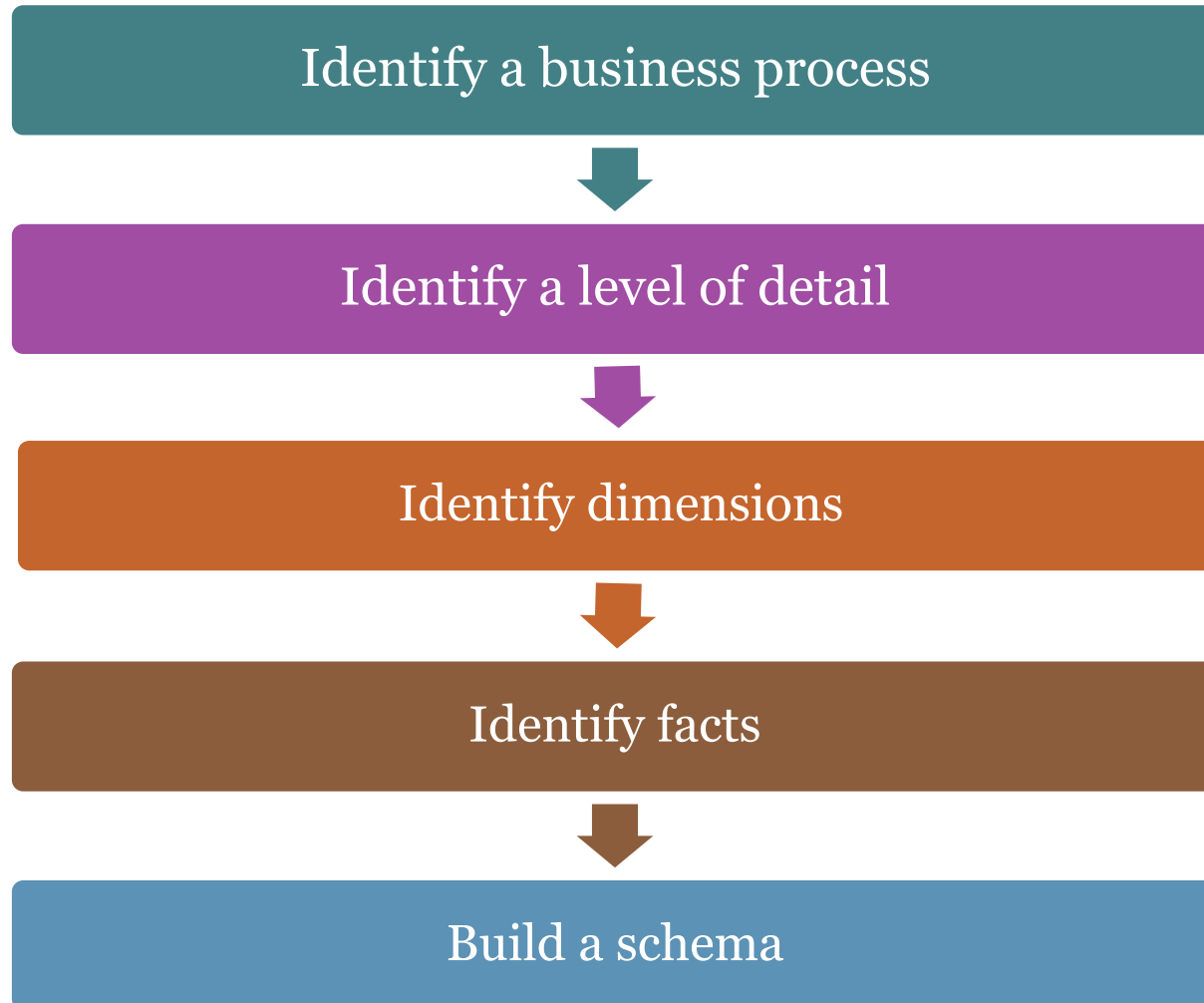
# DW & DM Data Structures

## Star Schema



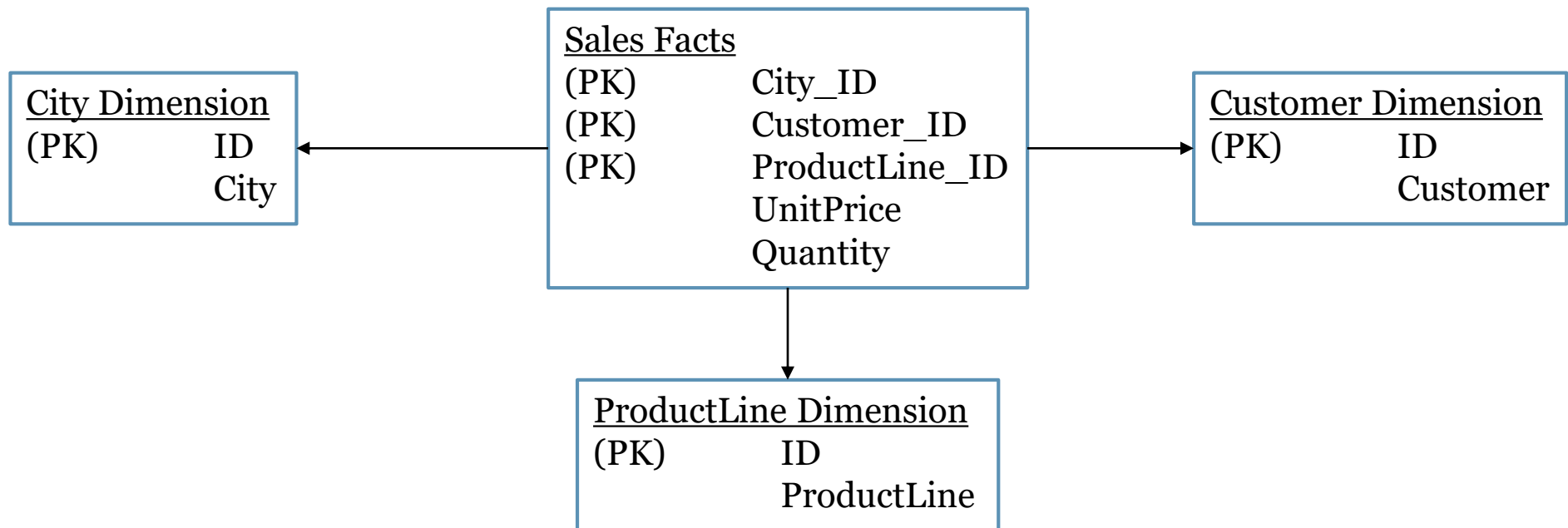
## Snowflake Schema

# Dimensional Modeling Process



# Star Schema

- The star schema is simplest but extensively used nowadays data warehouse schema
- According to the star schema, the fact table is at the center and the dimension tables are nodes of the “star”



# Data Visualization

- Dashboards and reports are used at the top presentation layer of the whole BI architecture
