Lecture 5

Data Visual Design

Haoyu Yue / yohaoyu@washington.edu
Ph.D. Student, Interdisciplinary Urban Design and Planning
University of Washington

RE 519 Real Estate Data Analytics and Visualization
Course Website: www.yuehaoyu.com/data-analytics-visualization/
Autumn 2025

Data Visualization Principles

A Framework for Visualization from Tamara Munzner

Actions of Data Visualization	→ users' actions toward visualization
Target of Data Visualization	→ what part of data that users are focusing on
The Choice of Visualization **Idioms**	→ which form best present it
Marks and Channels	→ how to encode them visually
Expressiveness vs **Effectiveness**	→ key standards for good visualization
Elements of A Single Graph	→ components in a graph
User **Experience** and Organization	→ how people will use and understand the visualization
Graphic **Interaction**	→ how people can interact with the visualization

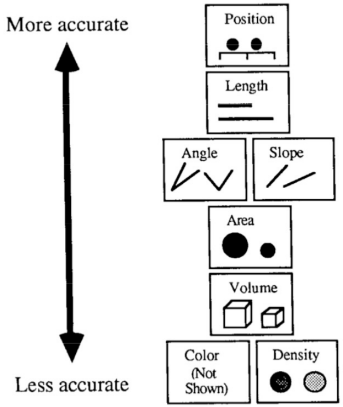
It represents a thinking flow — from understanding the goal of visualization, to selecting the right form, to ensuring clarity, usability, and interaction.

Expressiveness + Effectiveness

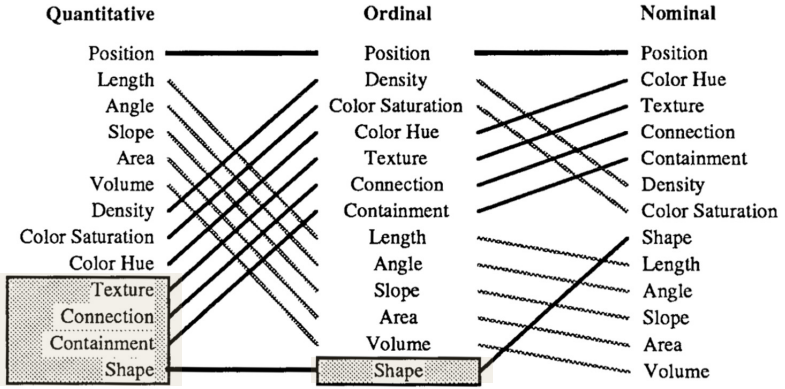
Expressiveness: Matching channel to data type

A visualization is expressive if it represents all of, and only, the facts in the data set being visualized.

Accuracy ranking of quantitative perceptual tasks



Ranking of perceptual tasks

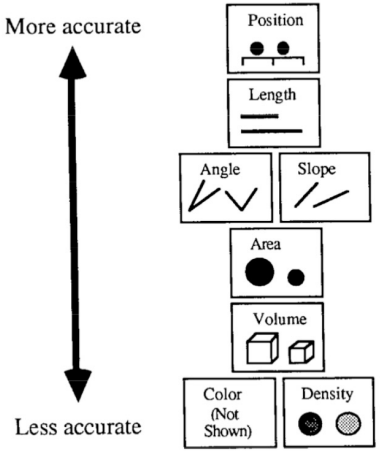


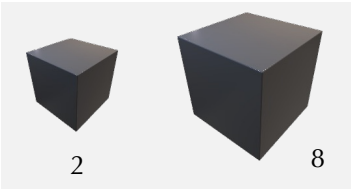
Note: The tasks shown in the gray boxes are not relevant to these types of data.
Source: Mackinlay, J. (1986). "Automating the Design of Graphical Presentations of Relational Information." ACM Transactions on Graphics (TOG), 5(2), 110–141.

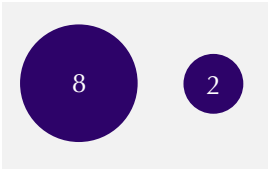
Expressiveness + Effectiveness

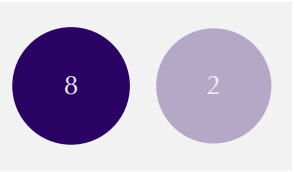
Effectiveness: Choosing the channels by importance ordering

Accuracy ranking of quantitative perceptual tasks









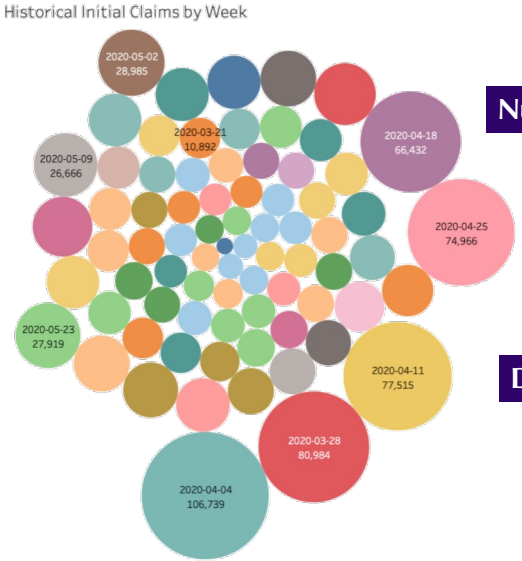
One sentence takeaway

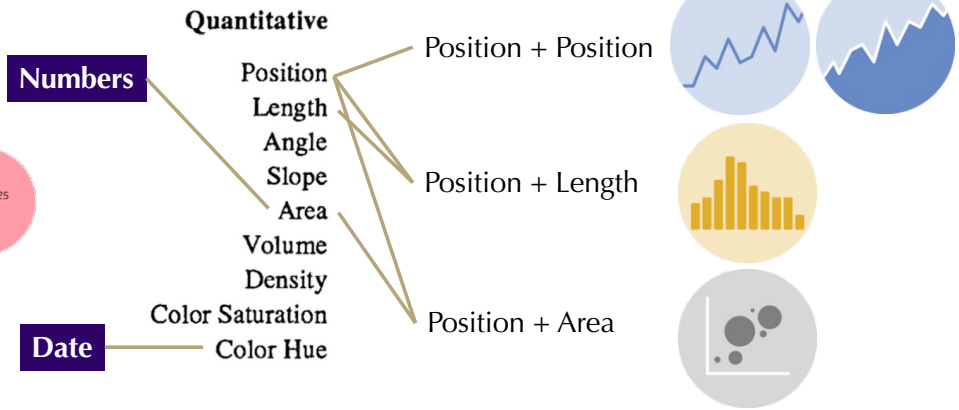
Use elements at the top of the list for important variables

