Aalto University
School of Business

Business Intelligence

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

Agenda

- Good and bad data visualization
- Data visualization checklist
- BI Dashboard Design
- BI report monitoring and storytelling

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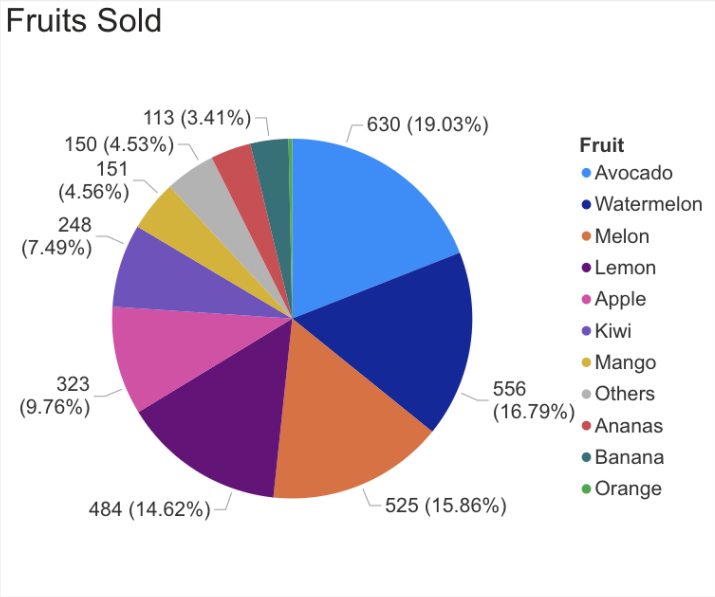
Section 1: Good and bad data visualization

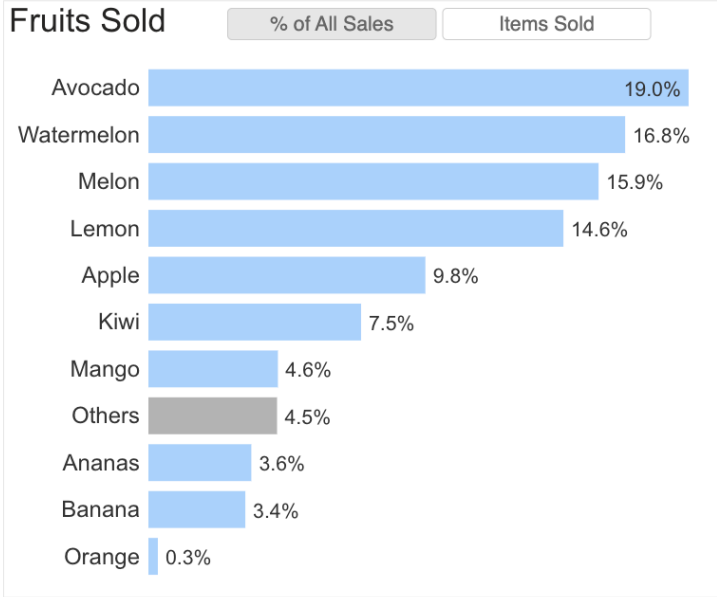
Good vs Bad Data Visualizations

https://blog.getpeerless.com/hubfs/Good%20vs%20Bad.png

Bad vs. Good Visualization

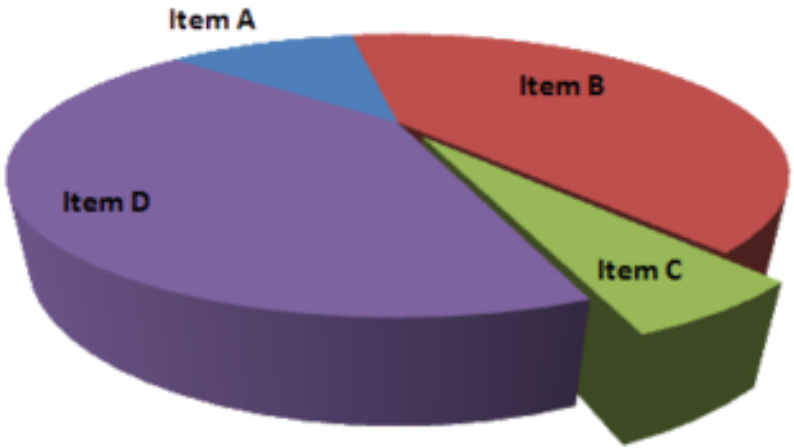
Pie Chart?

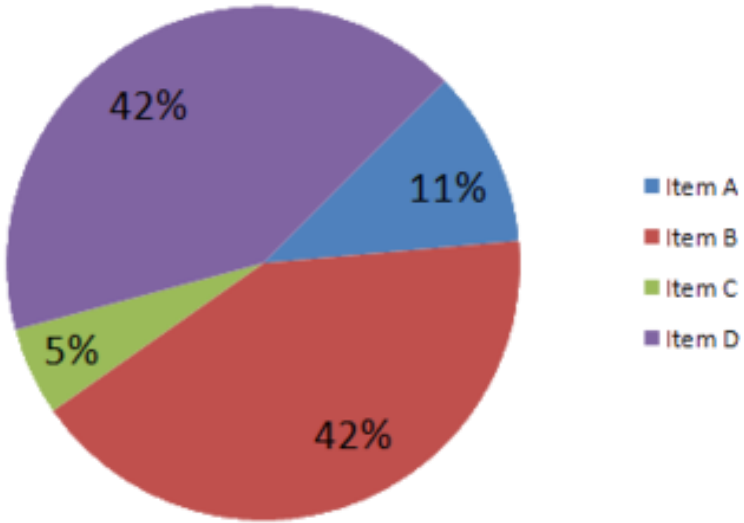




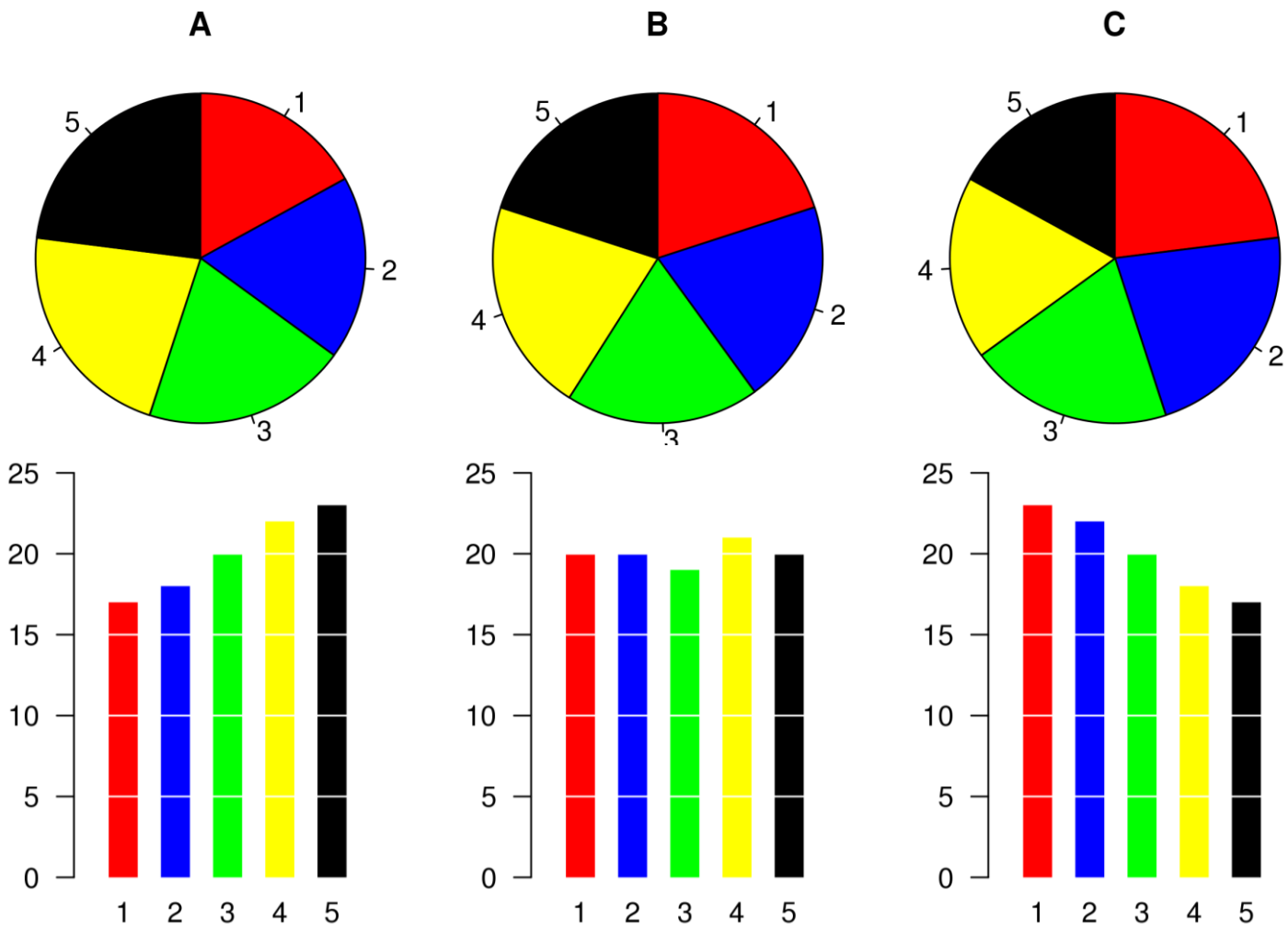
https://powerofbi.org/bad-and-good-charts-in-power-bi/

Pei Chart + 3D





https://en.wikipedia.org/wiki/Misleading_graph



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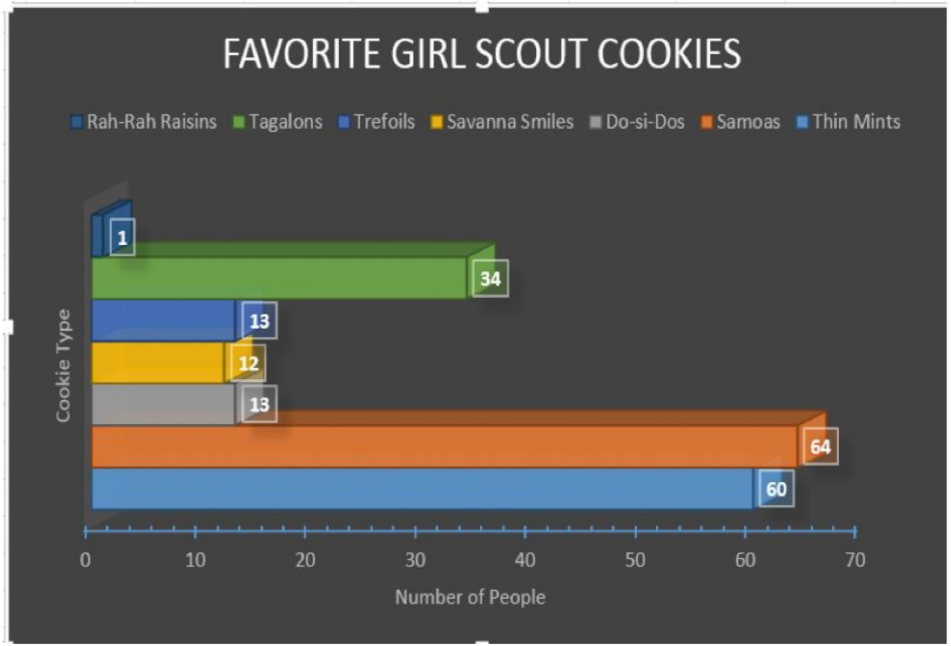
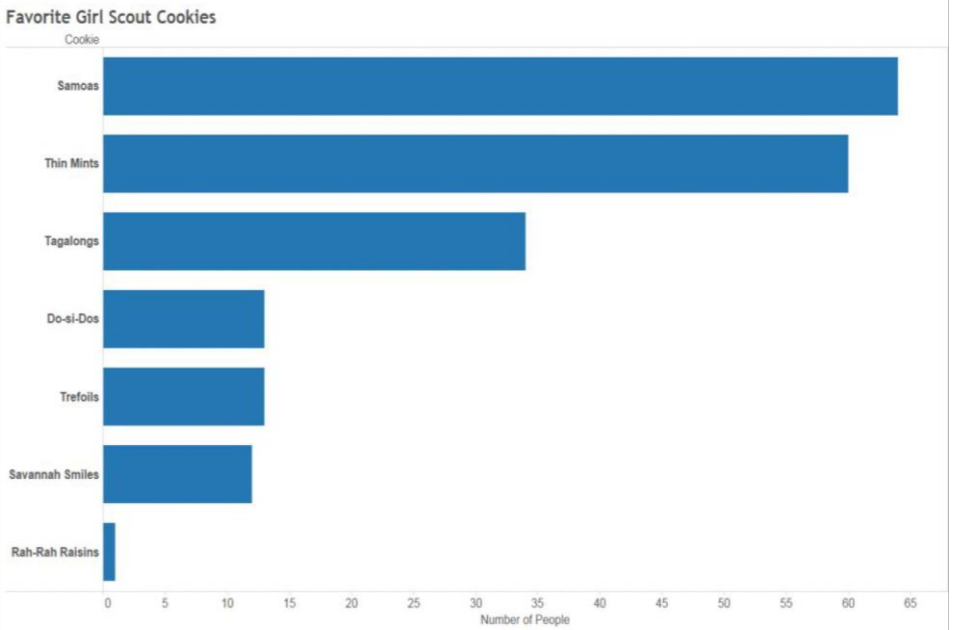
Bad vs. Good Visualization

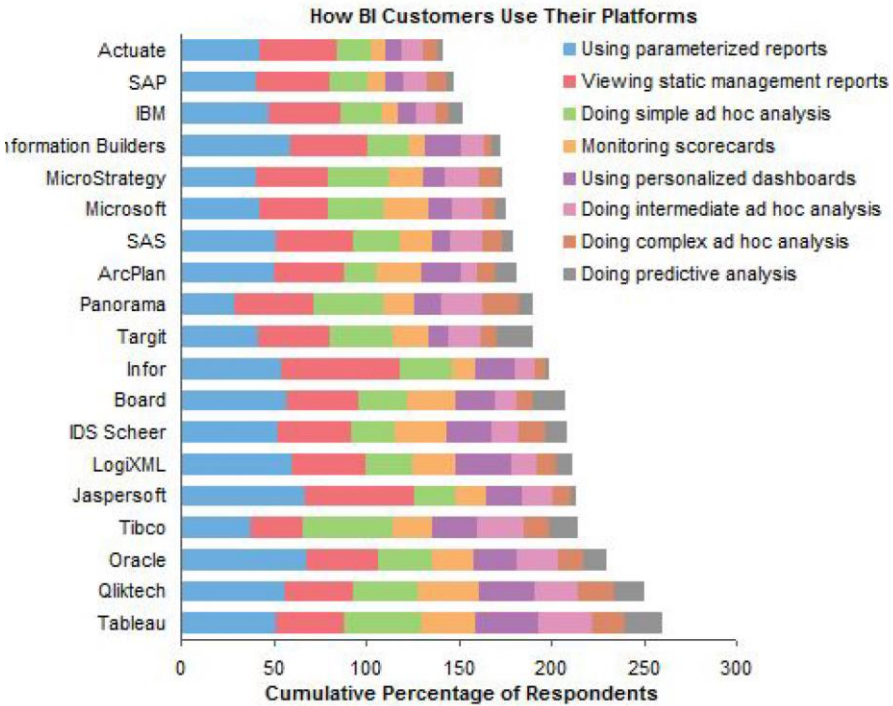


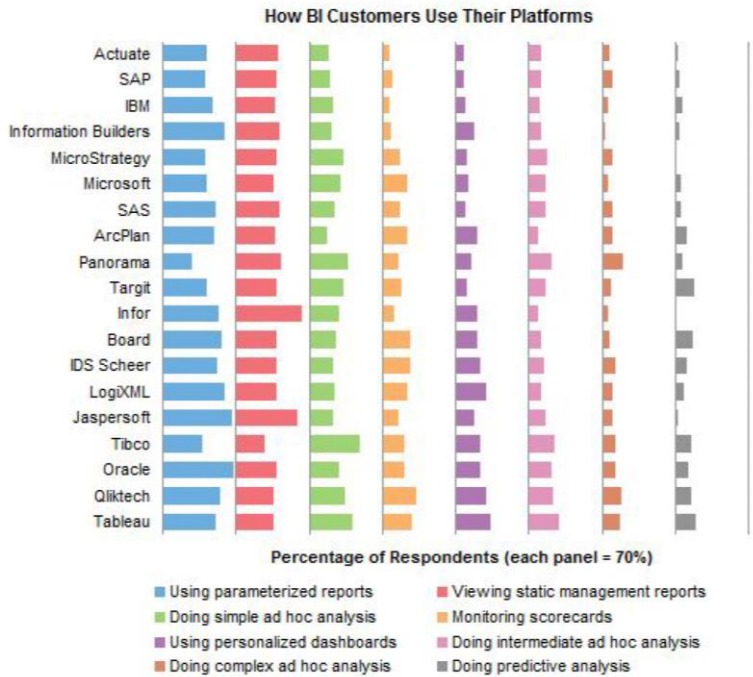


https://caul-cbua.ca/sites/default/files/CAUL%20Data%20Visualization%202017%20December.pdf

Bad vs. Good Visualization

Panel bar chart - keep the scales the same!





https://caul-cbua.ca/sites/default/files/CAUL%20Data%20Visualization%202017%20December.pdf

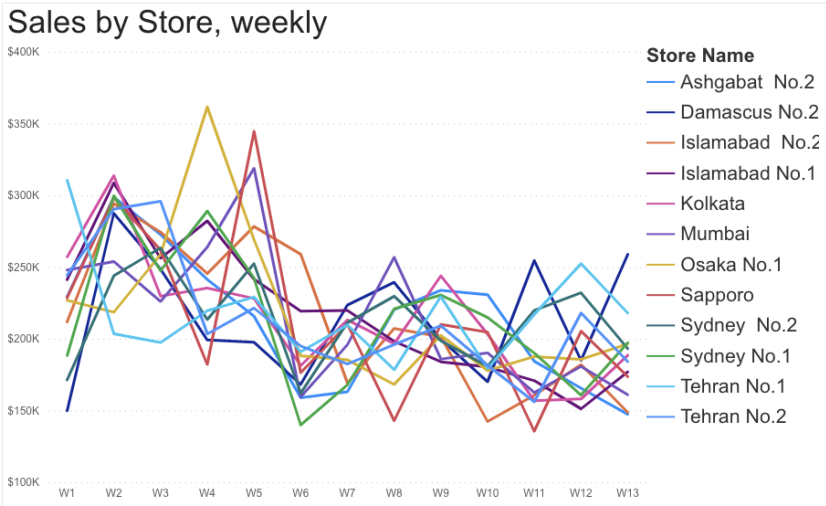
Bad vs. Good Visualization

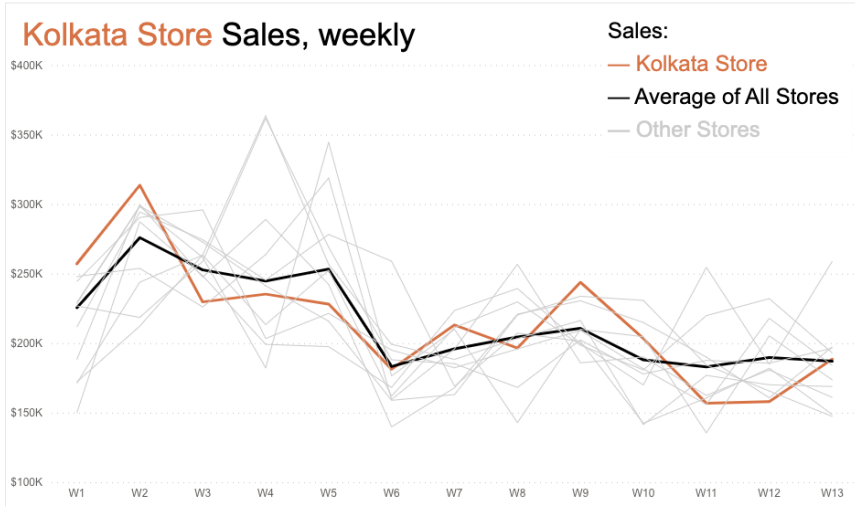
Bad and Good Charts in Power BI. Visualized by Andrzej Leszkiewicz

Line Chart with a Legend

Select a store:

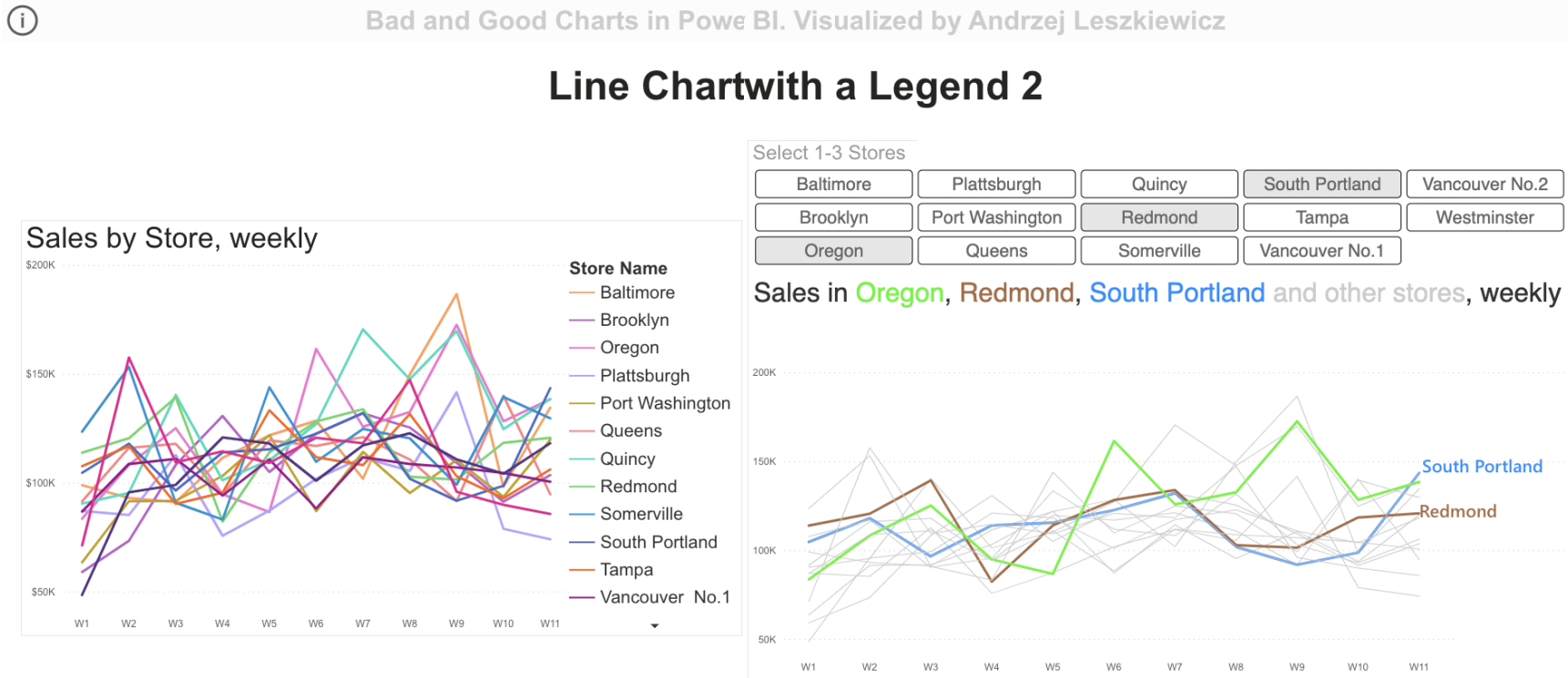
Kolkata





https://powerofbi.org/bad-and-good-charts-in-power-bi/

Bad vs. Good Visualization



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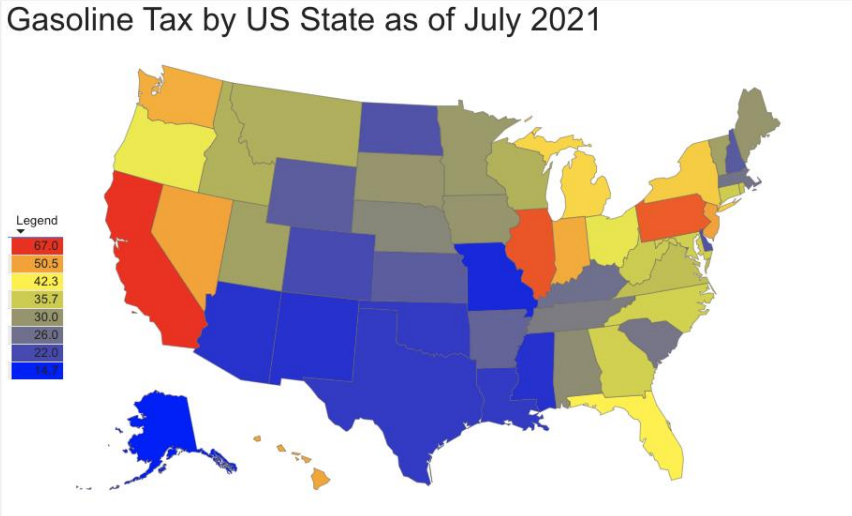
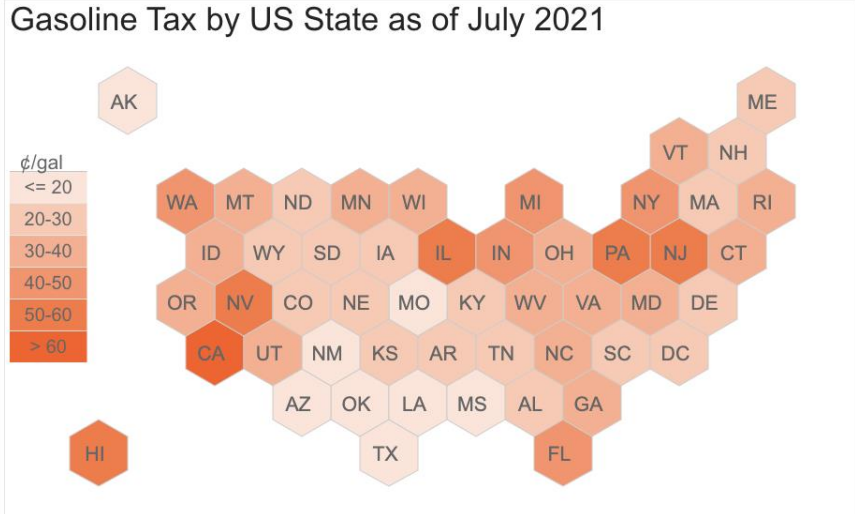
Bad vs. Good Visualization





https://powerofbi.org/bad-and-good-charts-in-power-bi/

Recap: Use of color for a numeric variable

If you only have one numeric variable, using the different intensity of ONE color to visualize the difference of values, but not multiple colors.

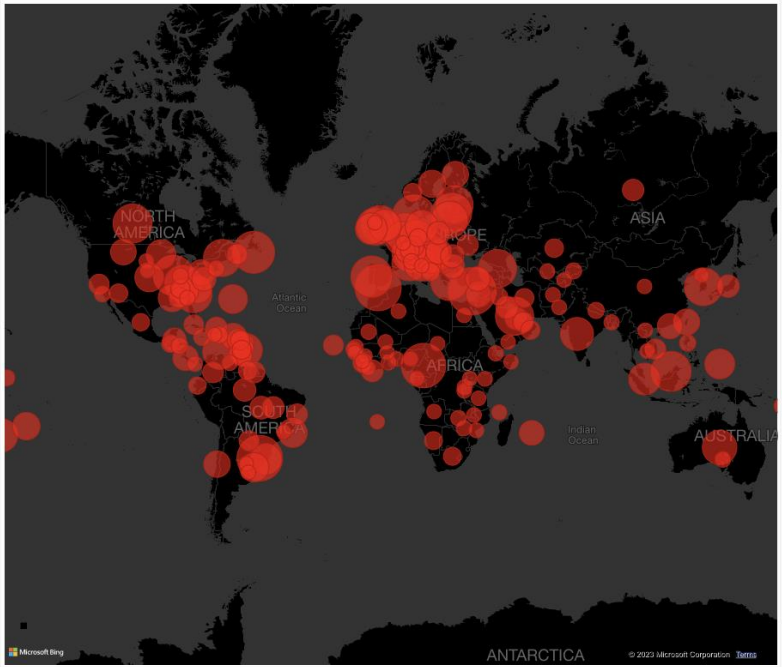
Bad vs. Good Visualization

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

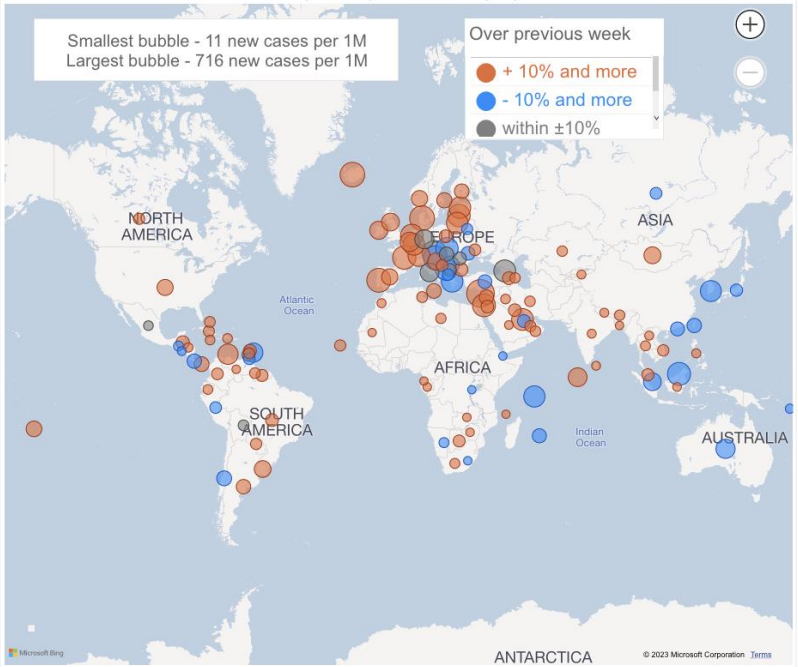
Click on the legend to highlight countries with increasing, decreasing or relatively constant number of new cases

Bubble Map

COVID-19 total cases per 1M population



COVID-19 new cases (7 days average) per 1M population



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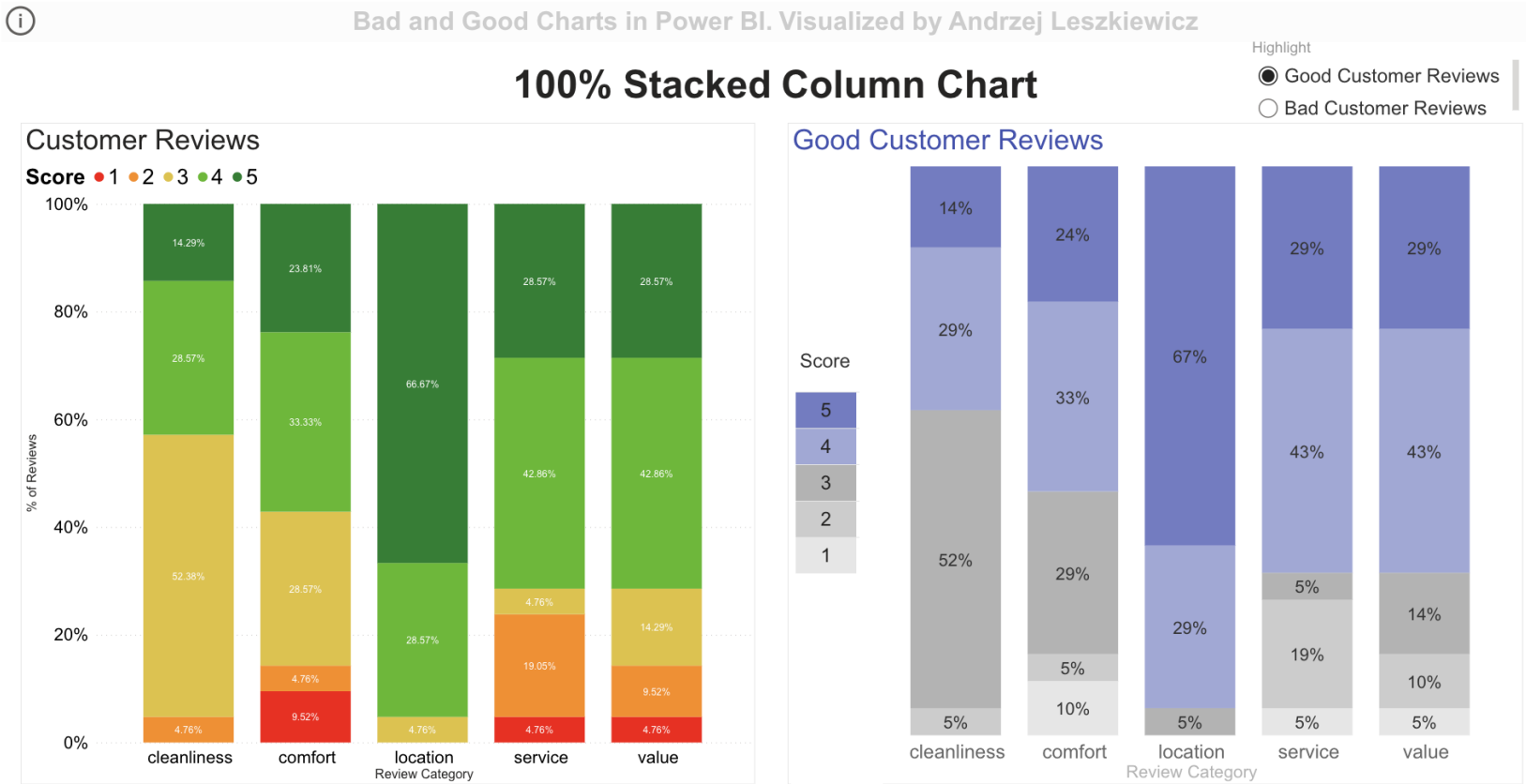
Bad vs. Good Visualization



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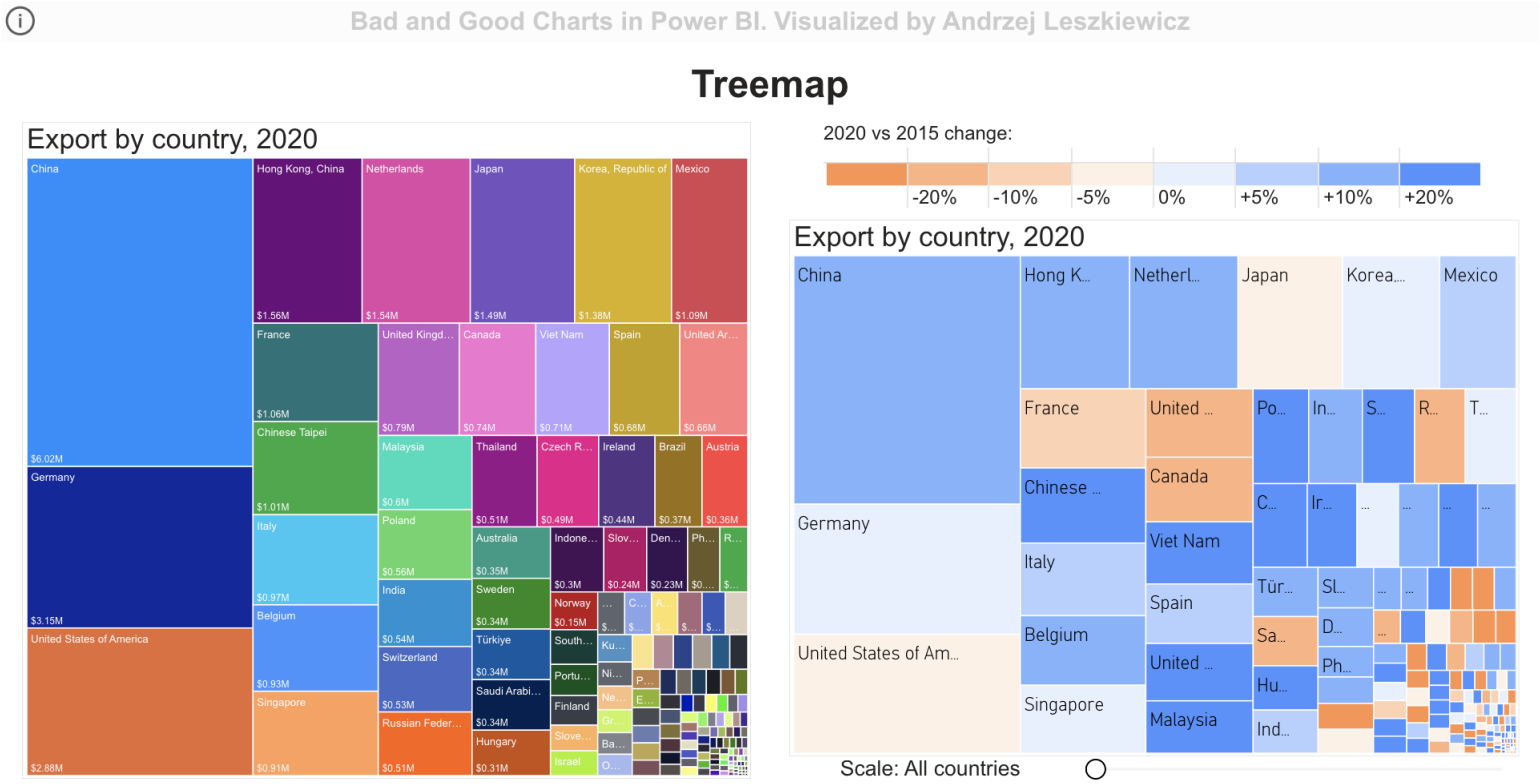
Bad vs. Good Visualization

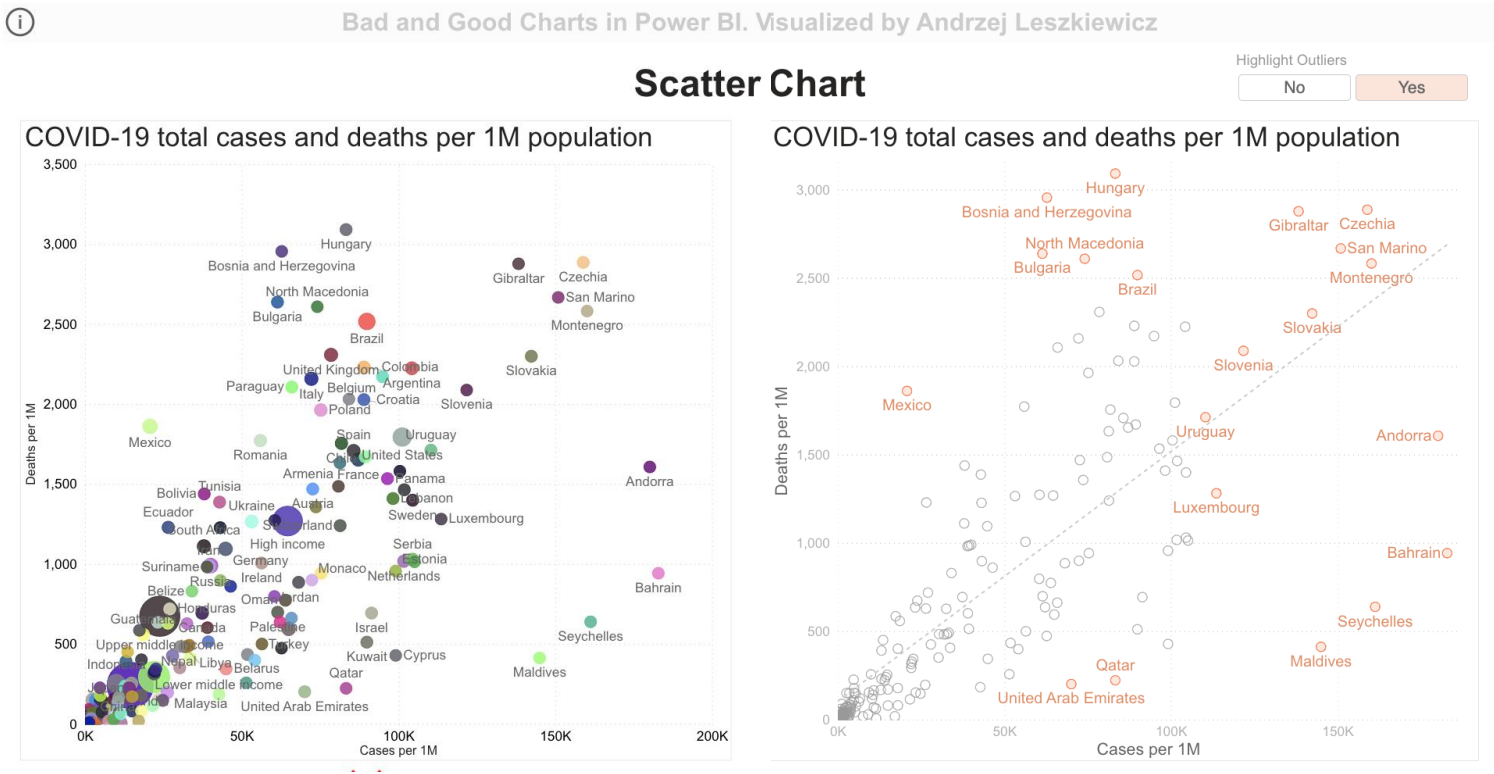


https://powerofbi.org/bad-and-good-charts-in-power-bi/

Recap: Use of color for a numeric variable

If the numeric variable involves substantial categorical difference (e.g. two categories of positive and negative values), TWO colors featured with different intensity would be a good choice.

