



Aalto University  
School of Business

# Business Intelligence

*Lecturer: Associ. Prof. Yong Liu (yong.liu@aalto.fi);  
37E00500*

# Agenda

- **Purposes of data visualization**
- **Theories of data visualization**
- **Understanding Charts & Design**
- **Good and bad data visualization**
- **BI Dashboard Design**
- **BI report monitoring and storytelling**

# Tableau Assignment Team Formation

With regard to the Tableau assignment, please vote for the use of a randomly selected team formation method or a self-formed one for the assignment.

---

I vote for a randomly selected team formation method.

80

---

I vote for a self-formed team formation method.

93

---

Voting results.

# Research assistant

- **Job content:** data collection and analysis of people's perceptions of AI service robot design through doing interviews.
- **Salary:** 16 euro/hour
- **Expected workload:** 50 hours +
- **Flexible working time**
- **Requirement:** fluent English
- **Contact:** Yong.liu@aalto.fi



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# Section 1: Purposes of Data Visualization



# What is data visualization?

1. Something people often believe is easy, yet they consistently struggle to do it well.
2. People often think they can create cool visualizations just by going with their gut, but there's a clear gap in quality between experienced and inexperienced folks when it comes to visualizing data.
3. Data visualization is a **Science**!

# Why visualize data?

**Data visuals are more attractive, simpler to take in, and easier to remember.**

Try it for yourself. Take a look at this table:

Month	Jan	Feb	Mar	Apr	May	Jun
Sales	45	56	36	58	75	62



**Data visualization is the graphical representation of data. In other words, data visualization is used to visualize data.**

**Do you agree?**

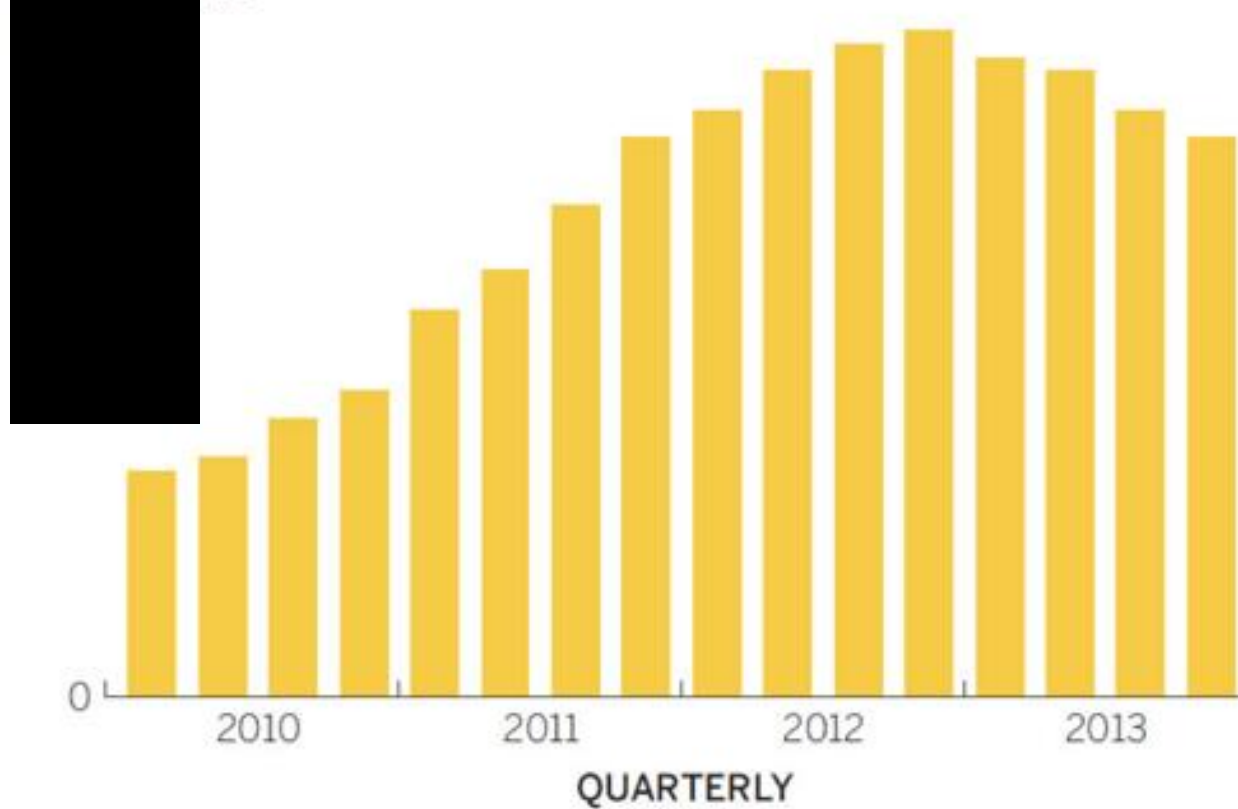
**Submit your answer at:  
<https://presemio.aalto.fi/bic/>**



Visualization needs data (values), but visualizations are NOT normally created to show data values.

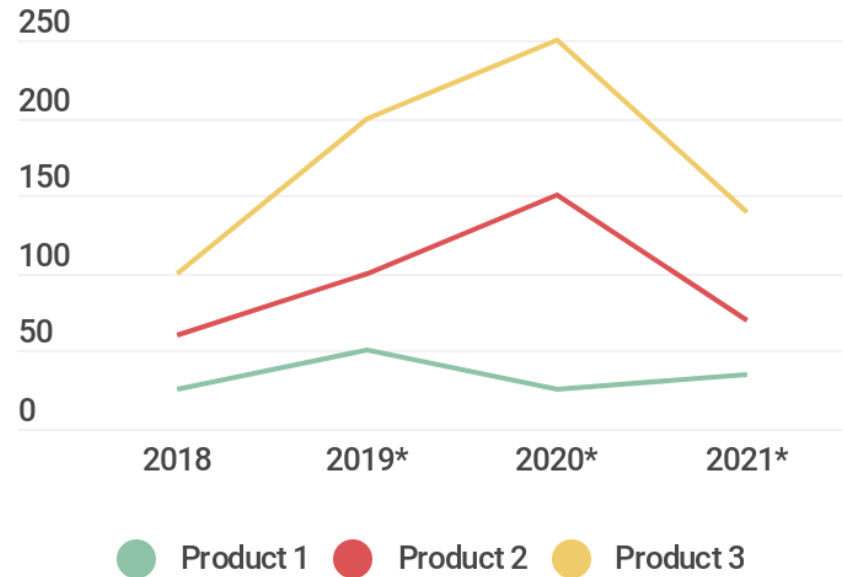
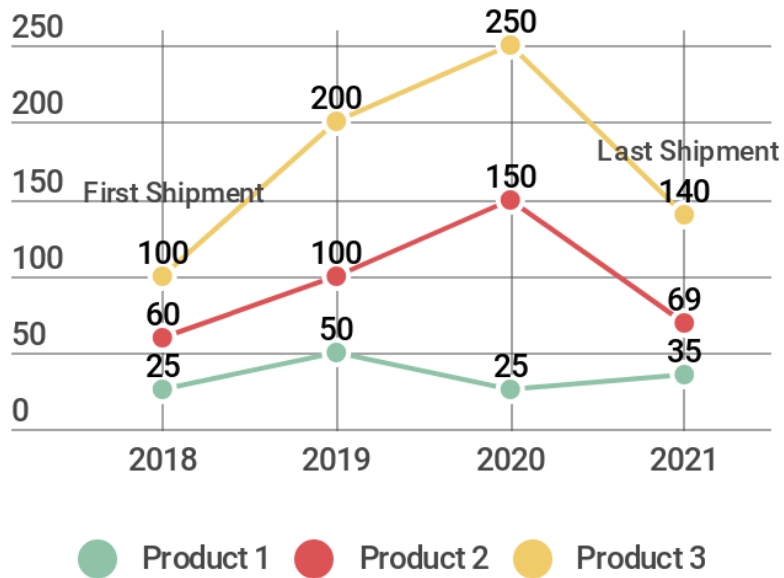
## GLOBAL REVENUE

IN MILLIONS



SOURCE: COMPANY RESEARCH

dd.mm.yyyy  
9



# What is the purpose of data visualizations for companies?

- Visualization is meant to **compare and contrast** data.
- Understanding visualization takes (“saves”) time and effort.
- Good visualization lets you easily compare and identify **differences/patterns** with less time and effort.

Data is needed to create data visualization, but data visualization is not typically created to show the data values but to **highlight** the differences or patterns!

## A faked 'real' dialogue

**BA:** Hi, we are happy to show you a dashboard that took us lots of time to develop. We believe it is relevant to your business, and it shows a tendency that the department ....

**Financial person:** Sorry, the dashboard does not work, the numbers there do not match.

**BA:** Oh, Sorry for that! Nonetheless, it shows a tendency that ....

**Financial person:** Sorry, I cannot **trust** your dashboard because the numbers do not match.

**Who will you stand for,  
the BA or the financial person?**

6.3.2024

Offer your answer at: <https://premo.aalto.fi/bic/>

**Should data visualization  
always use precisely  
accurate data?**

6.3.2024

Offer your answer at: <https://premo.aalto.fi/bic/>

# Precision

(being stable or clustered)

# VS

# Accuracy

(being on target)



Precise  
Accurate



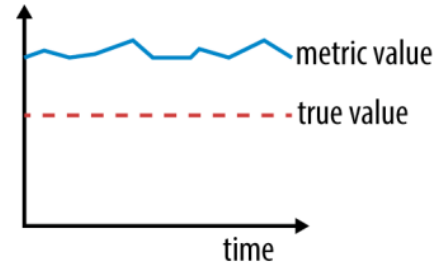
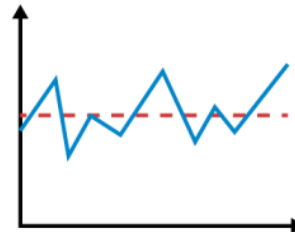
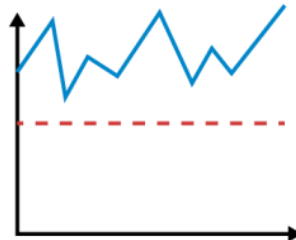
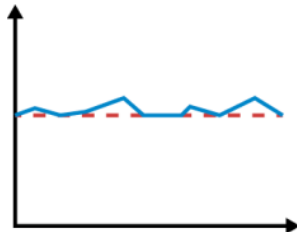
Not Precise  
Not Accurate



Not Precise  
Accurate



Precise  
Not Accurate



## A faked 'real' dialogue

**BA:** Hi, we are happy to show you a dashboard that took us lots of time to develop. We believe it is relevant to your business, and it shows a tendency that the department ....

**Financial person:** Sorry, the dashboard does not work, the numbers there do not match.

**BA:** Oh, Sorry for that! Nonetheless, it shows a tendency that ....

**Financial person:** Sorry, I cannot **trust** your dashboard because the numbers do not match.

Positive  
Viewpoint



Negative  
Viewpoint



Everything depends on  
the way YOU see!



# Key takeaway

- We use data visualization to detect tendencies and differences.
- Real-world (data) is messy!
- Data *per se* is accurate but not necessarily in line with reality.
- You must pay attention to / balance data precision vs. accuracy in data preparation work.
- You need to educate your users.

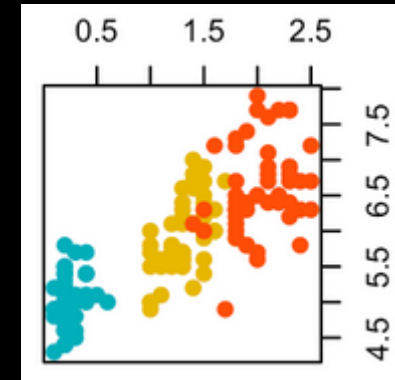


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# Section 2: Theories of Data Visualization



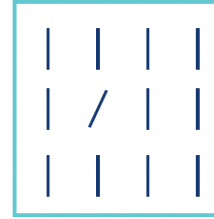
# How can we highlight something in a chart?



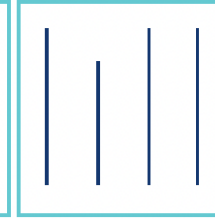
# Theory of data visualization

## Shape

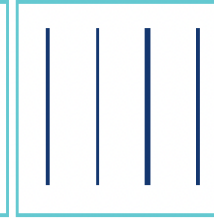
Orientation



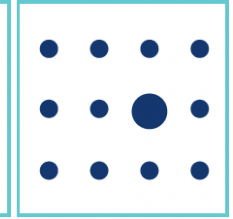
Line Length



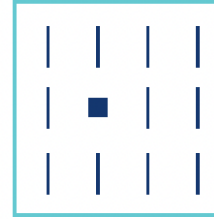
Line Width



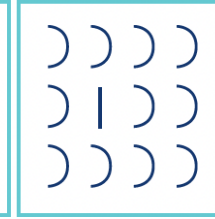
Size



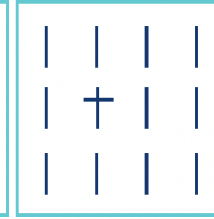
Shape



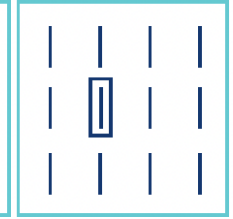
Curvature



Added Marks

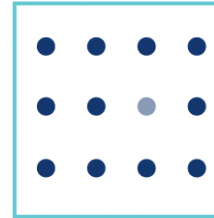


Enclosure

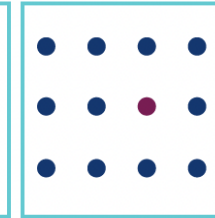


## Color

Intensity

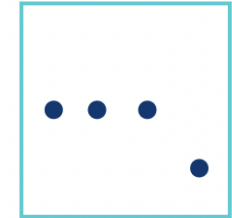


Hue



## Spatial Position





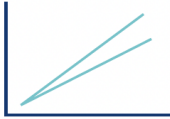
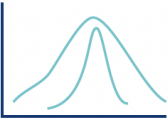



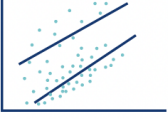
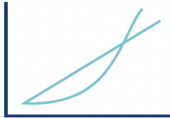

2-D Position



Netquest (2023). Visualize It: A Comprehensive Guide to Data Visualization, <https://www.netquest.com/en/download-ebook-data-visualization>

# Visualization of patterns

Netquest (2023). Visualize It: A Comprehensive Guide to Data Visualization,  
<https://www.netquest.com/en/download-ebook-data-visualization>

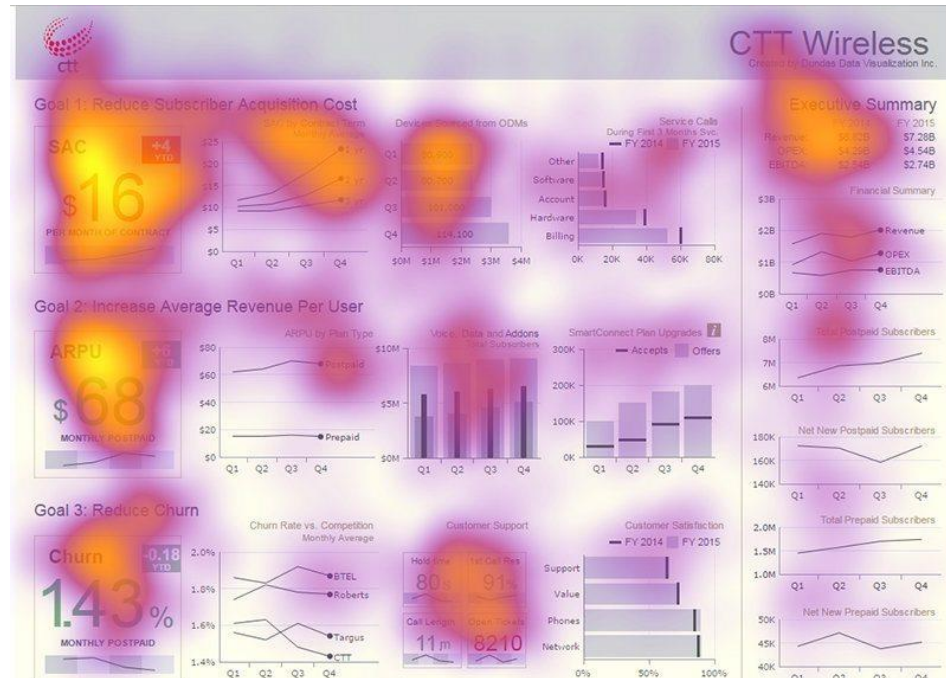
Pattern	Example	Pattern	Example
High, low and in between		Non-intersecting and intersecting	
Going up, going down and remaining flat		Symmetrical and skewed	
Steep and gradual		Wide and narrow	
Steady and fluctuating		Clusters and gaps	
Random and repeating		Tightly and loosely distributed	
Straight and curved		Normal and abnormal	

# Common reading patterns

**Common reading patterns** describe how human view dashboards, which determines the best sequence of putting the charts.

