

Lecture 5

Data Visual Design

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RE 519 Real Estate Data Analytics and Visualization

Course Website: www.yuehaoyu.com/data-analytics-visualization/

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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.

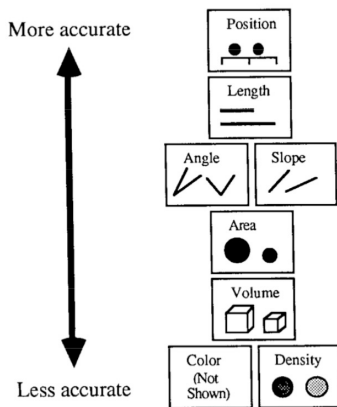
Expressiveness + Effectiveness

Expressiveness: Matching channel to data type

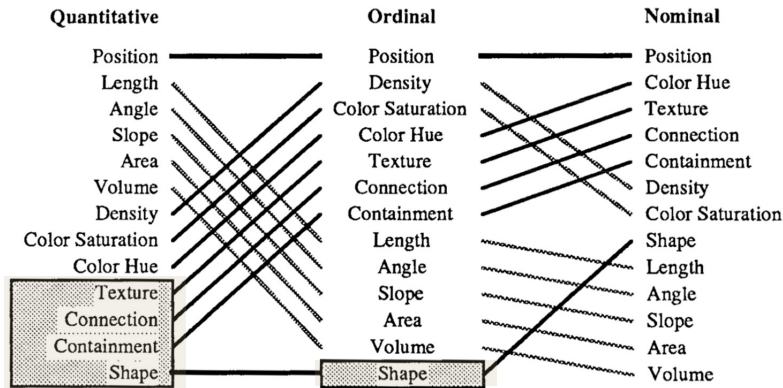
Actions of Data Visualization
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A visualization is expressive if it represents all of, and only, the facts in the data set being visualized.

Accuracy ranking of quantitative perceptual tasks



Ranking of perceptual tasks



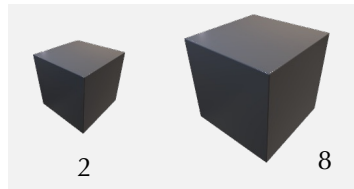
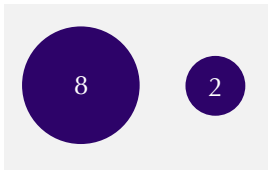
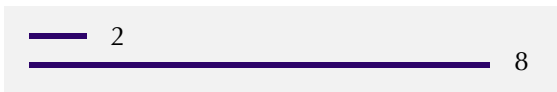
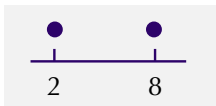
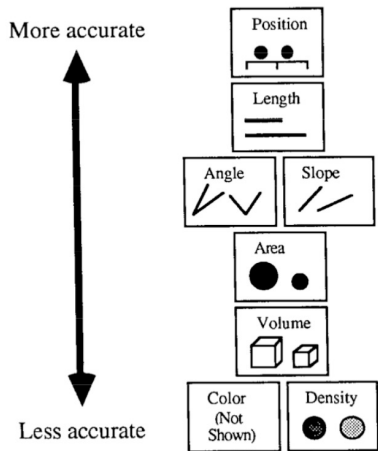
Note: The tasks shown in the gray boxes are not relevant to these types of data.

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

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Expressiveness + Effectiveness

They Made a Terrible Visualization...

Weekly Unemployment Insurance Claims

Source: Alabama Department of Labor

Historical Initial Claims by Week



Numbers

Date

Quantitative

Position

Length

Angle

Slope

Area

Volume

Density

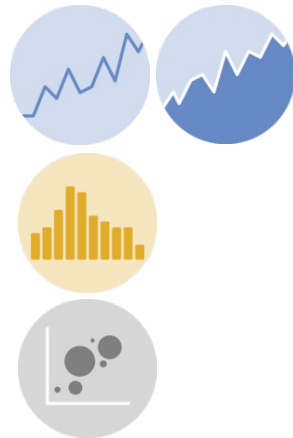
Color Saturation

Color Hue

Position + Position

Position + Length

Position + Area



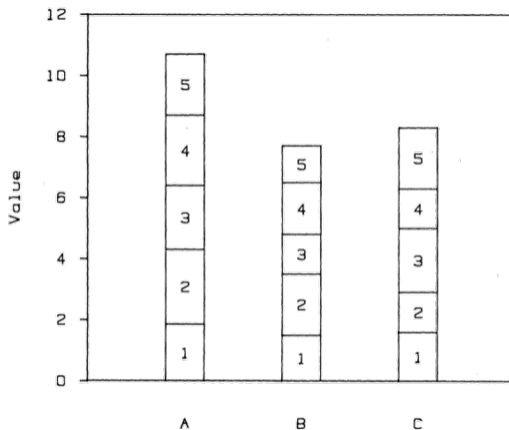
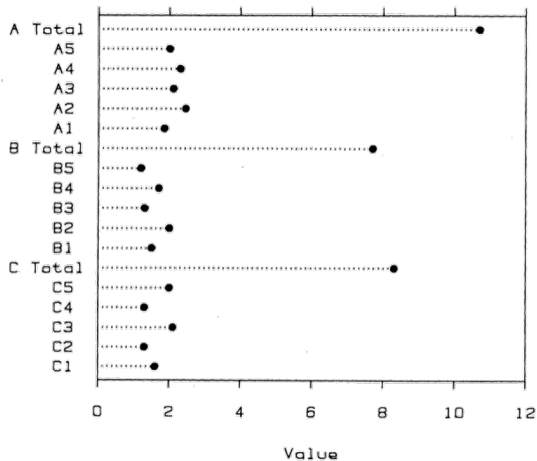
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Source: From Data to Viz: <https://www.data-to-viz.com/>