Expressiveness + Effectiveness

They Made a Terrible Visualization…

Weekly Unemployment Insurance Claims
Source: Alabama Department of Labor



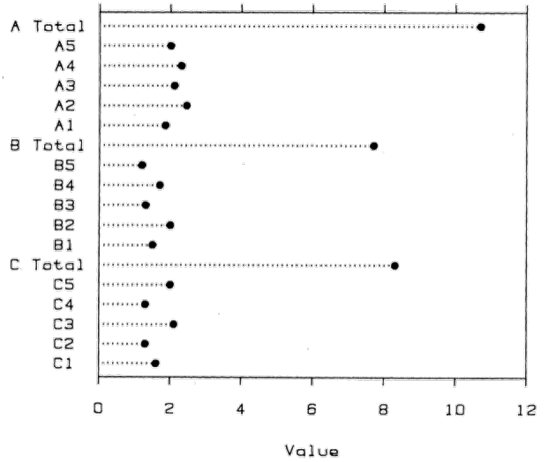


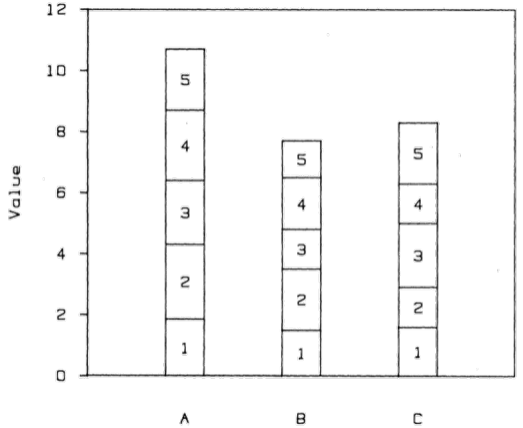
Source: From Data to Viz: https://www.data-to-viz.com/

Expressiveness + Effectiveness

Elements of Data Encoding: Position vs. Length

Which one is easier to read?





Quantitative

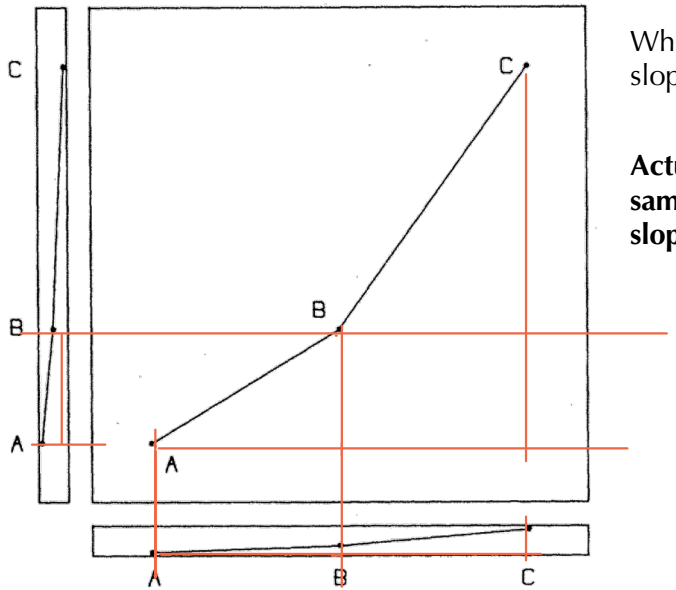
Position
Length
Angle
Slope
Area
Volume
Density
Color Saturation
Color Hue

Use elements with higher perception accuracy to present your information

Source: W. Cleveland & R McGill, 1985, Graphical Perception and Graphical Methods for Analyzing Scientific Data

Expressiveness + Effectiveness

Elements of Data Encoding: Angle vs. Slope



Which one has the largest ratio of the slope of BC to the slope of AB?

Actually, the three groups have the same ratio of the slope BC to the slope AB

Quantitative

Position
Length
Angle
Slope
Area
Volume
Density
Color Saturation
Color Hue

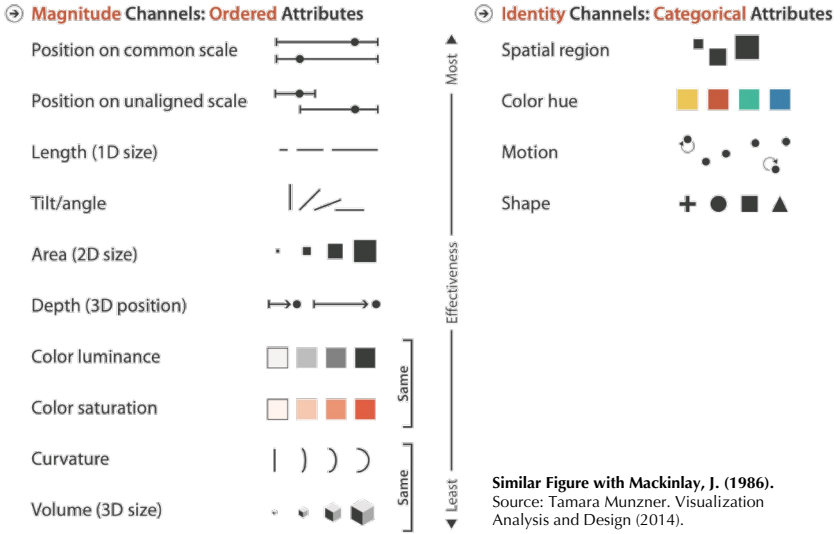
When presenting with elements of lower perception accuracy, add complementary graphics to help the audience understand.

Source: W. Cleveland & R McGill, 1985, Graphical Perception and Graphical Methods for Analyzing Scientific Data

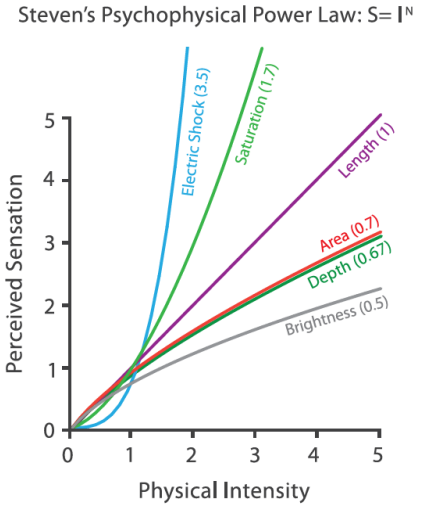
Expressiveness + Effectiveness

Stevens' Psychophysical Power Law

Channels: Expressiveness Types and Effectiveness Ranks



Similar Figure with Mackinlay, J. (1986).
Source: Tamara Munzner. Visualization Analysis and Design (2014).