**Two common reading patterns:**

- F-Pattern
- Z-Pattern

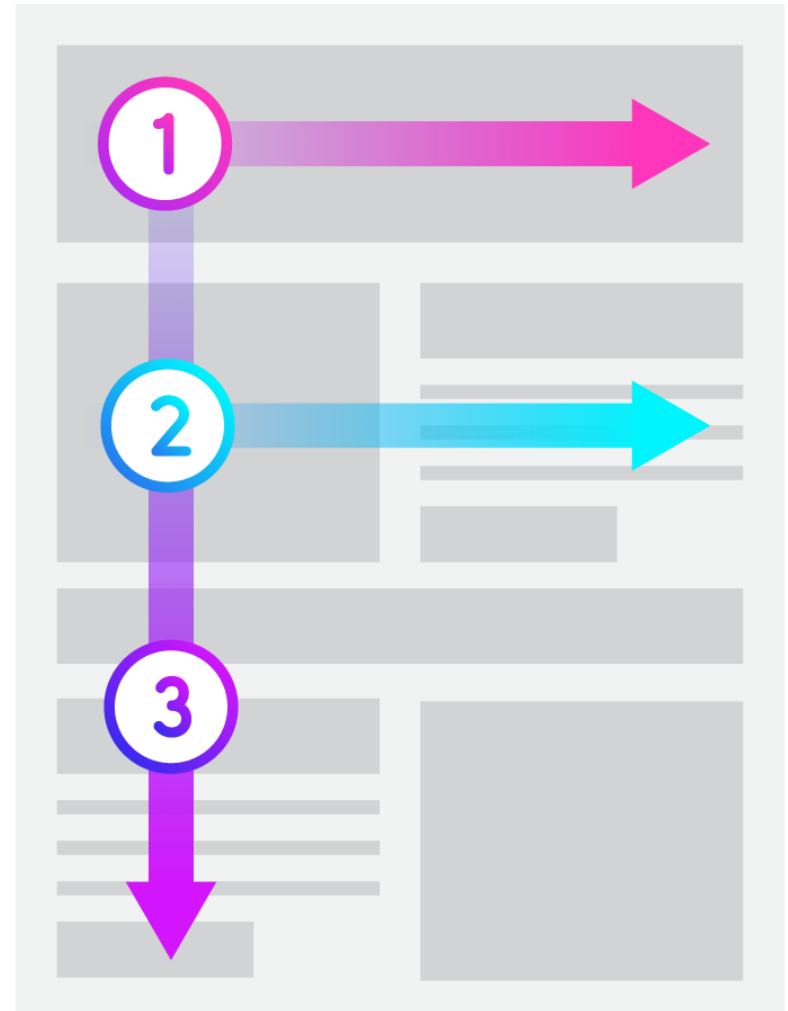


# F-Pattern

F-pattern is the most common eye-scanning pattern for dashboards with a **big amount of content, but also for webpages**. The general behavior related to this pattern:

- The propensity for humans to consume web pages in an “upper-left > bottom-right” pattern

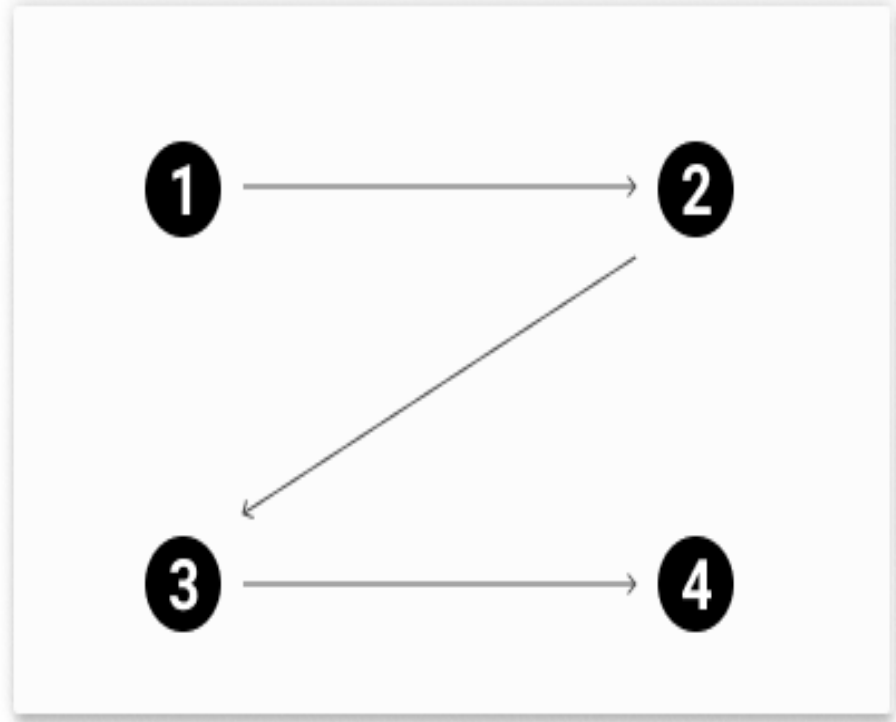
Jakob Nielsen (2006-04-17). "F-Shaped Pattern For Reading Web Content".



# Z-Pattern

Z-pattern is typical for **dashboards that are not content-heavy**. In such case human eyes follow the natural scanning route:

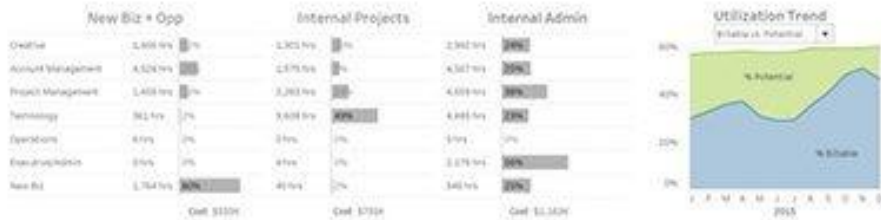
## Z-PATTERN





# Application: Location of KPIs

Agency Utilization Rollup

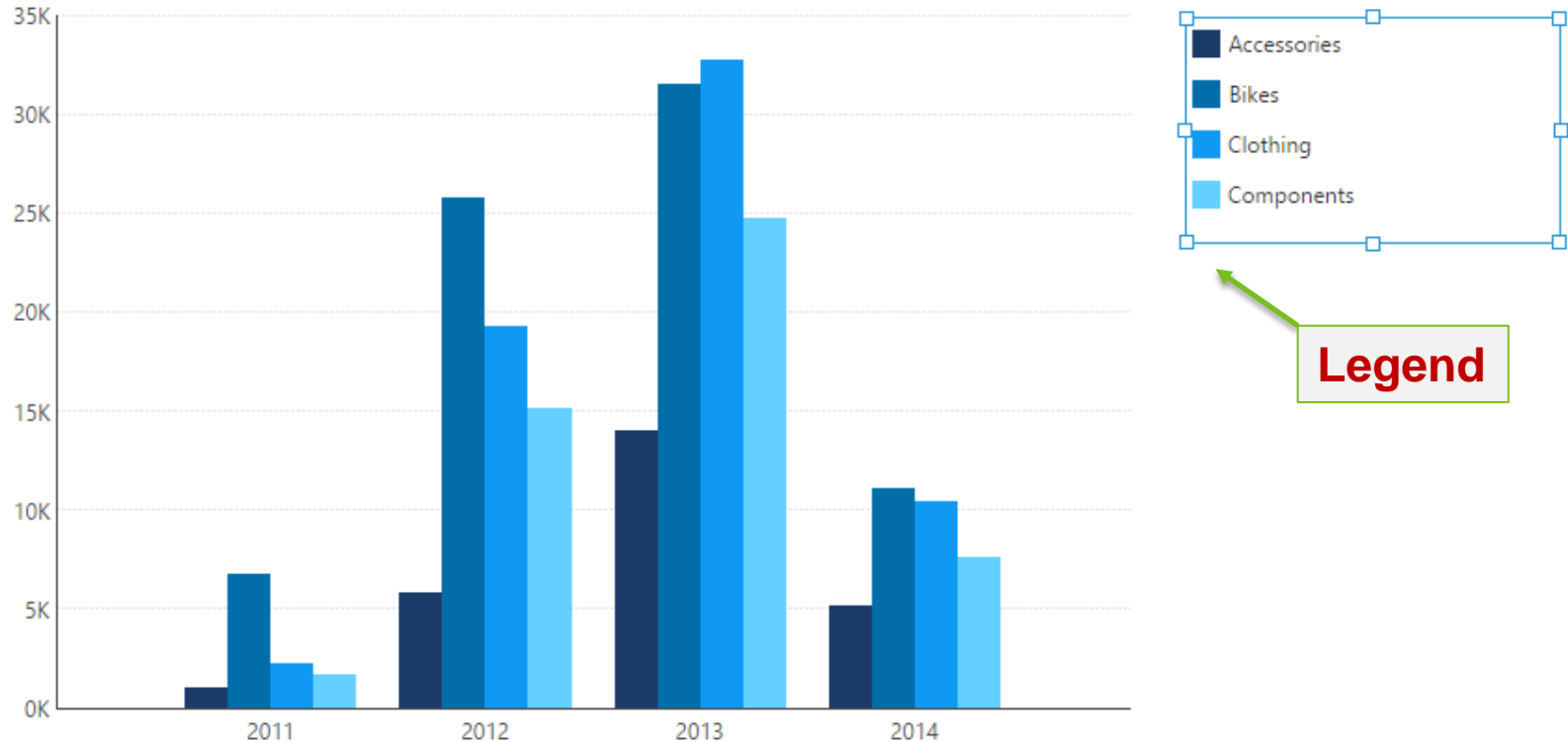


Agency Utilization Rollup



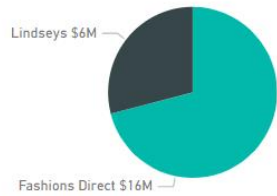
# Let's test your data visualization knowledge

# Before the test, some key definitions.



# Store Sales Overview

This Year Sales by Chain

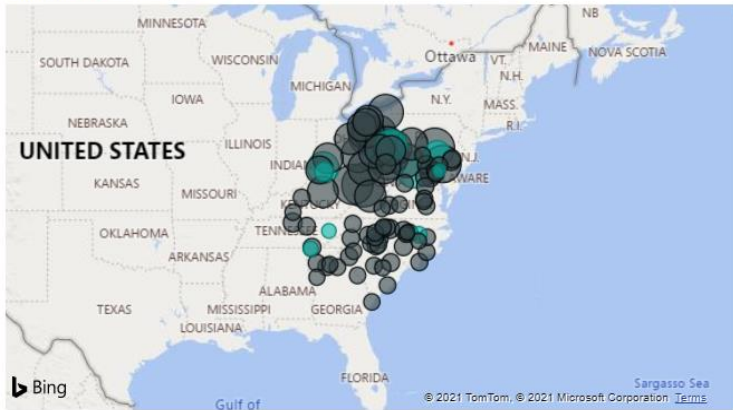


10  
New Stores

104  
Total Stores

This Year Sales by PostalCode and Store Type

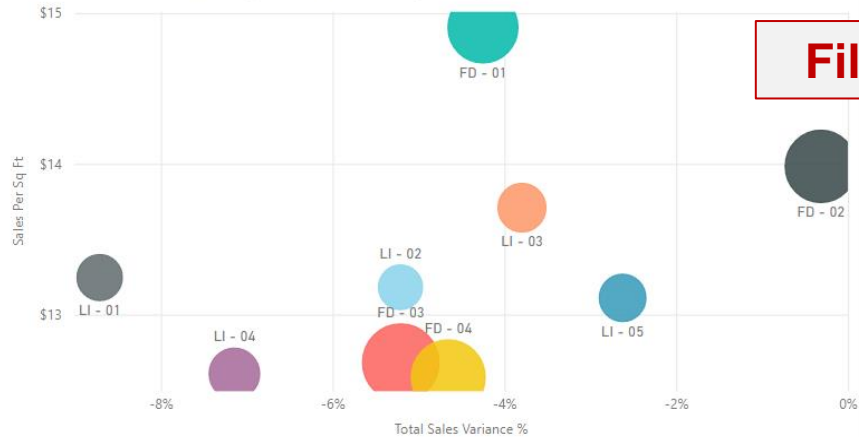
Store Type ● New Store ● Same Store



Total Sales Variance by FiscalMonth and District Manager



Total Sales Variance %, Sales Per Sq Ft and This Year Sales by District and District



## Filters

Search

Filters on this page

Chain  
is (All)City  
is (All)District  
is (All)Name  
is (All)Open Month  
is (All)Store Type  
is (All)**Filters**

# Questions: use **Yes** or **No** to answer the questions based on your own reflections.

1. Pai chart is easy to read and create and a good option for data visualization.
2. 2d figures are popular, but 3d can often be visually attractive and good to use.
3. In a dashboard, filters of figures are better put together.
4. In a dashboard, legends of figures are better put together.
5. The use of many bright colors makes the dashboard attractive.
6. Having the figure titles right-justified in the right-left corner is good.
7. Using borderlines for figures is good.
8. Red and green are beautiful and commonly used colors in real life, and they are also good to use together in developing figures.

# Answers

1. Pie chart is easy to read and create and a good option for data visualization.
2. 2d figures are popular, but 3d can often be visually attractive and good to use.
3. **In a dashboard, filters of figures are better put together.**
4. In a dashboard, legends of figures are better put together.
5. The use of many bright colors makes the dashboard attractive.
6. Having the figure titles right-justified in the right-left corner is good.
7. Using borderlines for figures is good.
8. Red and green are beautiful and commonly used colors in real life, and they are also good to use together in developing figures.