- Dashboards and reports allow business users to visualize data by combining a plethora of charts, graphs, and other data visualization widgets together
- Advanced BI tools allow users to visualize results of various machine learning models (classification, clustering, regression, etc.) in an interactive graphical user-friendly interface

# Data Visualization & Reporting Tools

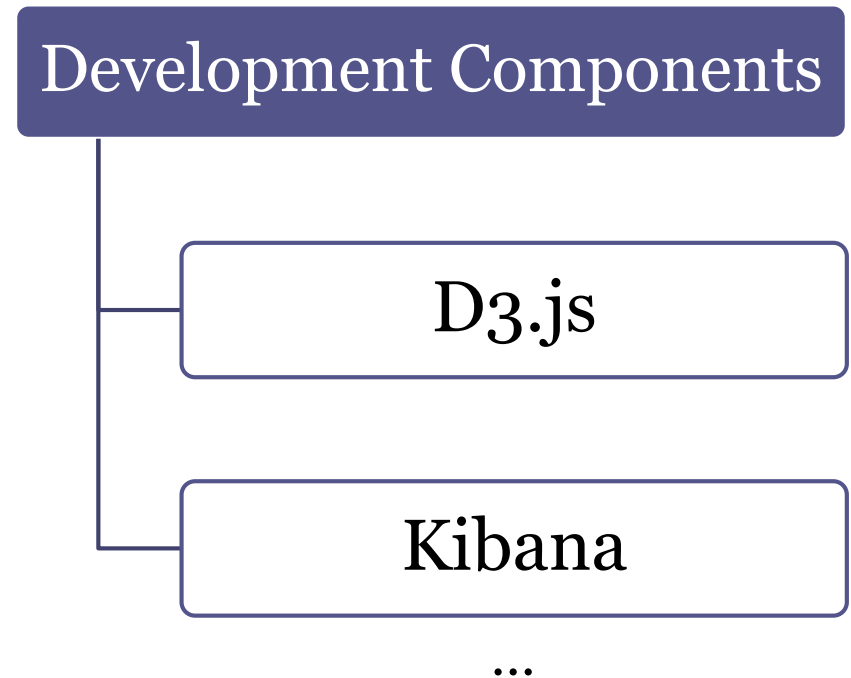
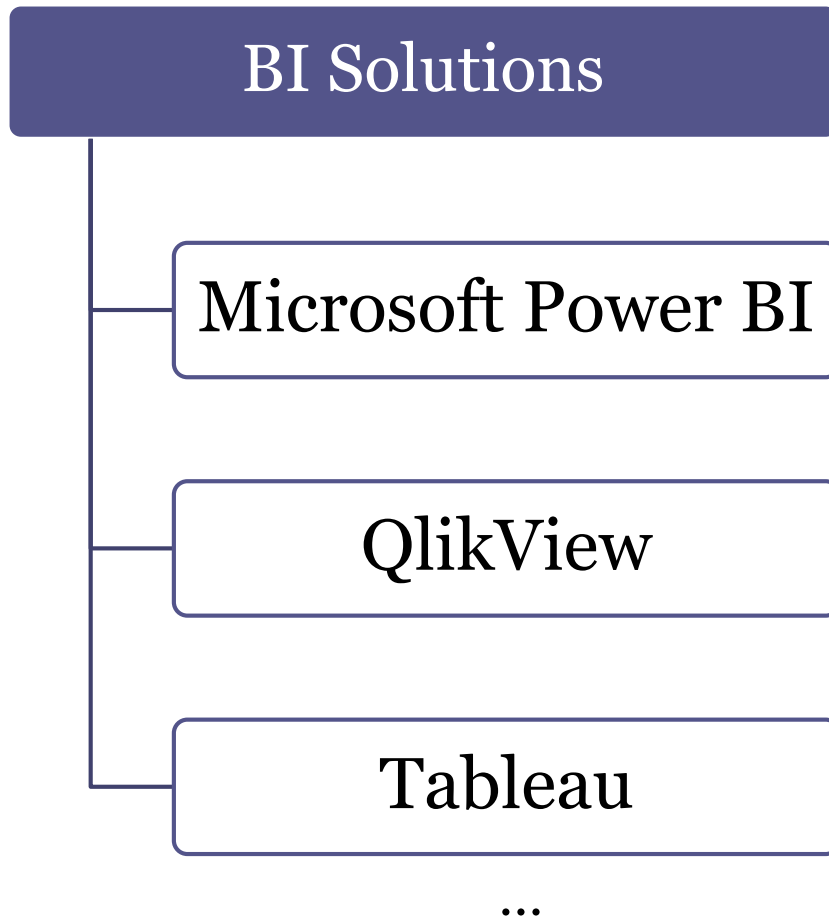