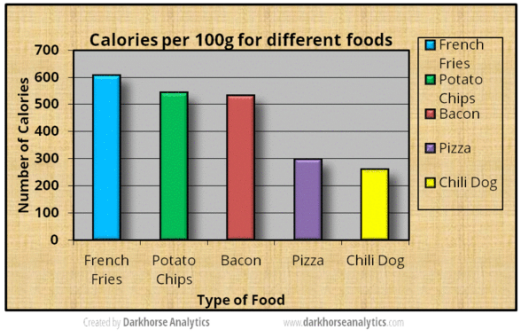
Source: Tamara Munzner. Visualization Analysis and Design (2014).

Expressiveness + Effectiveness

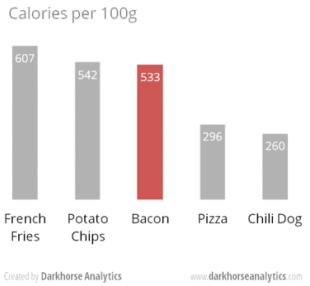
Data-Ink Ratio

= Data ink / Total ink use in graphics
= Proportion of a graphic's ink devoted to non-redundant display of data.
= 1.0 – proportion of graphics that can be erased.

Remove backgrounds

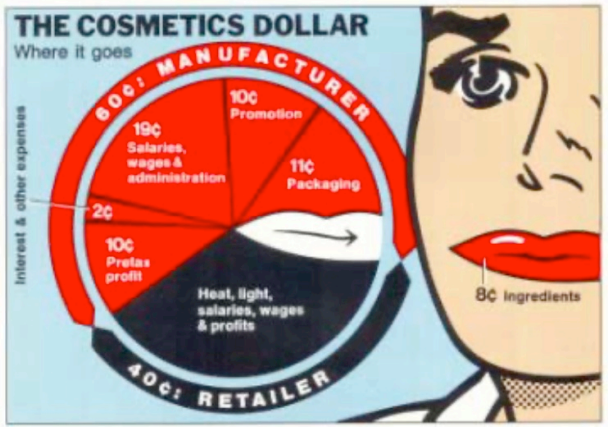


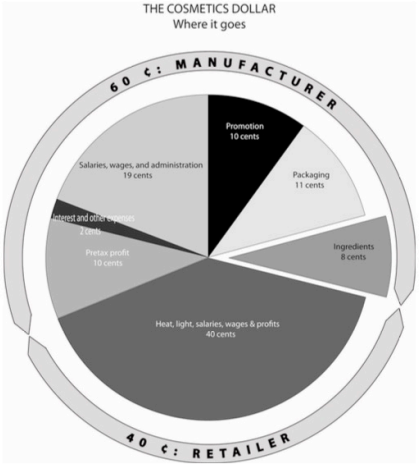
Direct label



Expressiveness + Effectiveness

Data-Ink Ratio





Source: Bateman et al., CHI 2010

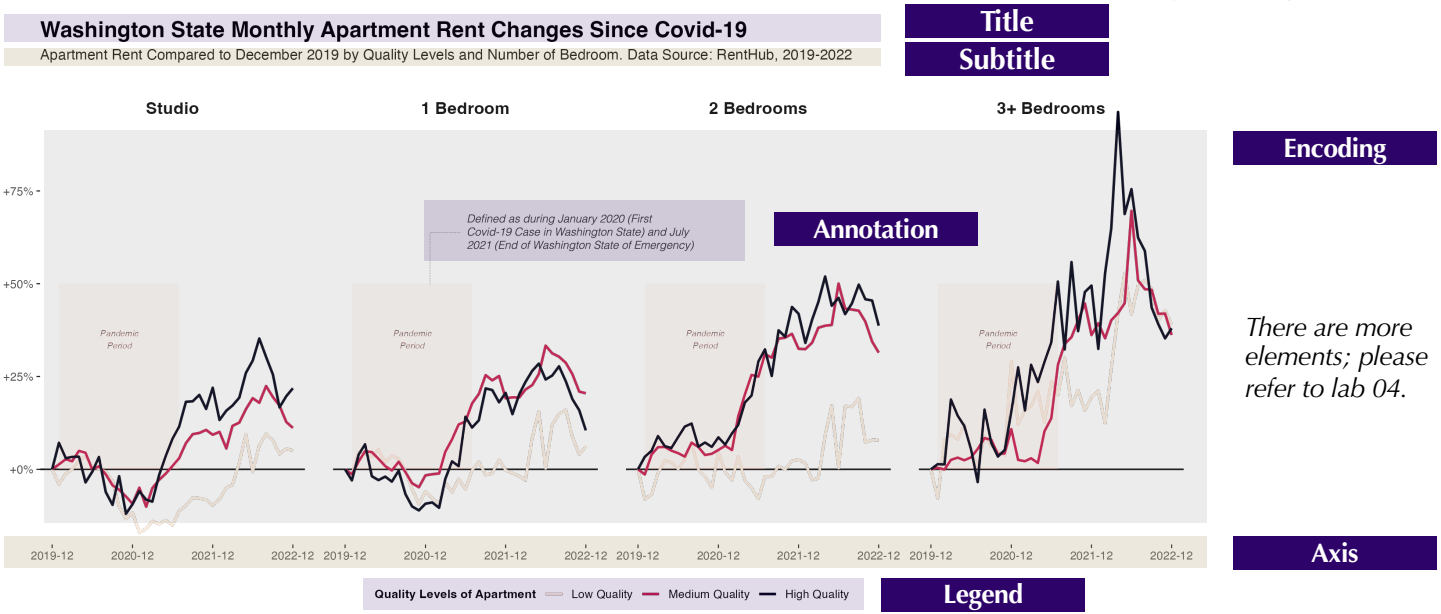
Chartjunk is not always harmful. In some cases, it may even increase the memorability and engagement of a visualization.

Remove

to improve

(the **data-ink** ratio)

Elements of a Single Graph



There are more elements; please refer to lab 04.

User Experience and Organization

User Experience

What motivates us at a deep level are the things that satisfy basic psychological needs?