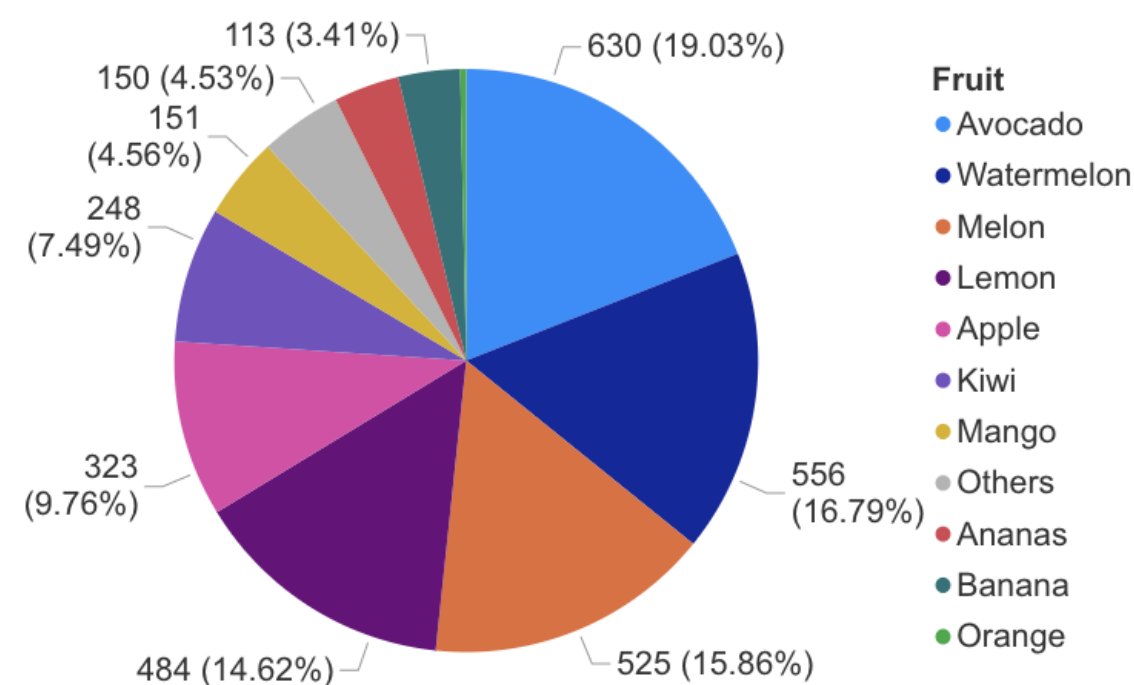
You get one point by answering Yes to the question 3.

You get one point by answering No to the rest of the questions.

Please sum up the points you get.

Otherwise, you get zero points for the question.

# Fruits Sold



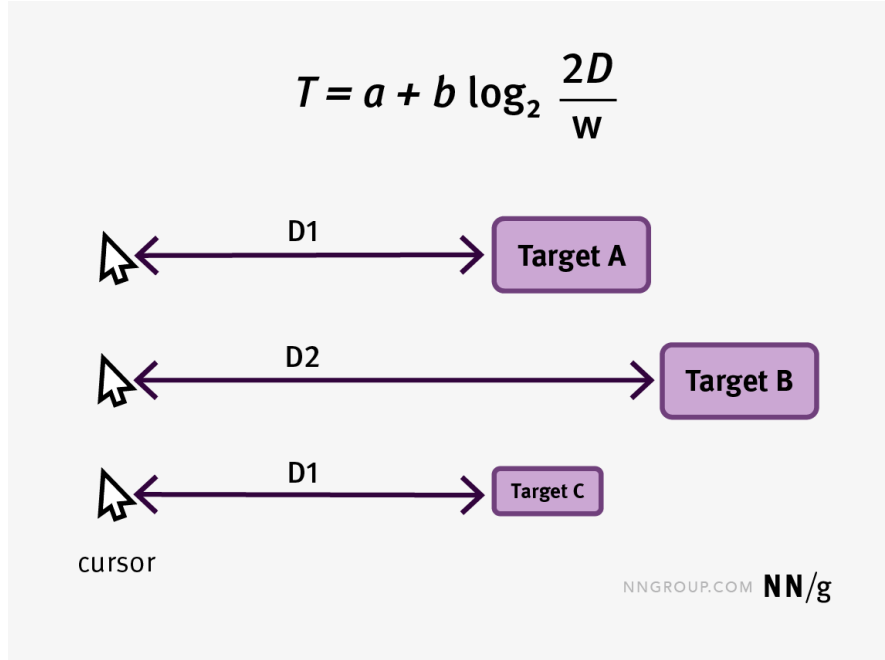
**Do you think this  
is a good data  
visualization or  
not?**

**Submit your  
answer to:  
<https://presemontoalto.fi/bic/>**

# HCI theory: Fitts' Law

**Fitts' law** states that the amount of time required for a person to move a pointer (e.g., mouse cursor) to a target area is a function of the distance to the target divided by the target size. Thus, the longer the distance and the smaller the target's size, the longer it takes.

In 1954, psychologist Paul Fitts, examining the human motor system, showed that the time required to move to a target depends on the distance to it, yet relates inversely to its size. By his law, fast movements and small targets result in greater error rates, due to the speed-accuracy trade-off. Although multiple variants of Fitts' law exist, *all* encompass this idea.



Where  $D$  is the distance to the target,  $w$  is the width of the target (technically, measured along the axis of movement), and  $a$  and  $b$  are constants that vary depending on the type of pointer (e.g., mouse, finger, etc.).

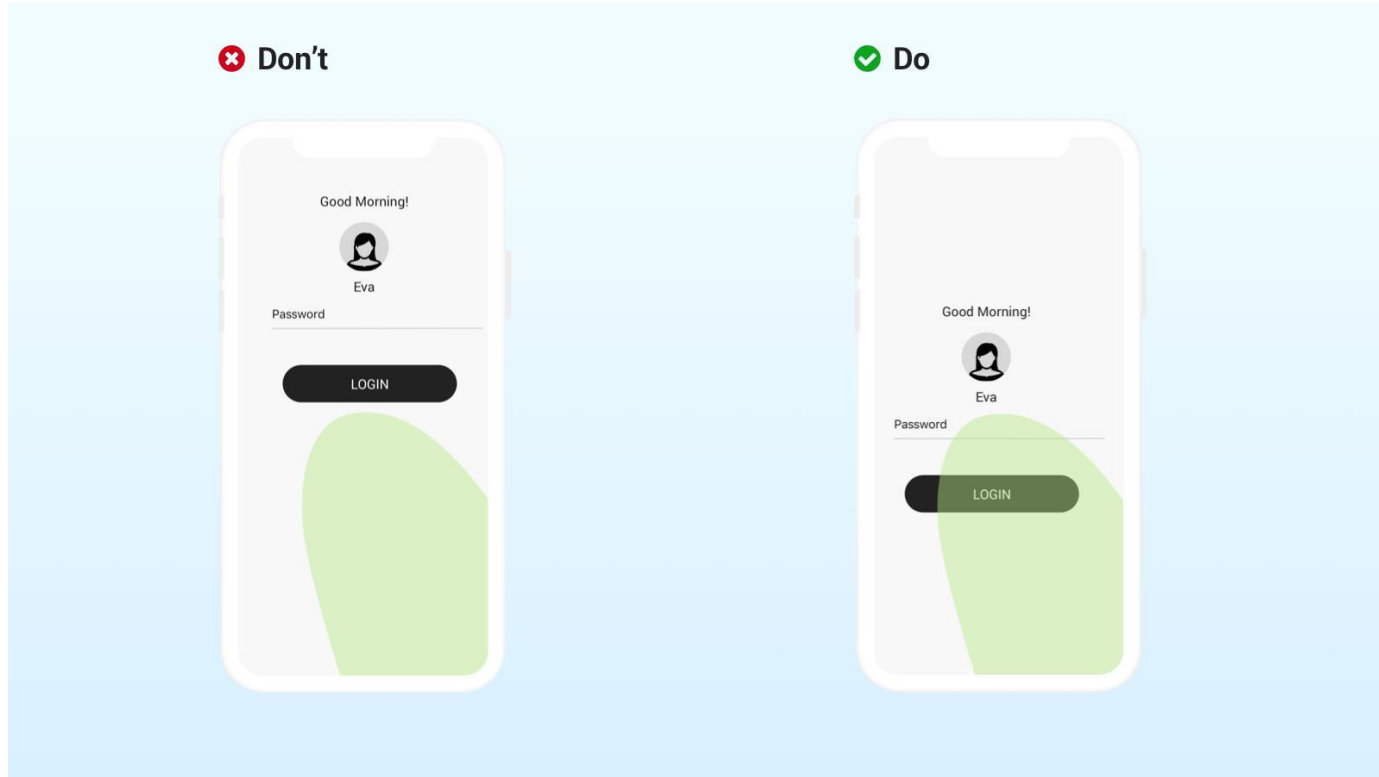
dd.mm.yyyy

<https://www.interaction-design.org/literature/topics/fitts-law> <sup>32</sup>

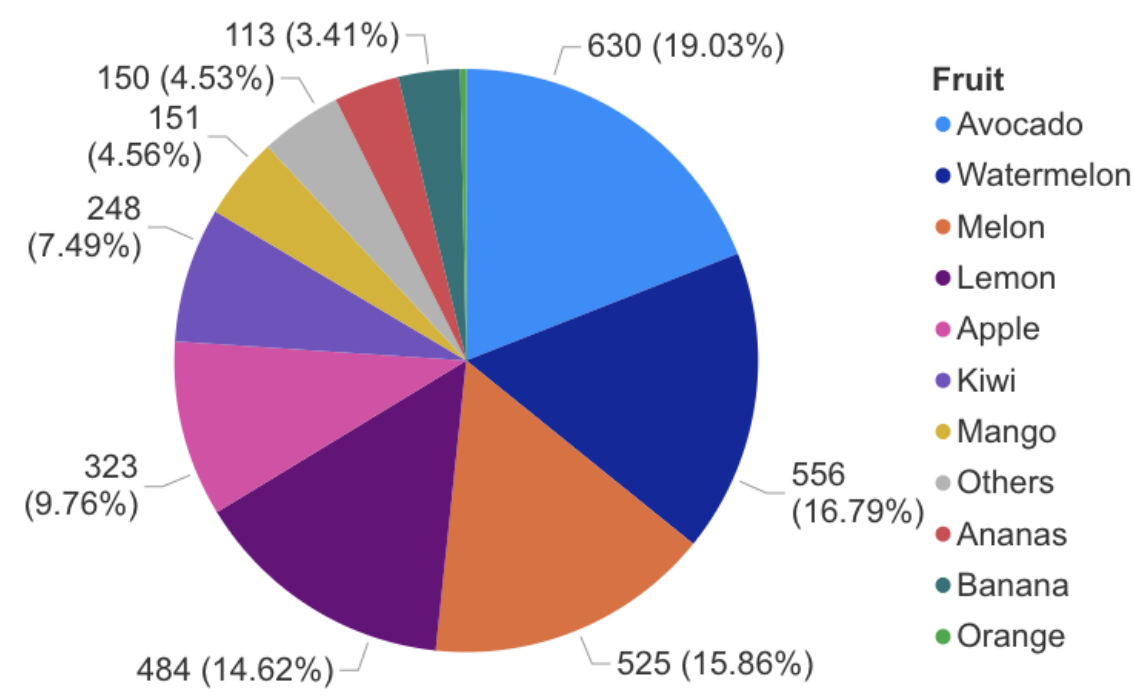
<https://www.nngroup.com/articles/fitts-law/>



# Example of Fitts' Law



# Fruits Sold



The time and effort for you to understand a chart is affected by:

Distance between different visual elements for you to understand one piece of information.

Size of the visual elements

# Visualization: Something people often believe is easy, yet they consistently struggle to do it well.

The marketing department has a KPI relevant to the number of new customers. Specifically,

- The targeted number of new customers for this quarter is **1200**;
- The critical minimum is **400**;
- Currently, the team has attracted **700** new customers;

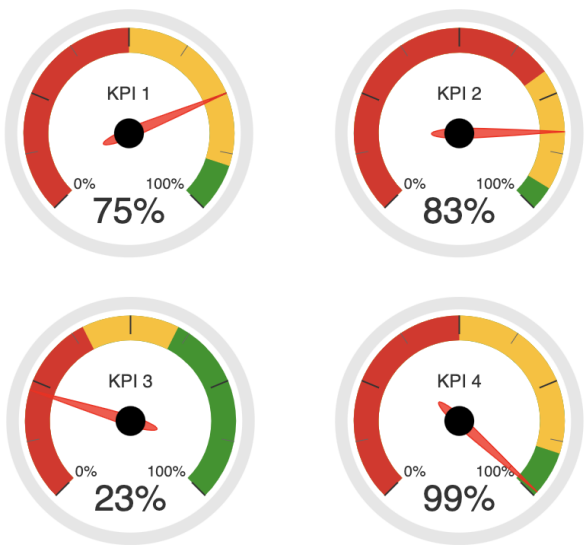
**Could you please create a chart(s) to visualize these data?**

# Is it a good visualization?



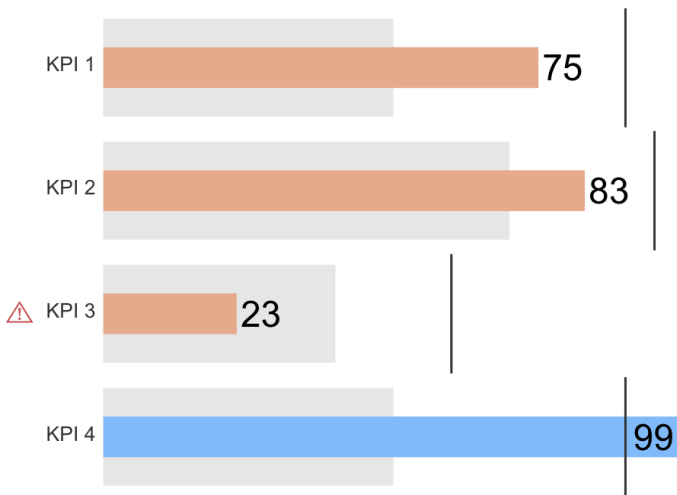
Bad and Good Charts in Power BI. Visualized by Andrzej Leszkiewicz

## Gauge?



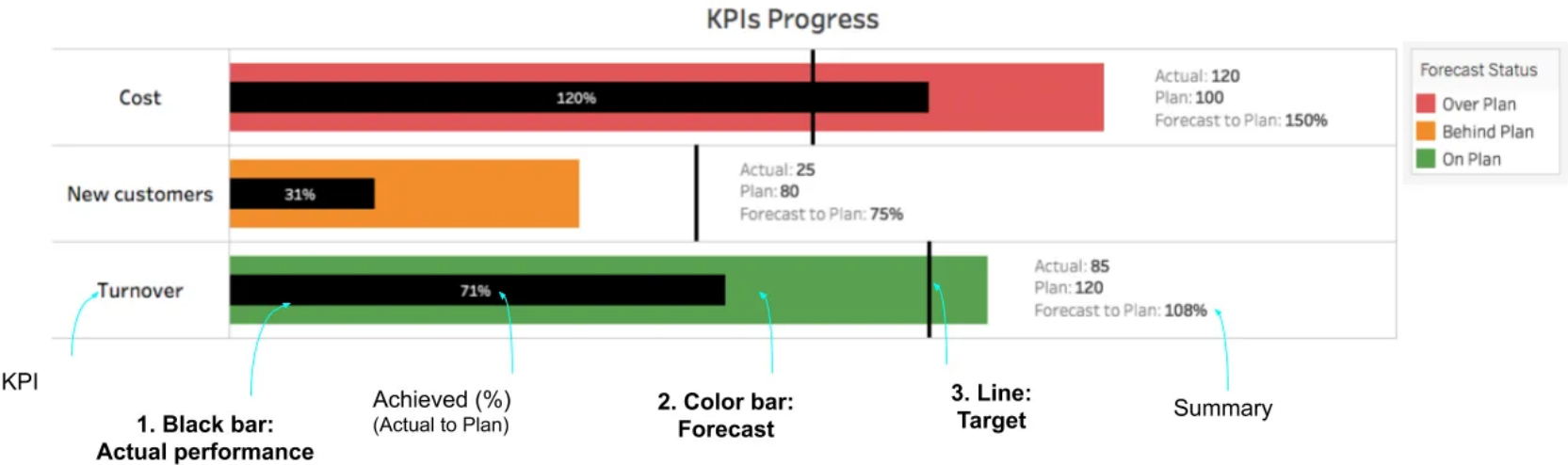
KPIs, %

■ above ■ below target | ■ critical minimum



Click on the red warning sign for more details about the

# Bullet Graph



# Kinds of Data

- **Numeric data - "countable" = Metrics**
  - e.g., sales, prices, return
  - Can do arithmetic on: add, median/mean, min/max - meaningfully
  - may be absolute or percentage
- **Categorical (nominal) data = Dimensions**
  - labels like different collections of books: Stacks, Reference, Oversize
  - includes "nominal" data that looks like numbers but isn't really, like ISBNs, room numbers
- **Dates/times - can be metrics (e.g. median pub years) or dimensions (month of year); has a natural order that should override "most to least"**
- **Ordinal data - rankings - the number does not represent a quantity of anything**