Bad vs. Good Visualization

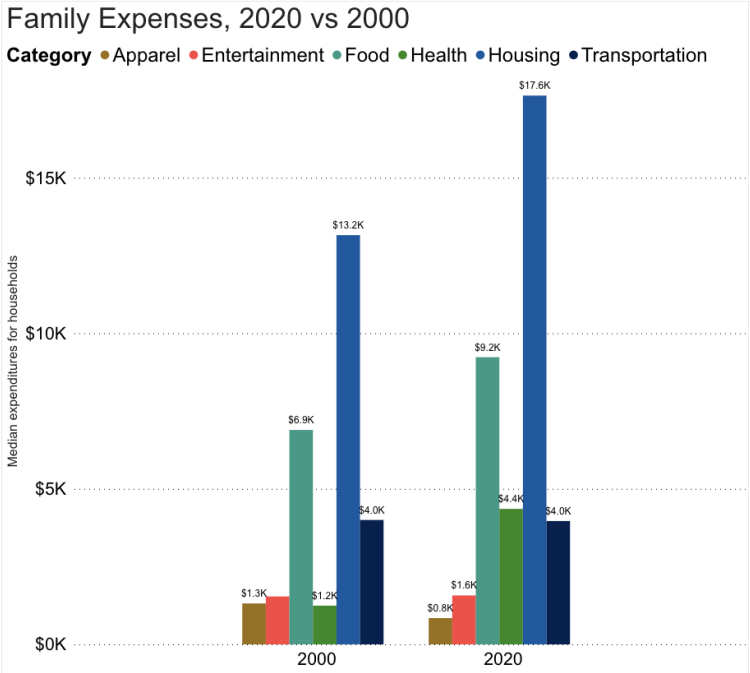


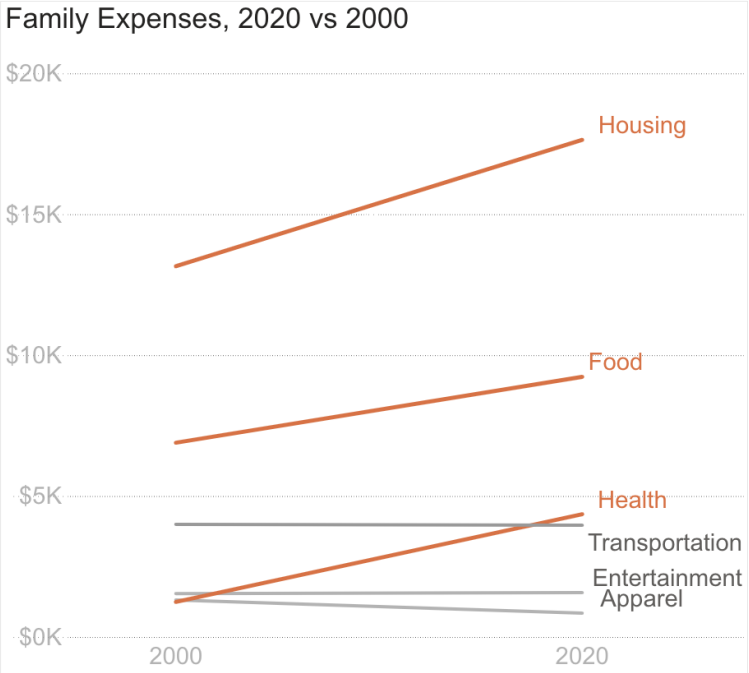
https://powerofbi.org/bad-and-good-charts-in-power-bi/

Bad vs. Good Visualization

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

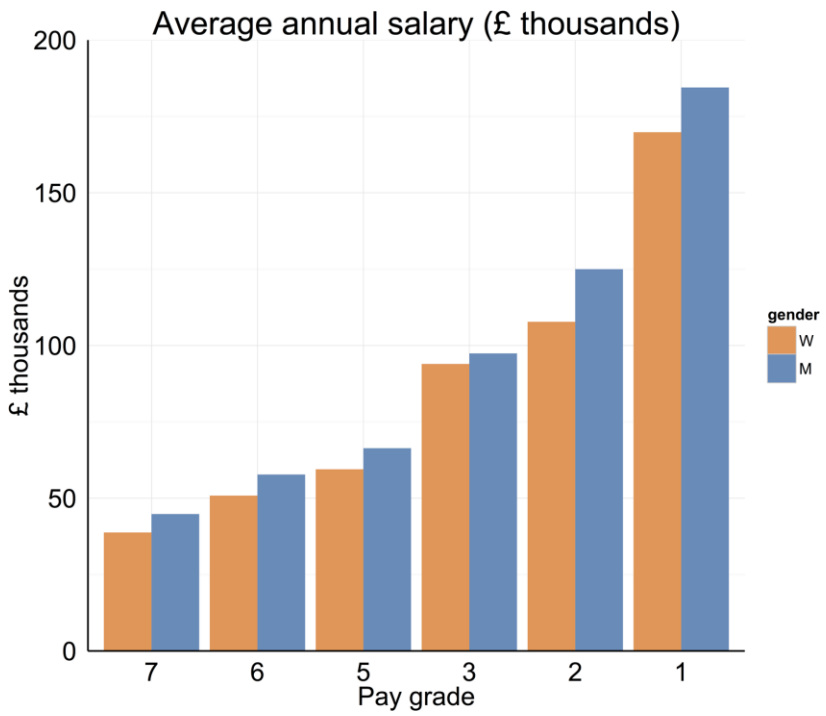
Clustered Column Chart?



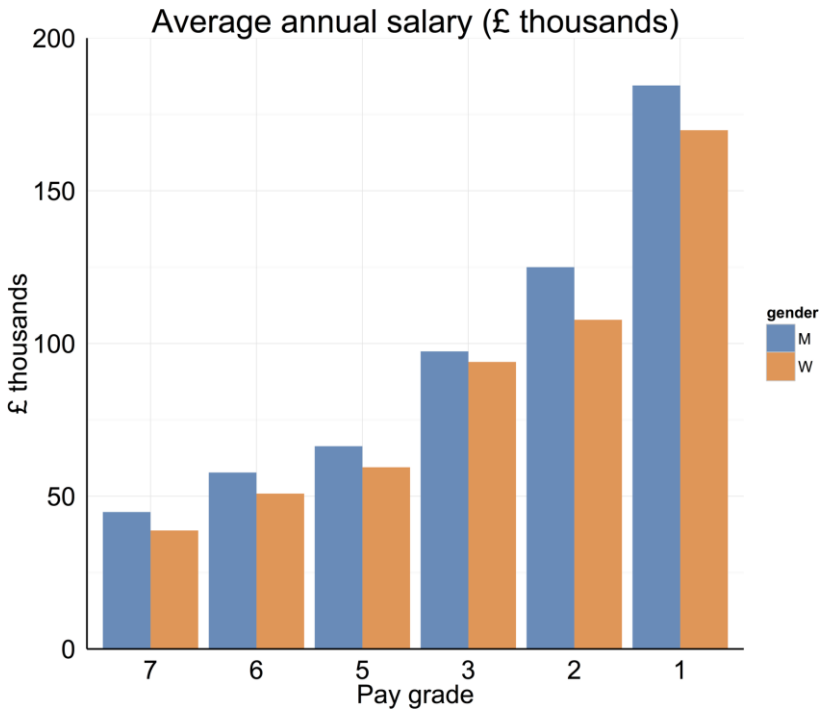


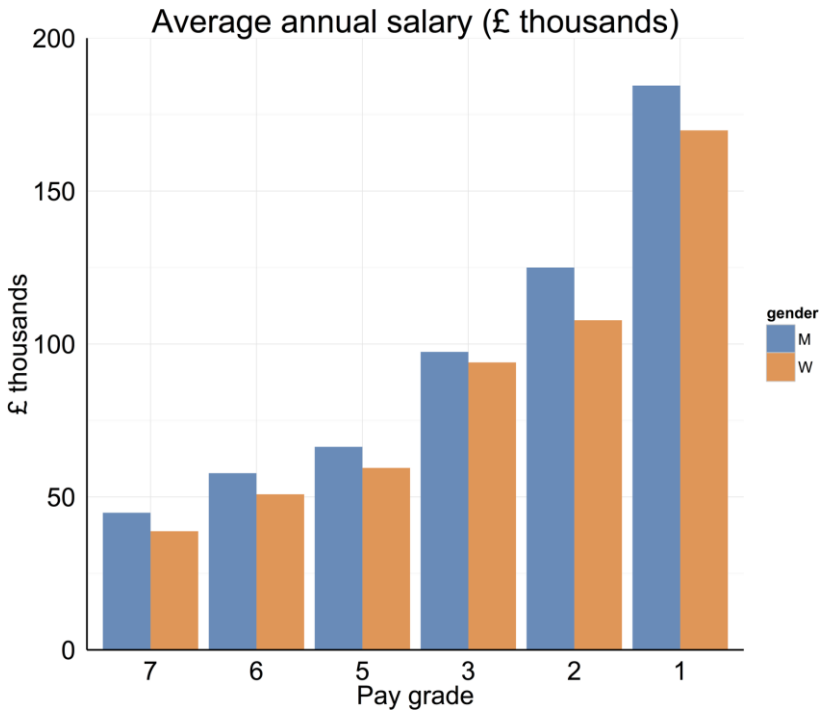
https://powerofbi.org/bad-and-good-charts-in-power-bi/

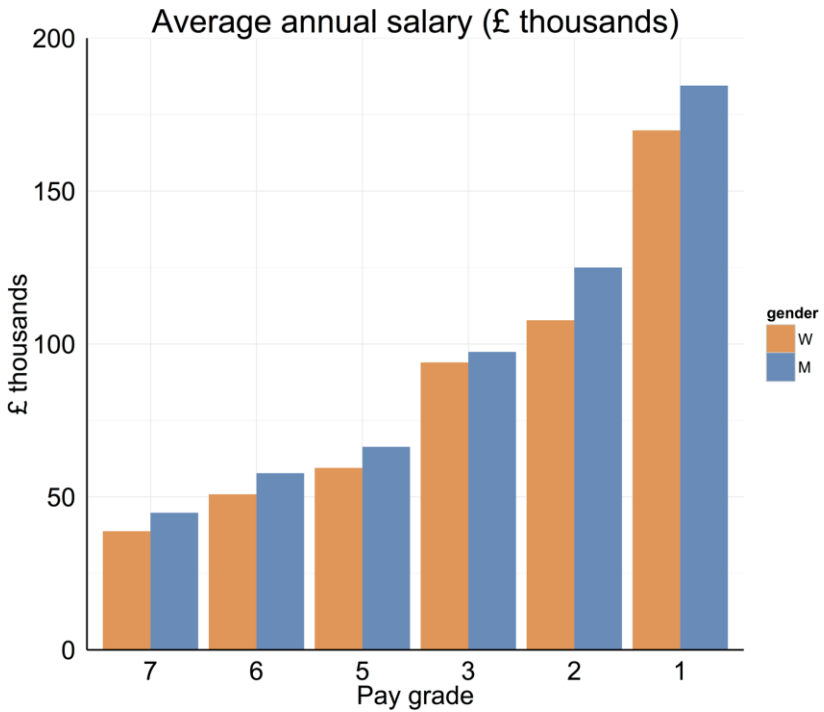
What do you see first?



What do you see first?

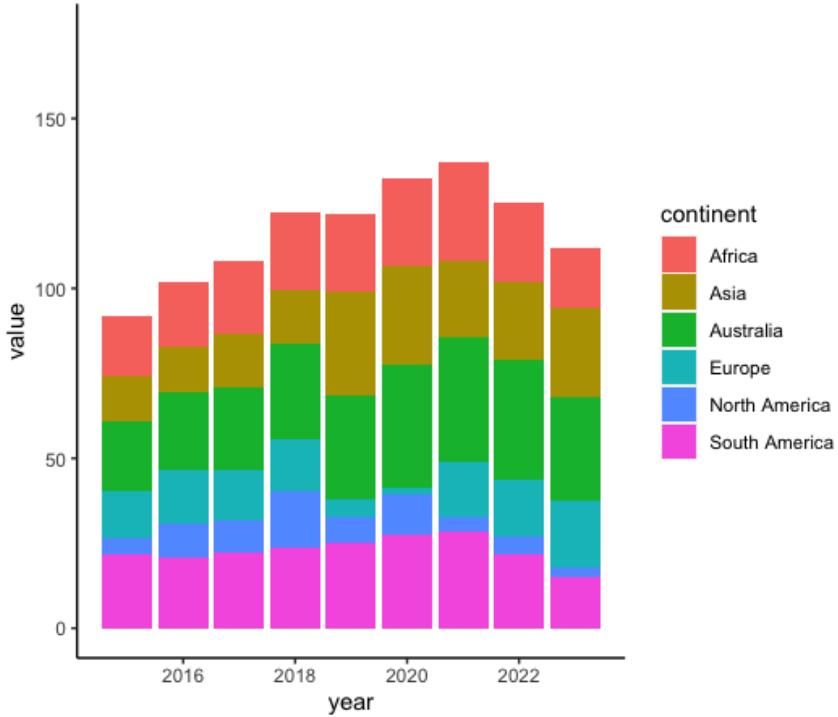


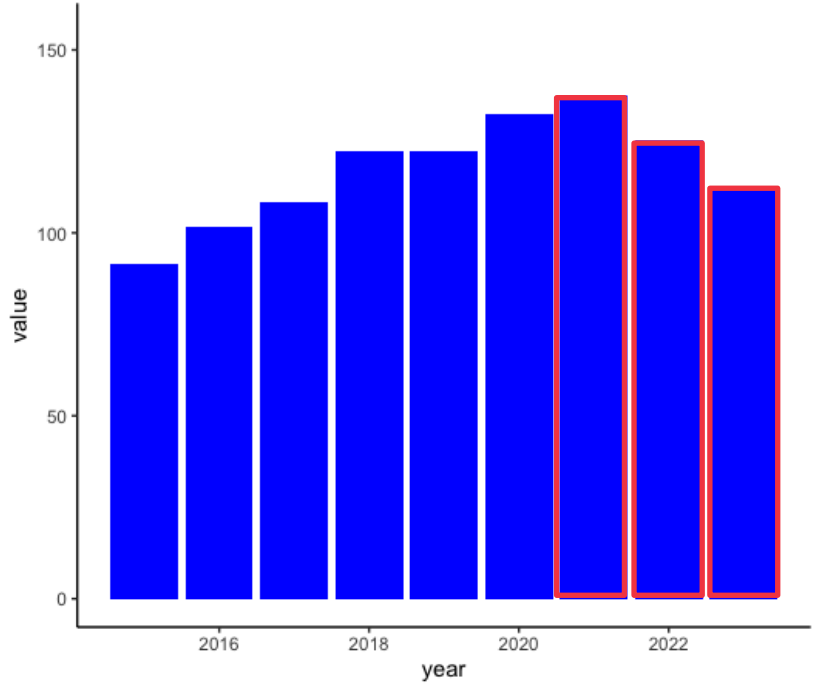




Carl Anderson. 2022. Creating a Data-Driven Organization, O'Reilly

What is the intended message?





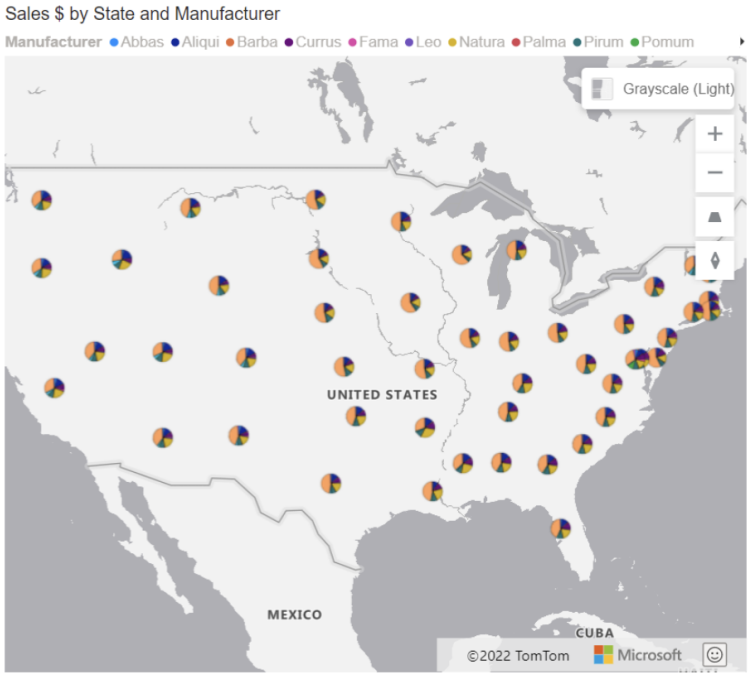
Recap: Intended Message & Visually Appealing

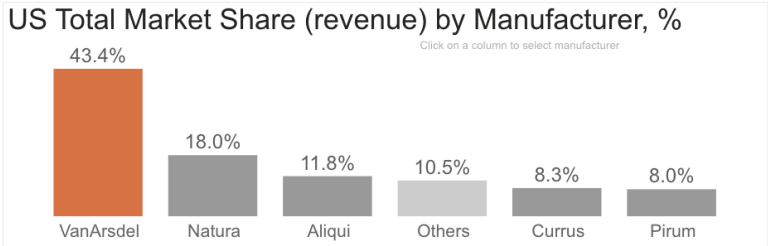
- **A figure can be visually appealing but is ineffective in delivering the key message you want the audience to grasp.**
- **Keep the purpose of your visualization in mind, and consider whether the visualization supports the delivery of the key information that you would like the audience to receive and remember.**

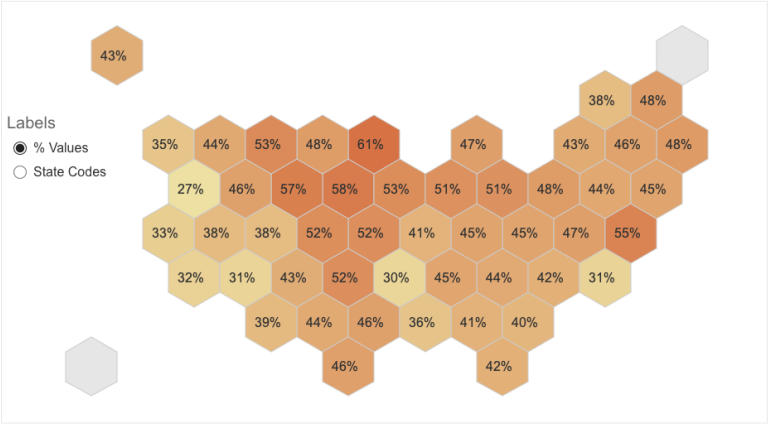
Bad vs. Good Visualization

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

Map with Pie Charts?







https://powerofbi.org/bad-and-good-charts-in-power-bi/

Recap: “Collaboration” between Figures

- **If it is difficult to visualize the key information using one figure, considering using a couple of figures to do visualization.**
- **A bar chart can be served as a filter when used properly.**

Misleading graph

5 languages

Article Talk Read Edit View history Tools

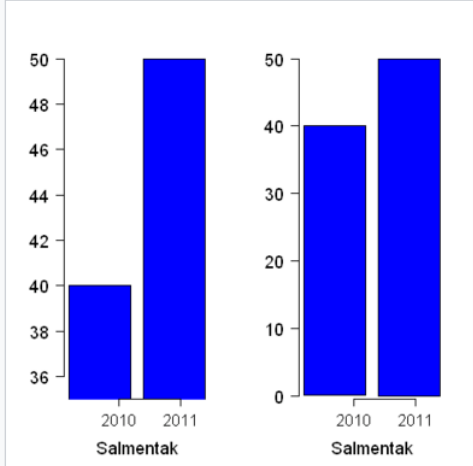
From Wikipedia, the free encyclopedia

In statistics, a **misleading graph**, also known as a **distorted graph**, is a graph that misrepresents data, constituting a misuse of statistics and with the result that an incorrect conclusion may be derived from it.

