

The background of the entire image is a light gray field populated with numerous small, solid-colored circles. These circles are scattered across the frame in a seemingly random pattern. The colors of the dots include a variety of hues: blue, orange, green, red, yellow, purple, brown, pink, and gray. The dots vary slightly in size but are generally uniform in appearance.

Visualization

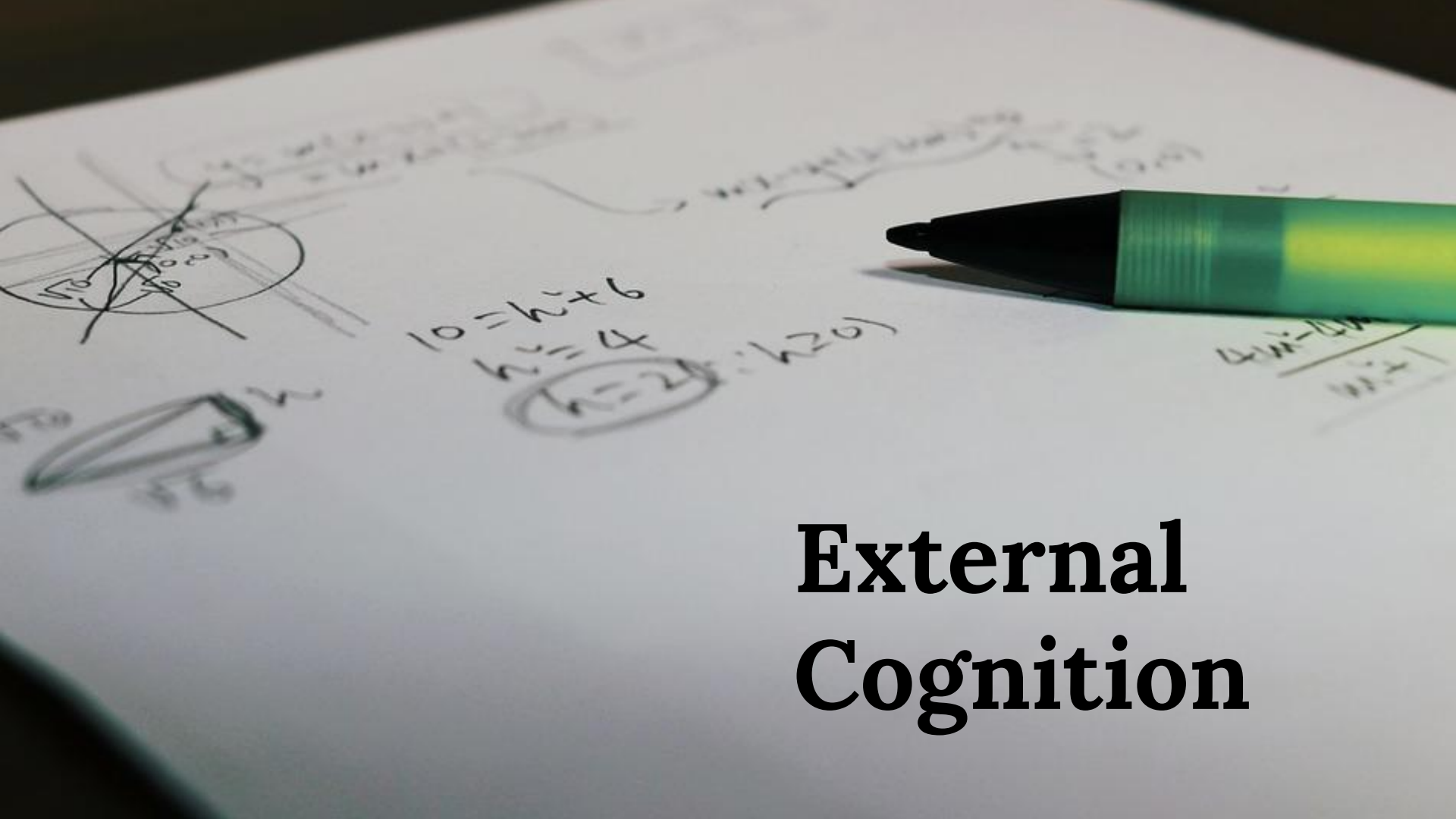
By Eitan Lees



“The ubiquity of visual metaphors in describing cognitive processes hints at a nexus of relationships between **what we see and what we think**”