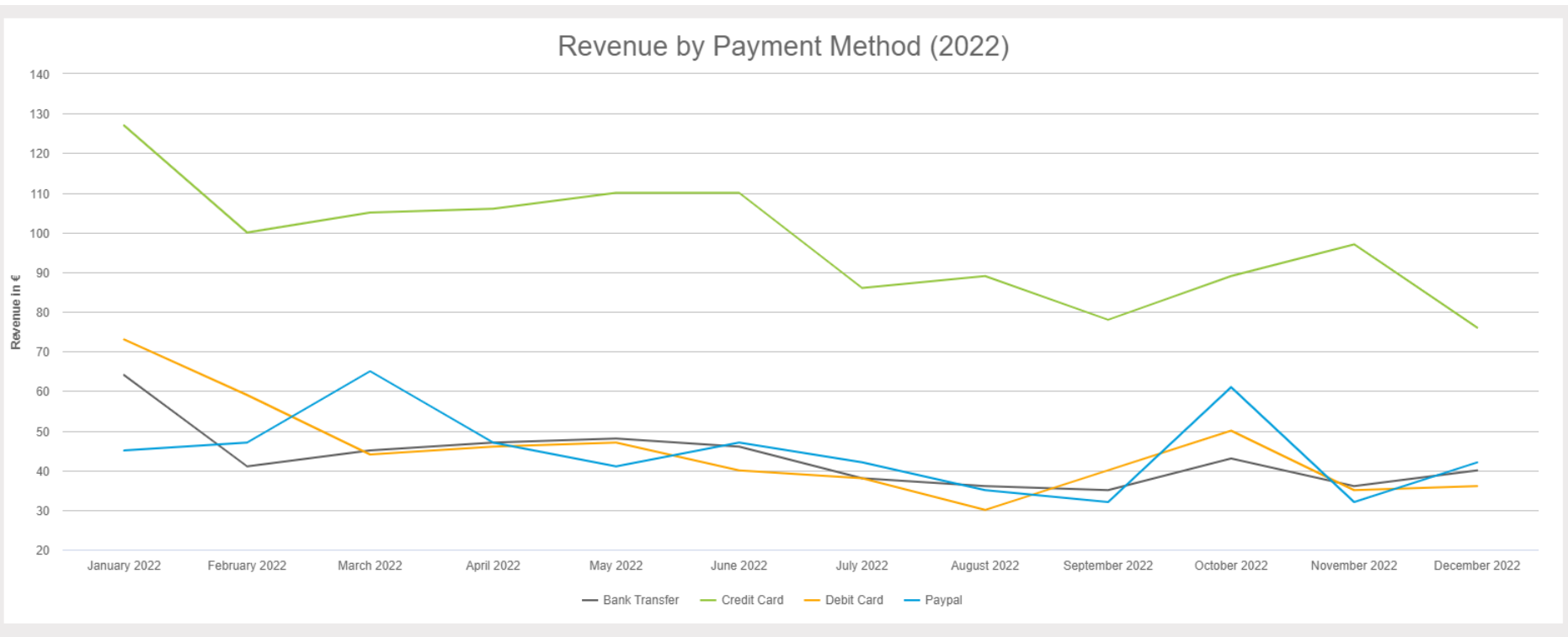


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# Section 3: Understanding Charts & Design



# 1. Line Chart: y-axis ranges are important





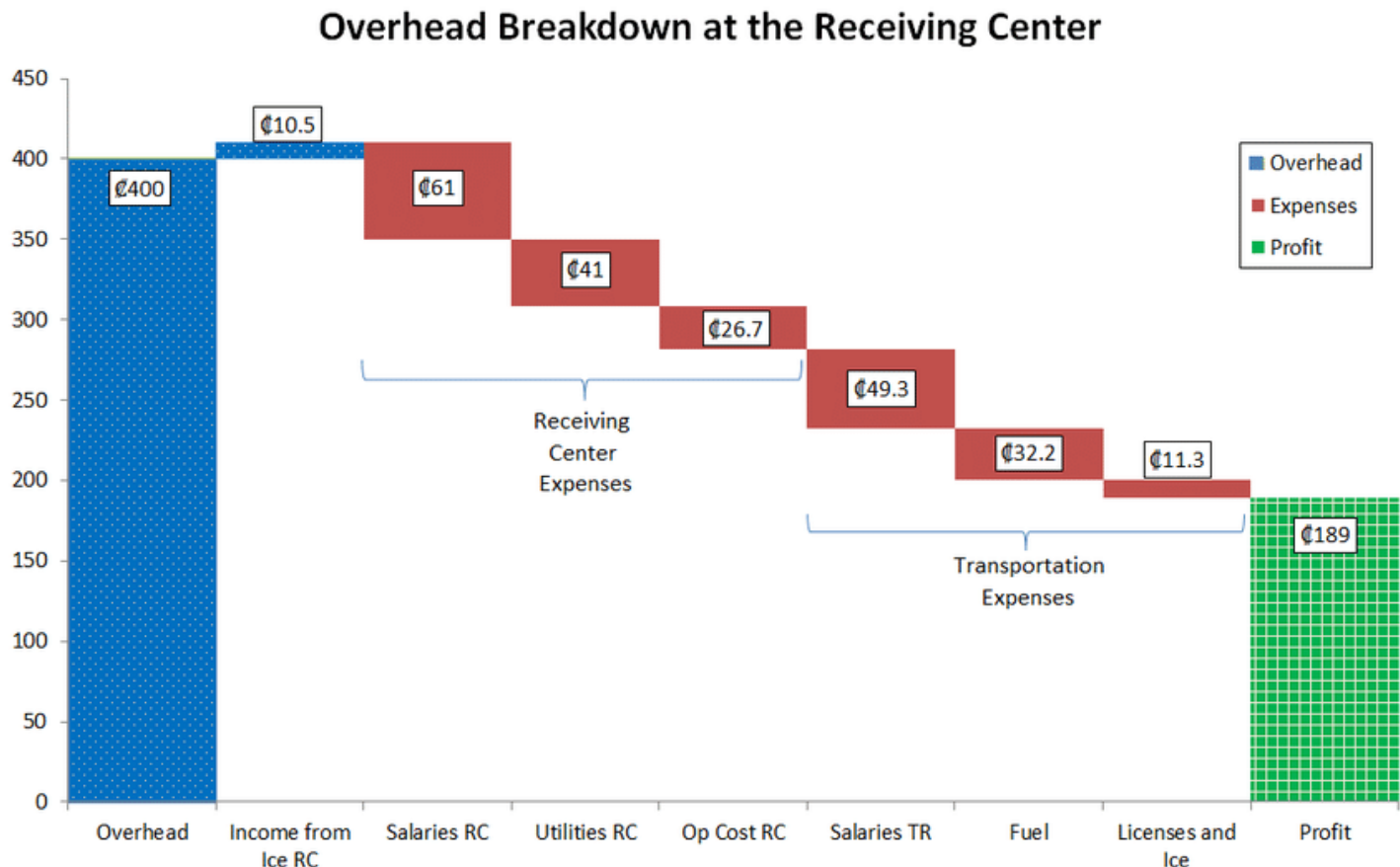
## 2. Map: If location matters.



6.3.2024

41

### 3. Waterfall Chart: Often for revenue composition



Veronica Coyle (2015). Analyzing and Improving the Costa Rican Fishing Supply Chain

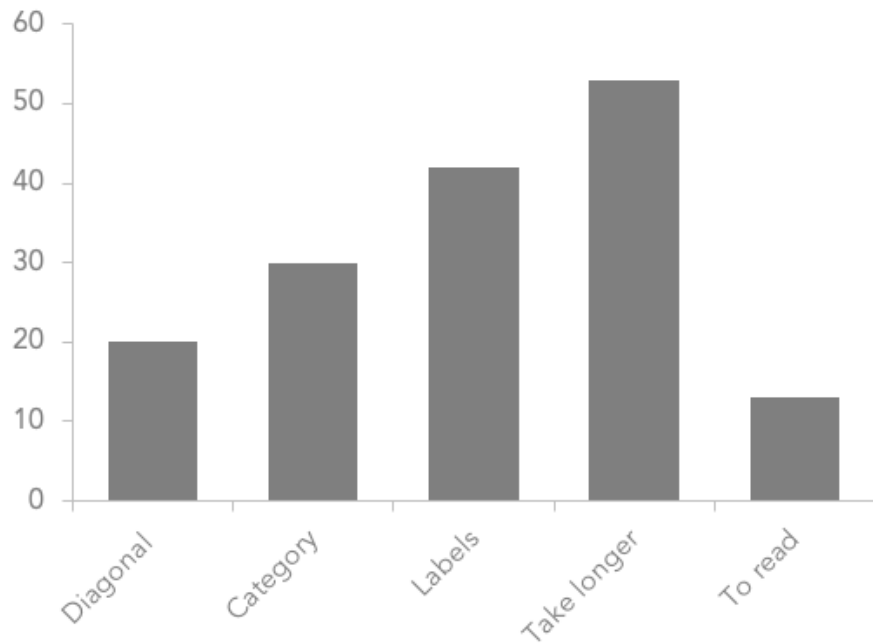
# 4. Horizontal Bar Graphs: Value sorting matters

Top 5 Products on Sales (last year)

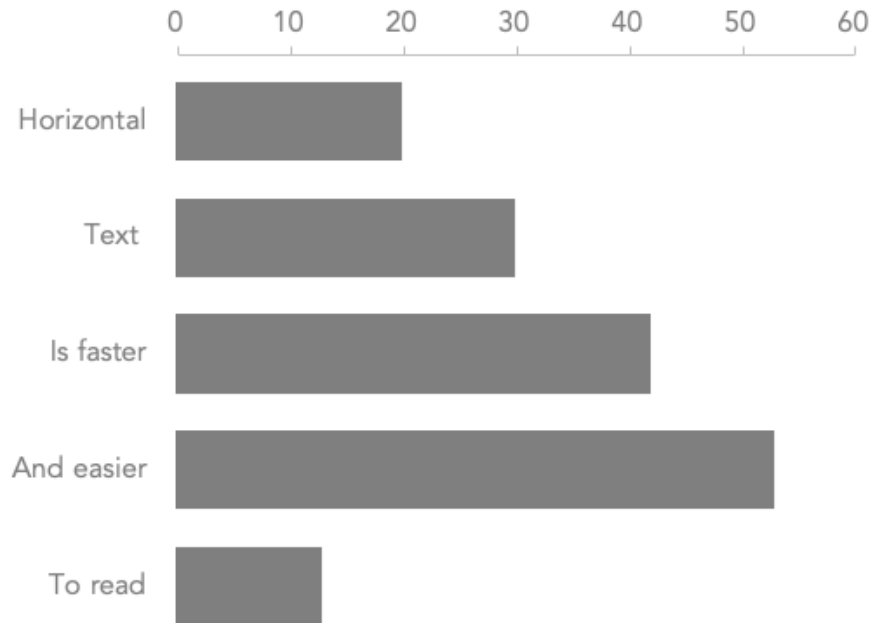


# When should you use horizontal or vertical bar charts?

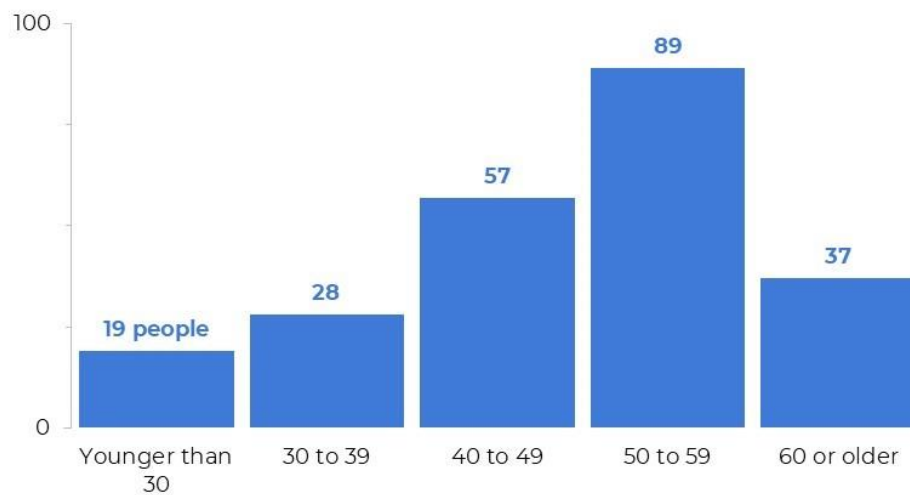
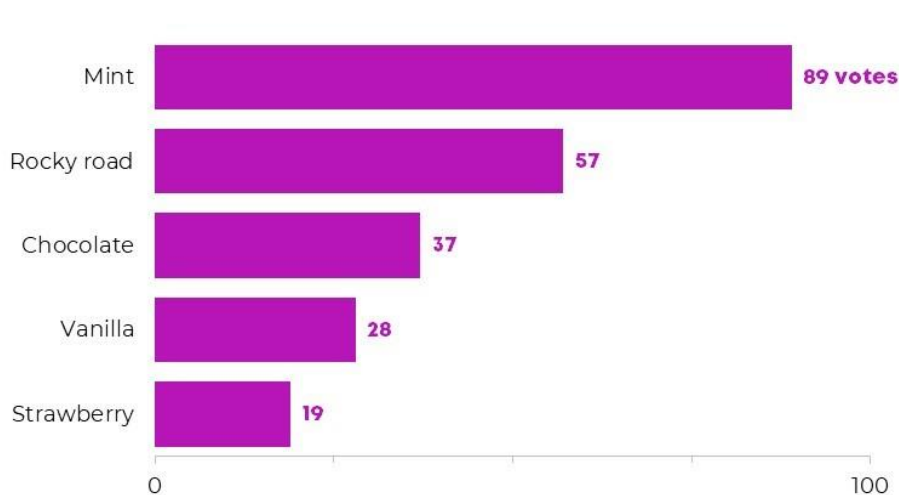
Vertical bar chart