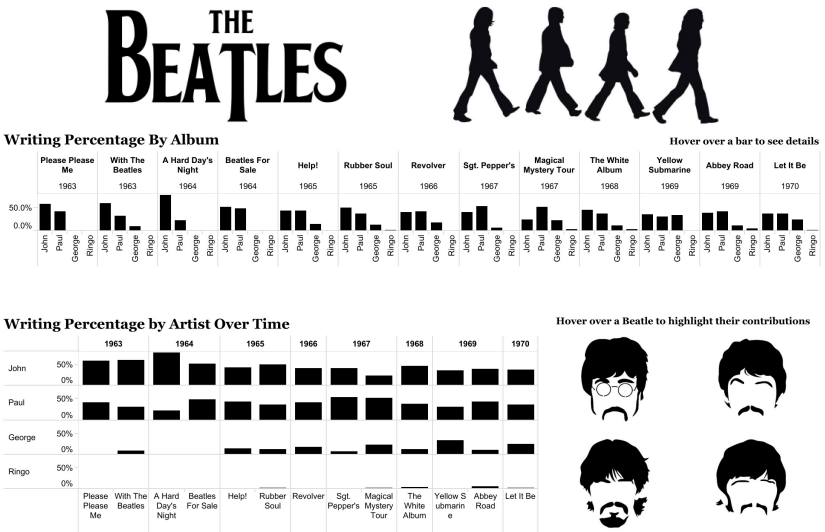
Autonomy →
- Structure beats no structure – easy to navigate

Relatedness →
- No need to be too creative – keep content relevant to the audience

Competence →
- Select information and use guidance to make visualization intuitive and easy to understand- it is not an IQ test!

User Experience and Organization

Organization - Unity



Author: Mike Moore. Source: https://public.tableau.com/s/gallery/beatles-albums

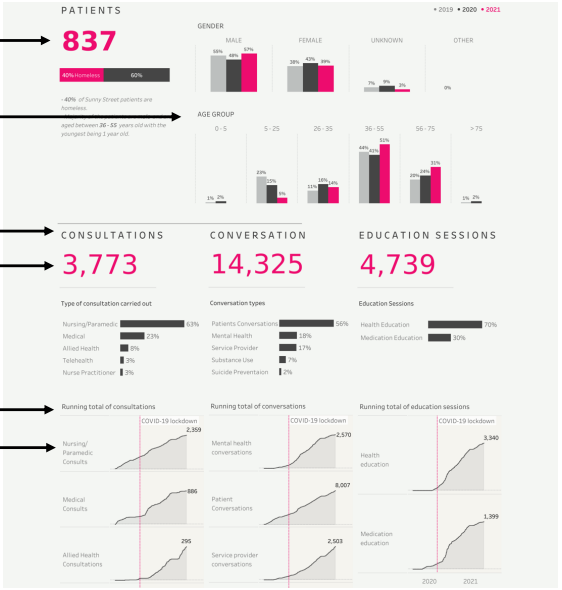
Unity is the application of methods that ensure that elements in the design (color, font, shape) appear to "go together."

User Experience and Organization

Organization - Hierarchy

Hierarchy is the application of design methods to indicate importance and "flow" within the visual (size, placement)

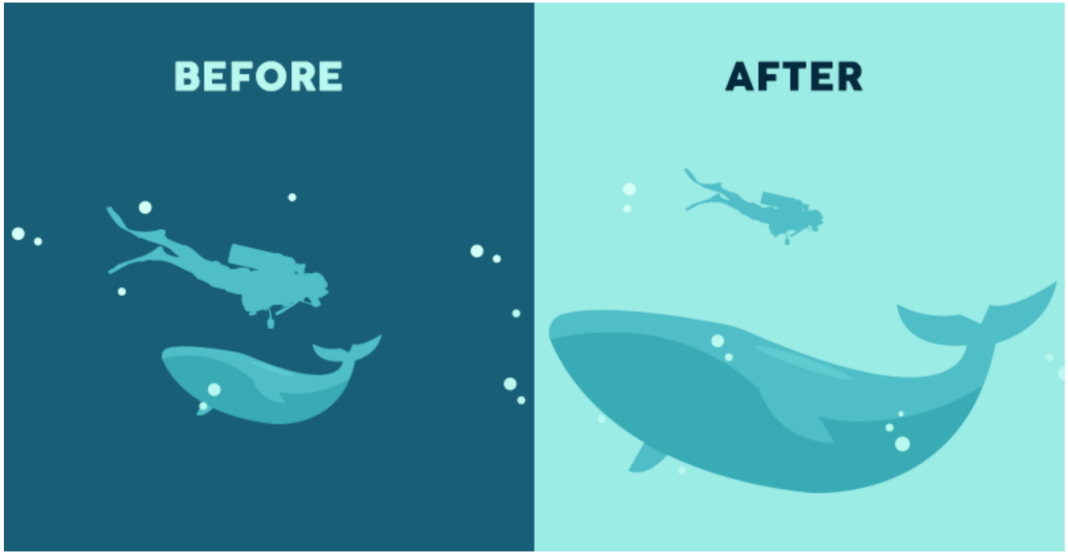
Level 1 →
Level 4 →
Level 3 →
Level 2 →
Level 5 →
Level 6 →



Author: Zainab Ayodimeji. Source: https://public.tableau.com/en-us/gallery/sunny-street?tab=viz-of-the-day&type=viz-of-the-day