Figure 1: Magic Quadrant for Analytics and Business Intelligence Platforms





# Sample Dataset: Supermarket Sales

## Data Explorer

128.45 KB

📄 supermarket\_sales - Sheet1...

< **supermarket\_sales - Sheet1.csv** (128.45 KB) ↓ 🗄

Detail Compact Column 10 of 17 columns ▾

▲ Invoice ID	▲ Branch	▲ City	▲ Customer ...	▲ Gender	▲ Product line	# Unit price
750-67-8428	A	Yangon	Member	Female	Health and beauty	74.69
226-31-3081	C	Naypyitaw	Normal	Female	Electronic accessories	15.28
631-41-3108	A	Yangon	Normal	Male	Home and lifestyle	46.33
123-19-1176	A	Yangon	Member	Male	Health and beauty	58.22
373-73-7910	A	Yangon	Normal	Male	Sports and travel	86.31
699-14-3026	C	Naypyitaw	Normal	Male	Electronic accessories	85.39
355-53-5943	A	Yangon	Member	Female	Electronic accessories	68.84
315-22-5665	C	Naypyitaw	Normal	Female	Home and lifestyle	73.56
665-32-9167	A	Yangon	Member	Female	Health and	36.26

# Attributes

- Invoice id: Computer generated sales slip invoice identification number
- Branch: Branch of supercenter (3 branches are available identified by A, B and C).
- City: Location of supercenters
- Customer type: Type of customers, recorded by Members for customers using member card and Normal for without member card.
- Gender: Gender type of customer
- Product line: General item categorization groups - Electronic accessories, Fashion accessories, Food and beverages, Health and beauty, Home and lifestyle, Sports and travel
- Unit price: Price of each product in \$
- Quantity: Number of products purchased by customer
- Tax: 5% tax fee for customer buying
- Total: Total price including tax
- Date: Date of purchase (Record available from January 2019 to March 2019)
- Time: Purchase time (10am to 9pm)
- Payment: Payment used by customer for purchase (3 methods are available – Cash, Credit card and E-wallet)
- COGS: Cost of goods sold
- Gross margin percentage: Gross margin percentage
- Gross income: Gross income
- Rating: Customer stratification rating on their overall shopping experience (On a scale of 1 to 10)