Graphs may be misleading by being excessively complex or poorly constructed. Even when constructed to display the characteristics of their data accurately, graphs can be subject to different interpretations, or unintended kinds of data can seemingly and ultimately erroneously be derived.[1]

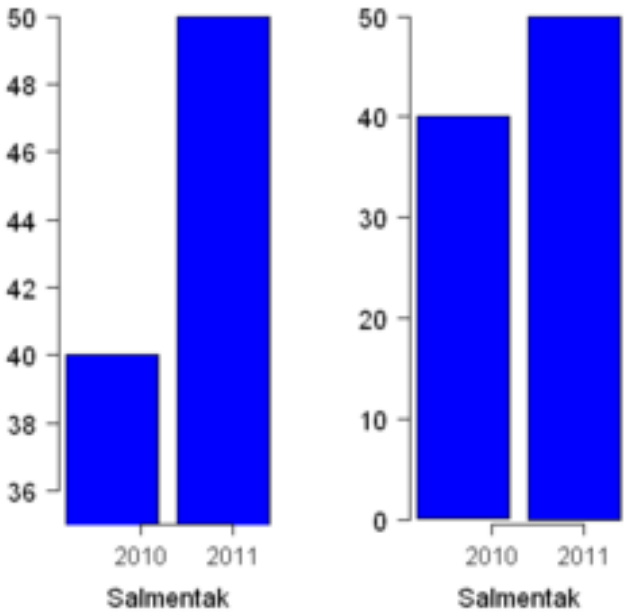
Misleading graphs may be created intentionally to hinder the proper interpretation of data or accidentally due to unfamiliarity with graphing software, misinterpretation of data, or because data cannot be accurately conveyed. Misleading graphs are often used in false advertising. One of the first authors to write about misleading graphs was Darrell Huff, publisher of the 1954 book *How to Lie with Statistics*.

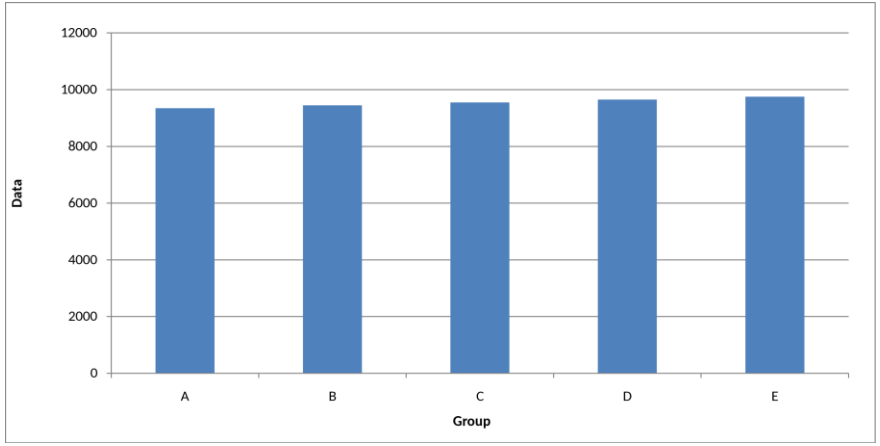
The field of data visualization describes ways to present information that avoids creating misleading graphs.

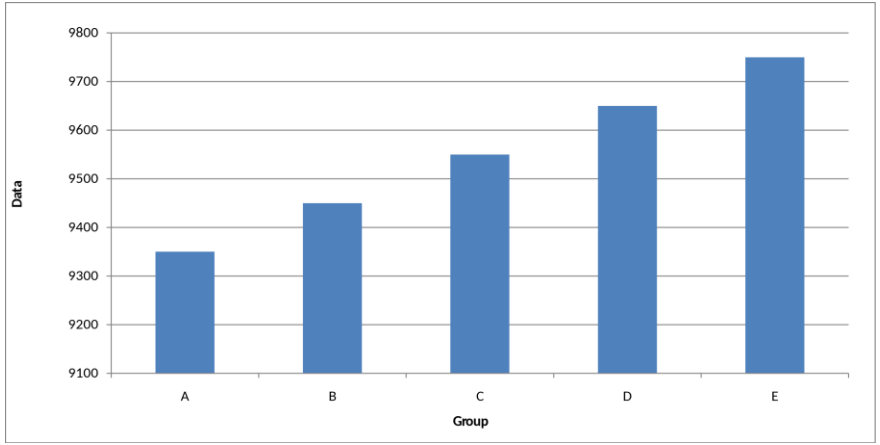


Example of a truncated (left) vs full-scale graph (right), using the same data

Misleading Visualizations?



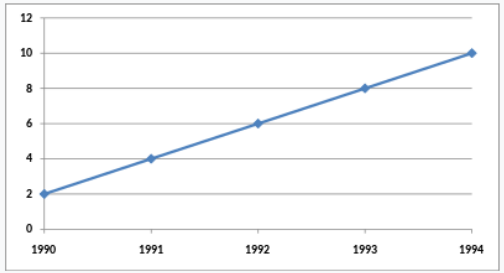
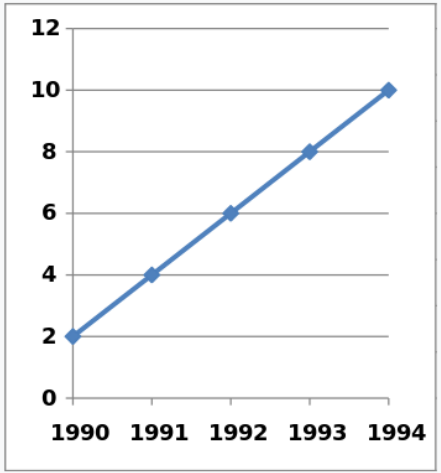
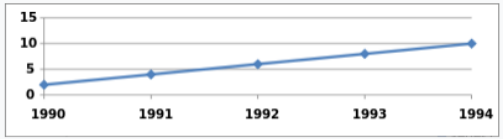




https://en.wikipedia.org/wiki/Misleading_graph
By Smallman12q - Own work, CC0,
https://commons.wikimedia.org/w/index.php?curid=20059375

Visualization in Question

Changing ratio of graph dimensions

Original graph	Half-width, twice the height	Twice width, half-height
		

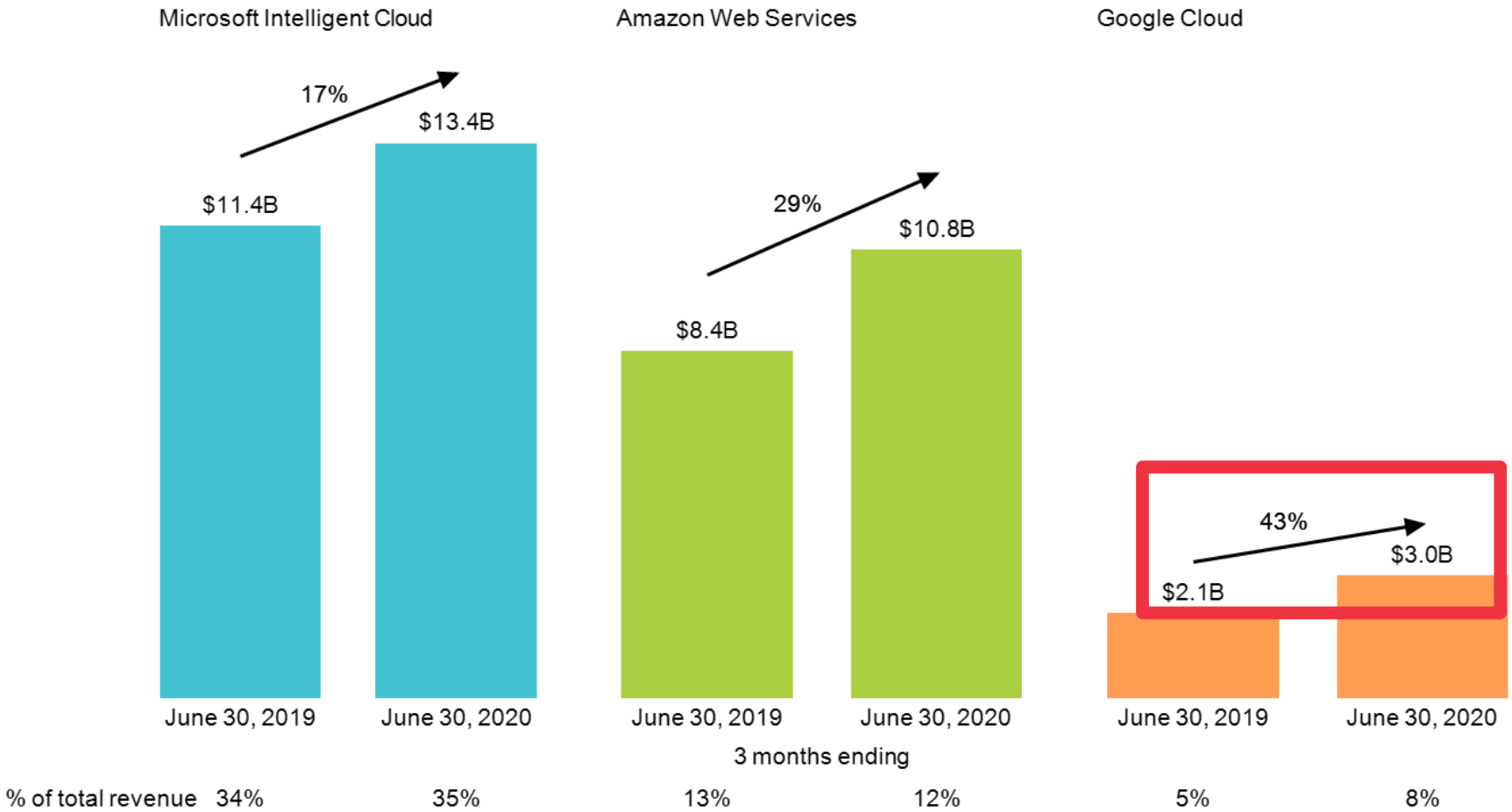
https://en.wikipedia.org/wiki/Misleading_graph

What is your opinion about misleading visualization?

Do you think manipulation of the y-axis (as a result, creating a misleading visualization) is always a bad thing?

Offer your answer at: **https://presemo.aalto.fi/bic/**

Microsoft, Amazon and Google Cloud Revenue Growth in Bar Charts with Growth Line and Data Row



https://www.mekkographics.com/cloud-revenue-growth/

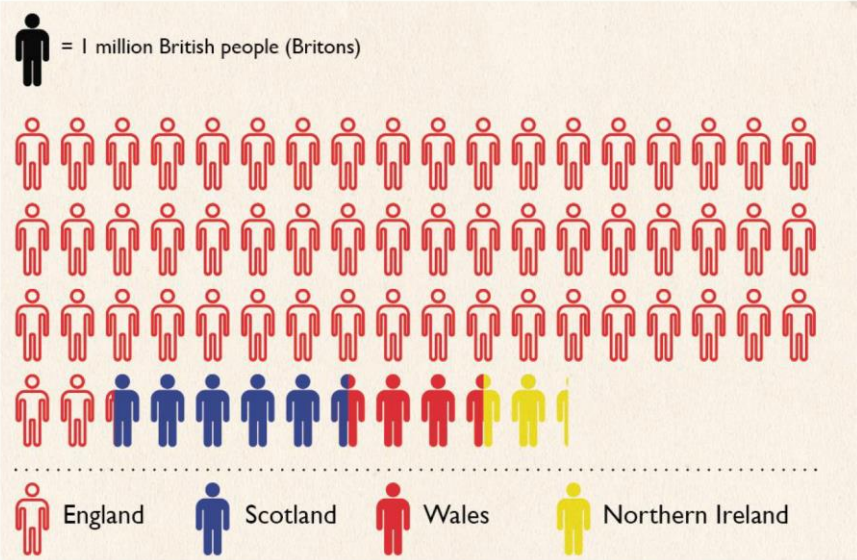
Recap: Visualizations can be misleading

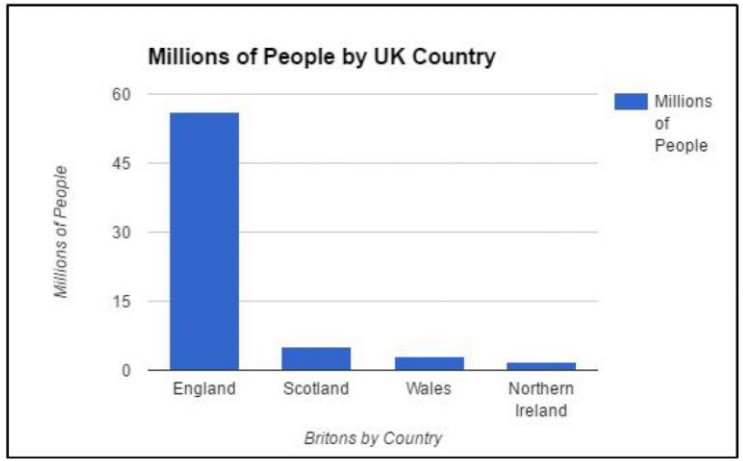
- **Be careful with x-axis and y-axis ratio that can cause misleading in the delivered message of data visualization.**
- **Sometime, “misleading” can be difficult to avoid, educating your user and BA is important.**

Visualization in Question

Unit Charts - Bad!

Which is easier to understand quickly?





https://en.wikipedia.org/wiki/Misleading_graph

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Section 2: Data visualization checklist

Data Visualization Checklist

Text

- 6-12 word descriptive title is left-justified in the upper left corner.
- Subtitles and/or annotations provide additional information.
- Text size is hierarchical and readable.
- Text is horizontal.
- Data are labeled directly.
- Labels are used sparingly.

Carl Anderson. 2022. Creating a Data-Driven Organization, O'Reilly

Data Visualization Checklist (II)

Arrangement

- Proportions are accurate.
- Data are intentionally ordered.
- Axis intervals are equidistant.
- Graphs are two-dimensional.
- The display is free from decoration.

Carl Anderson. 2015. Creating a Data-Driven Organization, O'Reilly

Data Visualization Checklist (III)

Color

- Color scheme is intentional.
- Color is used to highlight key patterns.
- Color is legible when printed in black and white.
- Color is legible for people with colorblindness.
- Text sufficiently contrasts the background.

Carl Anderson. 2022. Creating a Data-Driven Organization, O'Reilly

Color blindness

Red–green color blindness is the most common form, followed by **blue–yellow color** blindness and total color blindness.

What are the proportions of people affected by color blindness in the population?

- 1 in **???** **men** are color blind
- 1 in **???** **women** are color blind

Offer your answer at: **https://presemo.aalto.fi/bic/**

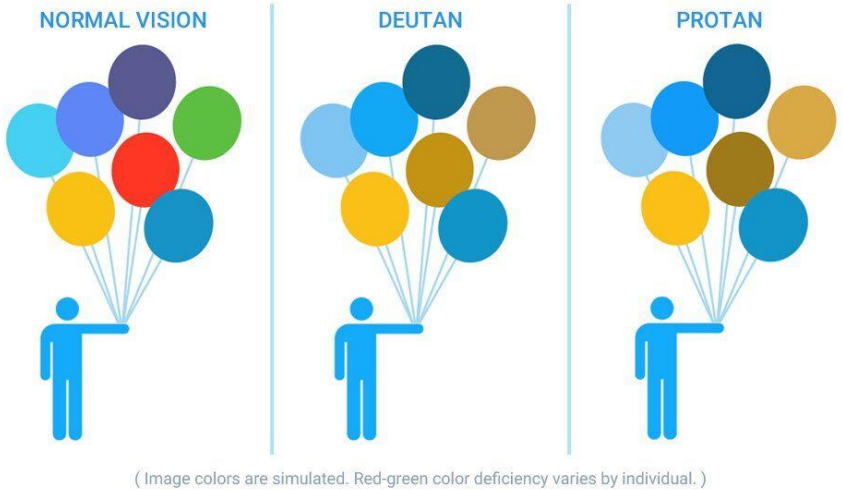
https://www.clintoneye.com/color-blindness.html
https://en.wikipedia.org/wiki/Color_blindness

Color blindness

There are an estimated **300** million people in the world with color vision deficiency (**Red–green**).

- 1 in **12** men are color blind (8%).
- 1 in **200** women are color blind (0.5%).

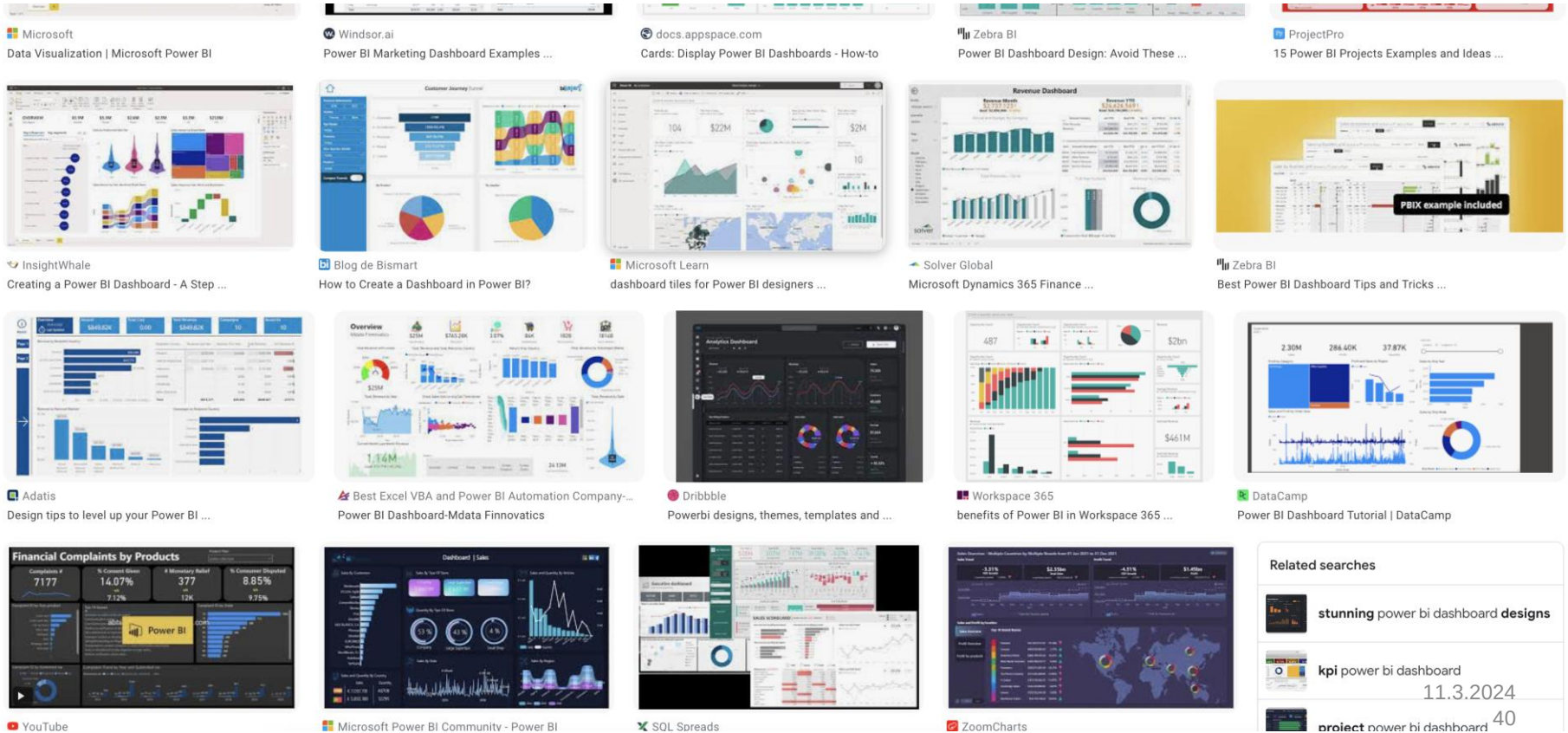
About 1% of people have **blue–yellow** color blindness, and both men and women are equally affected.



Deutan and Protan are two types of red-green color blindness.

https://www.clintoneye.com/color-blindness.html
https://en.wikipedia.org/wiki/Color_blindness
https://www.allaboutvision.com/conditions/color-blindness/tritanopia/

What is the most often used color in BI dashboards?



A screen shot from google image

Avoid colour pollution

Color pollution consists of an inappropriate color arrangement that causes or increases disorder in the perception of a visual field.