User Experience and Organization

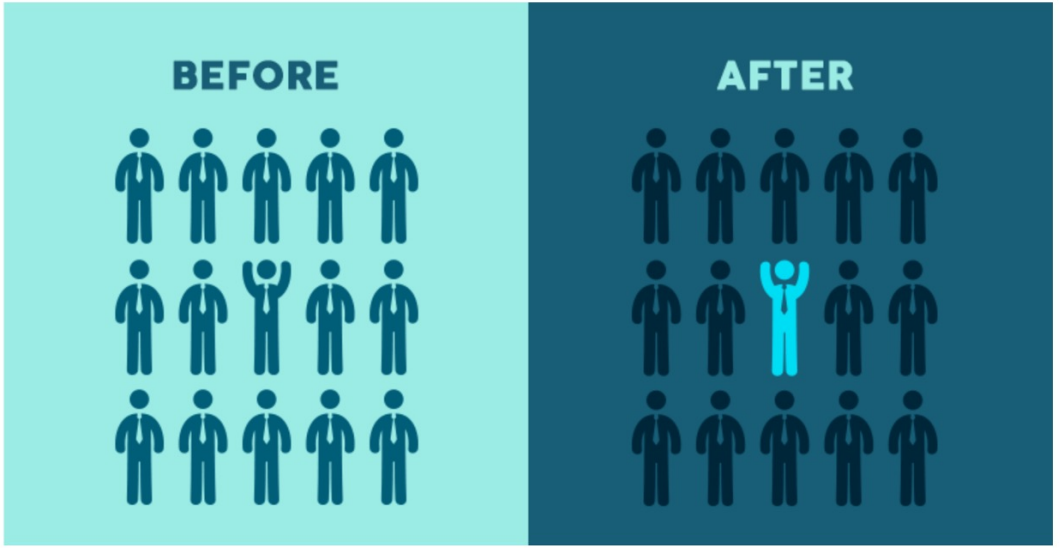
Organization - Size



Source: https://visme.co/blog/visual-hierarchy/

User Experience and Organization

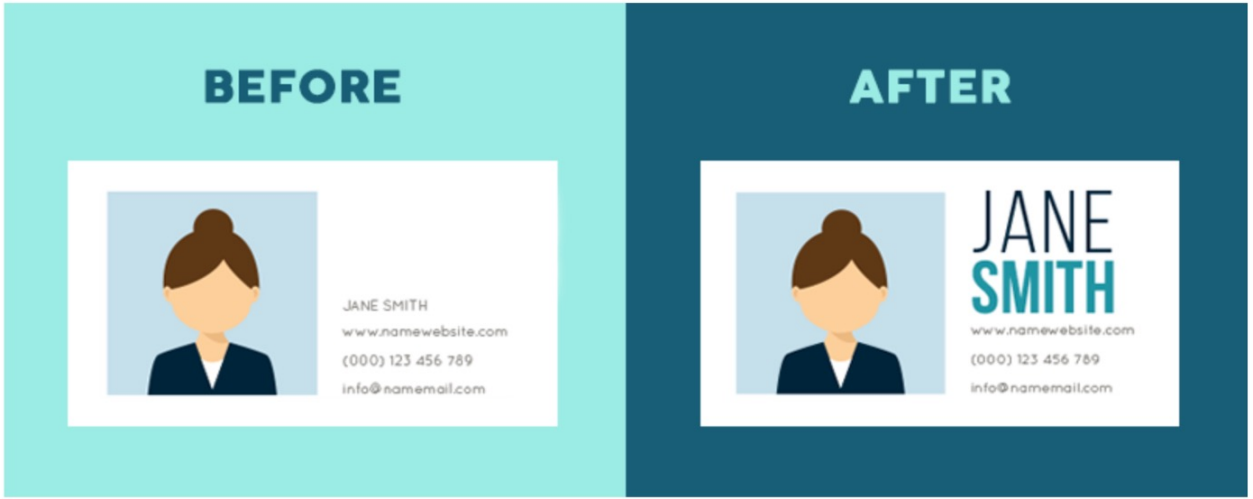
Organization - Color Contrast



Source: https://visme.co/blog/visual-hierarchy/

User Experience and Organization

Organization - Using Font to Organize Design

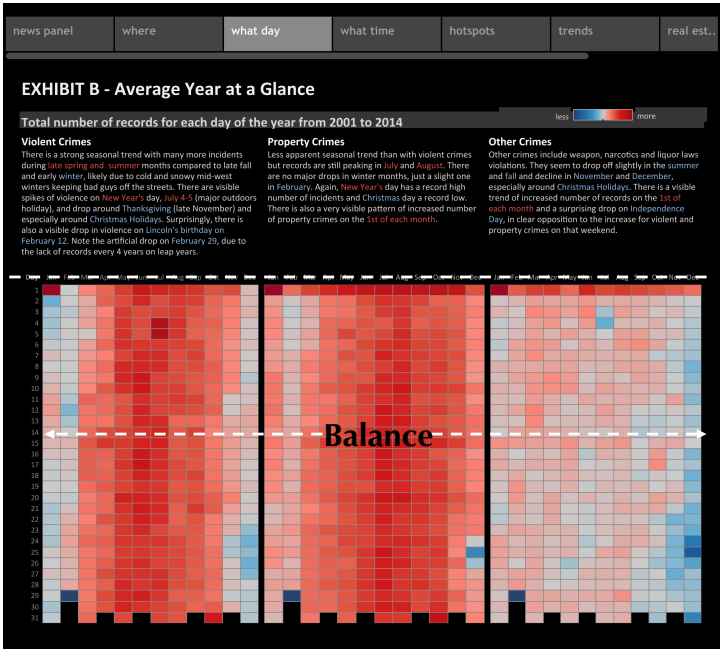


Source: https://visme.co/blog/visual-hierarchy/

User Experience and Organization

Organization - Balance and Alignment

Balance and alignment are used to create harmonious visuals that do not distract from the message being communicated.

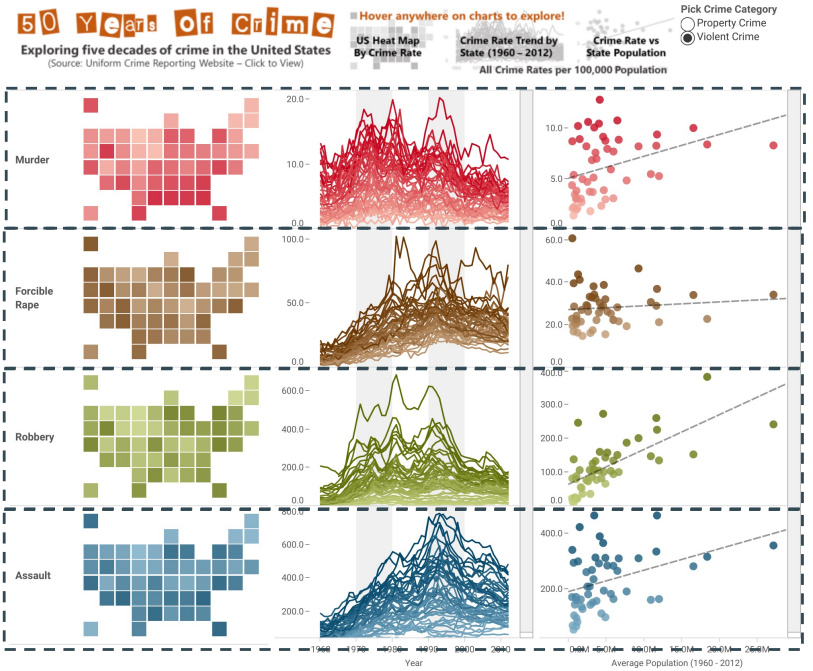


Author: George Goczynski. Source: https://public.tableau.com/en-us/gallery/chicago-crime-scene

User Experience and Organization

Organization - Grouping and Spacing

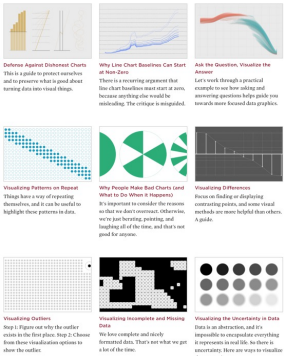
Grouping and spacing can be used to associate similar elements and provide a narrative or visual flow within the visualization.