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

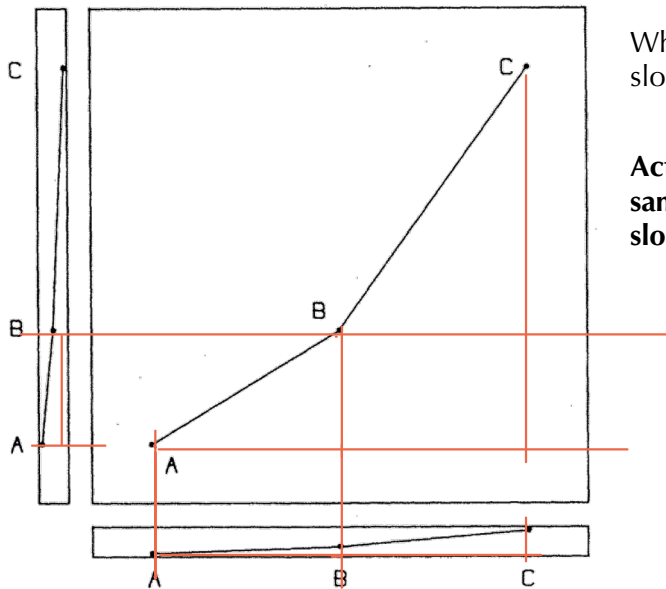
**Use elements with
higher perception
accuracy to present
your information**

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

Expressiveness + Effectiveness

Elements of Data Encoding: Angle vs. Slope

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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

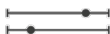
Stevens' Psychophysical Power Law

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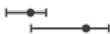
Channels: Expressiveness Types and Effectiveness Ranks

➡ Magnitude Channels: Ordered Attributes

Position on common scale



Position on unaligned scale



Length (1D size)



Tilt/angle



Area (2D size)



Depth (3D position)



Color luminance



Color saturation



Curvature



Volume (3D size)



Most

Effectiveness

Least

➡ Identity Channels: Categorical Attributes

Spatial region



Color hue



Motion

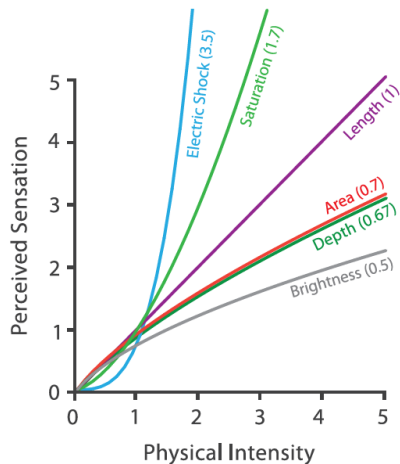


Shape



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

Steven's Psychophysical Power Law: $S = I^N$



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

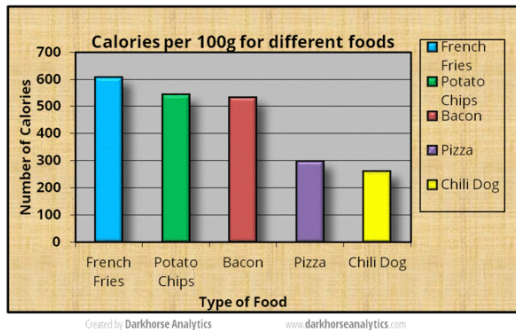
Expressiveness + Effectiveness

Data-Ink Ratio

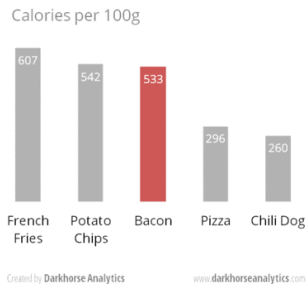
- = Data ink / Total ink use in graphics
- = Proportion of a graphic's ink devoted to non-redundant display of data.
- = 1.0 – proportion of graphics that can be erased.