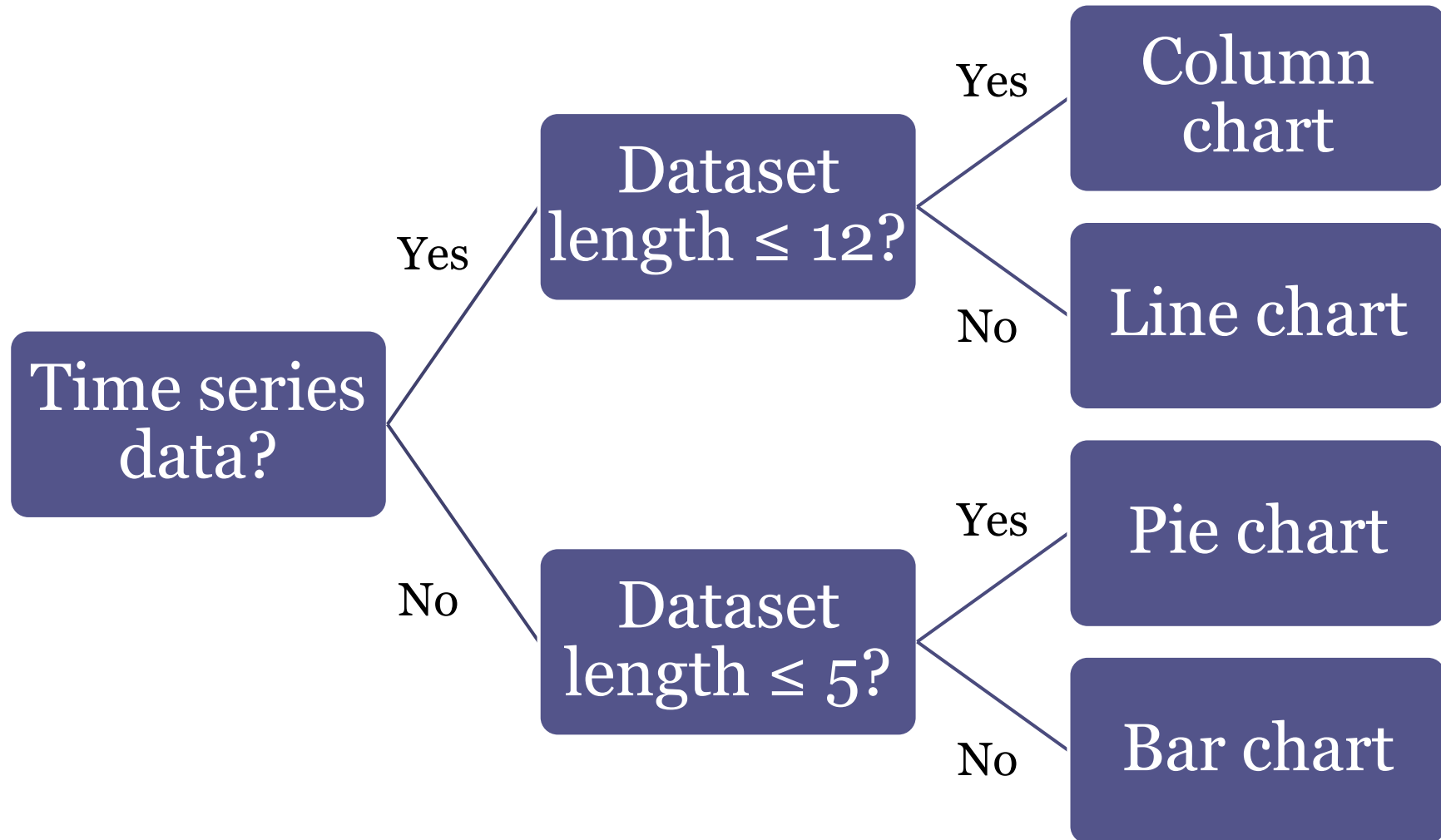
# Raw Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Invoice ID	Branch	City	Customer type	Gender	Product line	Unit price	Quantity	Tax 5%	Total	Date	Time	Payment	cogs	gross margin percentage	gross income	Rating
2	750-67-8428	A	Yangon	Member	Female	Health and beauty	74.69	7	26.1415	548.9715	1/5/2019	13:08	Ewallet	522.83	4.761904762	26.1415	9.1
3	226-31-3081	C	Naypyitaw	Normal	Female	Electronic accessories	15.28	5	3.82	80.22	3/8/2019	10:29	Cash	76.4	4.761904762	3.82	9.6
4	631-41-3108	A	Yangon	Normal	Male	Home and lifestyle	46.33	7	16.2155	340.5255	3/3/2019	13:23	Credit card	324.31	4.761904762	16.2155	7.4
5	123-19-1176	A	Yangon	Member	Male	Health and beauty	58.22	8	23.288	489.048	1/27/2019	20:33	Ewallet	465.76	4.761904762	23.288	8.4
6	373-73-7910	A	Yangon	Normal	Male	Sports and travel	86.31	7	30.2085	634.3785	2/8/2019	10:37	Ewallet	604.17	4.761904762	30.2085	5.3
7	699-14-3026	C	Naypyitaw	Normal	Male	Electronic accessories	85.39	7	29.8865	627.6165	3/25/2019	18:30	Ewallet	597.73	4.761904762	29.8865	4.1
8	355-53-5943	A	Yangon	Member	Female	Electronic accessories	68.84	6	20.652	433.692	2/25/2019	14:36	Ewallet	413.04	4.761904762	20.652	5.8
9	315-22-5665	C	Naypyitaw	Normal	Female	Home and lifestyle	73.56	10	36.78	772.38	2/24/2019	11:38	Ewallet	735.6	4.761904762	36.78	8
10	665-32-9167	A	Yangon	Member	Female	Health and beauty	36.26	2	3.626	76.146	1/10/2019	17:15	Credit card	72.52	4.761904762	3.626	7.2
11	692-92-5582	B	Mandalay	Member	Female	Food and beverages	54.84	3	8.226	172.746	2/20/2019	13:27	Credit card	164.52	4.761904762	8.226	5.9
12	351-62-0822	B	Mandalay	Member	Female	Fashion accessories	14.48	4	2.896	60.816	2/6/2019	18:07	Ewallet	57.92	4.761904762	2.896	4.5
13	529-56-3974	B	Mandalay	Member	Male	Electronic accessories	25.51	4	5.102	107.142	3/9/2019	17:03	Cash	102.04	4.761904762	5.102	6.8
14	365-64-0515	A	Yangon	Normal	Female	Electronic accessories	46.95	5	11.7375	246.4875	2/12/2019	10:25	Ewallet	234.75	4.761904762	11.7375	7.1
15	252-56-2699	A	Yangon	Normal	Male	Food and beverages	43.19	10	21.595	453.495	2/7/2019	16:48	Ewallet	431.9	4.761904762	21.595	8.2
16	829-34-3910	A	Yangon	Normal	Female	Health and beauty	71.38	10	35.69	749.49	3/29/2019	19:21	Cash	713.8	4.761904762	35.69	5.7
17	299-46-1805	B	Mandalay	Member	Female	Sports and travel	93.72	6	28.116	590.436	1/15/2019	16:19	Cash	562.32	4.761904762	28.116	4.5
18	656-95-9349	A	Yangon	Member	Female	Health and beauty	68.93	7	24.1255	506.6355	3/11/2019	11:03	Credit card	482.51	4.761904762	24.1255	4.6
19	765-26-6951	A	Yangon	Normal	Male	Sports and travel	72.61	6	21.783	457.443	1/1/2019	10:39	Credit card	435.66	4.761904762	21.783	6.9
20	329-62-1586	A	Yangon	Normal	Male	Food and beverages	54.67	3	8.2005	172.2105	1/21/2019	18:00	Credit card	164.01	4.761904762	8.2005	8.6
21	319-50-3348	B	Mandalay	Normal	Female	Home and lifestyle	40.3	2	4.03	84.63	3/11/2019	15:30	Ewallet	80.6	4.761904762	4.03	4.4
22	300-71-4605	C	Naypyitaw	Member	Male	Electronic accessories	86.04	5	21.51	451.71	2/25/2019	11:24	Ewallet	430.2	4.761904762	21.51	4.8
23	371-85-5789	B	Mandalay	Normal	Male	Health and beauty	87.98	3	13.197	277.137	3/5/2019	10:40	Ewallet	263.94	4.761904762	13.197	5.1
24	273-16-6619	B	Mandalay	Normal	Male	Home and lifestyle	33.2	2	3.32	69.72	3/15/2019	12:20	Credit card	66.4	4.761904762	3.32	4.4
25	636-48-8204	A	Yangon	Normal	Male	Electronic accessories	34.56	5	8.64	181.44	2/17/2019	11:15	Ewallet	172.8	4.761904762	8.64	9.9
26	549-59-1358	A	Yangon	Member	Male	Sports and travel	88.63	3	13.2945	279.1845	3/2/2019	17:36	Ewallet	265.89	4.761904762	13.2945	6
27	227-03-5010	A	Yangon	Member	Female	Home and lifestyle	52.59	8	21.036	441.756	3/22/2019	19:20	Credit card	420.72	4.761904762	21.036	8.5
28	649-29-6775	B	Mandalay	Normal	Male	Fashion accessories	33.52	1	1.676	35.196	2/8/2019	15:31	Cash	33.52	4.761904762	1.676	6.7
29	189-17-4241	A	Yangon	Normal	Female	Fashion accessories	87.67	2	8.767	184.107	3/10/2019	12:17	Credit card	175.34	4.761904762	8.767	7.7
30	145-94-9061	B	Mandalay	Normal	Female	Food and beverages	88.36	5	22.09	463.89	1/25/2019	19:48	Cash	441.8	4.761904762	22.09	9.6