Horizontal bar chart

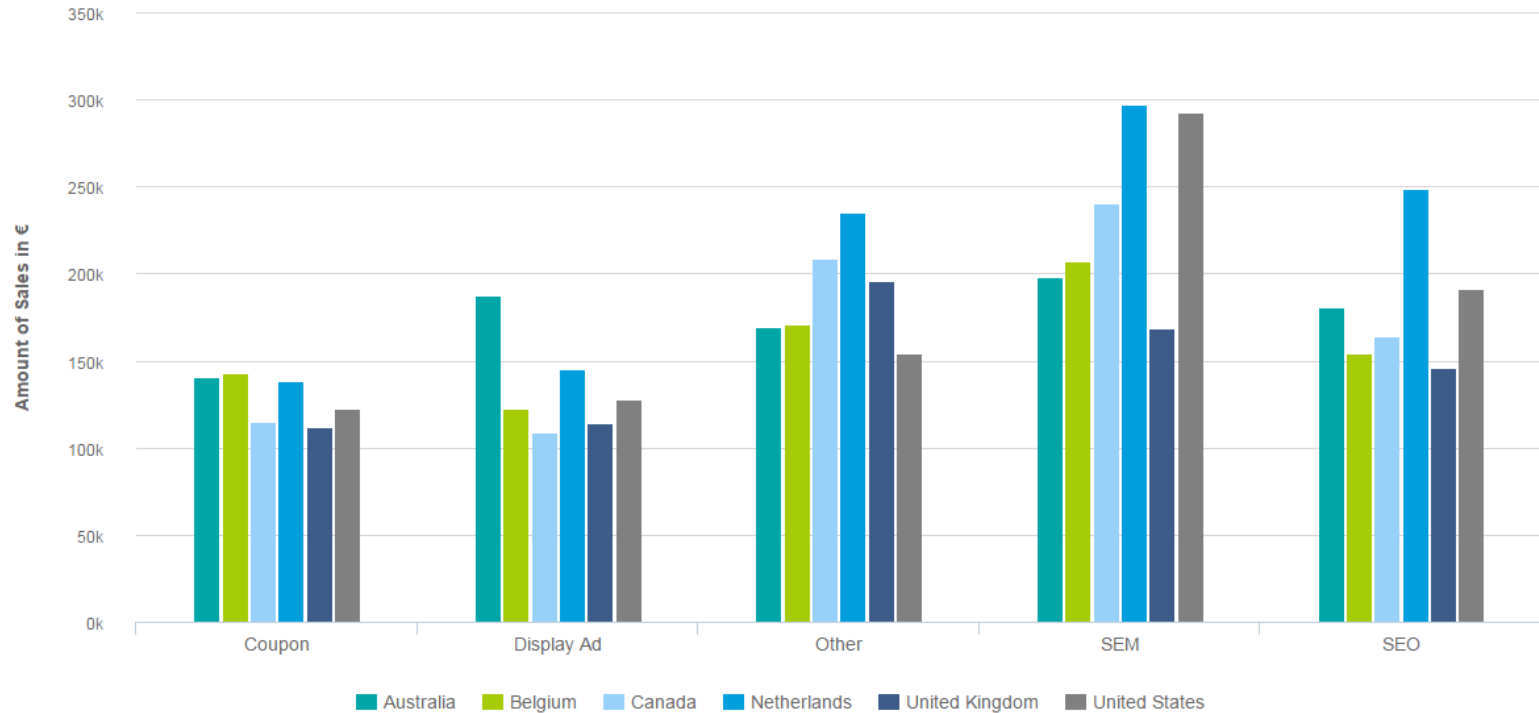


# 5. When to use horizontal or vertical bar charts?

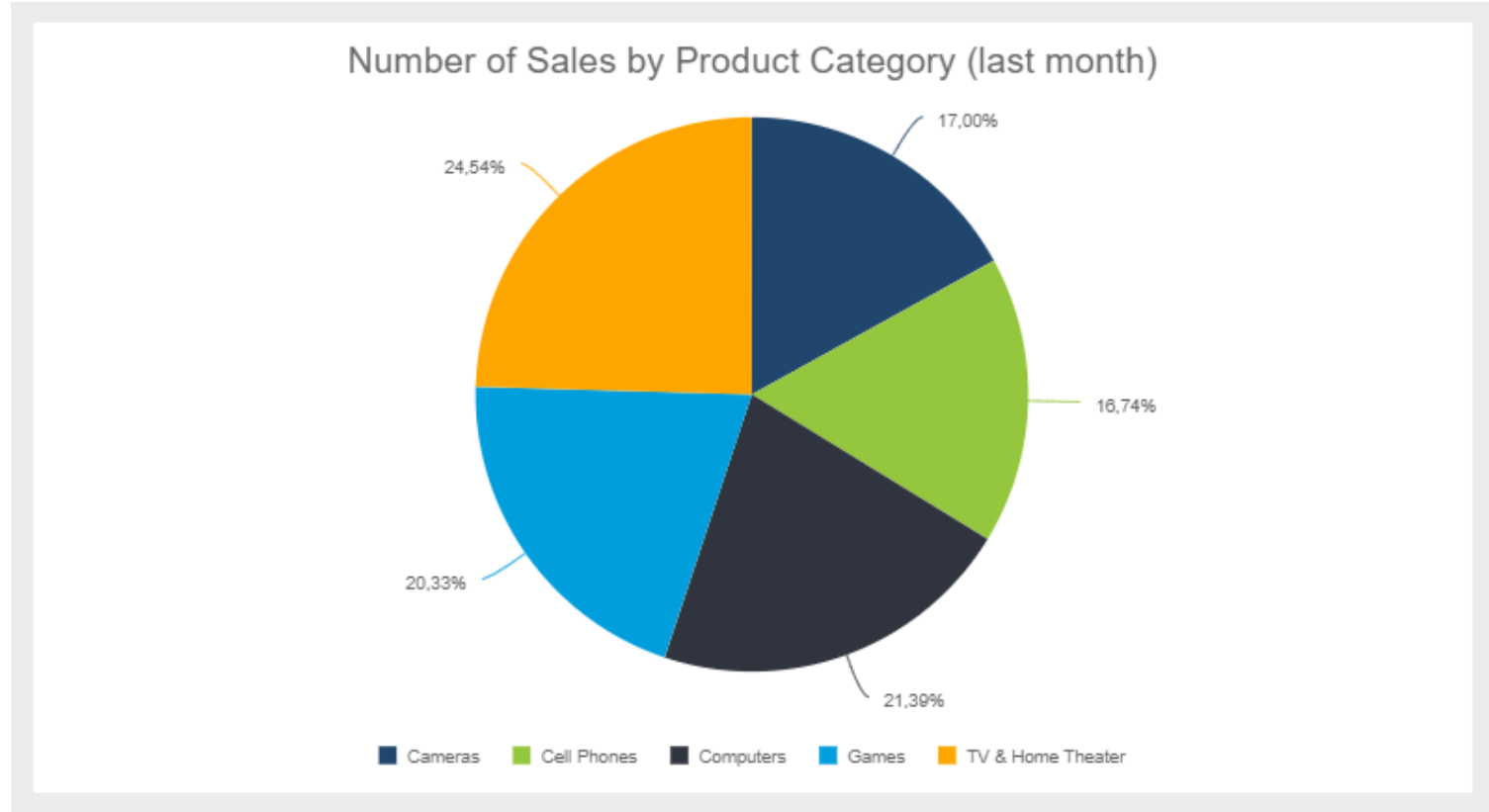


# 6. Grouped column chart

Amount of Sales per Channel and Country (last year)



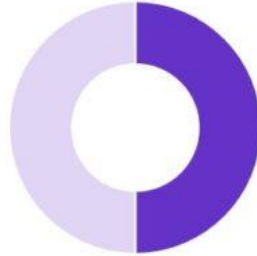
# 7. Pie Chart: No more than two categories



# Doughnut Chart

## Of the 60 Visitors We Surveyed...

**50%**  
first-time  
visitors



**Mostly from MA**

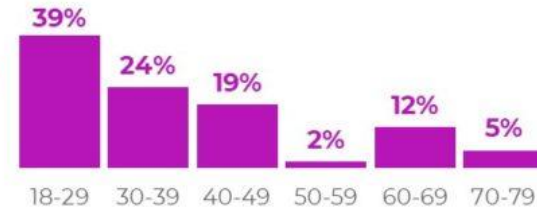
Plus 18 other states &  
5 other countries