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Remove backgrounds



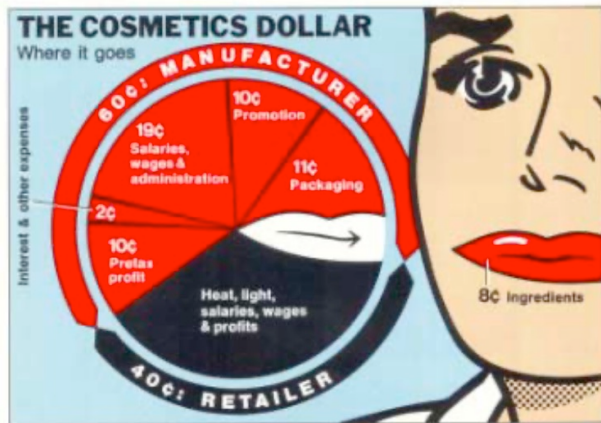
Direct label



Expressiveness + Effectiveness

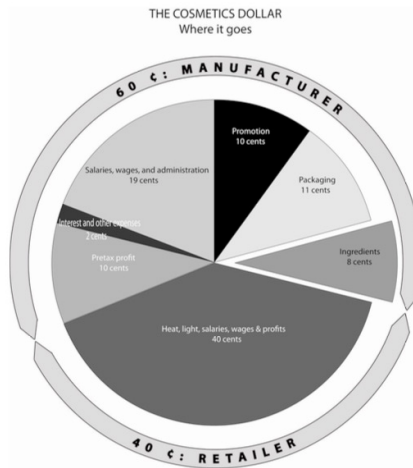
Data-Ink Ratio

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Source: Bateman et al., CHI 2010

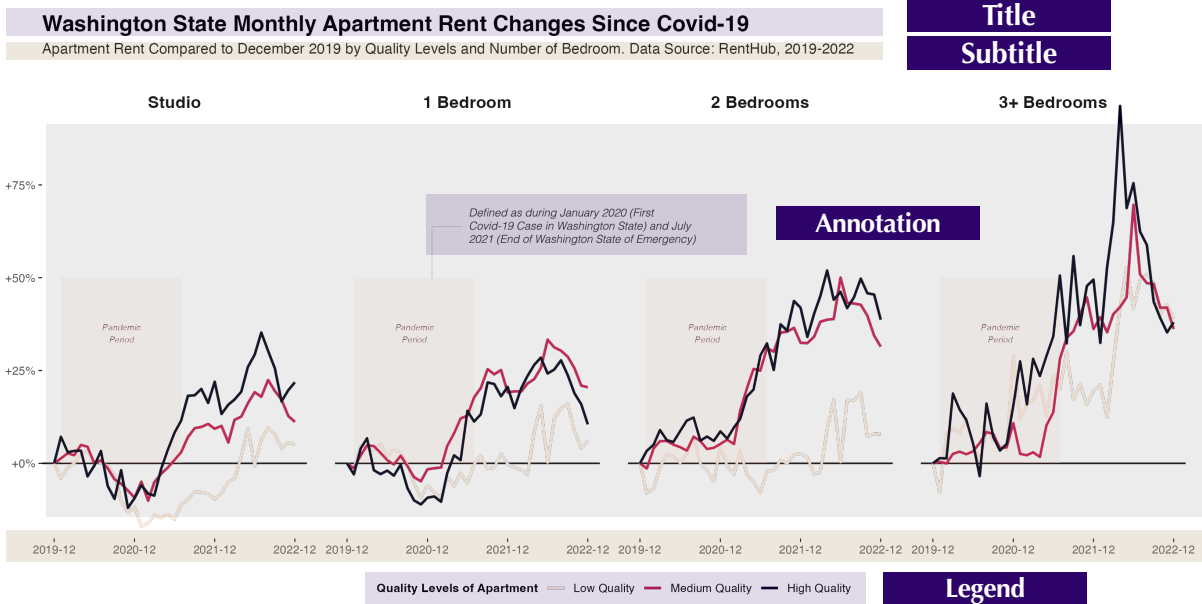
Chartjunk is not always harmful. In some cases, it may even increase the memorability and engagement of a visualization.



Remove
to improve
(the **data-ink** ratio)

Elements of a Single Graph

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User Experience and Organization

User Experience

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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

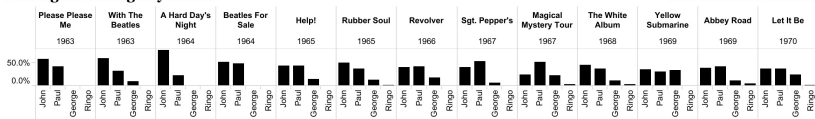
Organization - Unity

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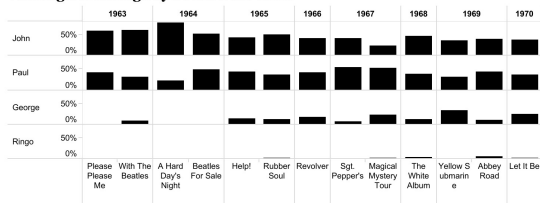
THE
BEATLES



Writing Percentage By Album



Writing Percentage by Artist Over Time



Hover over a Beatle to highlight their contributions



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.”