Please avoid using too many colors in a dashboard!

https://link.springer.com/referenceworkentry/10.1007/978-3-642-27851-8_249-1

Next slide will show a case of color pollution, please prepare to move your eye away if you feel uncomfortable viewing the next slide.

Ready?

Colour pollution:
Avoid bad colour contrast

I hope you will not see this kind of colour contrast in your future working environment!

Colour pollution:
Avoid bad colour contrast

I hope you will see this kind of colour contrast in your future working environment!

Background

Foreground	Red	Orange	Yellow	Green	Blue	Violet	Black	White	Gray
Red		Poor	Good	Poor	Poor	Poor	Good	Good	Poor
Orange	Poor		Poor	Poor	Poor	Poor	Good	Poor	Poor
Yellow	Good	Good		Poor	Good	Poor	Good	Poor	Good
Green	Poor	Poor	Poor		Good	Poor	Good	Poor	Good
Blue	Poor	Poor	Good	Good		Poor	Poor	Good	Poor
Violet	Poor	Poor	Good	Poor	Poor		Good	Good	Poor
Black	Poor	Good	Good	Good	Poor	Good		Good	Poor
White	Good	Good	Good	Poor	Good	Good	Good		Good
Gray	Poor	Poor	Good	Good	Poor	Poor	Poor	Good	

https://www.thoughtco.com/contrasting-foreground-background-colors-4061363

Please evaluate the figure below.

I hope everybody can enjoy reading this figure.

Offer your answer at: **https://presemo.aalto.fi/bic/**

Use sufficient color contrast

When text contrasts poorly with its background, it makes reading more difficult, especially for people with low vision. The same goes for icons and situations where highlighting draws attention (such as the hover effects on links).

https://accessibility.huit.harvard.edu/use-sufficient-color-contrast
https://webaim.org/resources/contrastchecker/

Good or Bad? Improvement?

http://stephanieevergreen.com/president-obamas-dataviz/

Some suggestions

1. **Don’t put red and green together as colours for comparison in a graph.**
2. **Don’t put blue and yellow together as colours for comparison in a graph.**
3. **If you must use red and green together, leverage light vs. dark**

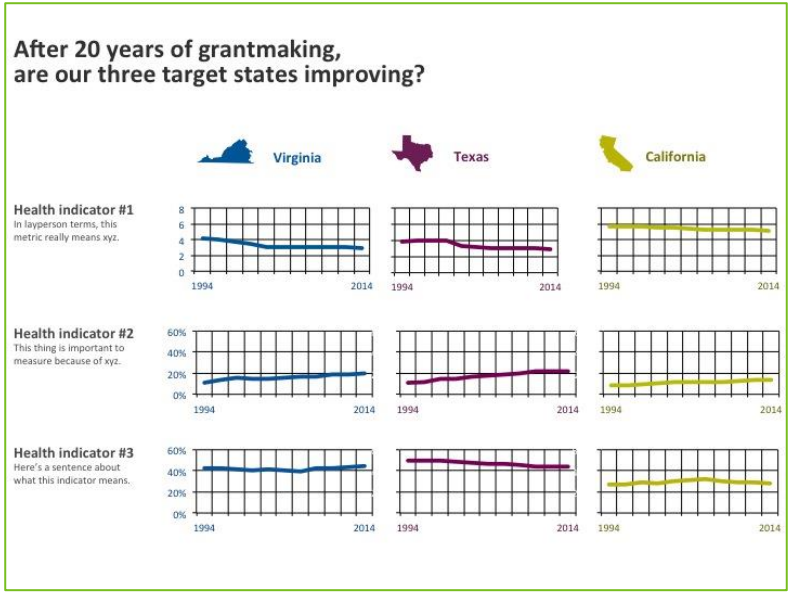
https://www.tableau.com/blog/examining-data-viz-rules-dont-use-red-green-together

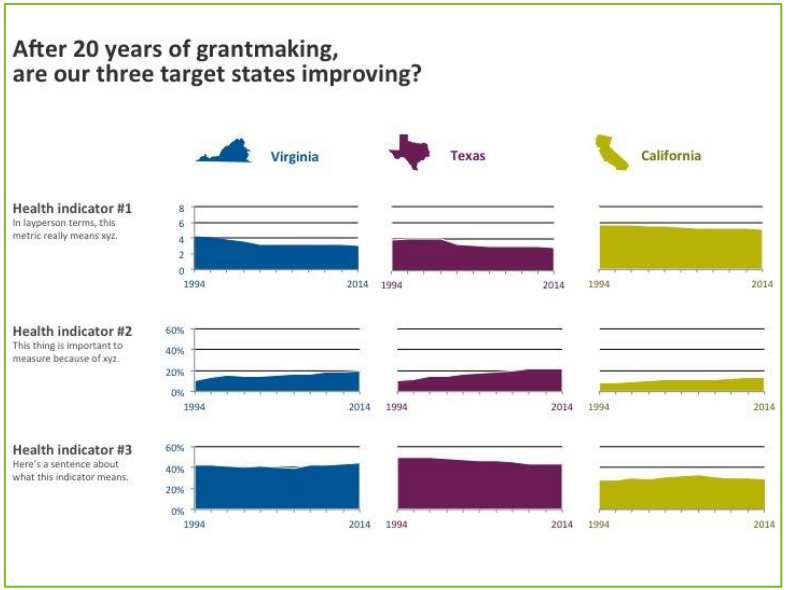
Data Visualization Checklist (IV)

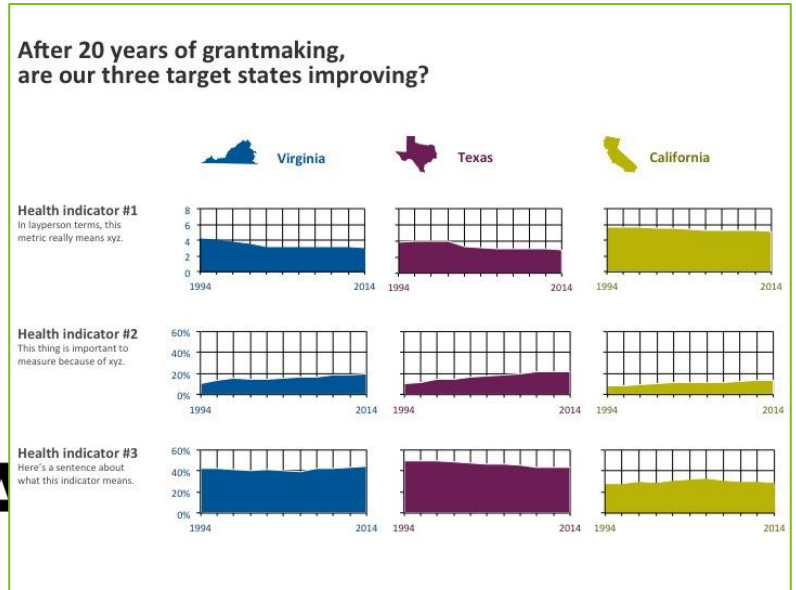
Lines

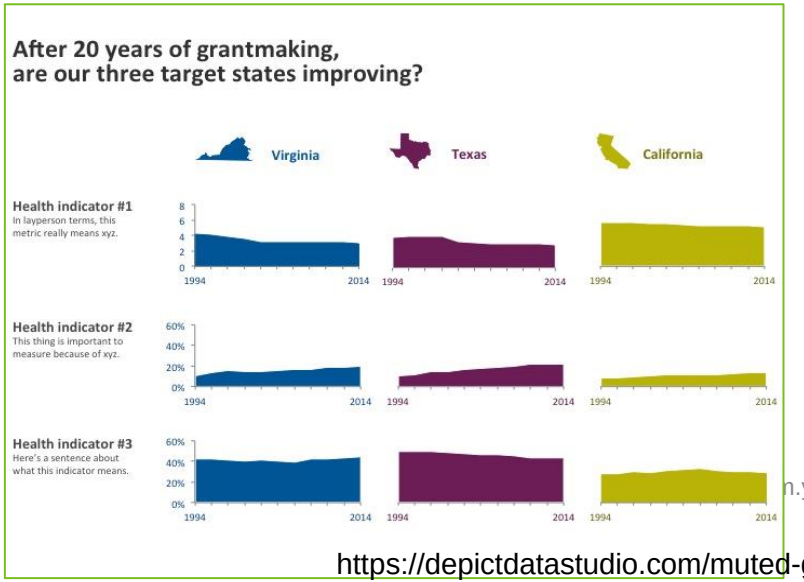
- **Gridlines, if present, are muted.**
- **Graph does not have borderline.**
- **Axes do not have unnecessary tick marks.**
- **Graph has one horizontal and one vertical axis.**

Carl Anderson. 2022. Creating a Data-Driven Organization, O'Reilly
https://stephanieevergreen.com/wp-content/uploads/2016/10/DataVizChecklist_May2016.pdf









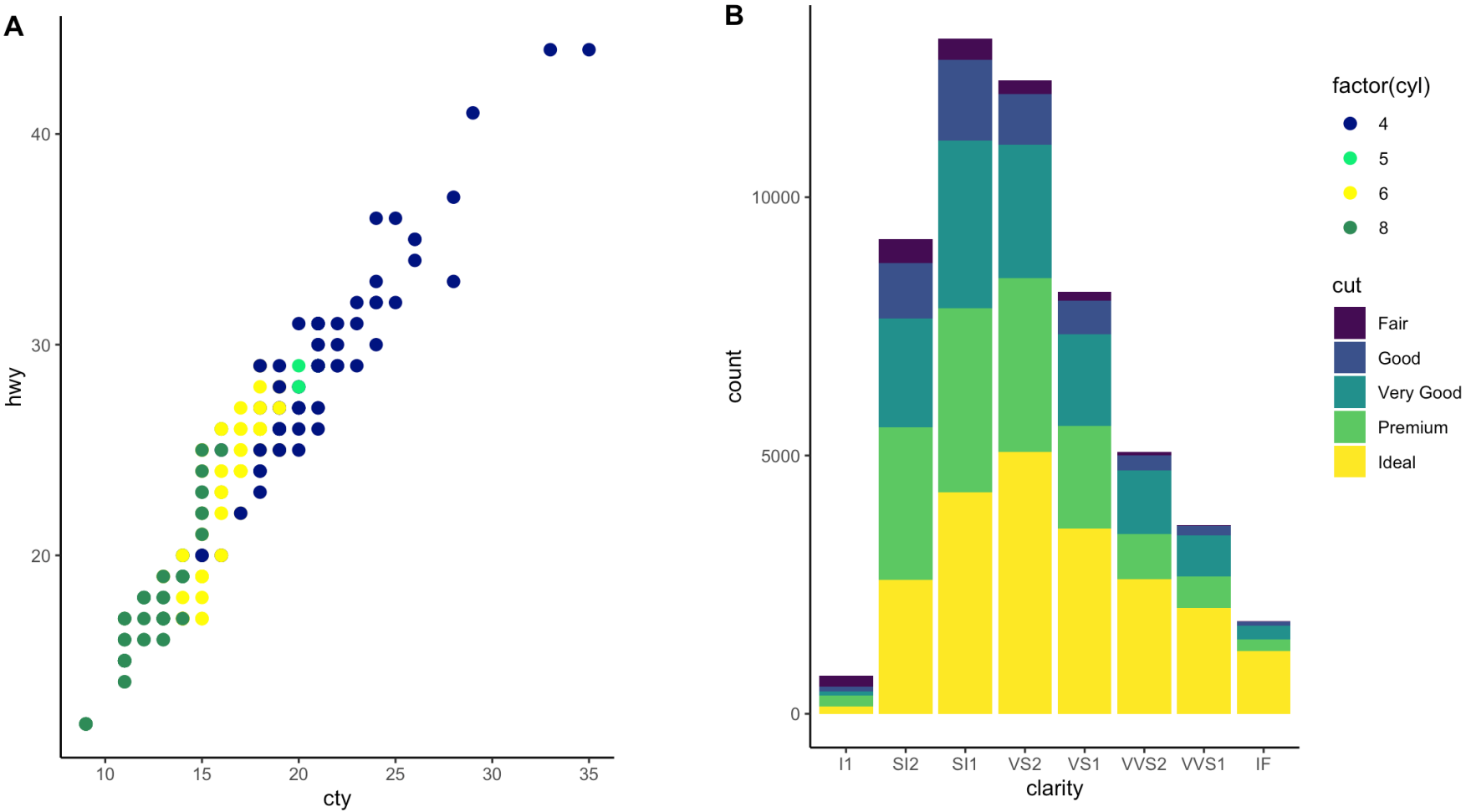
https://depictdatastudio.com/muted-grid-lines/

Data Visualization Checklist (V)

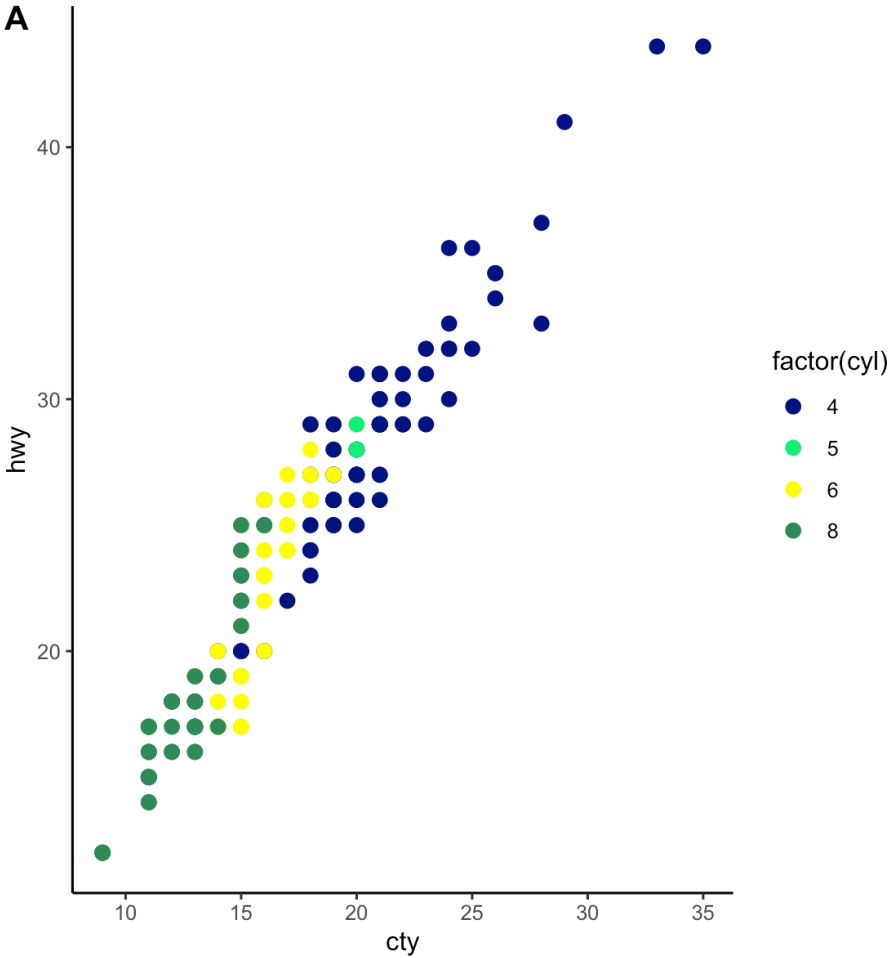
Overall

- **Graph highlights significant finding or conclusion.**
- **The type of graph is appropriate for data.**
- **Graph has appropriate level of precision.**
- **Contextualized or comparison data are present.**
- **Individual chart elements work together to reinforce the overarching takeaway message.**

Legends and Multiple figures



Better?


A
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factor(cyl)
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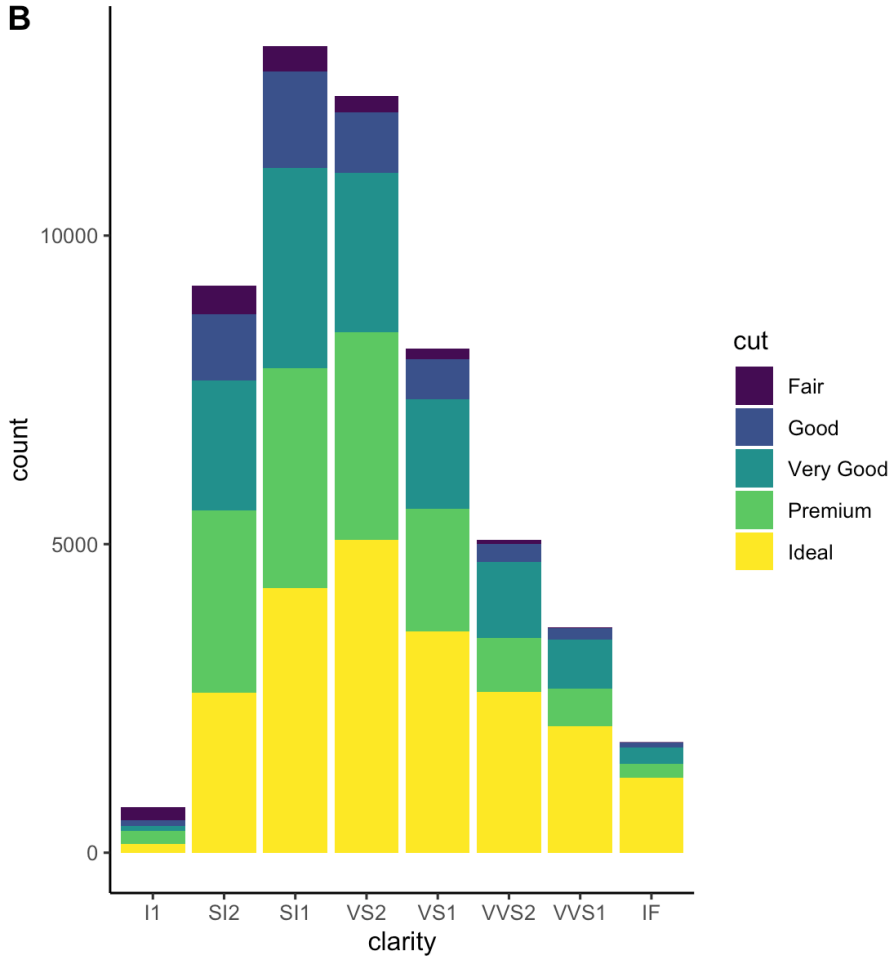
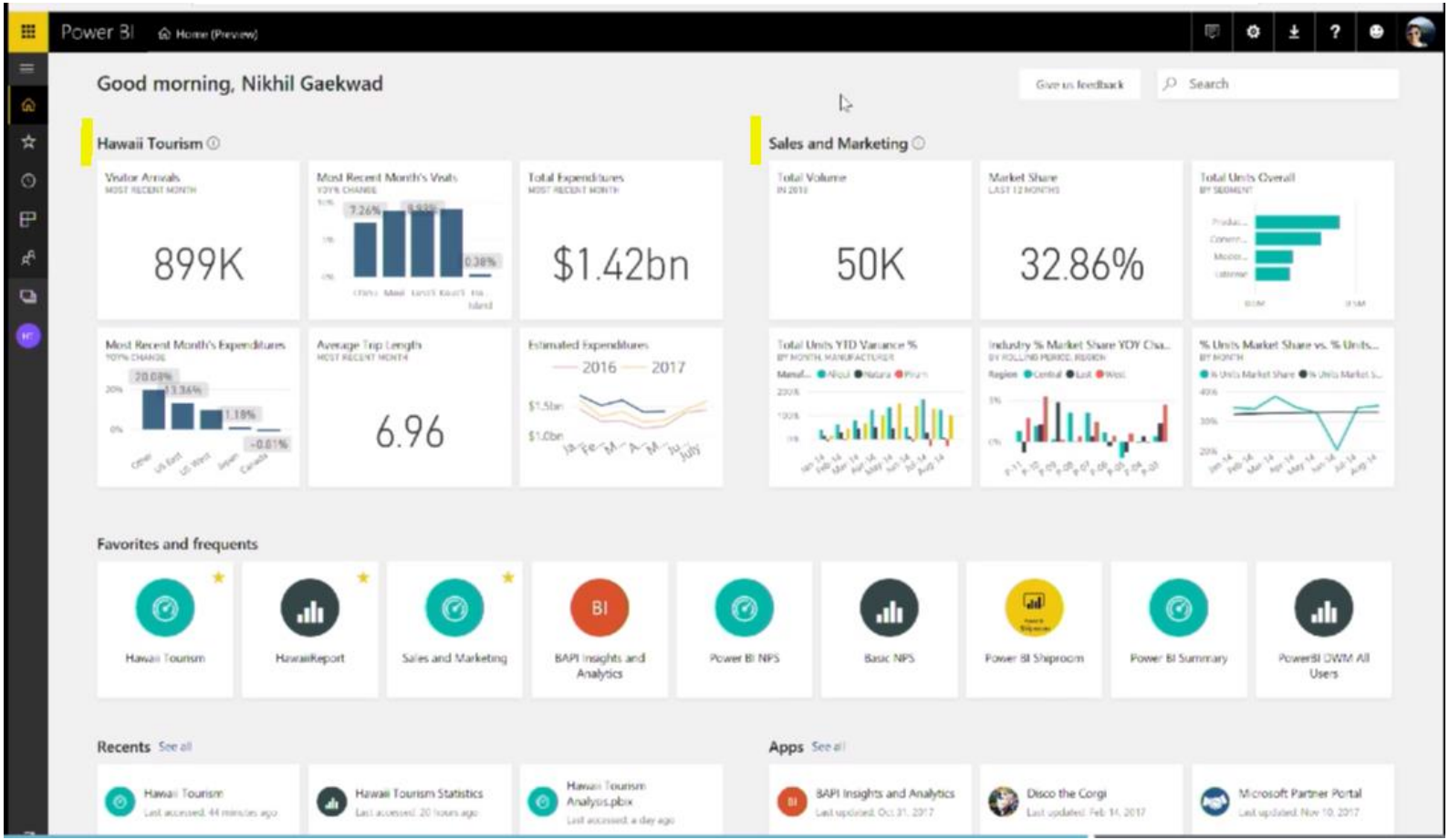