**30%**  
university  
affiliates



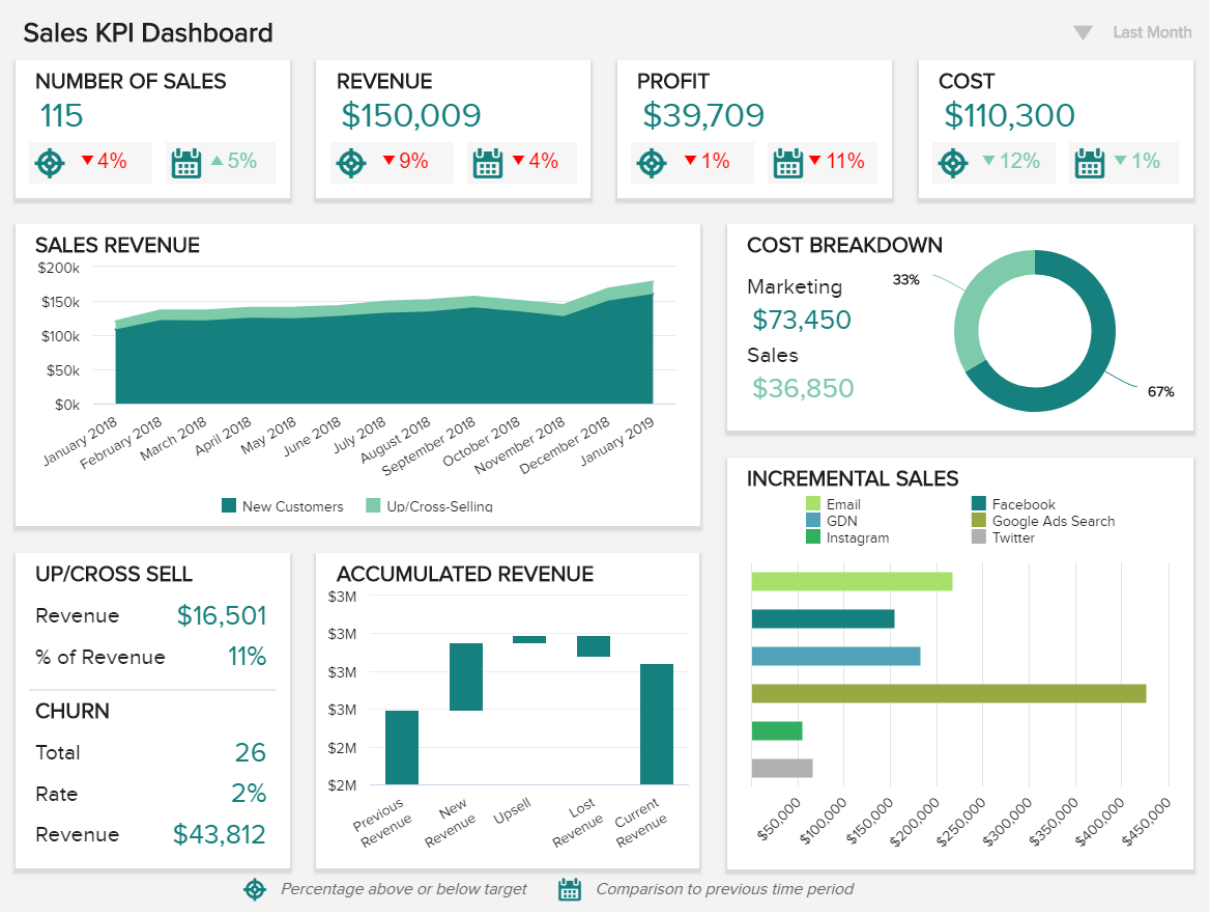
**On the  
younger  
side**



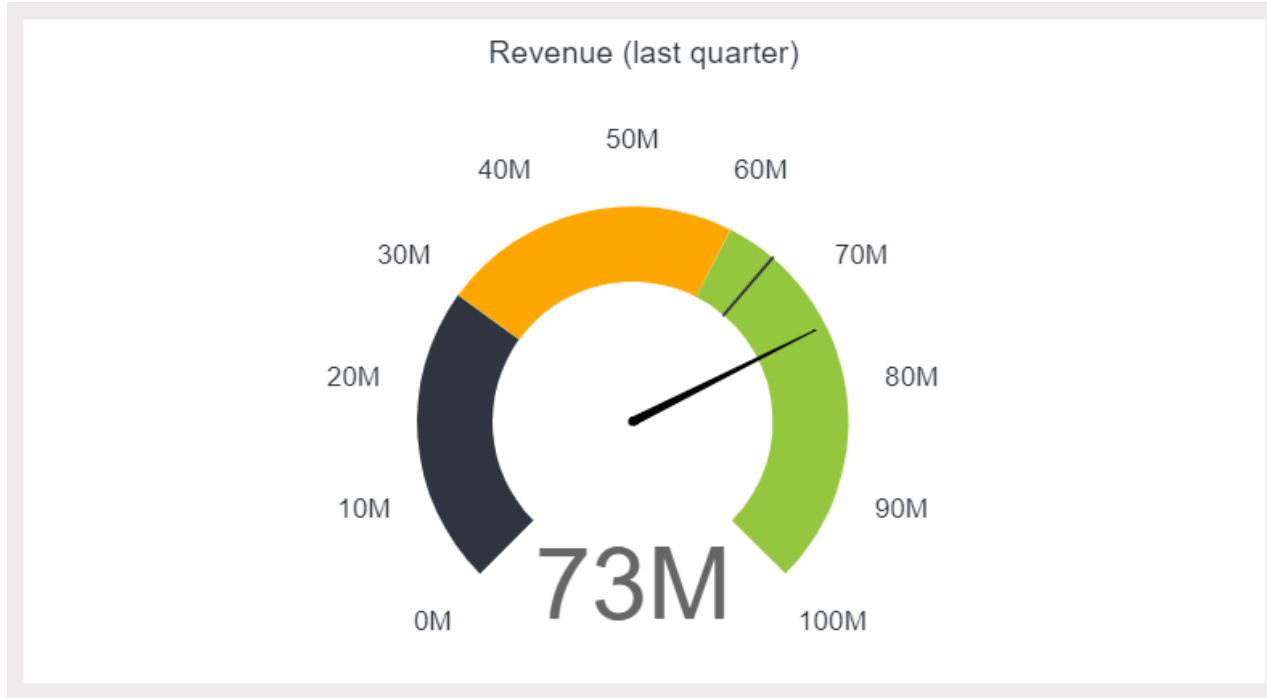
depict data studio



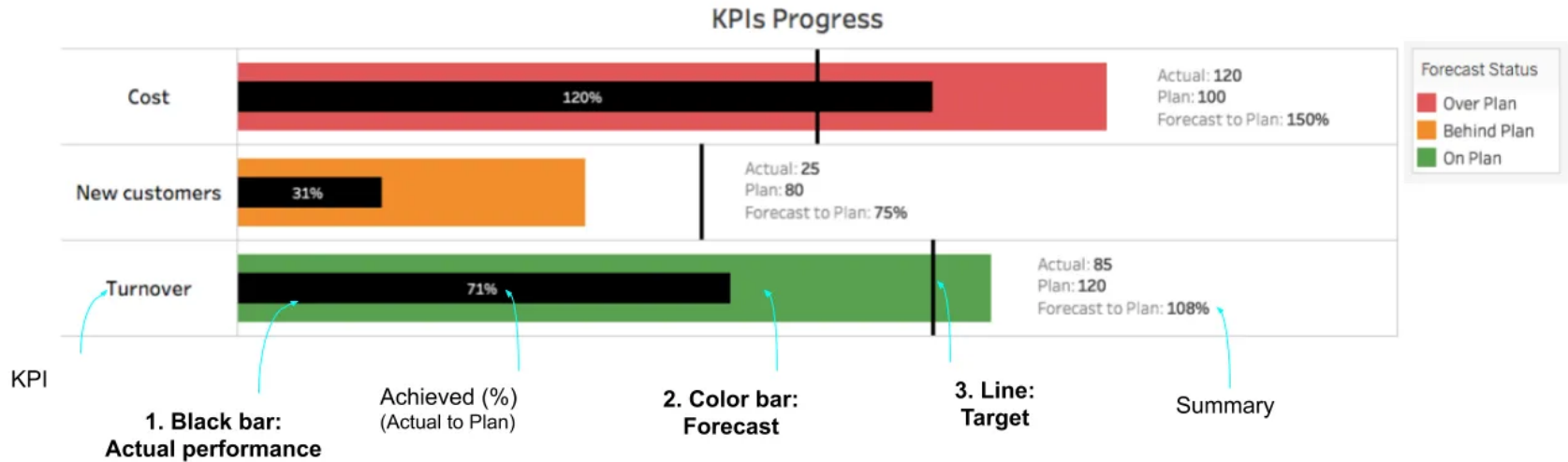
# Doughnut Chart 2



# 8. Gauge Charts

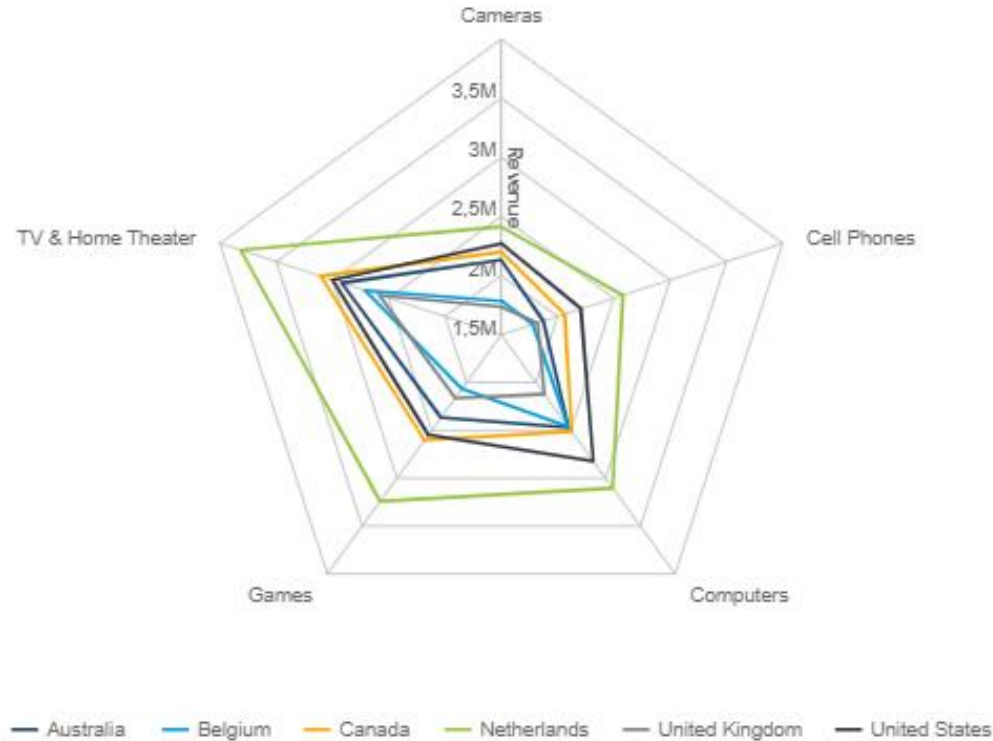


# 9. Bullet chart: Good for KPIs, but not good for non-technical audiences



# 10. Radar charts

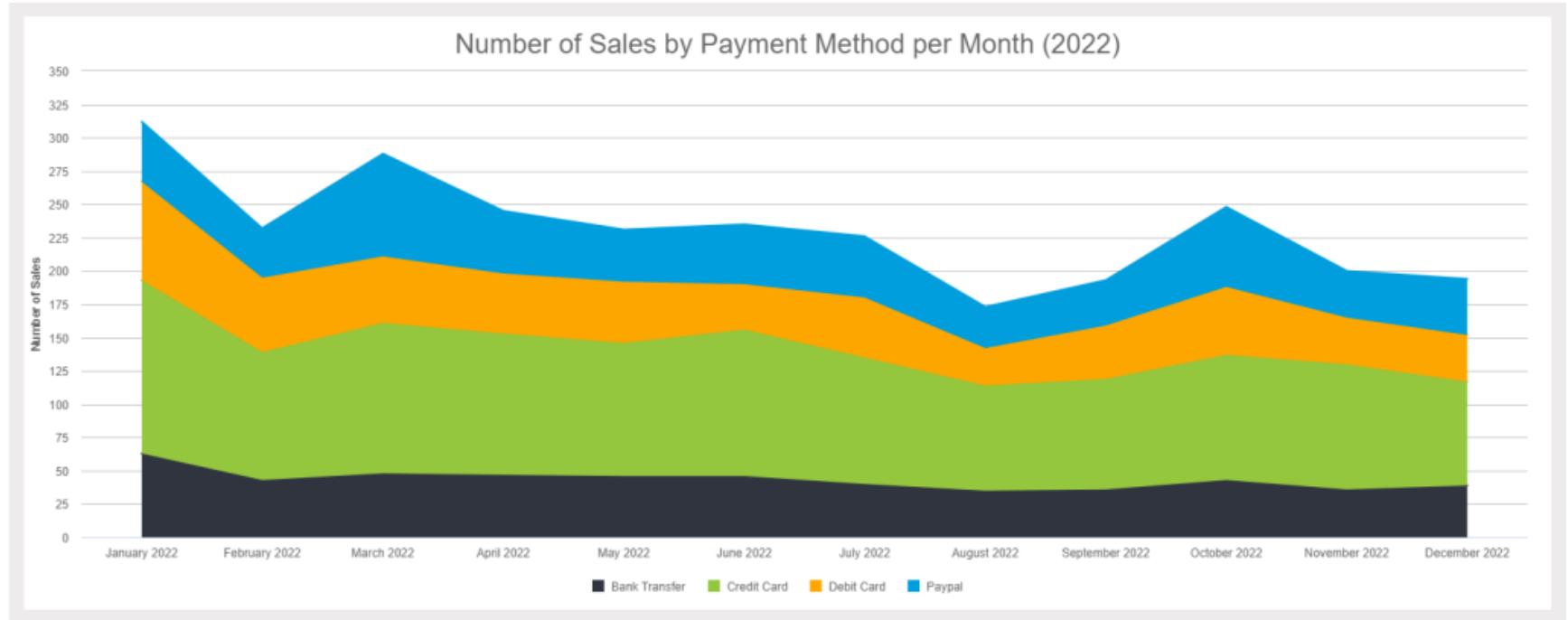
Revenue by Product Category per Country (last month)



# 11. Table: Color matters

Category	Status	Avg Price	Last Year	This Year	Goal
100-Groceries	●	\$1.36	\$810,176	\$829,776	\$810,176
090-Home	●	\$3.28	\$2,913,647	\$3,053,326	\$2,913,647
080-Accessories	●	\$4.22	\$1,273,096	\$1,379,259	\$1,273,096
070-Hosiery	●	\$3.57	\$573,604	\$486,106	\$573,604
060-Intimate	●	\$4.02	\$955,370	\$852,329	\$955,370
050-Shoes	●	\$13.73	\$3,640,471	\$3,574,900	\$3,640,471
040-Juniors	●	\$7.06	\$3,105,550	\$2,930,385	\$3,105,550
030-Kids	●	\$5.20	\$2,726,892	\$2,705,490	\$2,726,892
020-Mens	●	\$6.89	\$4,453,133	\$4,452,421	\$4,453,133
010-Womens	●	\$6.70	\$2,680,662	\$1,787,958	\$2,680,662
<b>Total</b>	●	<b>\$5.19</b>	<b>\$23,132,601</b>	<b>\$22,051,952</b>	<b>\$23,132,601</b>

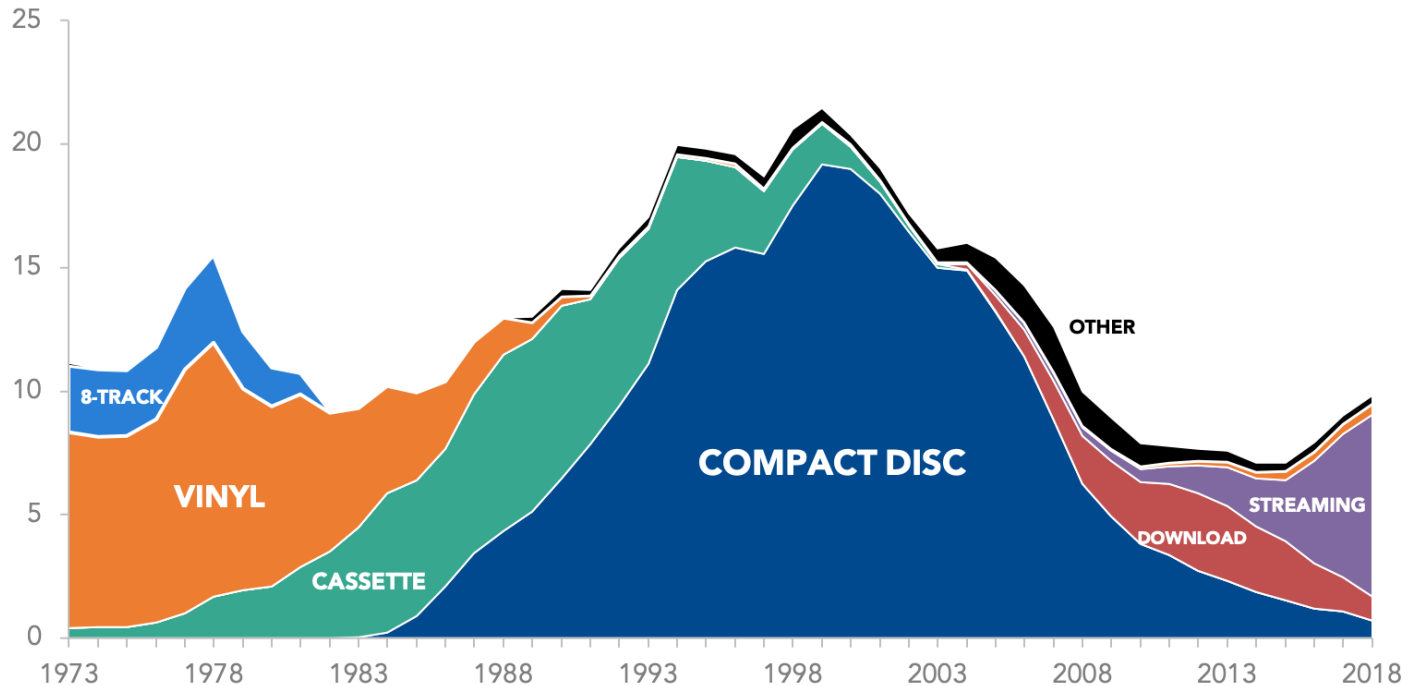
# 12. Area Chart



# Area chart: Example 1

## US music sales by format (inflation-adjusted)

IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

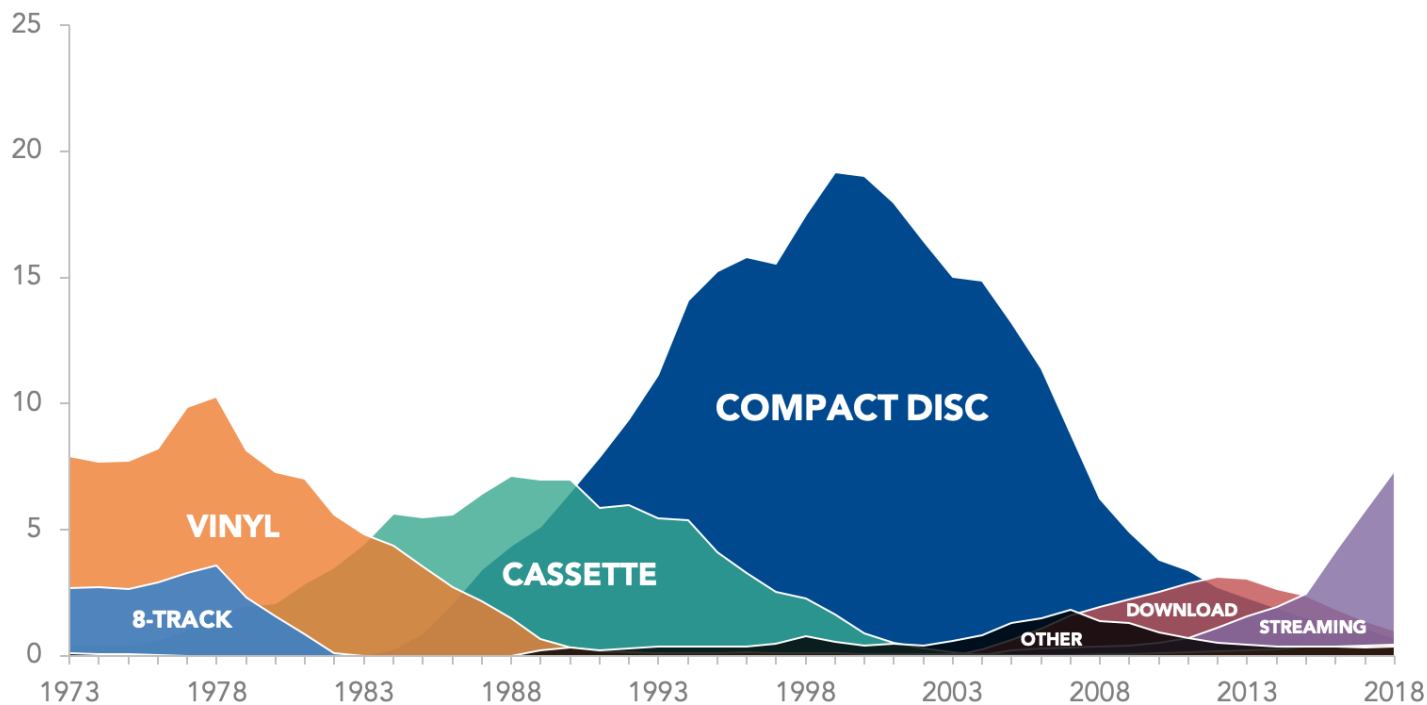
3.3.2024

55

# Area chart: Example 2

US music sales by format (inflation-adjusted)

IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

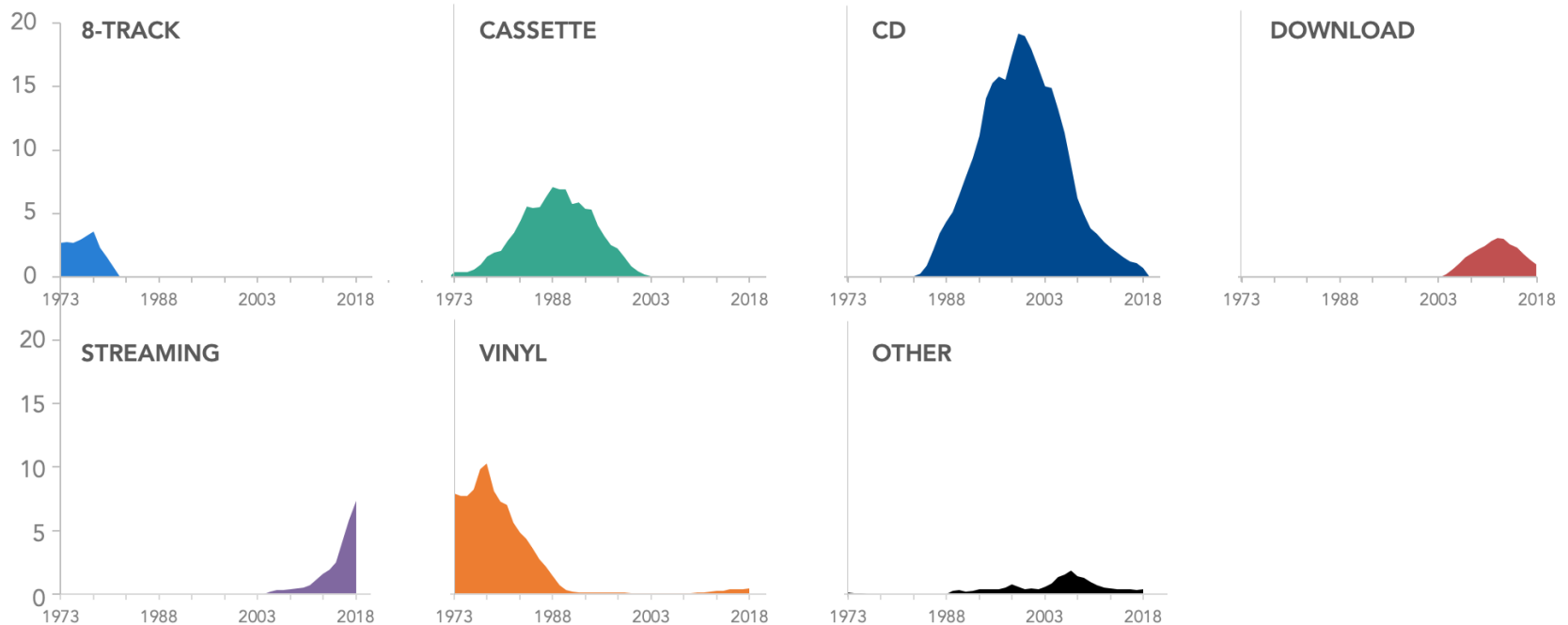
<https://www.storytellingwithdata.com/blog/2020/4/9/what-is-an-area-graph>