Author: Shine Pulikathara. Source: https://public.tableau.com/en-us/gallery/50-years-crime-us

Consume + Practice are More Important

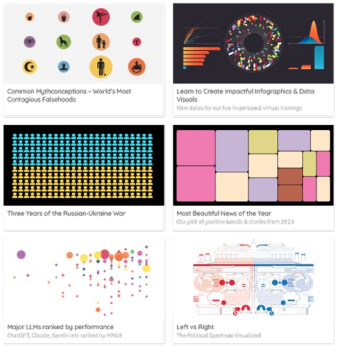
End of Data Visualization Principles



Flowing Data
https://flowingdata.com/learning/

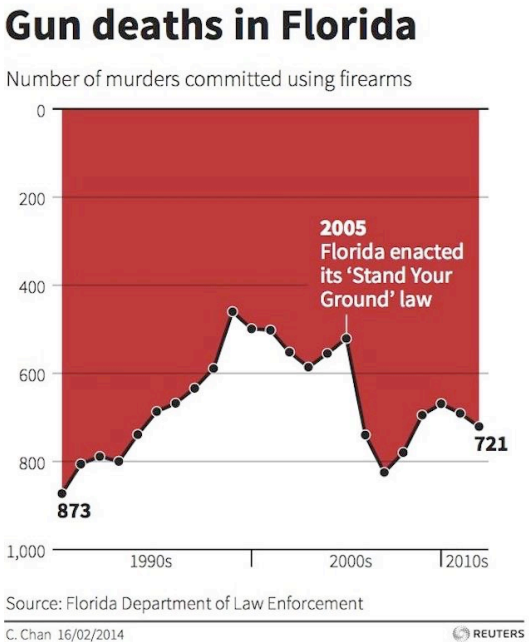
From Data to Viz
https://www.data-to-viz.com/

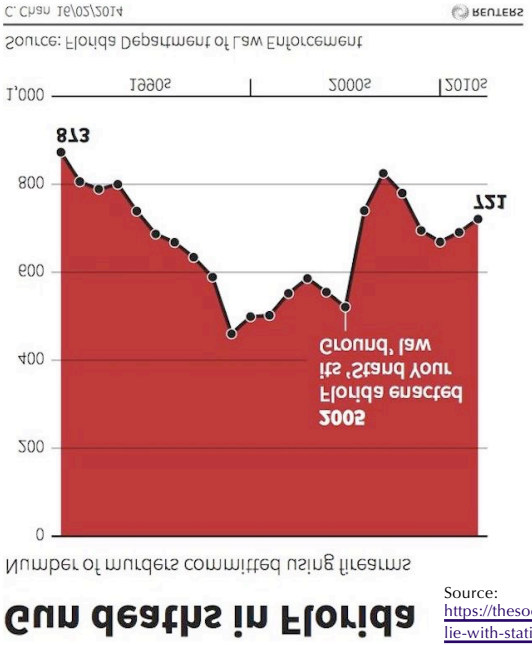
Data Viz Project
https://datavizproject.com/



Information is Beautiful
https://informationisbeautiful.net

Critique and Deceptive Visualization





Source: https://thesocietypages.org/socimages/2014/12/28/how-to-lie-with-statistics-stand-your-ground-and-gun-deaths/

Critique and Deceptive Visualization

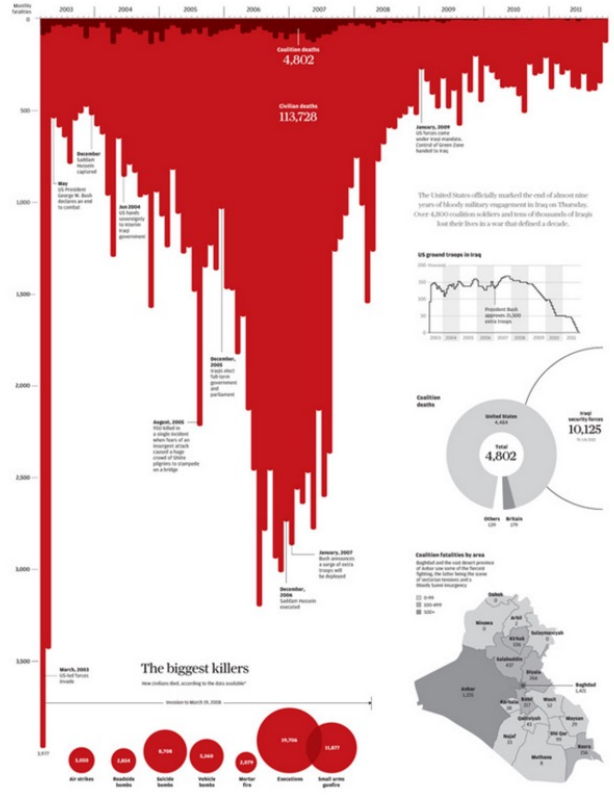
Which means BAD!

Visualization is a way to communicate.

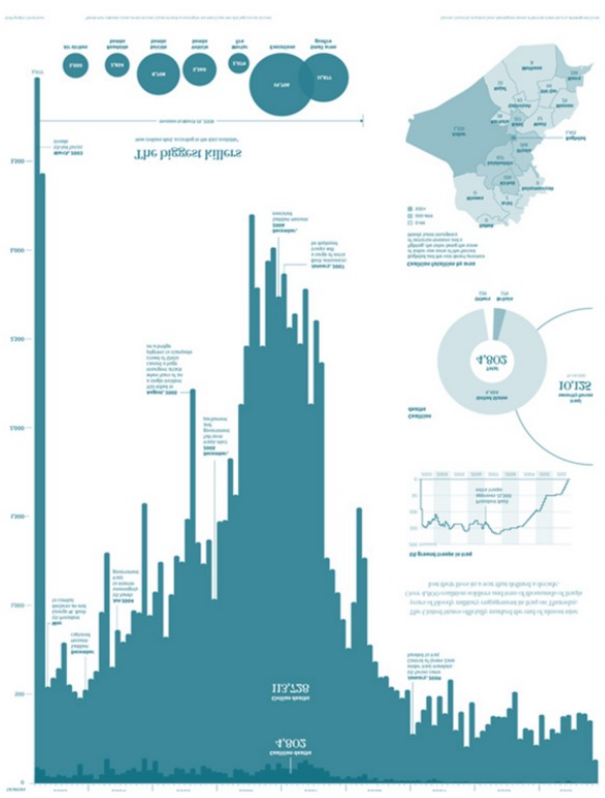
People can also use it to lie, distort, or redirect the truth, intentionally or unintentionally.