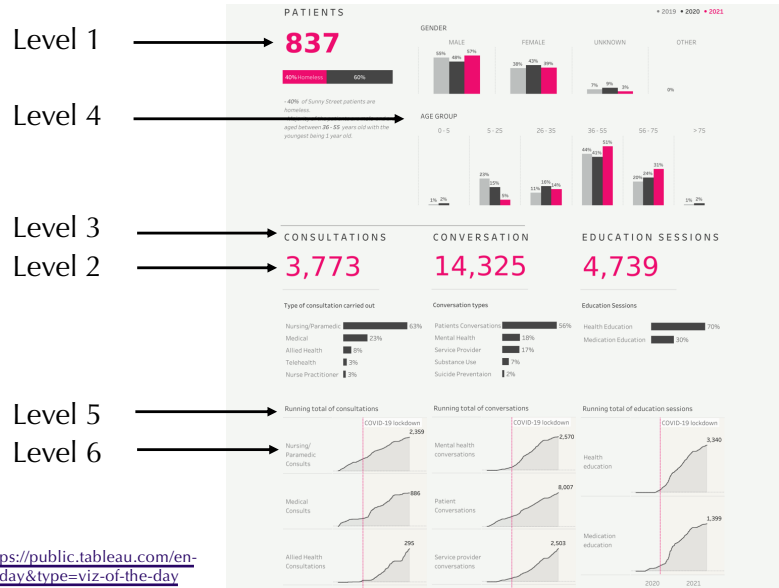
User Experience and Organization

Organization - Hierarchy

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

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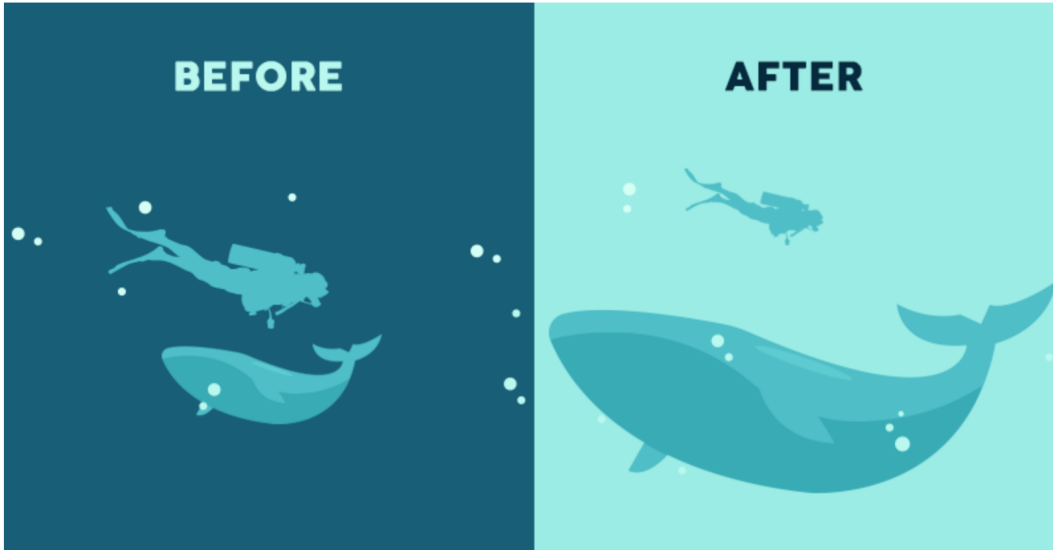
User Experience and Organization



User Experience and Organization

Organization - Size

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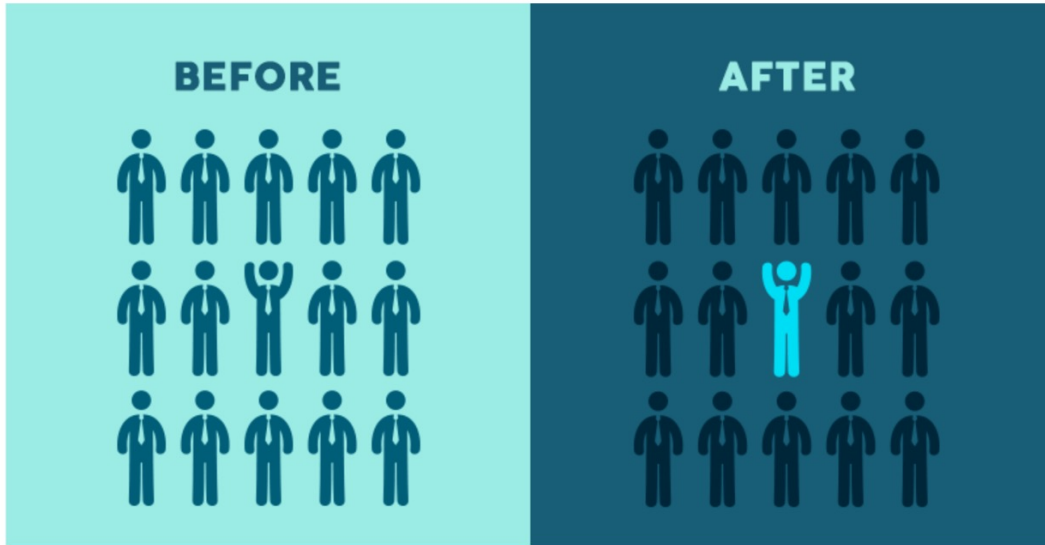