B
count
10000
5000
0
I1
SI2
SI1
VS2
VS1
VVS2
VVS1
IF
clarity
cut
Fair
Good
Very Good
Premium
Ideal

What if all legends are put together

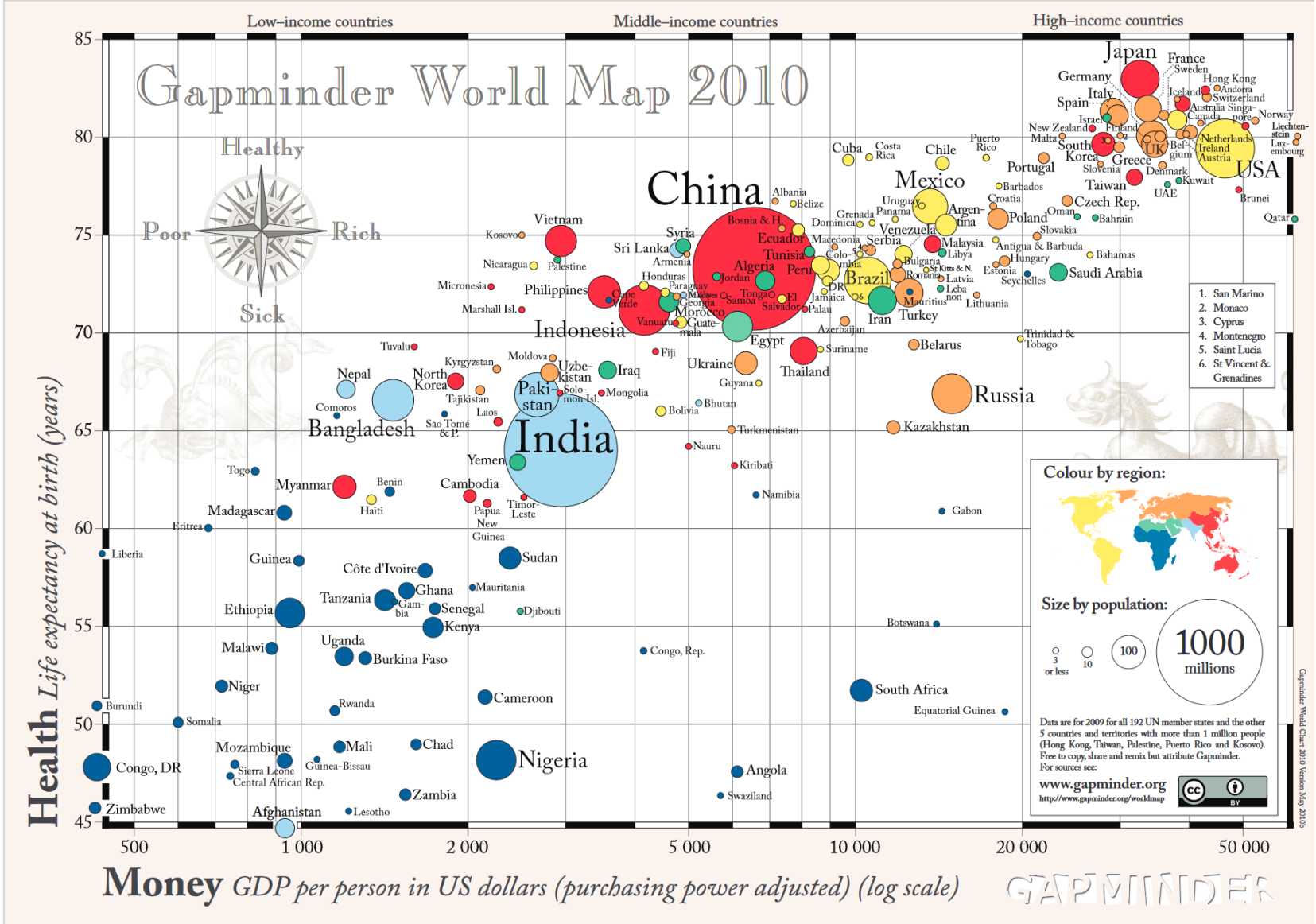


https://carldesouza.com/power-bi-home/

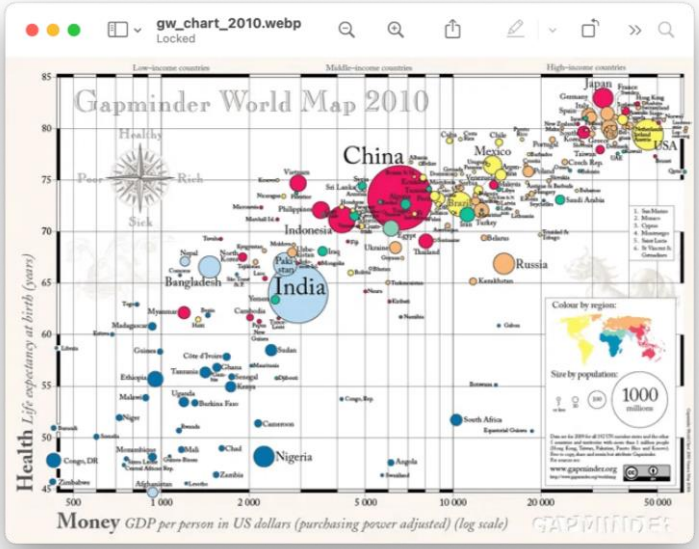
The collection of the guidelines

1) Subtitle and/or annotations provide additional information
2) Text size is hierarchical and readable
3) Data are labeled directly
4) Labels are used sparingly
5) Proportions are accurate
6) Data are intentionally ordered
7) Graph is two-dimensional
8) Color scheme is intentional
9) Color is used to highlight key patterns
10) Text sufficiently contrasts background
11) Graph has one horizontal and one vertical axis
12) Graph has appropriate level of precision
13) 6-12 words title is left-justified in the upper left corner.
14) Text is horizontal
15) Axis intervals are equidistant
16) The type of graph is appropriate for data
17) Display is free from decoration
18) Color is legible when printed in black and white
19) Color is legible for people with colorblindness
20) Gridlines, if present, are muted
21) Graph does not have borderline
22) Axes do not have unnecessary tick marks or axis lines
23) Graph highlights significant findings or conclusion
24) Individual chart elements work together to reinforce the overarching takeaway message

https://stephanieevergreen.com/data-viz-tcftf/



https://historytech.files.wordpress.com/2016/04/gapmindersort.pdf; https://stephanieevergreen.com/data-viz-tcftf/



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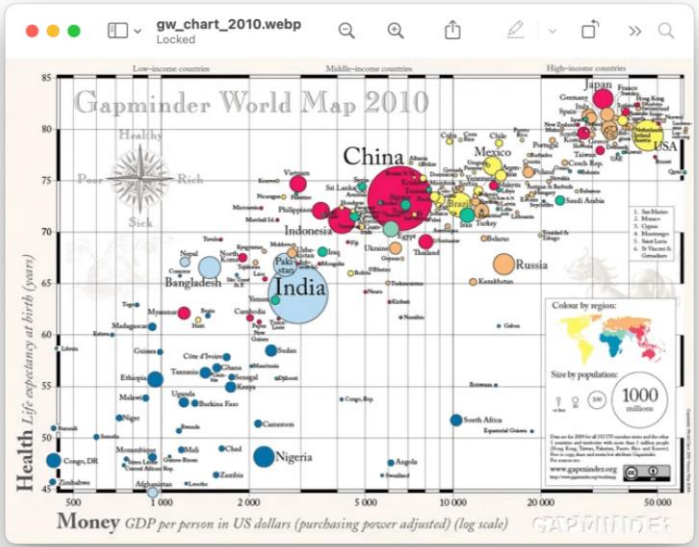

28 / 46 or **60.9%**
Great charts score 85% or higher

Results:
1-12: Fully met
13-16: Partially met
17-23: Not met
24: Not relevant

Aalto-yliopisto
Aalto-universitetet
Aalto University

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Partially Met

13) 6-12 word title is left-justified in upper left corner.
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15) Axis intervals are equidistant
16) The type of graph is appropriate for data

Not Met

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19) Color is legible for people with colorblindness
20) Gridlines, if present, are muted
21) Graph does not have border line
22) Axes do not have unnecessary tick marks or axis lines
23) Graph highlights significant finding or conclusion

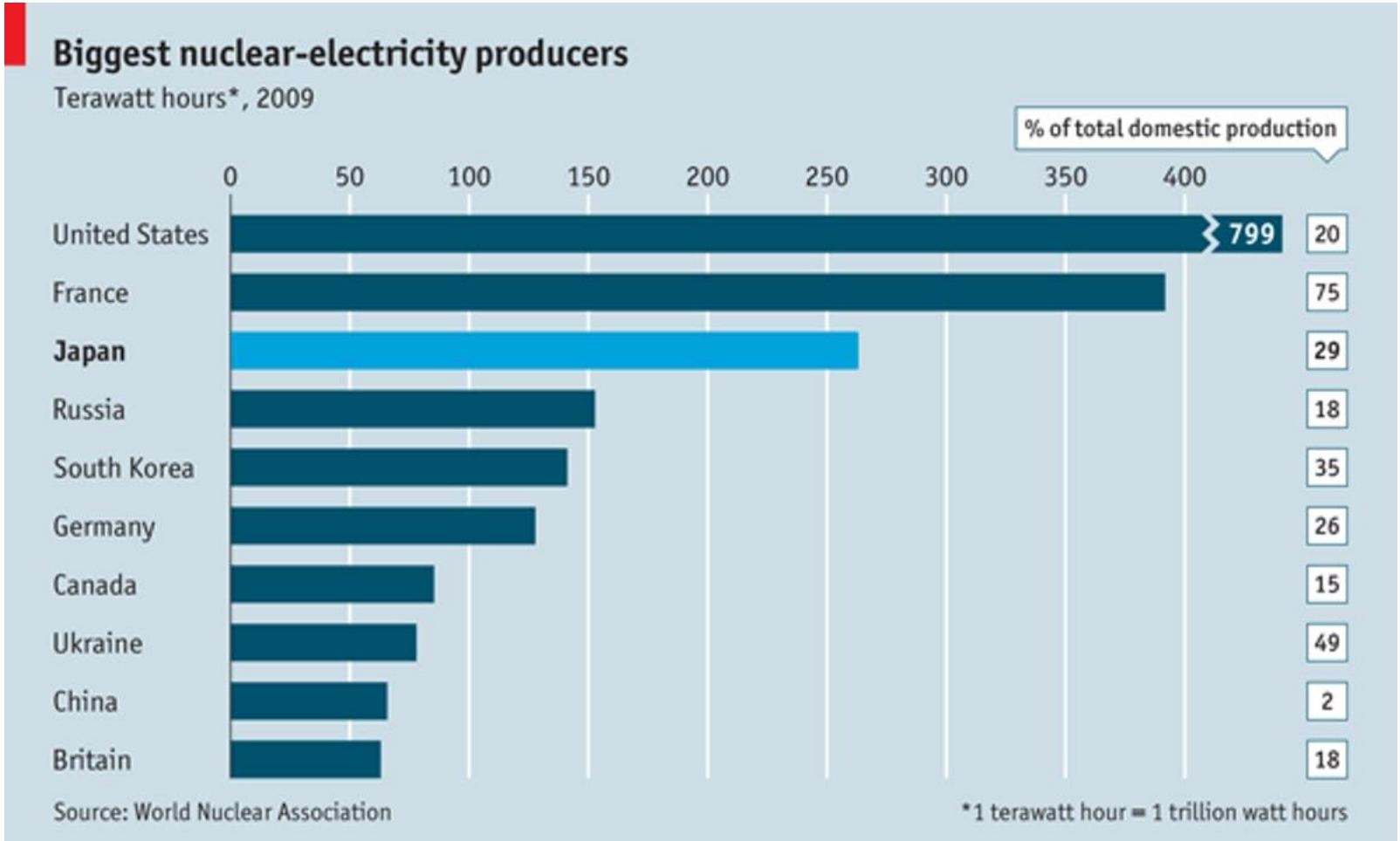
Not Applicable

24) Individual chart elements work together to reinforce the overarching takeaway message

https://stephanieevergreen.com/data-viz-tcftf/

Experience Matters: Think about developing a draft

1. **Show the nuclear electricity production (Terawatt) of the top 10 countries.**
2. **Show the approximate values of nuclear electricity production of all the countries.**
3. **Show the percentages of the nuclear electricity production against the total domestic electricity production.**
4. **One country has far more electricity production than the rest.**
5. **Highlight the country ranked third on the list of countries (the main purpose).**



https://www.economist.com/graphic-detail/2011/03/15/the-nuclear-family

Recap

1. Pai chart is easy to read and create and a good option for data visualization.
2. 2d figures are popular, but 3d can 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 blue 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 <u>Yes</u> to <u>the question 3</u>.
You get one point by answering <u>No</u> to <u>the rest of the questions</u>.
Please sum the points you get.

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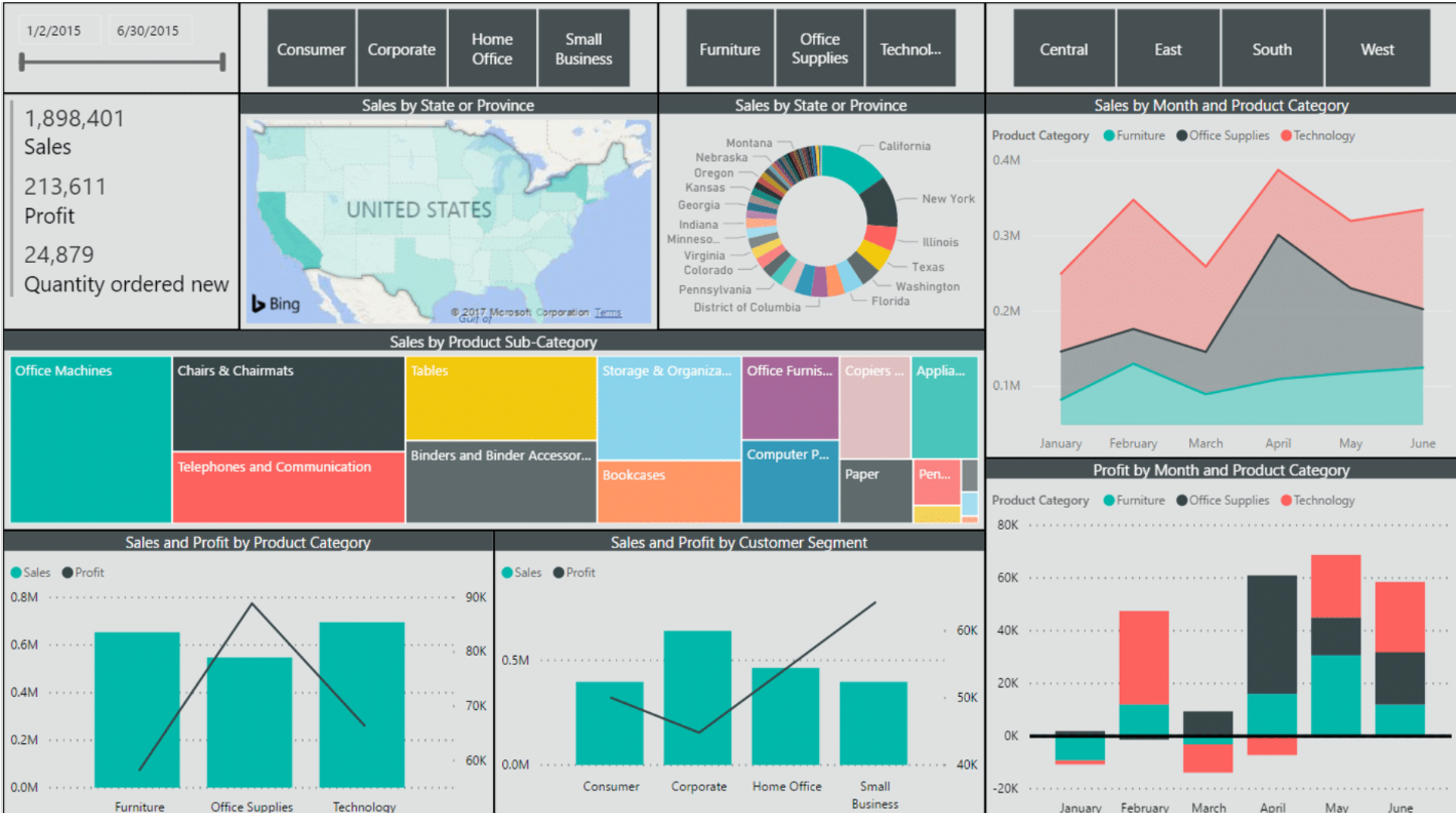
Section 3: BI dashboards

Do you think this is a useful BI report? Submit your answers at Presemo.



What makes a BI dashboard useless?

Possible reasons for a bad BI dashboard

- Information Overload
- Graphical Chaos
- Inconsistency
- Lacking Labelling
- Incorrect Labelling
- Etc.

https://www.fundipedia.com/2020/06/16/the-5-most-common-mistakes-in-power-bi/

If a BI dashboard is not bad, can it be useful?
For instance, for a BI dashboard that have no problems mentioned in the previous slides

What makes a useful BI dashboard?

Submit your answers at Presemo.

Key Factors for Good BI Dashboard Design

Understandable

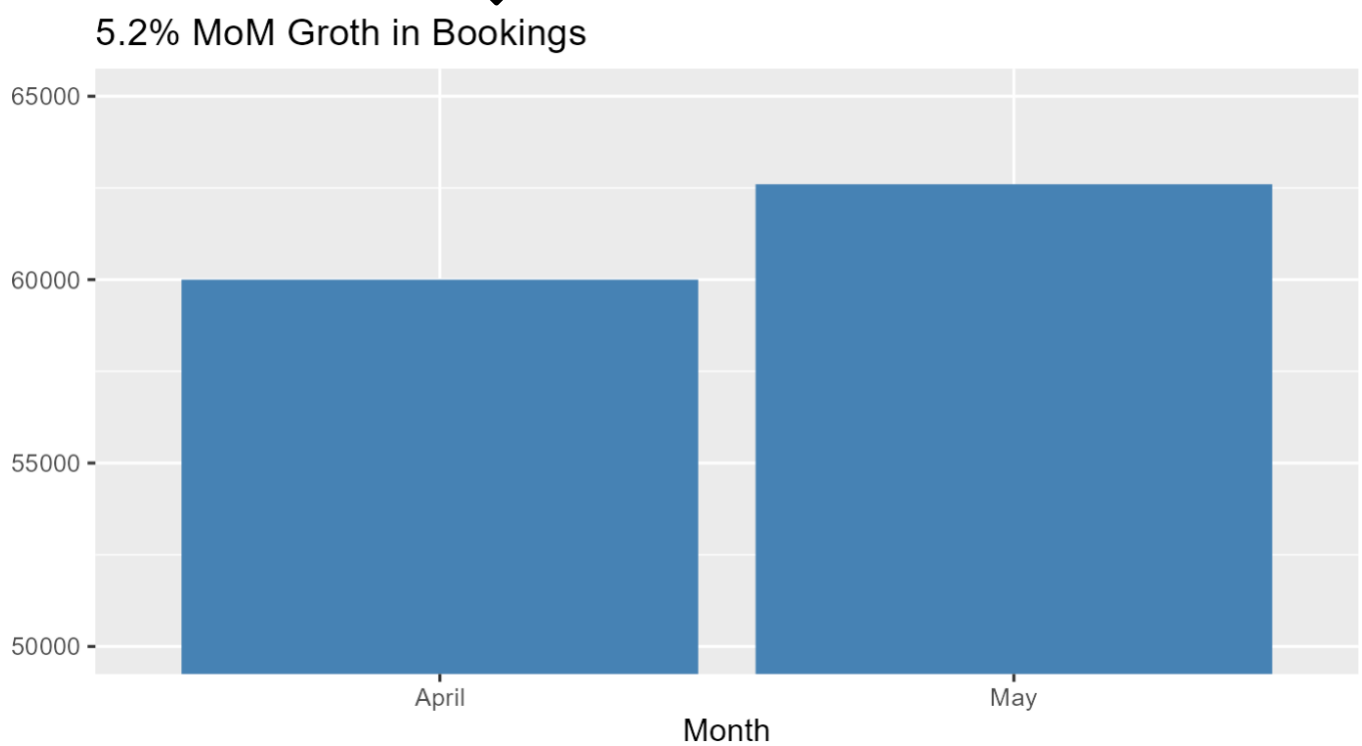
You can understand the meaning of the graphs shown in the dashboard

Actionable

You can use the dashboard to answer particular questions and obtain actionable insights.