# Key Data Visualization Principles

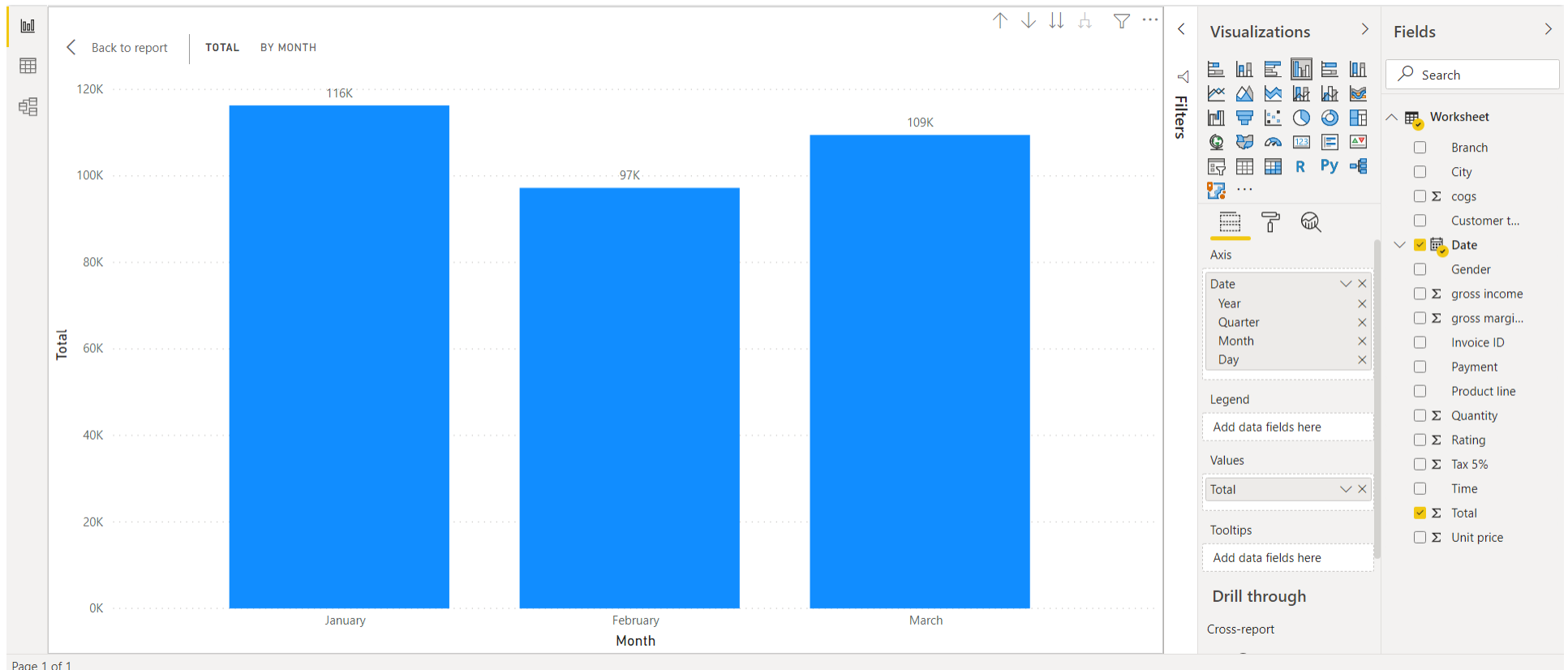
- The most appropriate visualizations, which are highly informative and best suitable for human-eye perception:
- **Bar charts.** Show comparison at different times, locations, and conditions.
- **Line charts.** Display trends over time in amounts, sizes, rates, etc.
- **Pie charts.** Show what parts make up a whole in order to compare relative sizes of these parts.
- **Text cards** may be used to display single-value measures, such as any generalized measures, ratios, or other possible scalar values.