Source: <https://visme.co/blog/visual-hierarchy/>

User Experience and Organization

Organization - Color Contrast

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

User Experience and Organization

Organization - Using Font to Organize Design

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

User Experience and Organization

Organization - Balance and Alignment

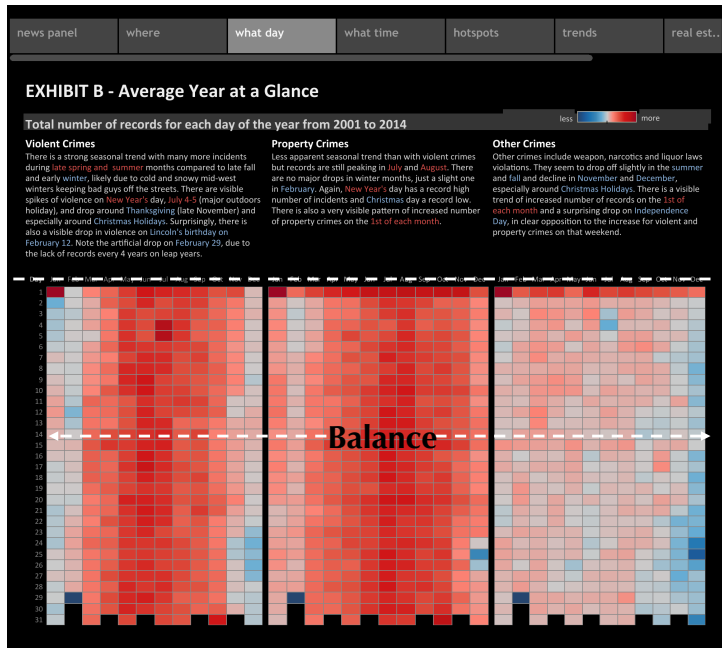
Balance and alignment are used to create harmonious visuals that do not distract from the message being communicated.

Alignment

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

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User Experience and Organization

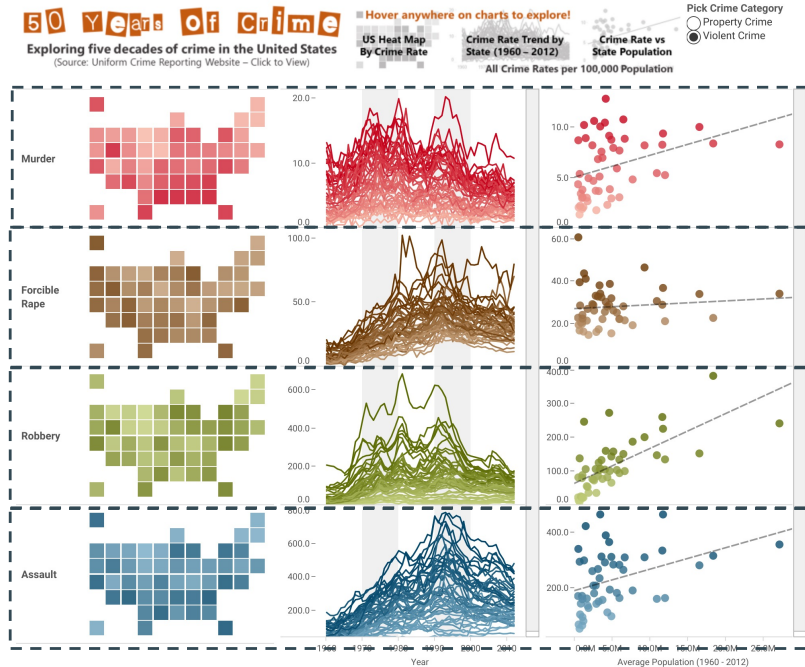
Organization - Grouping and Spacing

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>

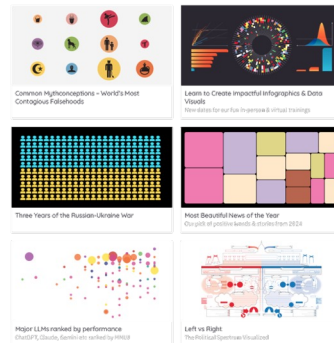
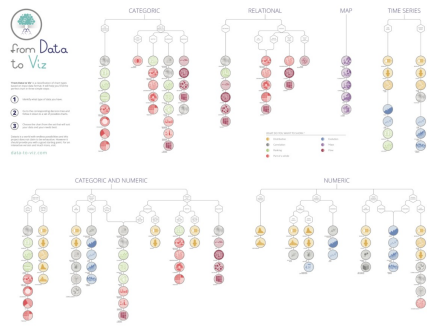
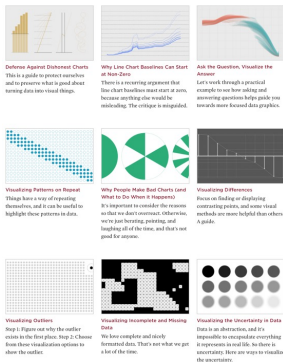
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Consume + Practice are More Important