- Mackinlay & Card (1999)

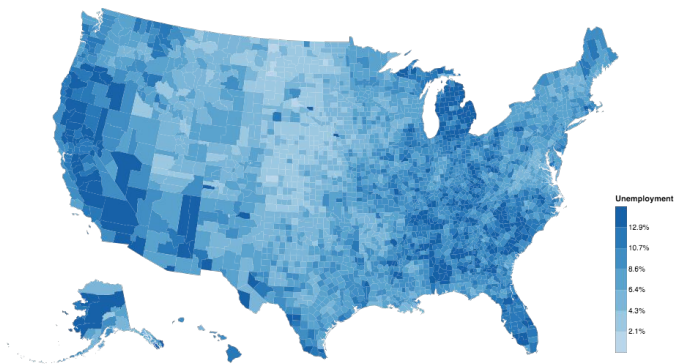
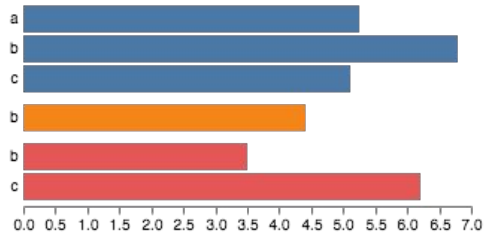
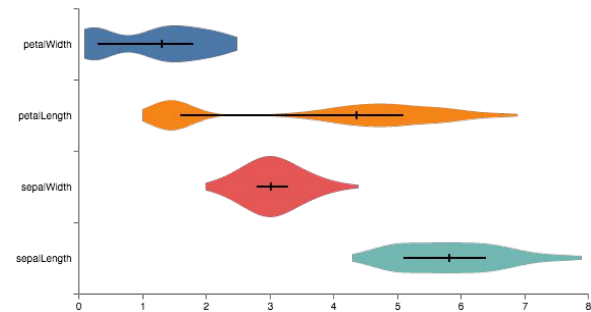
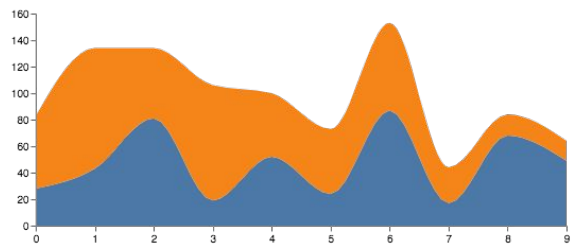
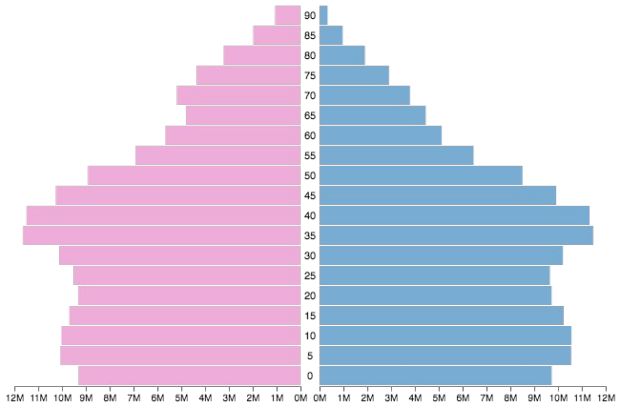