# Choosing Proper Data Visualizations



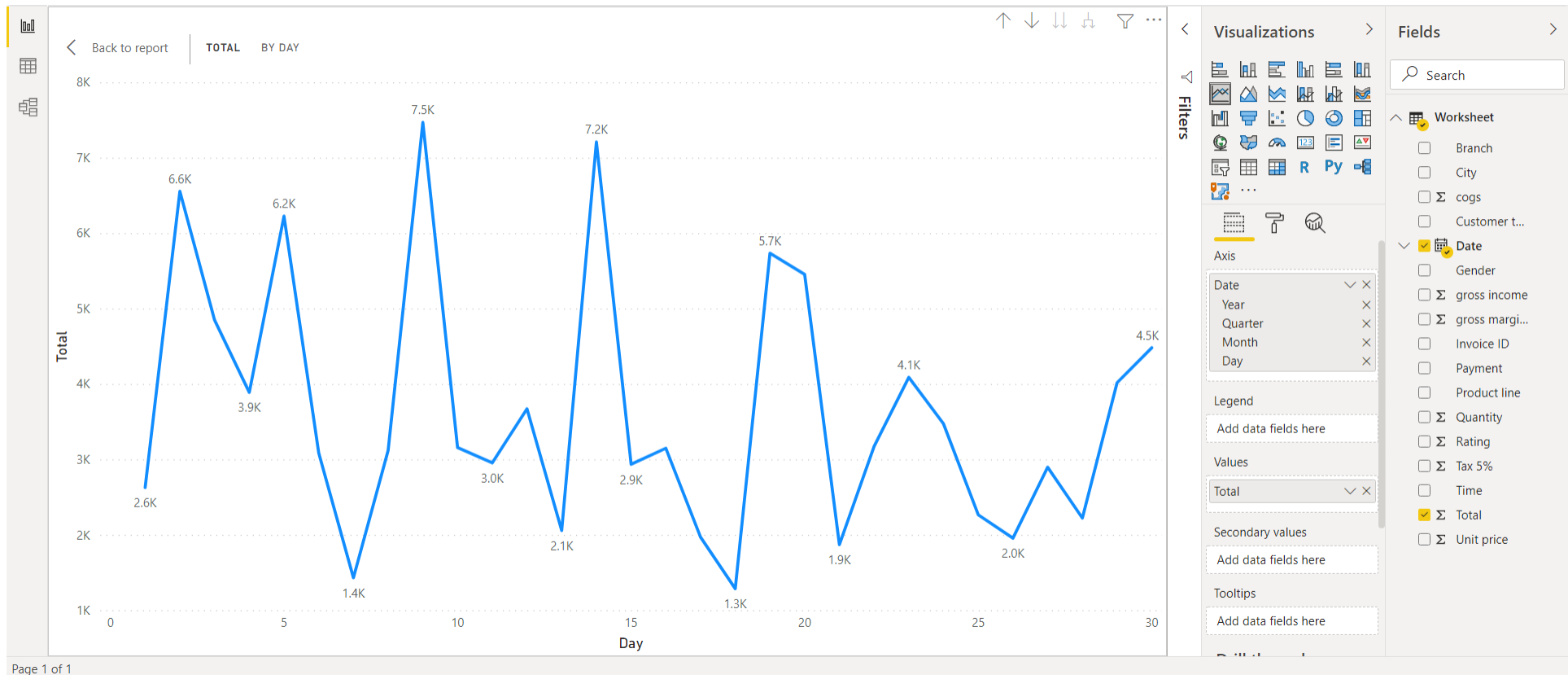
# Column Chart Example

- Total price (including tax) of purchased products by month



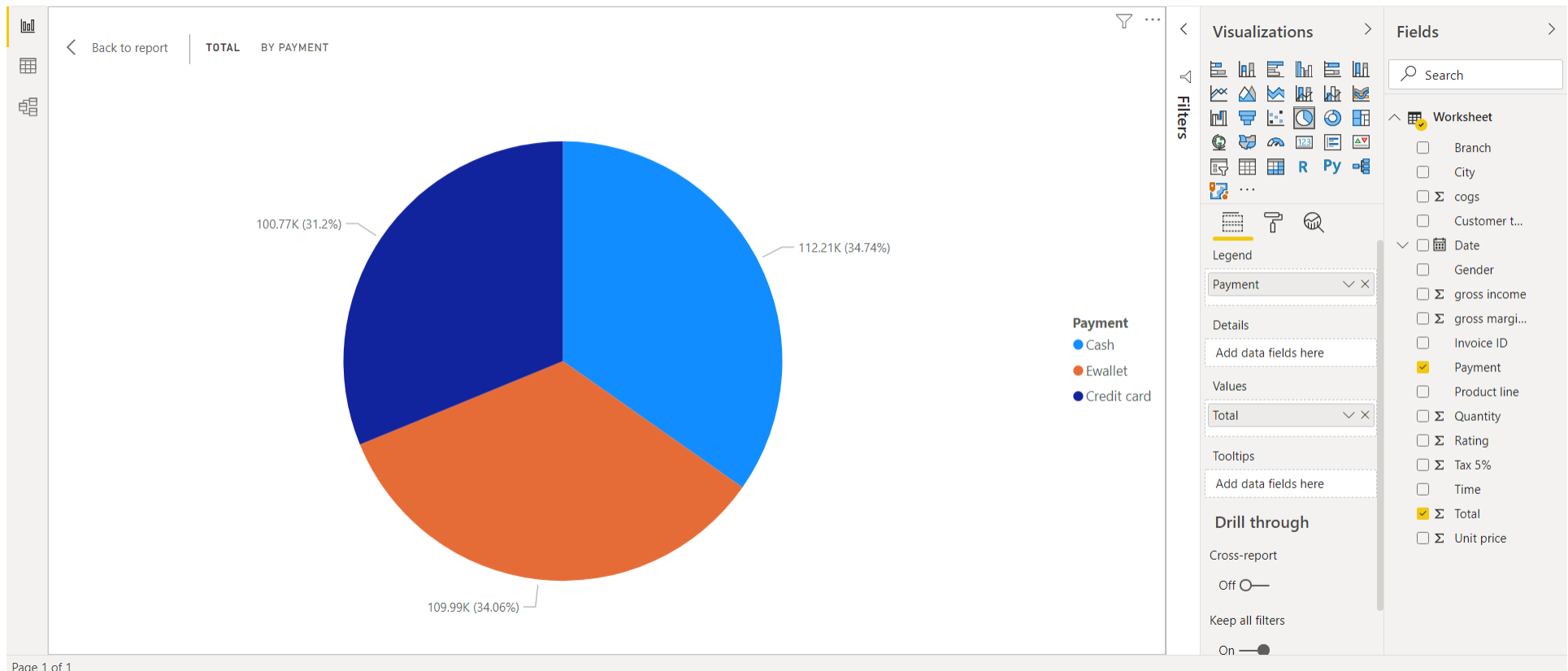