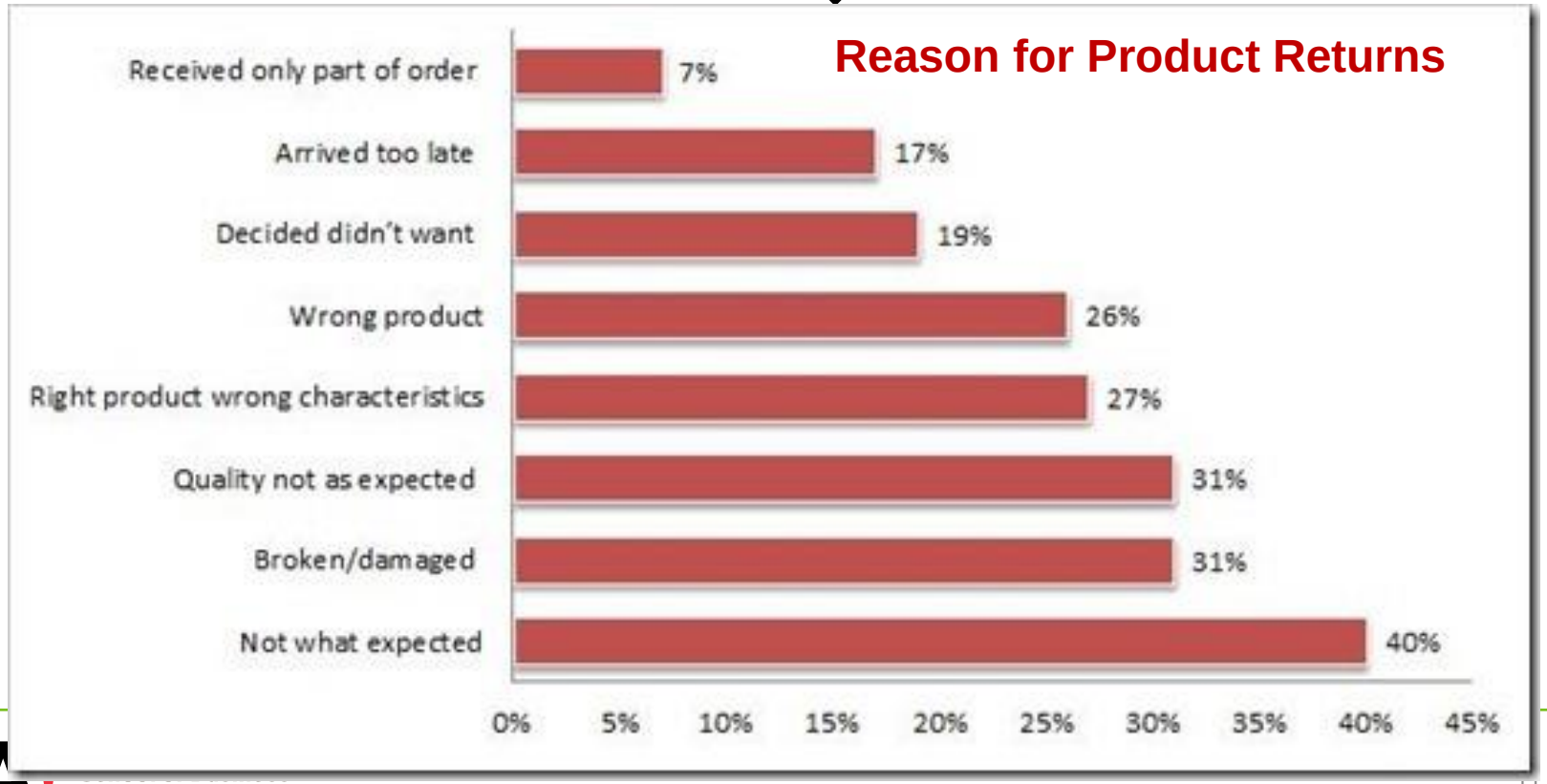
Reporting

Analysis

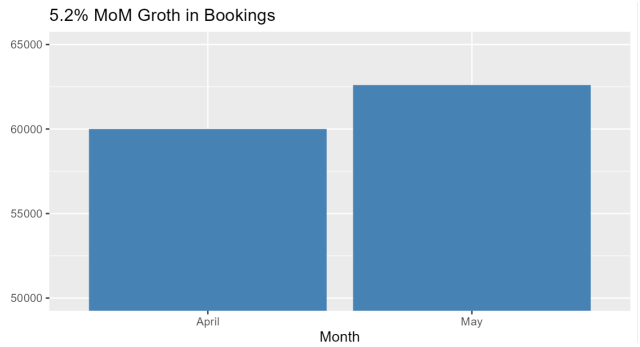


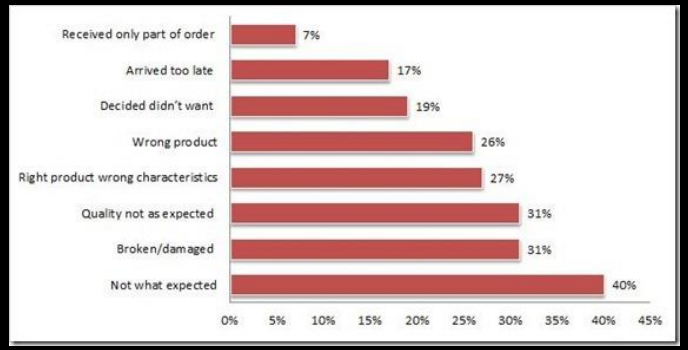
Reporting

Analysis



https://trak.in/tags/business/2012/06/22/indian-ecommerce-return-policy-logistics/





Reporting

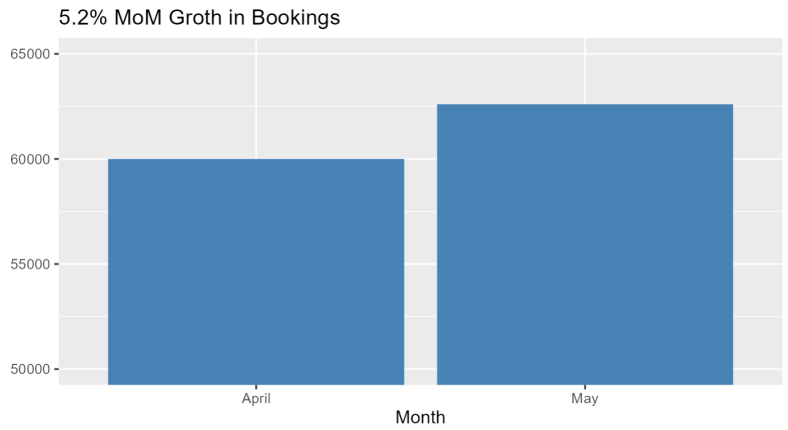
- Descriptive
- What?
- Backward-looking
- Raise questions
- Data → Information
- Reports, alerts
- No context

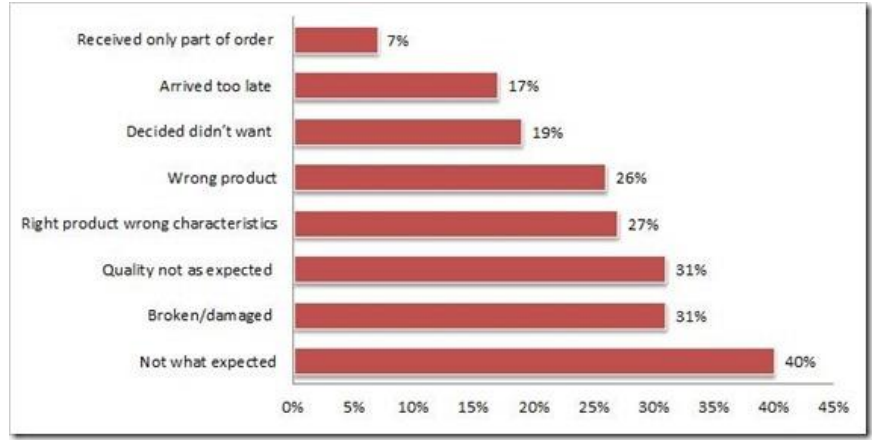
Often used in KPI dashboards and stakeholder reports

Analysis

- Prescriptive
- Why?
- Forward-looking
- Answer questions
- Data + Information→ Insights
- Findings, recommendations, predictions
- Context + storytelling

Davenport et al. 2010. Competing on analytics. Harvard Business Press.
Carl. 2015. Creating a data-driven organization, O.Reilly.

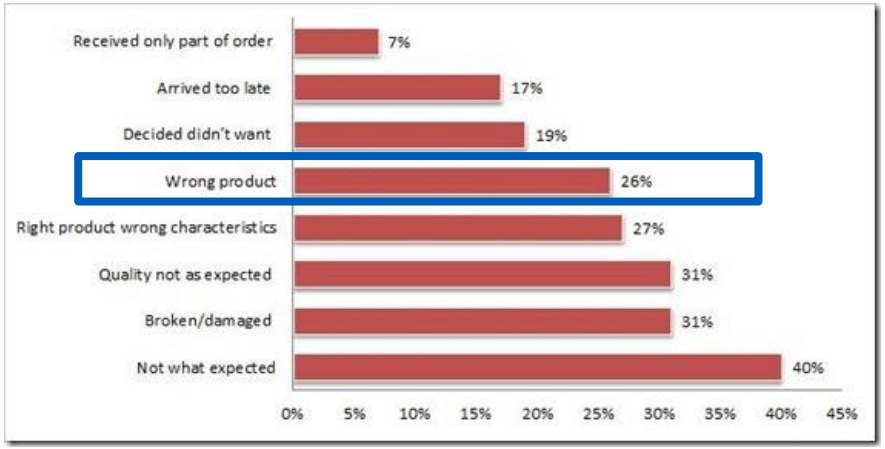


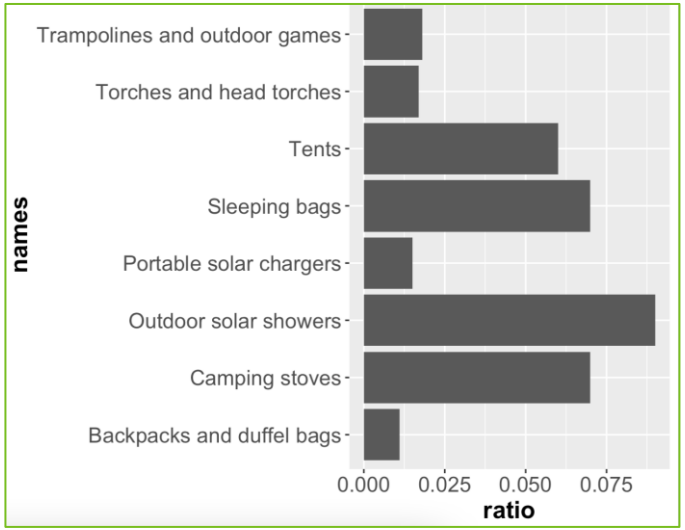


	Past	Present	Future
Information	**A) What happened?** Reporting	**B) What is happening now?** Alerts	**C) What will happen?** Extrapolation based on intuition
Insight	**D) How and why did it happen?** Modeling, experimental design	**E) What's the next best action?** Recommendation	**F) What's the best/worst that can happen?** Prediction, optimization, simulation

Davenport et al. 2010. Competing on analytics. Harvard Business Press.
Carl. 2015. Creating a data-driven organization, O.Reilly.

Reasons for Product Returns



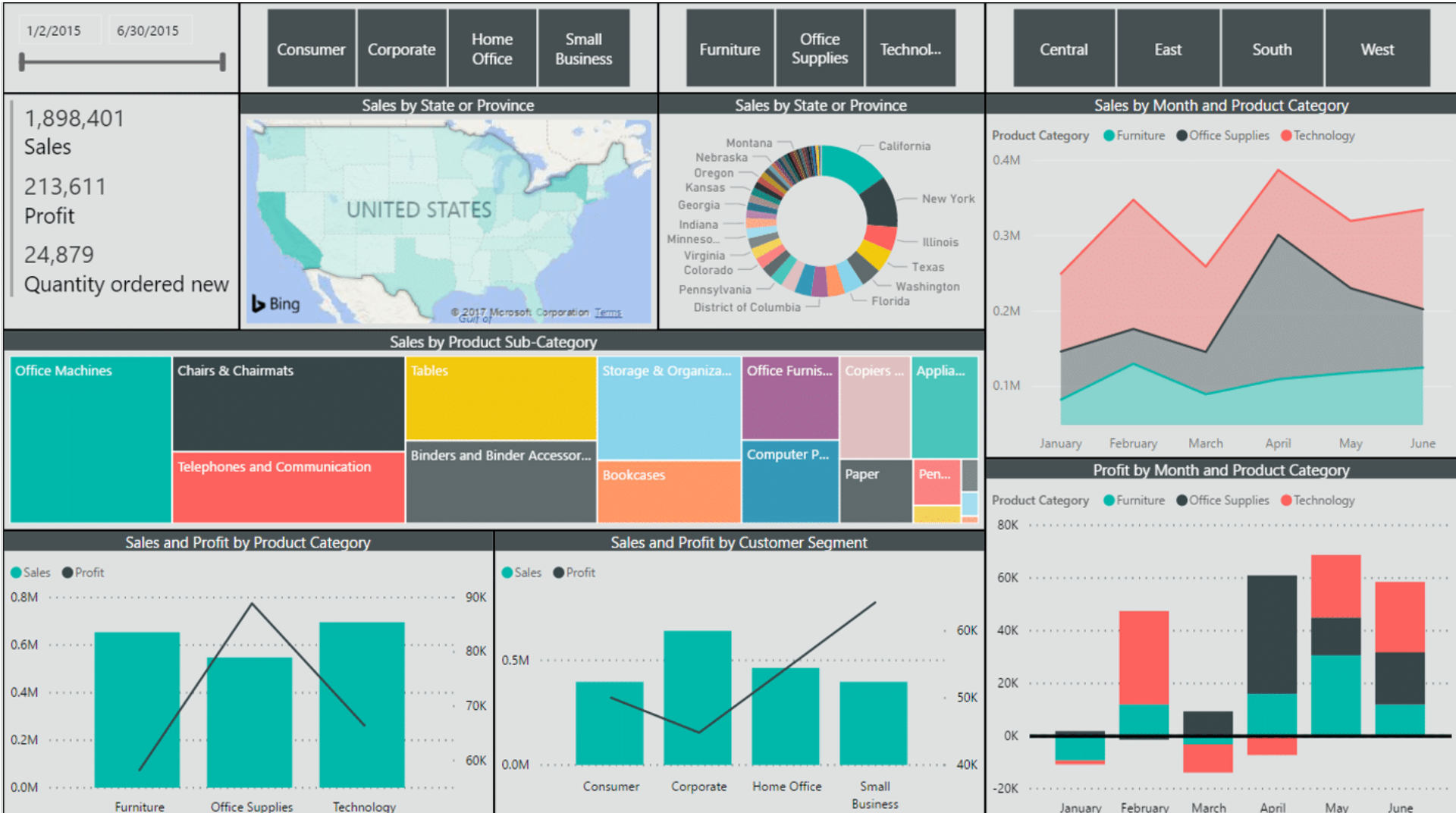


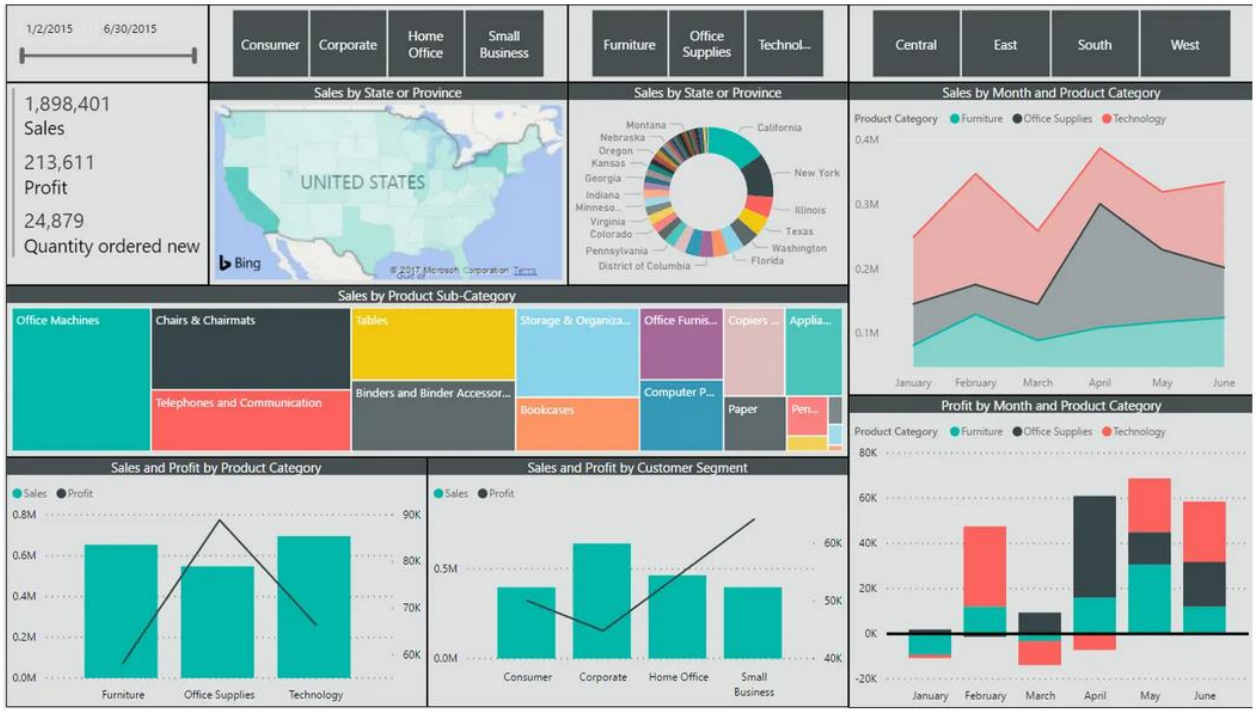
KPI

- Revenue
- Customer satisfaction

Ratios for wrong product

Image revisit!





High information density and plenty of colors do not make this dashboard actionable.

At first glance, it looks good. It's very colorful with lots of information, so we can say it has **good information density** and shows a lot of **detail**. However, when you see something like this for the first time, you have no idea what to look for, where to click, or where to **focus your attention**. It's obviously some kind of a **sales dashboard**. Here in the left corner, there is some sales information and there is some profit information and new orders quantity.