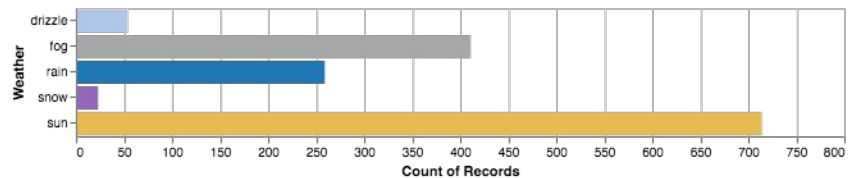
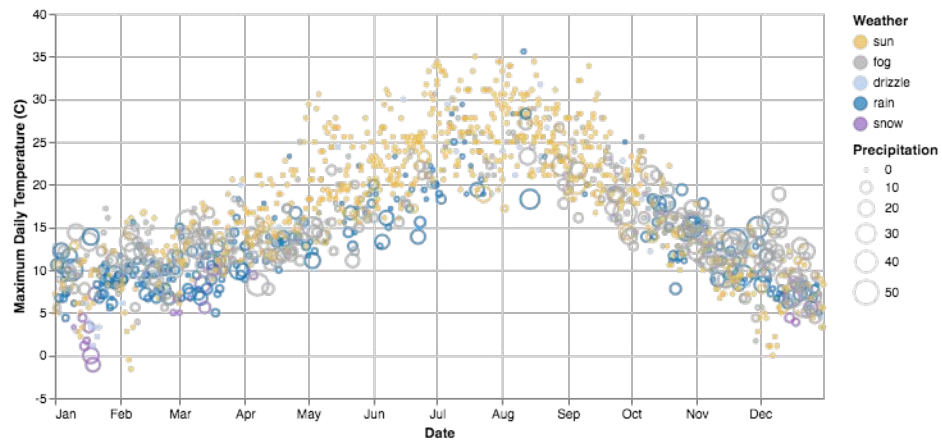
$$\begin{aligned} 10 &= k + 6 \\ k &= 4 \\ (k=2) &: (k=6) \end{aligned}$$