End of Data Visualization Principles



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

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

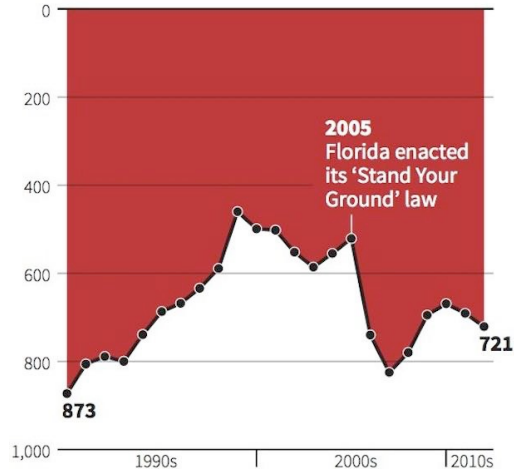
Data Viz Project
<https://datavizproject.com/>

Information is Beautiful
<https://informationisbeautiful.net>

Critique and Deceptive Visualization

Gun deaths in Florida

Number of murders committed using firearms



Source: Florida Department of Law Enforcement

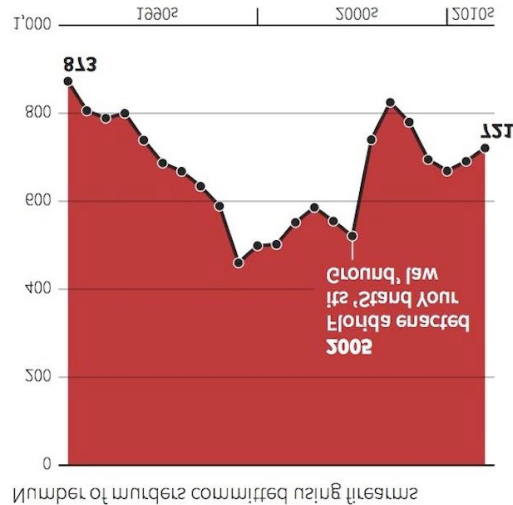
C. Chan 16/02/2014

REUTERS

C. Chan 16/02/2014

REUTERS

Source: Florida Department of Law Enforcement



Number of murders committed using firearms

Gun deaths in Florida

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.

The biggest killers
new coalition deaths, according to the data available*

*Validated to March 26, 2008

Coalition deaths
4,802

Coalition deaths
113,726

January, 2003
US leads coalition forces to invade Iraq. Control of Iraq is now in the hands of the coalition.

December, 2003
US troops capture Saddam Hussein.

August, 2005
Iraqi suicide bomber kills 32 US Marines in a single incident when he detonates a car bomb at a checkpoint in Baghdad.

January, 2007
Iraqi insurgents kill 13 US Marines in a car bomb attack in Baghdad.

January, 2008
Iraqi insurgents kill 13 US Marines in a car bomb attack in Baghdad.

US ground troops in Iraq
2003-2008

Coalition deaths by area
Iraqi security forces: 10,125
United States: 4,802
Others: 129

Coalition deaths by province
Baghdad and the surrounding provinces of Anbar and Nineveh saw the highest number of coalition deaths, accounting for more than half of the total.

Province
Anbar 1,233
Nineveh 1,157
Baghdad 1,012
Sulaymaniyah 427
Al-Qadisiyah 413
Al-Muthanna 312
Al-Basrah 271
Al-Mahdiah 261
Al-Najaf 251
Al-Karbala 251
Al-Faluja 251
Al-Ramadi 251
Al-Tikrit 251
Al-Hillah 251
Al-Dhi Qar 251
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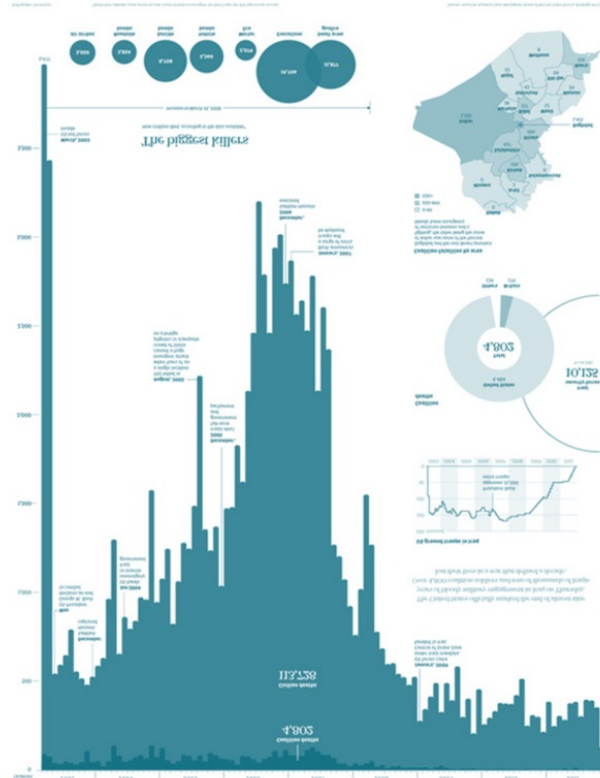
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Al-Faluja 251
Al-Ramadi 251
Al-Tikrit 251
Al-Hillah 251