# Area chart: Example 3

## US music sales by format (inflation-adjusted)

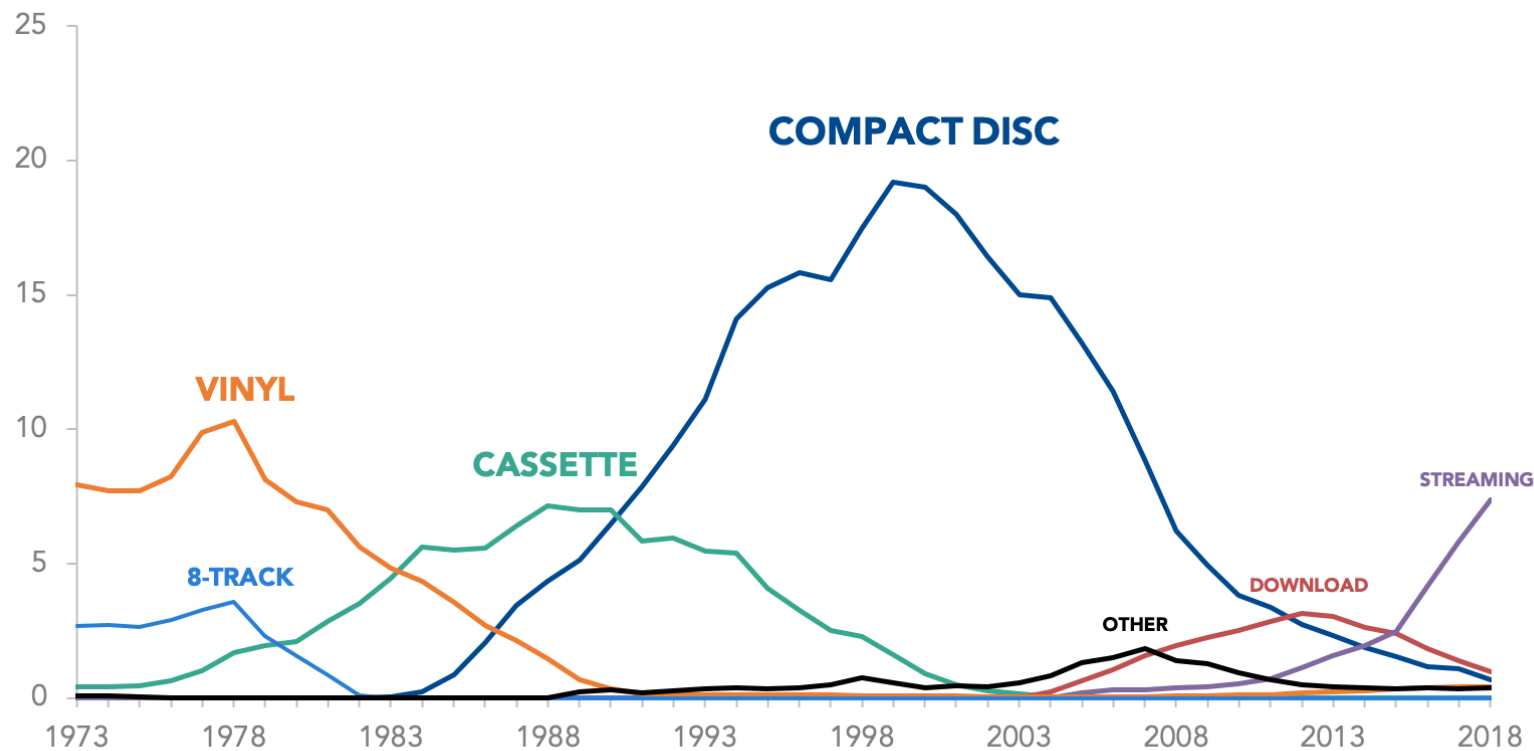
IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

# Area chart: Example 4

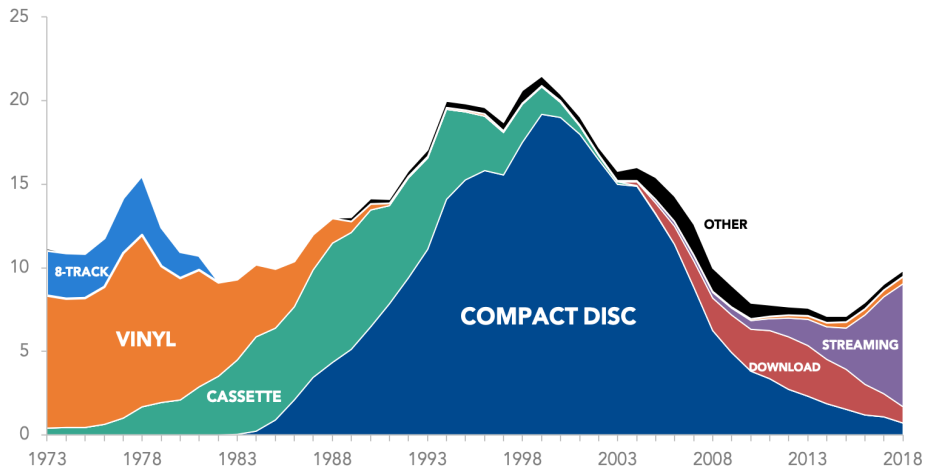
US music sales by format (inflation-adjusted)  
IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

# US music sales by format (inflation-adjusted)

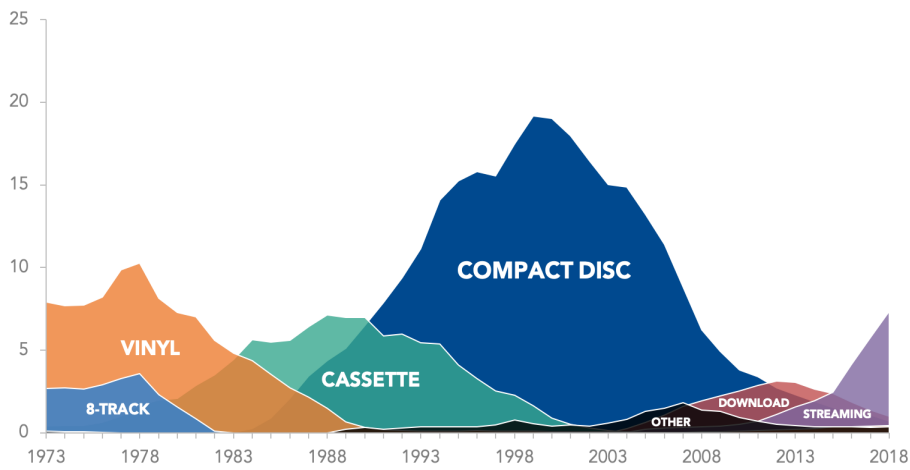
IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

# US music sales by format (inflation-adjusted)

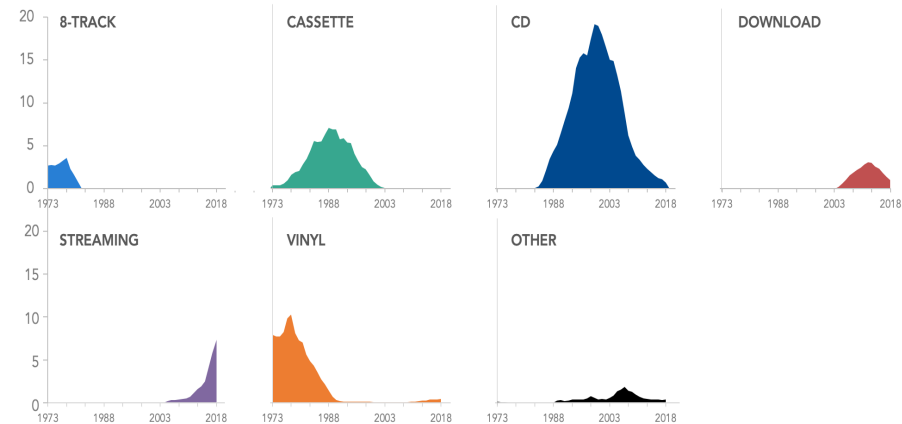
IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

# US music sales by format (inflation-adjusted)

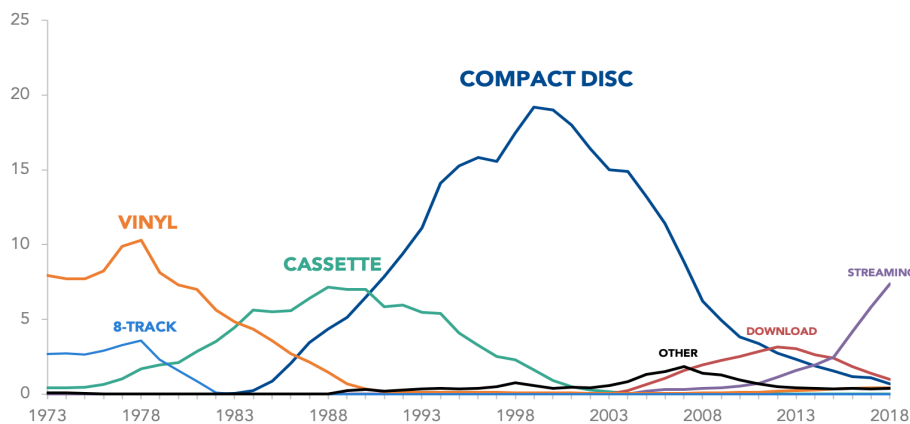
IN BILLIONS (USD)



SOURCE: Recording Industry Association of America

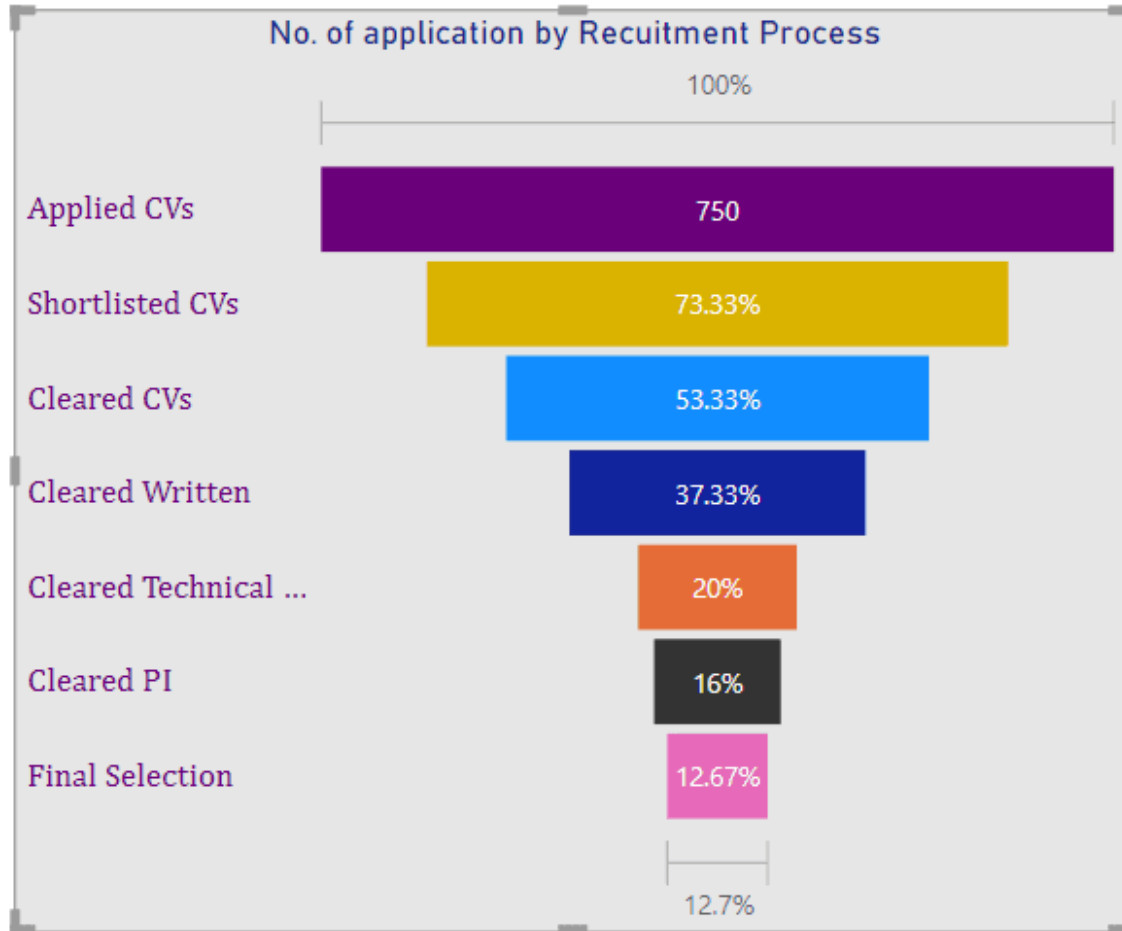
# US music sales by format (inflation-adjusted)

IN BILLIONS (USD)