External Cognition





Seattle Weather, 2012-2015





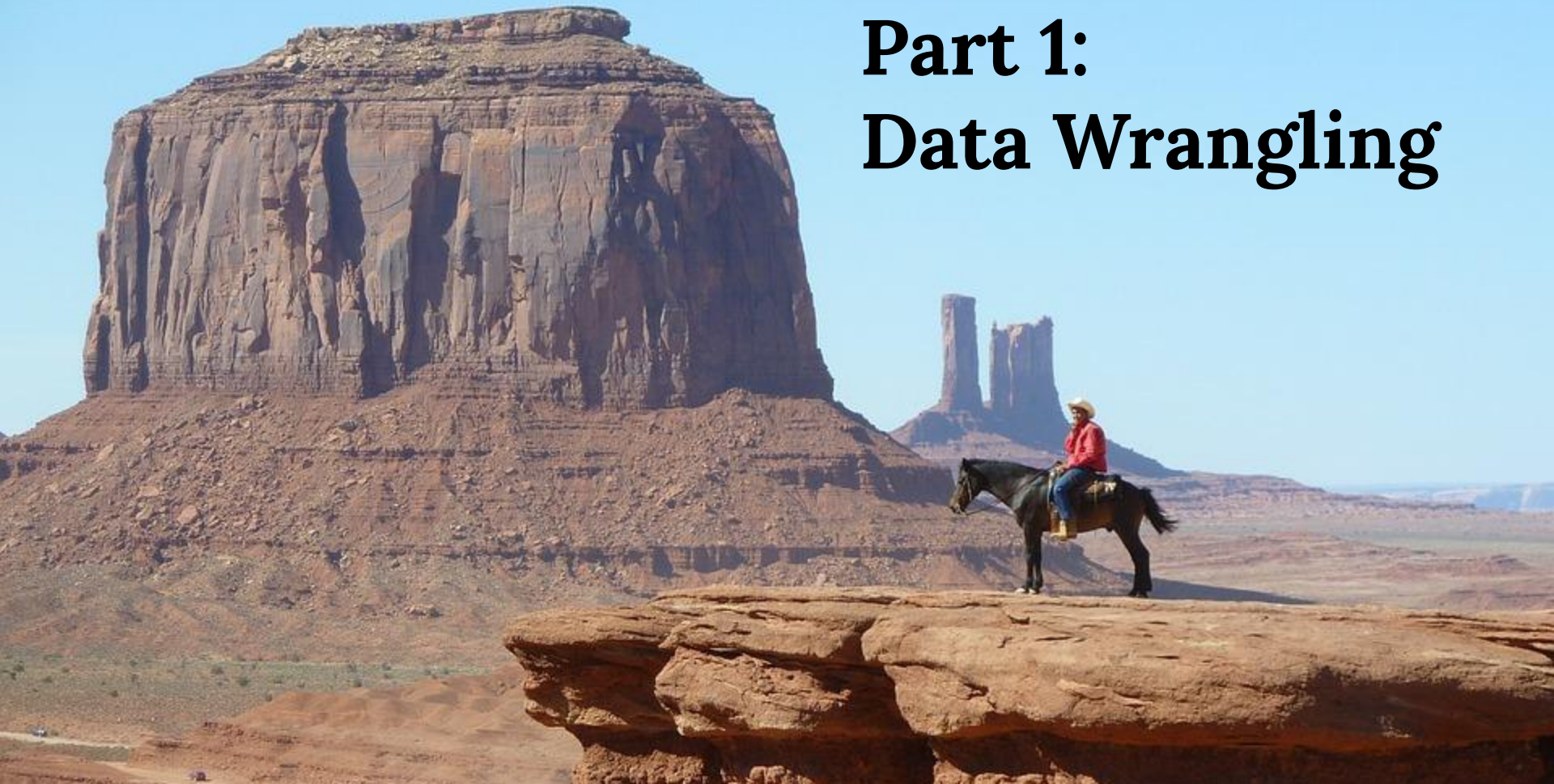
**Part 1:
Data Wrangling**

**Part 2:
Visual Encodings**

**Part 3:
Graphical Critique**

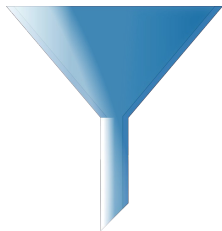
**Part 4:
Practical Advice**

Part 1: Data Wrangling





Clean data sets
are all alike;
every unclean
data set is
unclean in its
own way



Things to Consider:

- Make Numbers $\Rightarrow$ Numbers
- Make Dates $\Rightarrow$ Dates
- Make Nans $\Rightarrow$ Nans
- Make sure strings aren't corrupted



Before we visualize,
let's **tidy** up

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

Variables

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

Variables

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

Observations

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

Variables

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

Variables

Observations

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

We want to **gather** the values corresponding to each key.

country	year	key	value
Afghanistan	1999	cases	745
Afghanistan	1999	population	19987071
Afghanistan	2000	cases	2666
Afghanistan	2000	population	20595360
Brazil	1999	cases	37737
Brazil	1999	population	172006362
Brazil	2000	cases	80488
Brazil	2000	population	174504898
China	1999	cases	212258
China	1999	population	1272915272
China	2000	cases	213766
China	2000	population	1280428583

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

We want to **gather** the values corresponding to each key.

Tidy

country	1999	2000
Afghanistan	745	2666
Brazil	37737	80488
China	212258	213766

country	1999	2000
Afghanistan	745	2666
Brazil	37737	80488
China	212258	213766

We want to **spread** the values to the corresponding keys.

country	year	cases
Afghanistan	1999	745
Afghanistan	2000	2666
Brazil	1999	37737
Brazil	2000	80488
China	1999	212258
China	2000	213766

country	1999	2000
Afghanistan	745	2666
Brazil	37737	80488
China	212258	213766

We want to **spread** the values to the corresponding keys.

country	year	cases
Afghanistan	1999	745
Afghanistan	2000	2666
Brazil	1999	37737
Brazil	2000	80488
China	1999	212258
China	2000	213766

country	1999	2000
Afghanistan	745	2666
Brazil	37737	80488
China	212258	213766

We want to **spread** the values to the corresponding keys.