What makes bad figures bad?

- **Aesthetic**
  - Tacky, tasteless, or hodgepodge design
- **Substantive**
  - The way the data is being used is subpar, or the data itself is flawed. Wrong interpretation.
- **Perceptual**
  - Good data & aesthetics, but the graph is confusing or misleading.

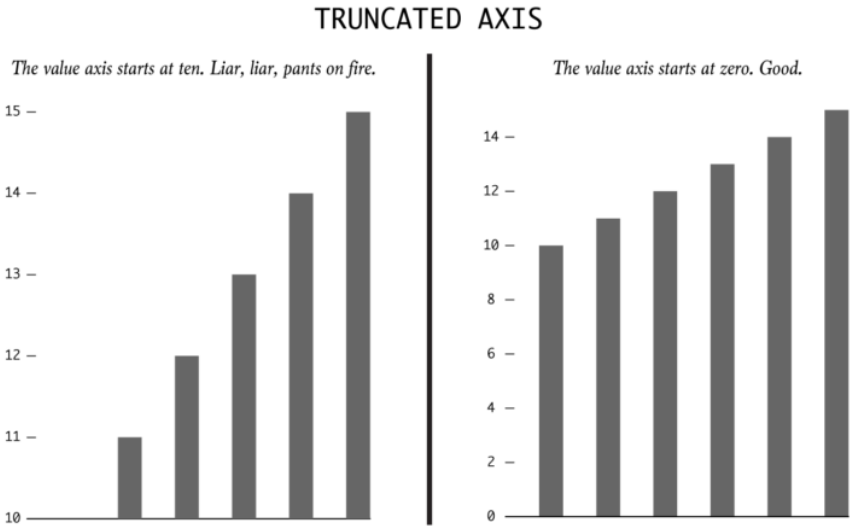


Source: https://www.infoworld.com/article/3088166/why-how-to-lie-with-statistics-did-us-a-disservice.html



Critique and Deceptive Visualization

Common Deceptive Visualization

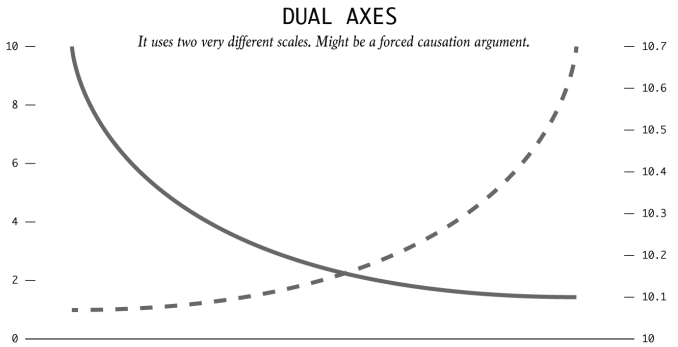


Bar charts use length as their visual cue, so when someone makes the length shorter using the same data by truncating the value axis, the chart dramatizes differences. Someone wants to show a bigger change than is actually there. (by Nathan Yau)

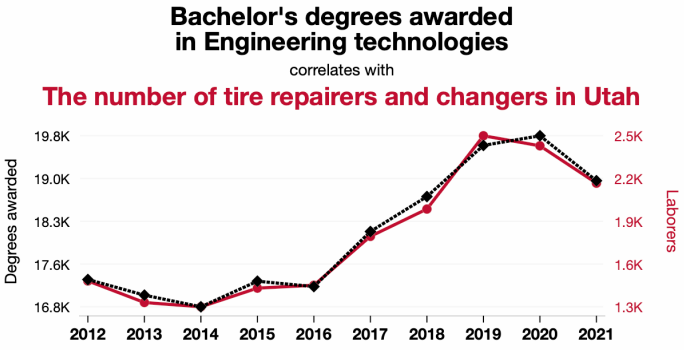
Source: Flowing Data by Nathan Yau https://flowingdata.com/

Critique and Deceptive Visualization

Common Deceptive Visualization



Source: Flowing Data by Nathan Yau https://flowingdata.com/

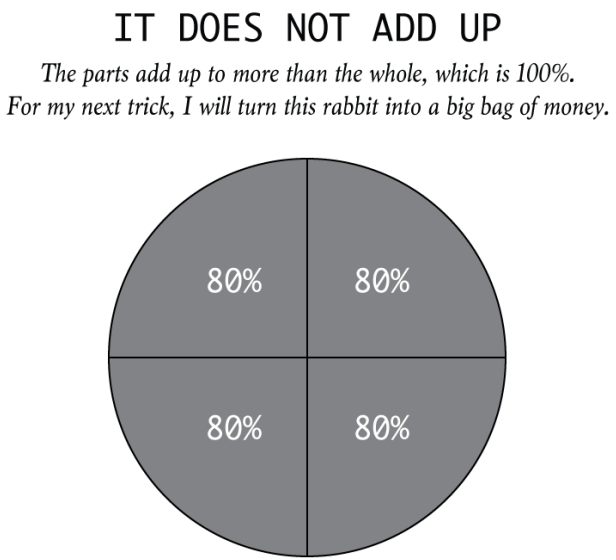


Source: Spurious Correlations https://tylervigen.com

By using dual axes, the magnitude can shrink or expand for each metric. This is typically done to imply correlation and causation. “Because of this, this other thing happened. See, it’s clear.” (by Nathan Yau)