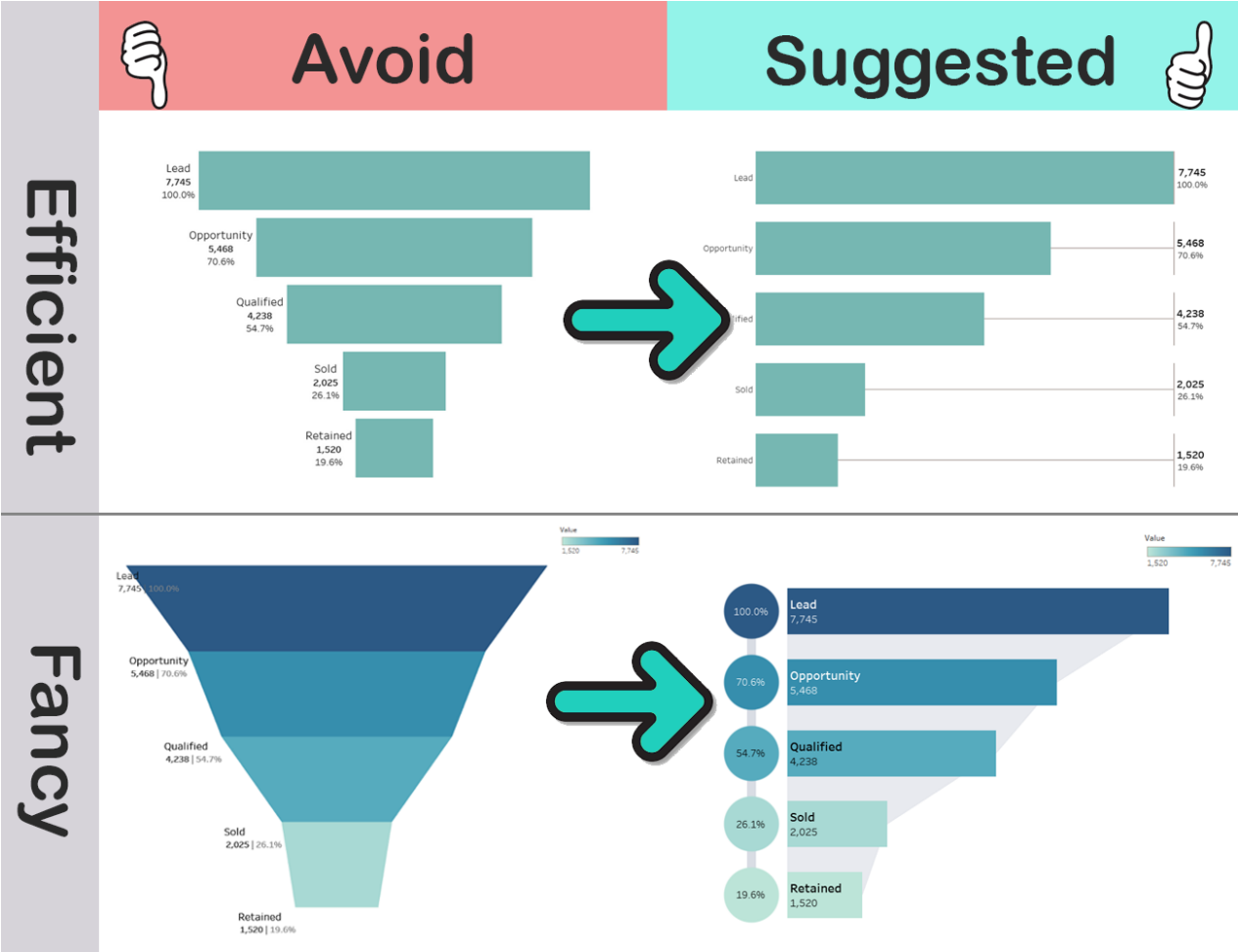


SOURCE: Recording Industry Association of America

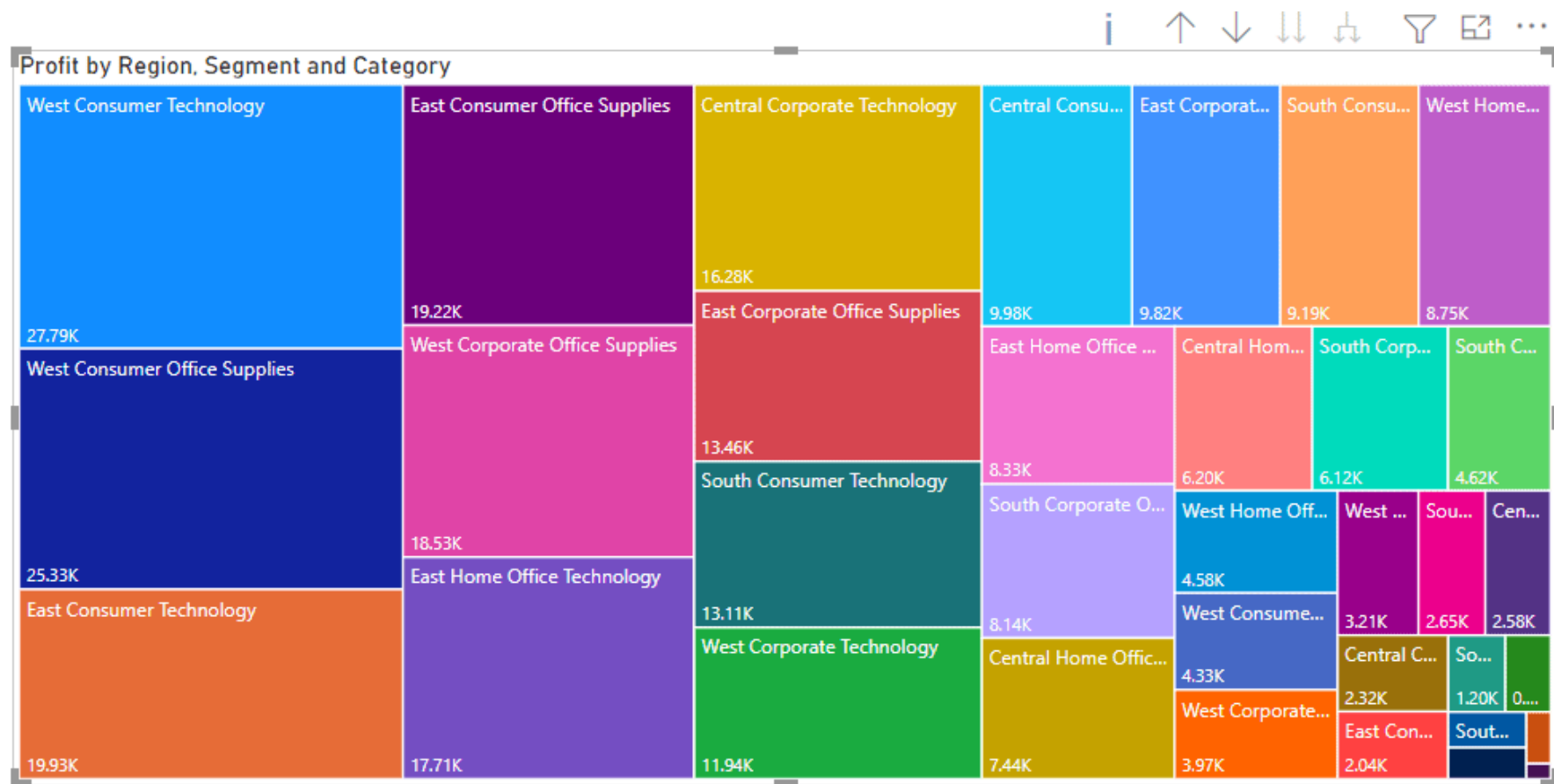
# 13. Funnel Chart:



# Funnel Chart: Tableau



# 14. Treemap chart





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# Section 4: Good and bad data visualization



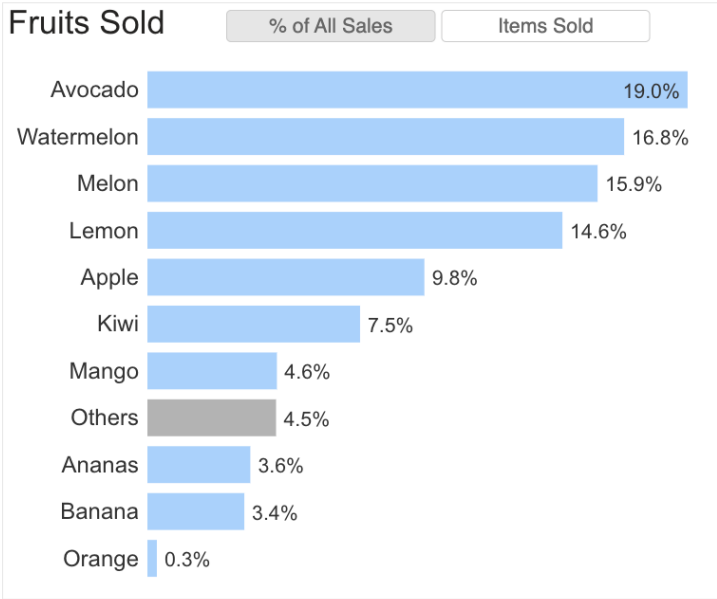
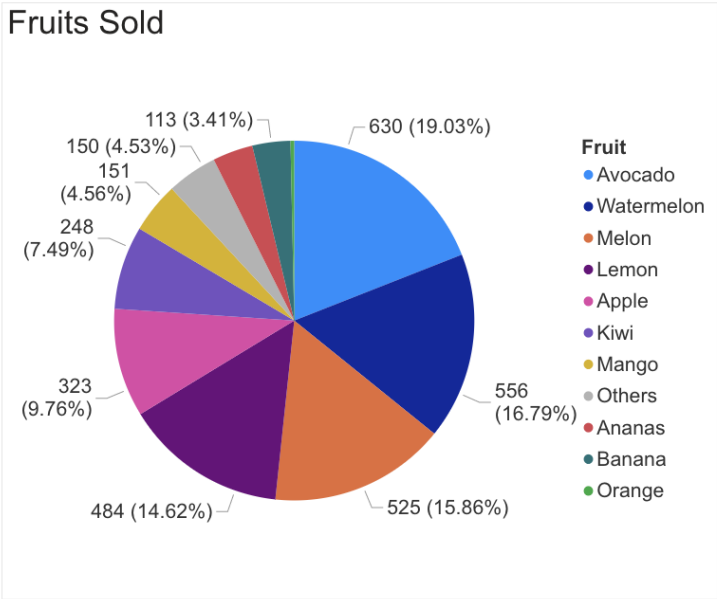
# Good vs Bad Data Visualizations



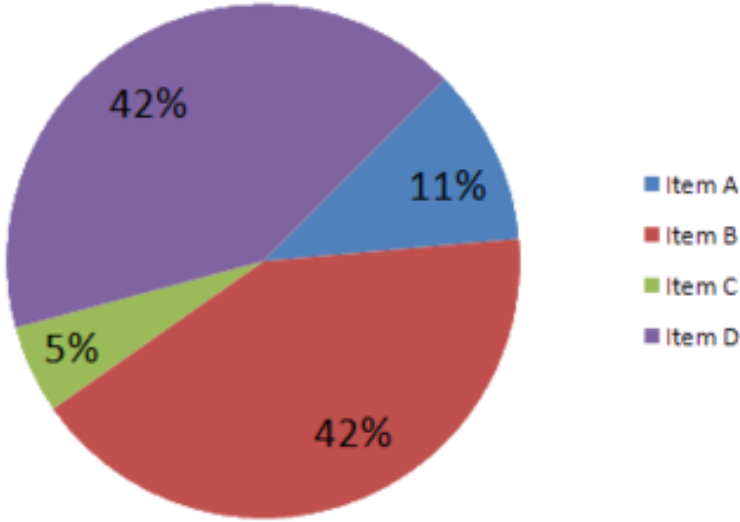
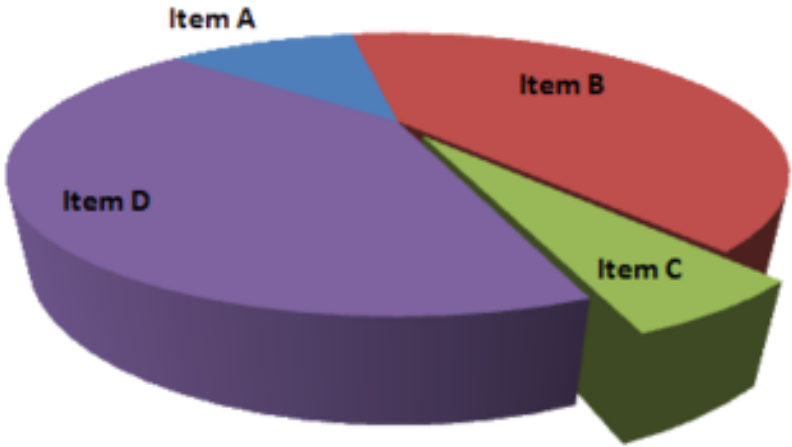


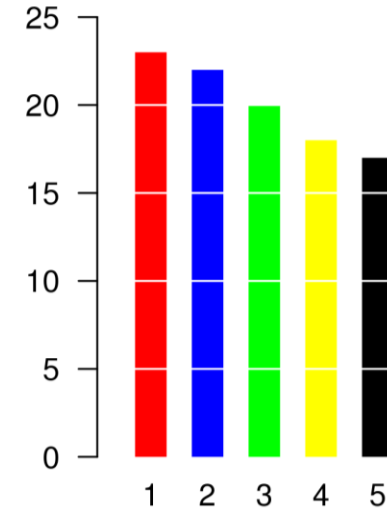
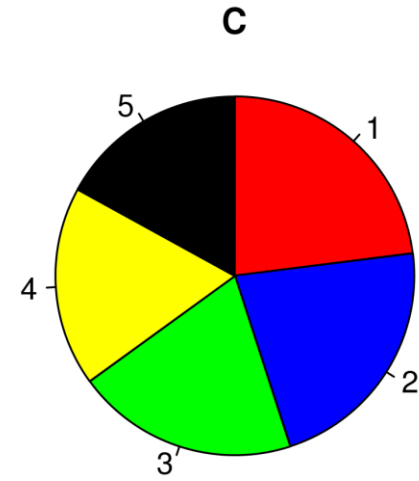
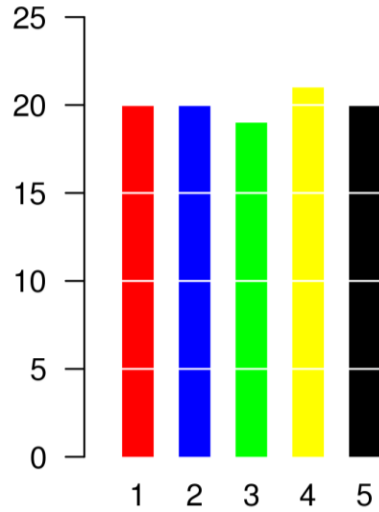
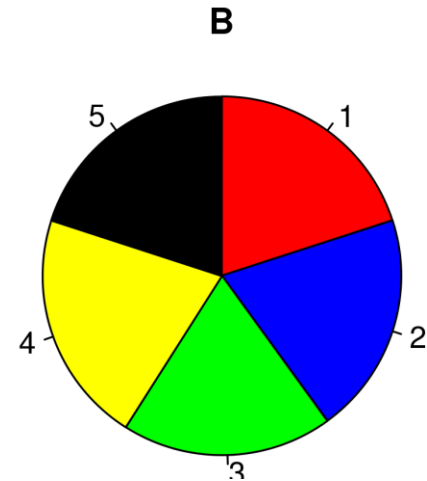
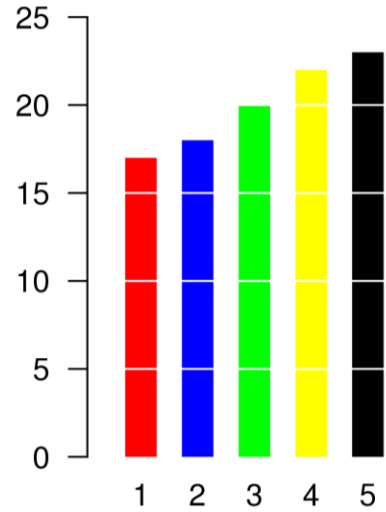
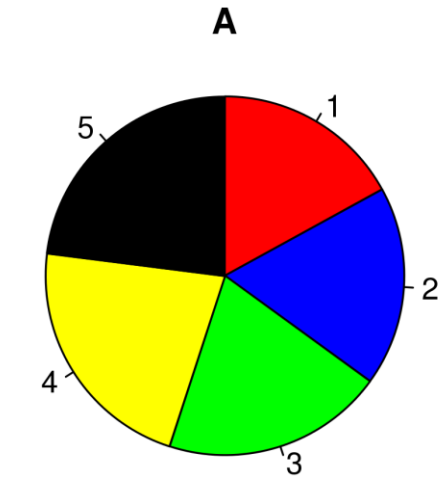
# Bad vs. Good Visualization

## Pie Chart?



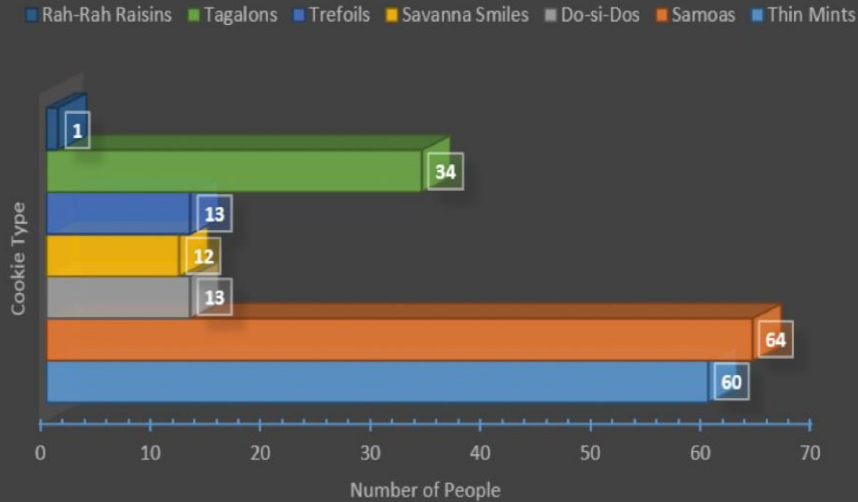
# Pei Chart + 3D





# Bad vs. Good Visualization

FAVORITE GIRL SCOUT COOKIES



Favorite Girl Scout Cookies