Tidy

Tidy Data

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	127295272
China	2000	213766	1280428583

Values

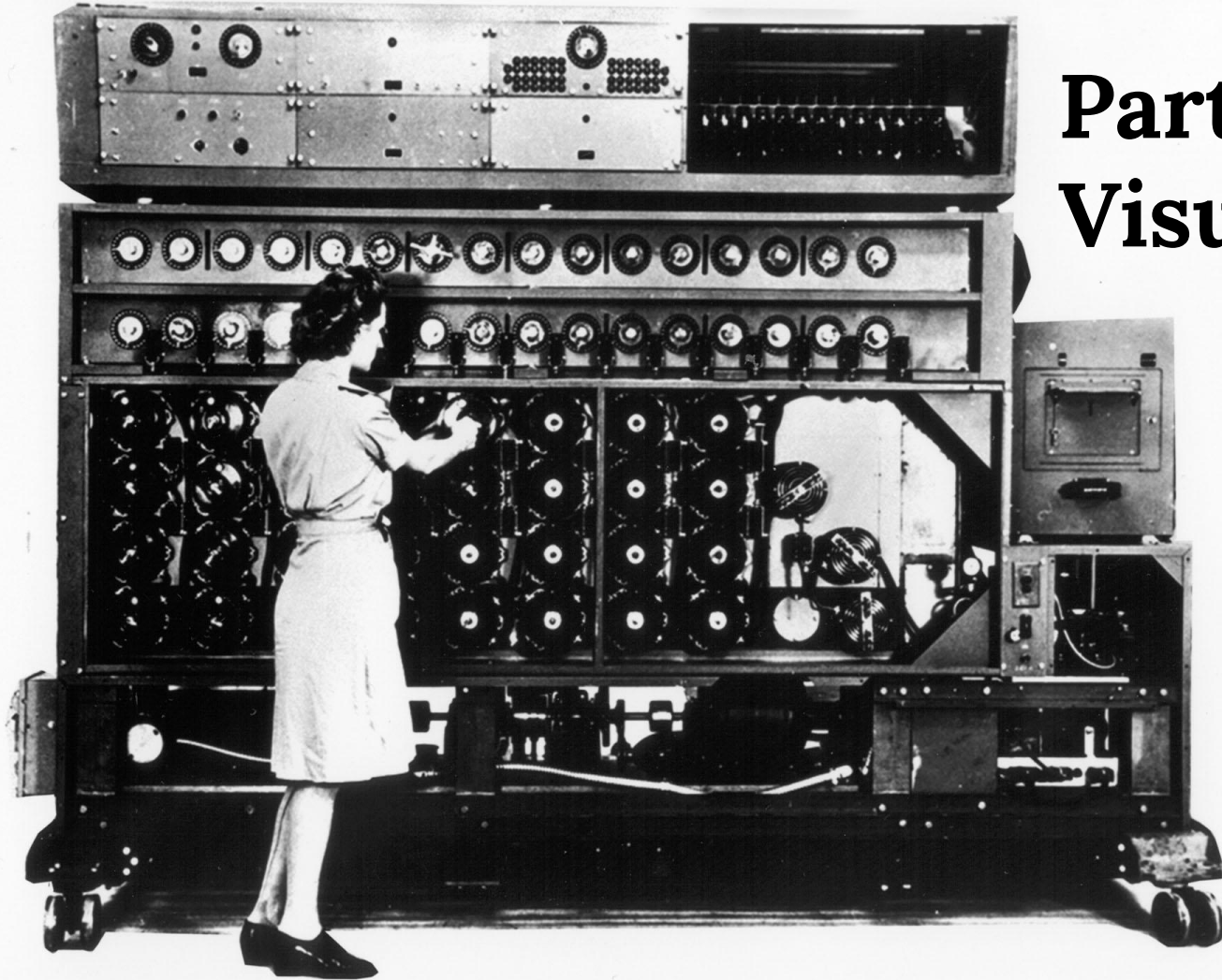
country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	127295272
China	2000	213766	1280428583