Critique and Deceptive Visualization

Common Deceptive Visualization



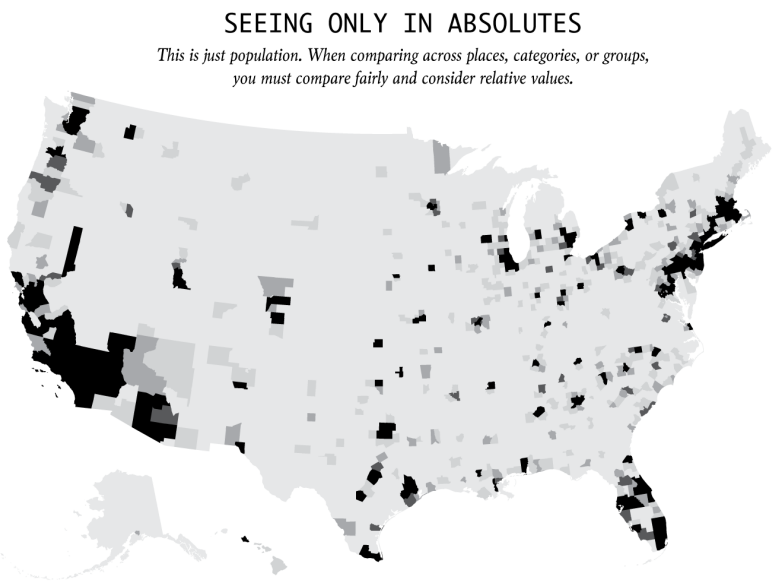
Some charts specifically show parts of a whole. When the parts add up to more than the whole, this is a problem. For example, pie charts represent 100 percent of something. Wedges that add up to more than that? Peculiar.

(by Nathan Yau)

Source: Flowing Data by Nathan Yau https://flowingdata.com/

Critique and Deceptive Visualization

Common Deceptive Visualization



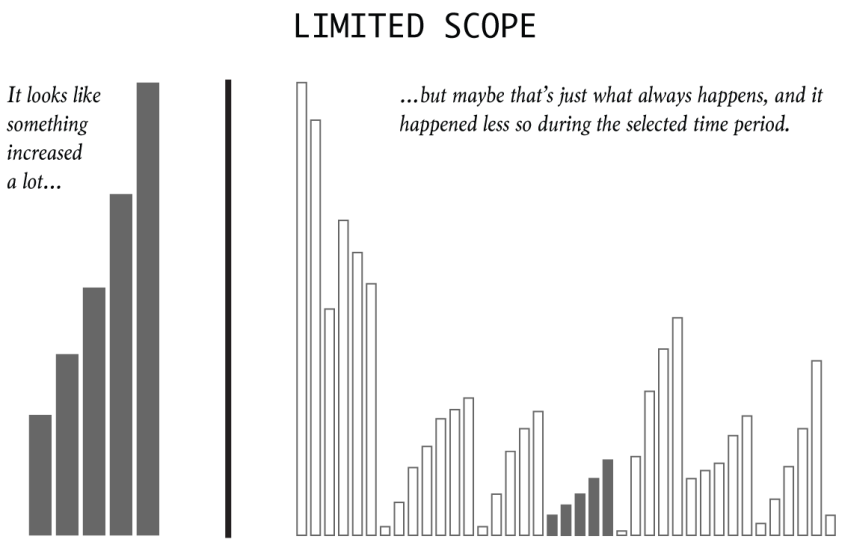
Everything is relative. You can't say a town is more dangerous than another because the first one had two robberies and the other only had one. What if the first town has 1,000 times the population that of the first? It is often more useful to think in terms of percentages and rates rather than absolutes and totals.

(by Nathan Yau)

Source: Flowing Data by Nathan Yau https://flowingdata.com/

Critique and Deceptive Visualization

Common Deceptive Visualization



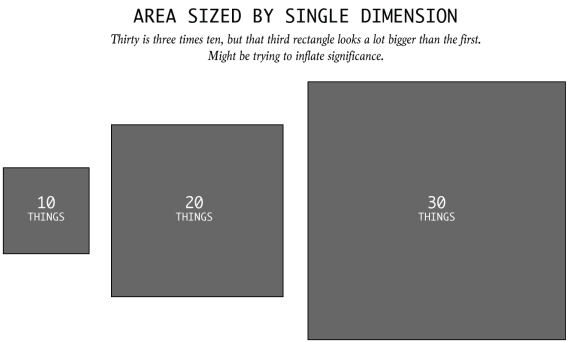
It's easy to cherry-pick dates and timeframes to fit a specific narrative. So consider history, what usually happens, and proper baselines to compare against.

(by Nathan Yau)

Source: Flowing Data by Nathan Yau https://flowingdata.com/

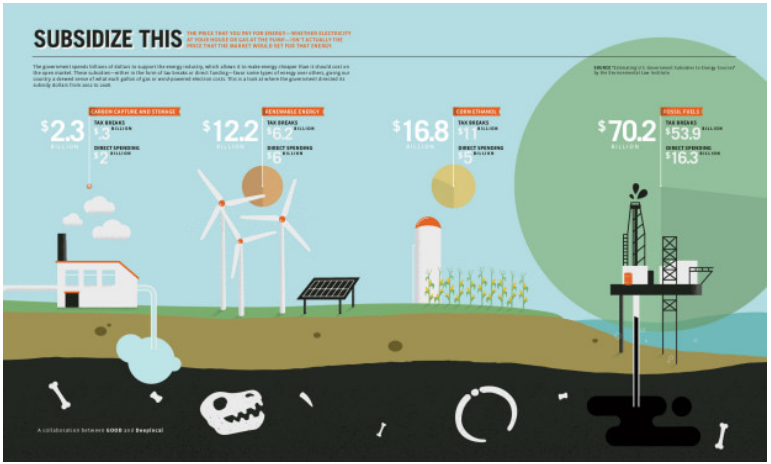
Critique and Deceptive Visualization

Common Deceptive Visualization



If area is the visual encoding, then one has to size by area. When someone linearly sizes an area-based encoding, like a square or a circle, they might be sniffing for dramatics.

(by Nathan Yau)



Source: Flowing Data by Nathan Yau https://flowingdata.com/

Reminders

- Lab 3 will be due tonight. However, if you cannot submit it via Canvas due to AWS disruption, we can extend to October 21.
- We will not have class on October 22 because I'm heading to Minneapolis for the ACSP Annual Conference 2025. Please use the time to work on Lab 4.
- My office hours availability will be very limited this week, and my response may have some level of delay.
- Next Monday (October 27), Drew Dolan (Principal of DXD Capital) will give us a guest lecture on data-driven real estate investment.
    - We will have a participation task due next Monday.

Thank you!

Haoyu Yue / yohaoyu@washington.edu
Ph.D. Student, Interdisciplinary Urban Design and Planning
University of Washington

RE 519 Real Estate Data Analysis and Visualization
Course Website: www.yuehaoyu.com/data-analytics-visualization/
Autumn 2025

The course was developed based on previous instructors: Christian Phillips, Siman Ning, Feiyang Sun
Cover page credits: Visax