Province
Anbar 1,233
Nineveh 1,157
Baghdad 1,012
Sulaymaniyah 427
Al-Qadisiyah 413
Al-Muthanna 312
Al-Basrah 271
Al-Mahdiah 261
Al-Najaf 251
Al-Karbala 251
Al-Faluja 251
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Al-Najaf 251
Al-Karbala 251
Al-Faluja 251
Al-Ramadi 251
Al-Tikrit

Iraq: Deaths on the decline

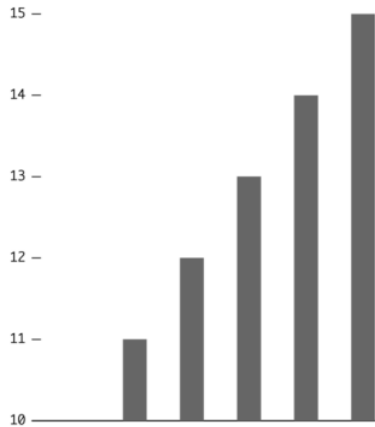


Critique and Deceptive Visualization

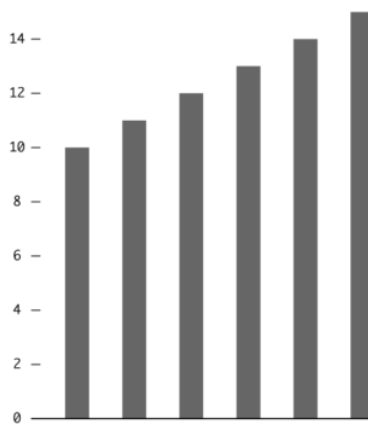
Common Deceptive Visualization

TRUNCATED AXIS

The value axis starts at ten. Liar, liar, pants on fire.



The value axis starts at zero. Good.

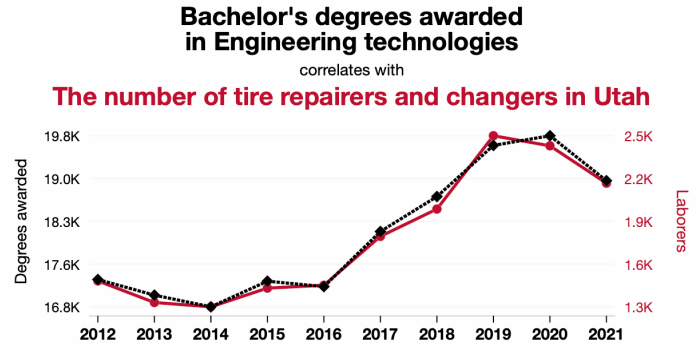
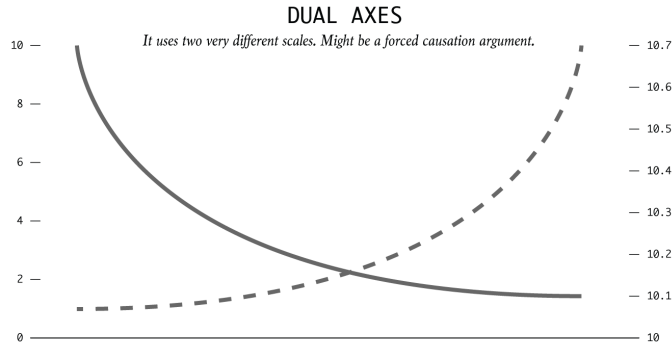


Bar charts use length as their visual cue, so when someone makes the length shorter using the same data by truncating the value axis, the chart dramatizes differences. Someone wants to show a bigger change than is actually there. (by Nathan Yau)

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

Critique and Deceptive Visualization

Common Deceptive Visualization



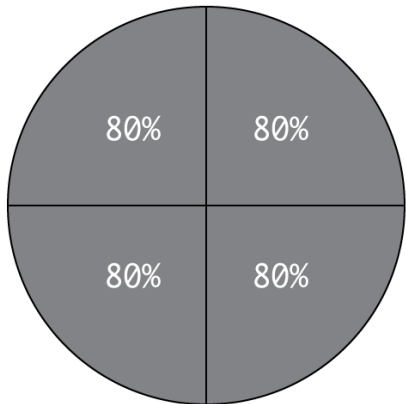
By using dual axes, the magnitude can shrink or expand for each metric. This is typically done to imply correlation and causation. "Because of this, this other thing happened. See, it's clear." (by Nathan Yau)

Critique and Deceptive Visualization

Common Deceptive Visualization

IT DOES NOT ADD UP

*The parts add up to more than the whole, which is 100%.
For my next trick, I will turn this rabbit into a big bag of money.*



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)