# Line Chart Example

- Total price (including tax) of purchased products by days of the last month



# Pie Chart Example

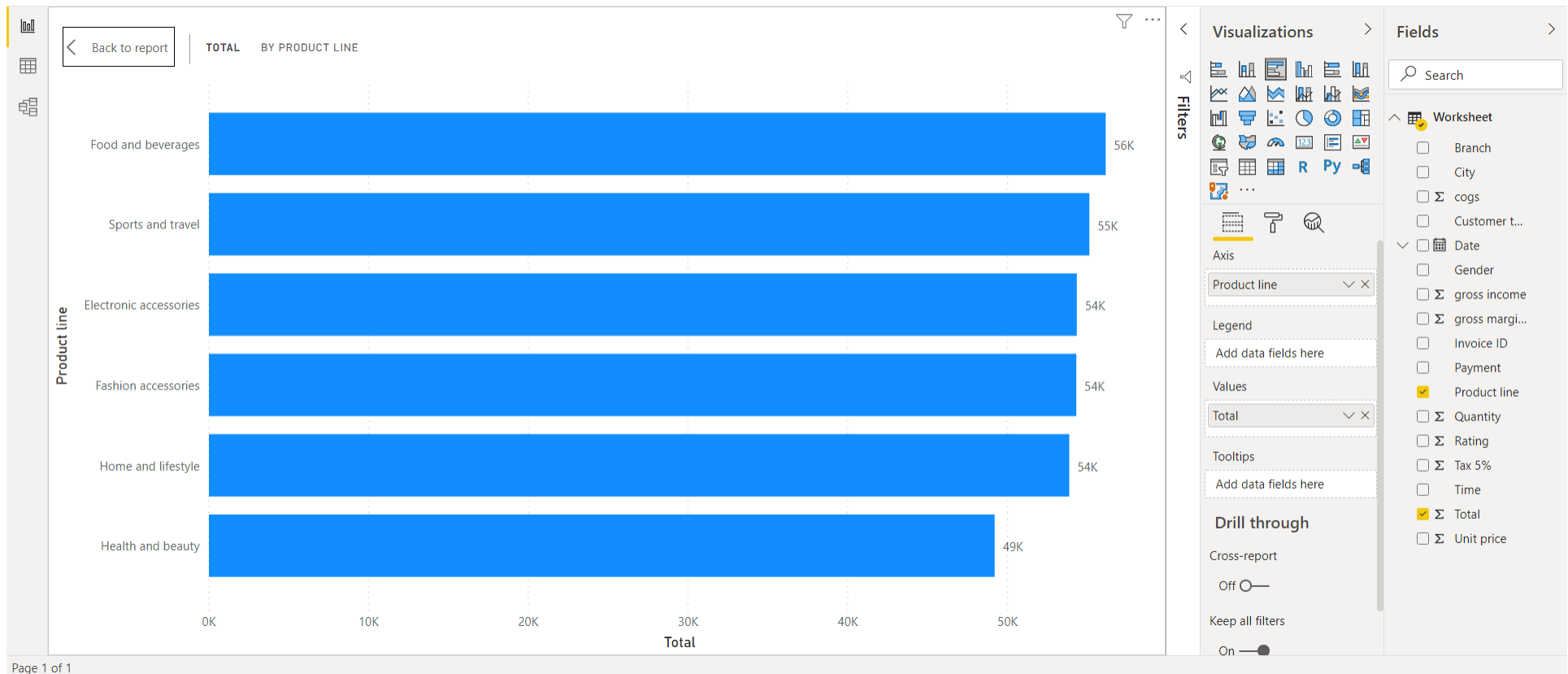
- Total price (including tax) of purchased products by payment type