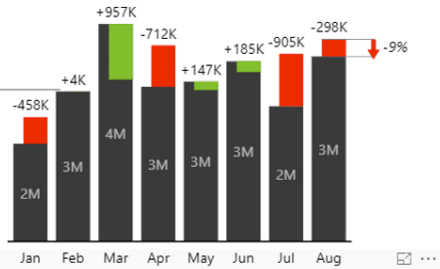
But if you're looking at your sales performance and look at this dashboard each month, it doesn't answer the most obvious question: "Is my sales performance good or bad?"

https://zebrabi.com/power-bi-dashboard-design/

Sales in USD
99 - MISCELLANEOUS
Jan..Aug 2017, AC vs BU

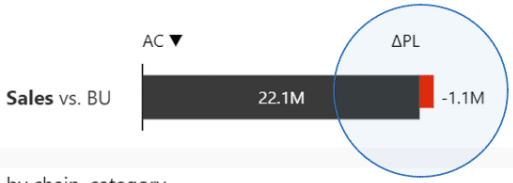
Click on a category name in the table to select a category like Mens or Womens

Click on the chart to select a month

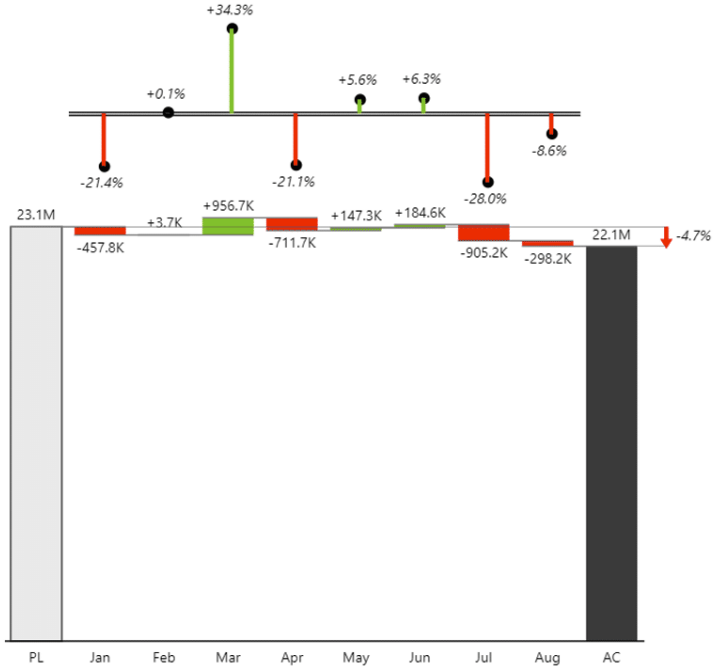


$22.1M
This Year Sales

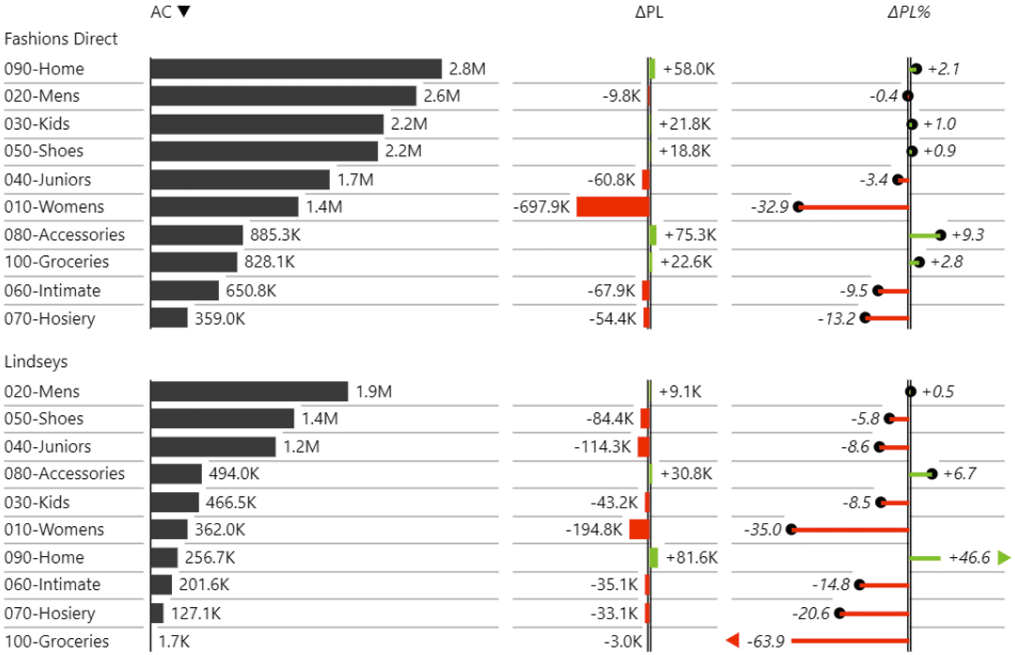
42%
Gross Margin This Year %



by month



by chain, category

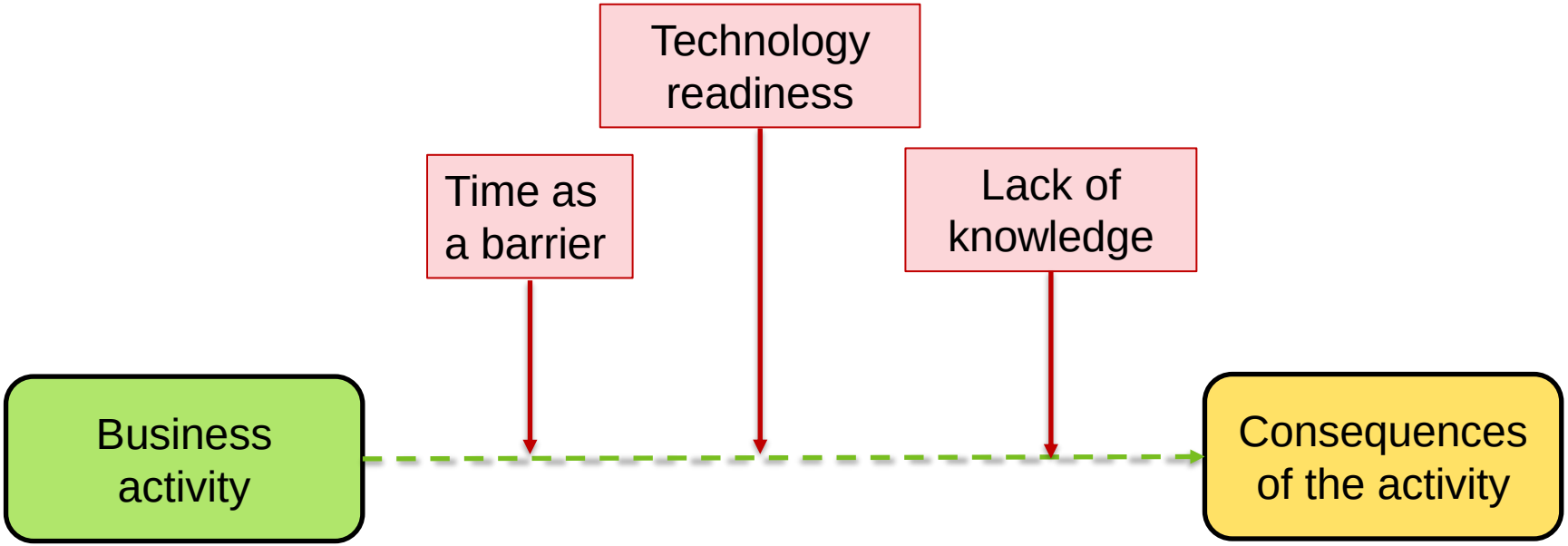


FILTERS

Home | Multiples | Sales vs BU by store | Monthly by store | Absolute variance | Relative variance | Features | IBCS | Download

https://zebrabi.com/power-bi-dashboard-design/

Why is generating useful reports difficult?



People may lose interest/ forget / have no ability to trace the consequence of a business activity

What makes an impactful BI dashboard?

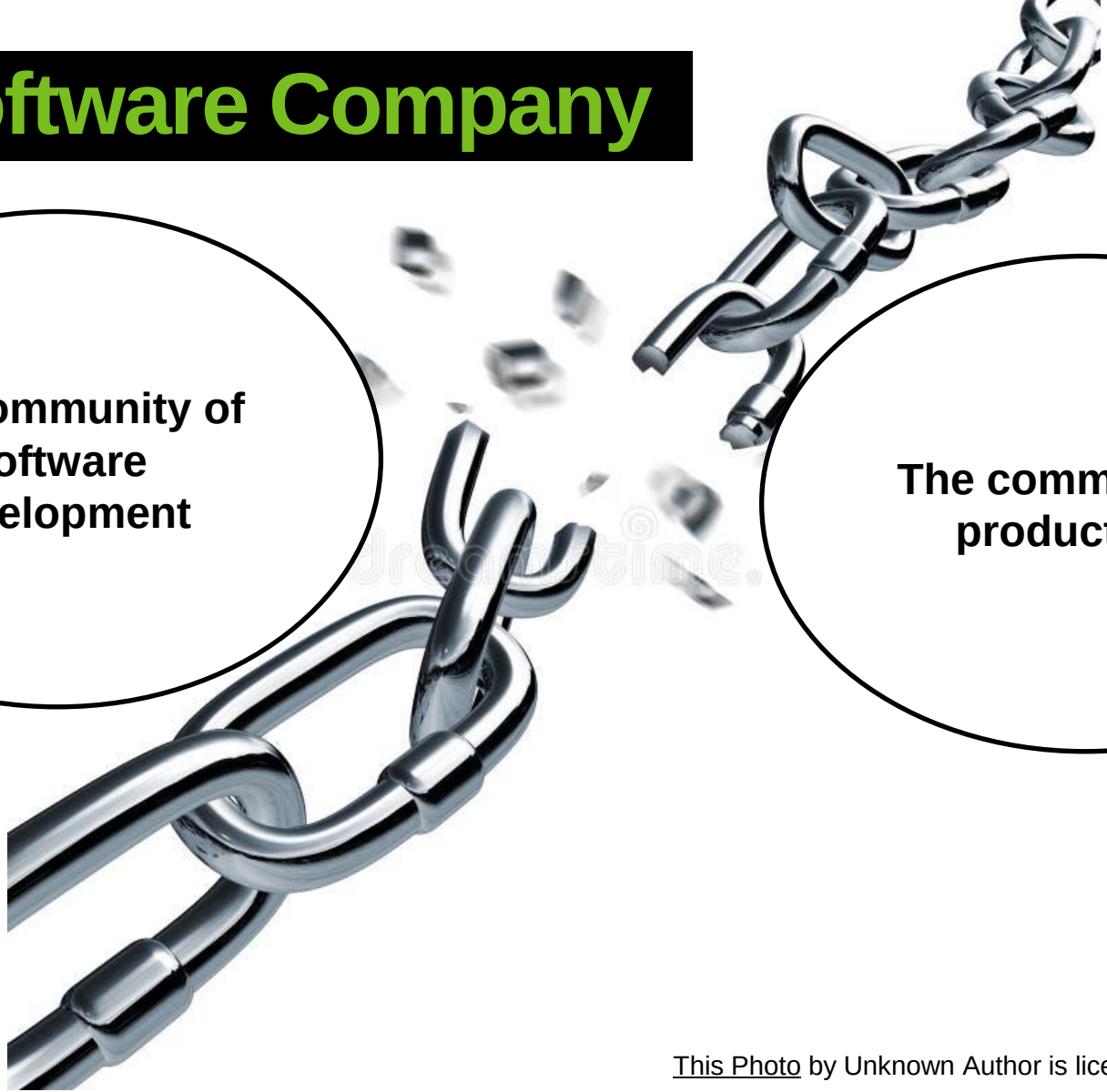
1. Connecting the separated business units
2. Connecting to operatable business activities
3. Connecting to KPI

Examples:

a) A software company

b) Reima

A Software Company

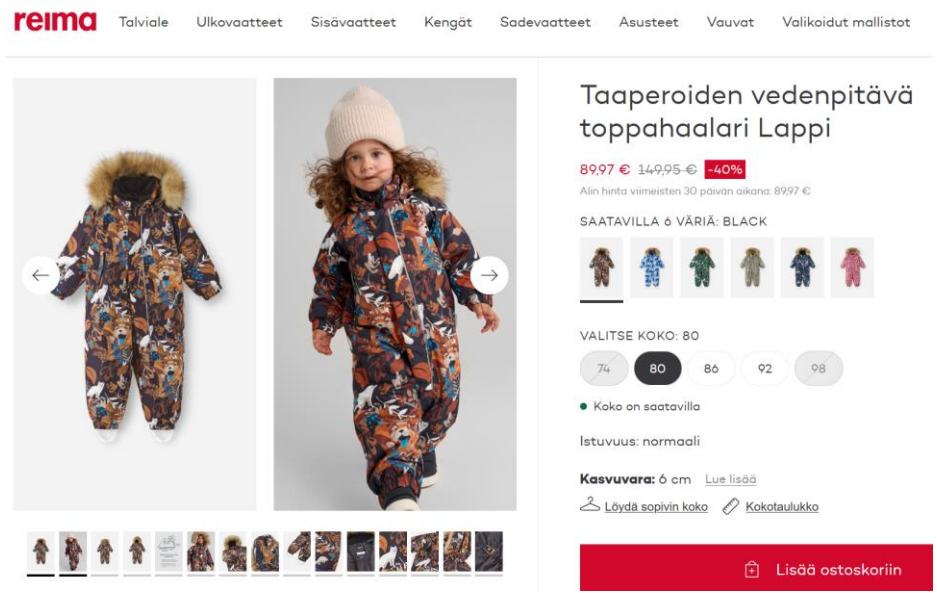


The community of software development

The community of product sale

This Photo by Unknown Author is licensed under CC BY-ND

Reima



A very long time

https://www.reima.com/fi-FI/products/reimatec-talvihaalari-lappi-1?colorId=9995

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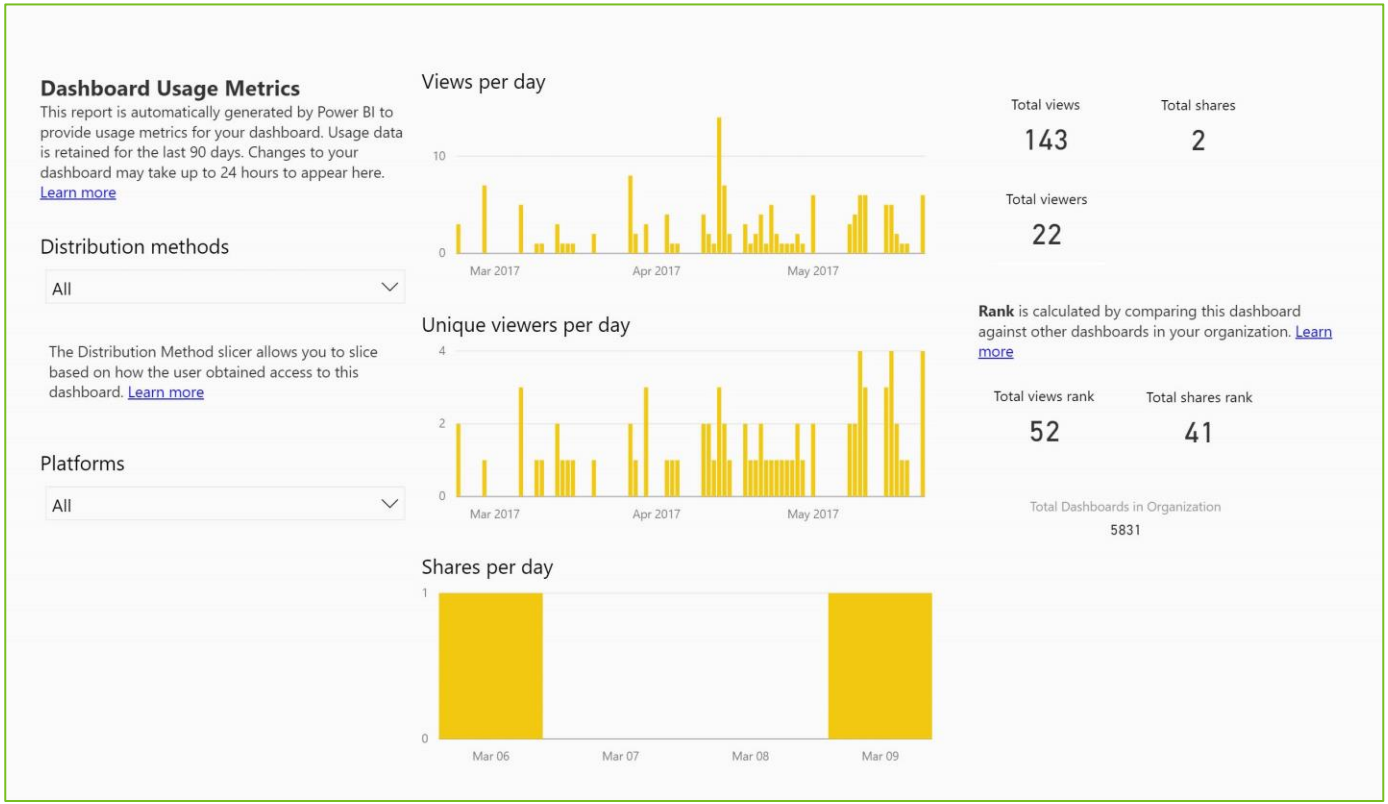
Section 4: BI report monitoring and storytelling

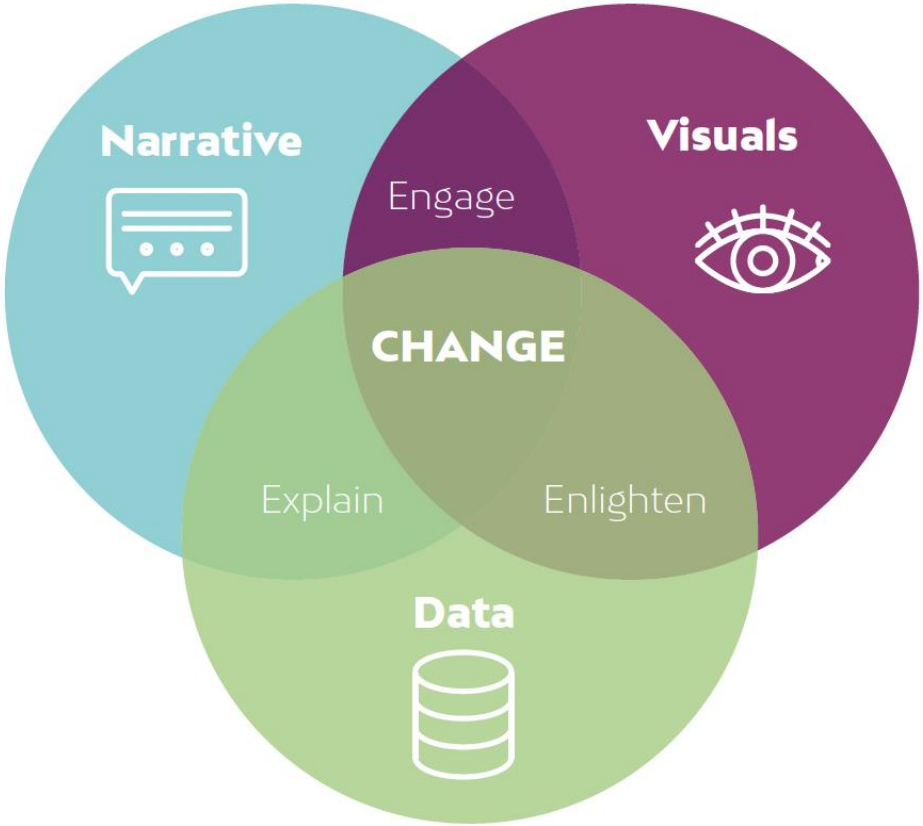
Monitoring use

A dashboard may have no value anyway, but it certainly cannot have any value if no one views it.



https://datachant.com/2017/06/05/power-bi-report-usage/

Storytelling



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

A basic recipe for storytelling in your presentations and final reports

In case you don't have a clear notion of how to include the "story" element in your data, we're going to outline a few points that will guide you, so that your presentations and reports manage to grab your audience's attention and have a major impact:

1. Find the story in your data. Write, write, and write. Write about the highlights of your research in different roles. Worry about presentation later.

2. Define the perspective. Who are you talking to? What's the best way to achieve your objective?

3. Create a hierarchy. What is the most important thing you are trying to convey? Establish different depths to your reading and data. Avoid irrelevant information.

4. Organize. Figure out the most suitable sequence for presenting your data. What relationships can you establish between different aspects of your data? What do some pieces of data mean relative to others? Are they the framework (data that reveals), the details (data that delves deeper), or the contrast (data that dramatizes differences)?

5. Plot. Generate interest; create tension. Depict the concept, crux, and resolution. Incentivize your audience to keep reading until the last page, so to speak. Establish relationships.

6. Use data to anchor your narrative. The story in your data ought to be simple; the vision drawn from the data comes with an implicit responsibility to be sincere and honest.

7. Design principles. Adhere to the best practices of design to visualize your data.

8. Review, review, review. Make sure that all of your analysis is precise.

9. Be familiar with your content and respect your audience.

10. Keep it short and sweet. Data-based storytelling is the product of hours of work. It's best to keep presentations short, with concrete ideas adapted to the audience so that your message is conveyed efficiently and smoothly.

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