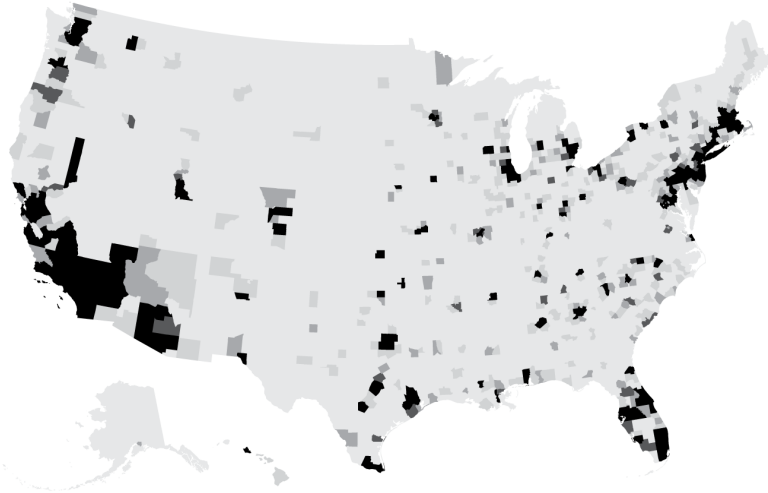
Source: Flowing Data by Nathan Yau <https://flowingdata.com/>

Critique and Deceptive Visualization

Common Deceptive Visualization

SEEING ONLY IN ABSOLUTES

This is just population. When comparing across places, categories, or groups, you must compare fairly and consider relative values.



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)

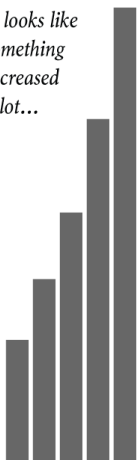
Source: Flowing Data by Nathan Yau <https://flowingdata.com/>

Critique and Deceptive Visualization

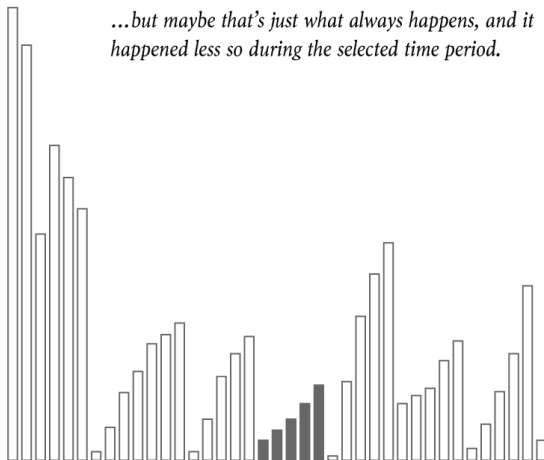
Common Deceptive Visualization

LIMITED SCOPE

It looks like something increased a lot...



...but maybe that's just what always happens, and it happened less so during the selected time period.



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)

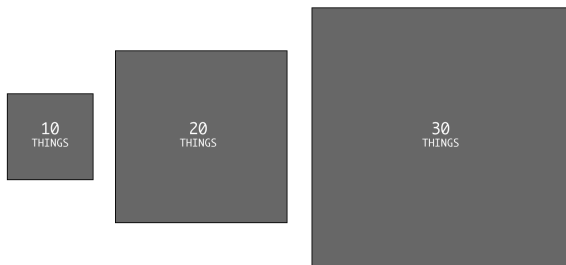
Source: Flowing Data by Nathan Yau <https://flowingdata.com/>

Critique and Deceptive Visualization

Common Deceptive Visualization

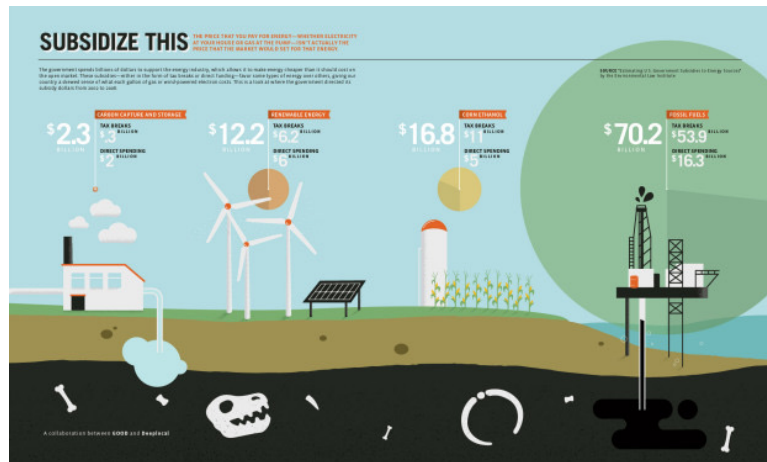
AREA SIZED BY SINGLE DIMENSION

Thirty is three times ten, but that third rectangle looks a lot bigger than the first.
Might be trying to inflate significance.



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)



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!

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RE 519 Real Estate Data Analysis and Visualization

Course Website: www.yuehaoyu.com/data-analytics-visualization/

Autumn 2025

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