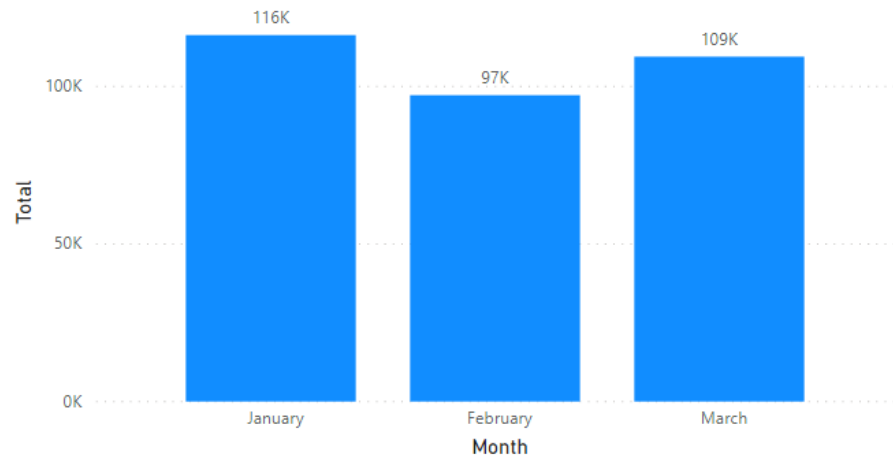
# Bar Chart Example

- Total price (including tax) of purchased products by product line

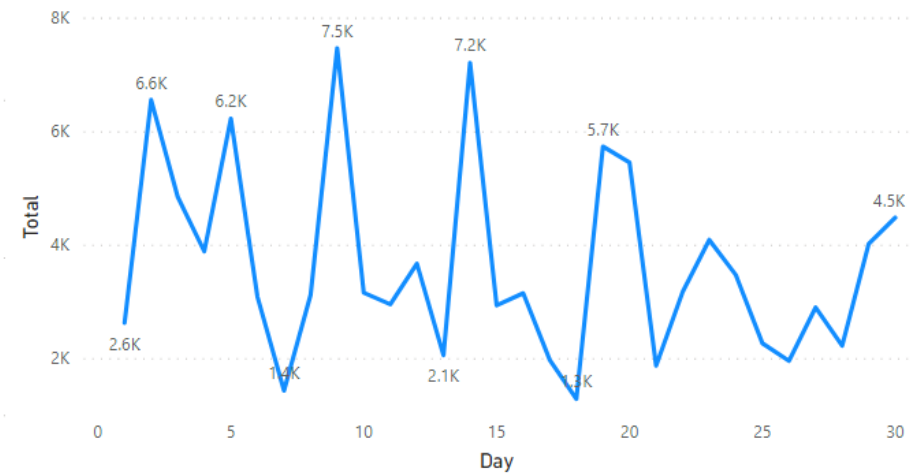


# Final Dashboard of Supermarket Sales

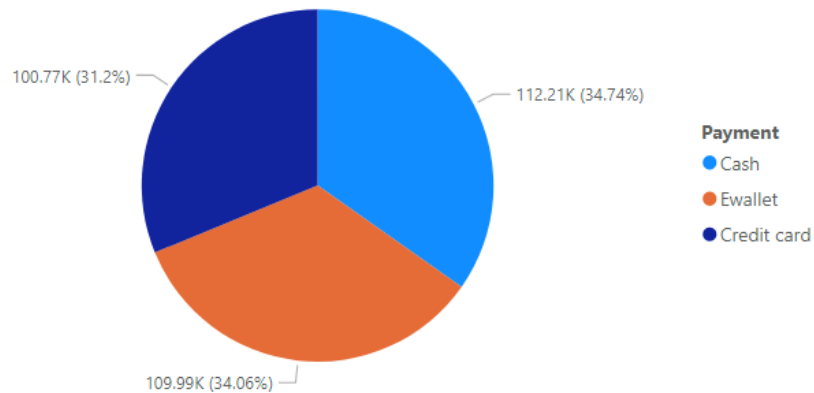
Total by Month



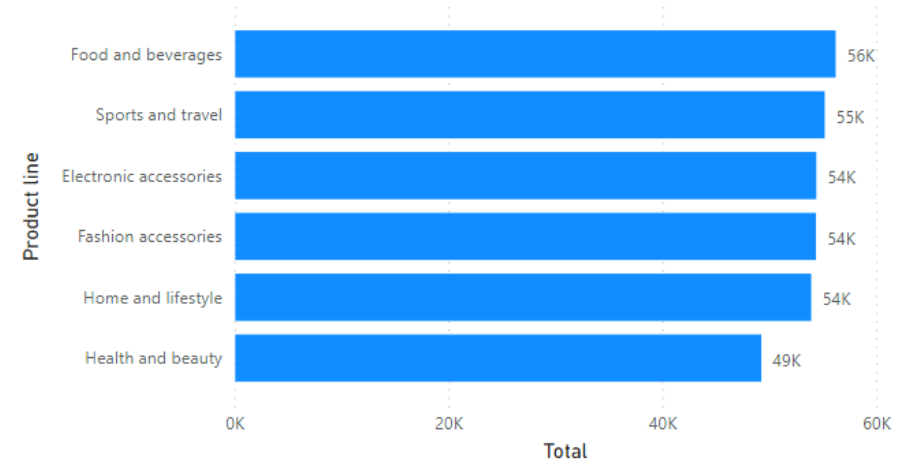
Total by Day



Total by Payment



Total by Product line



THANK YOU FOR YOUR ATTENTION!

Ask me: [kopp93@gmail.com](mailto:kopp93@gmail.com)