Variables

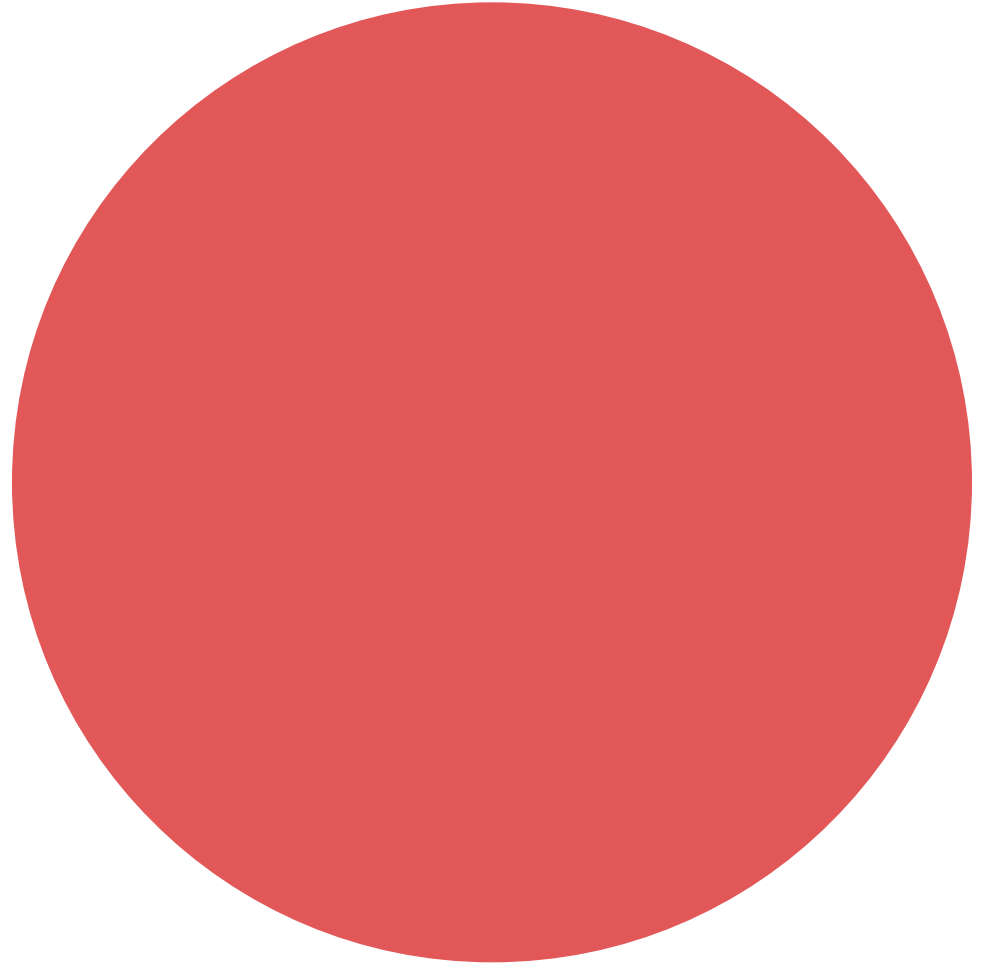
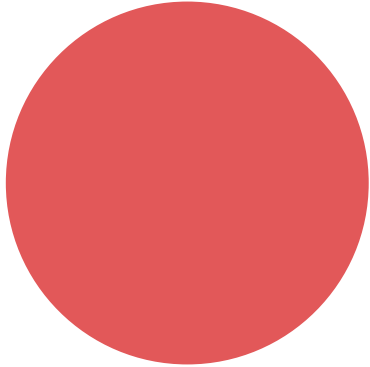
country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	127295272
China	2000	213766	1280428583

Observations

Part 2: Visual Encoding



Compare **area** of circles



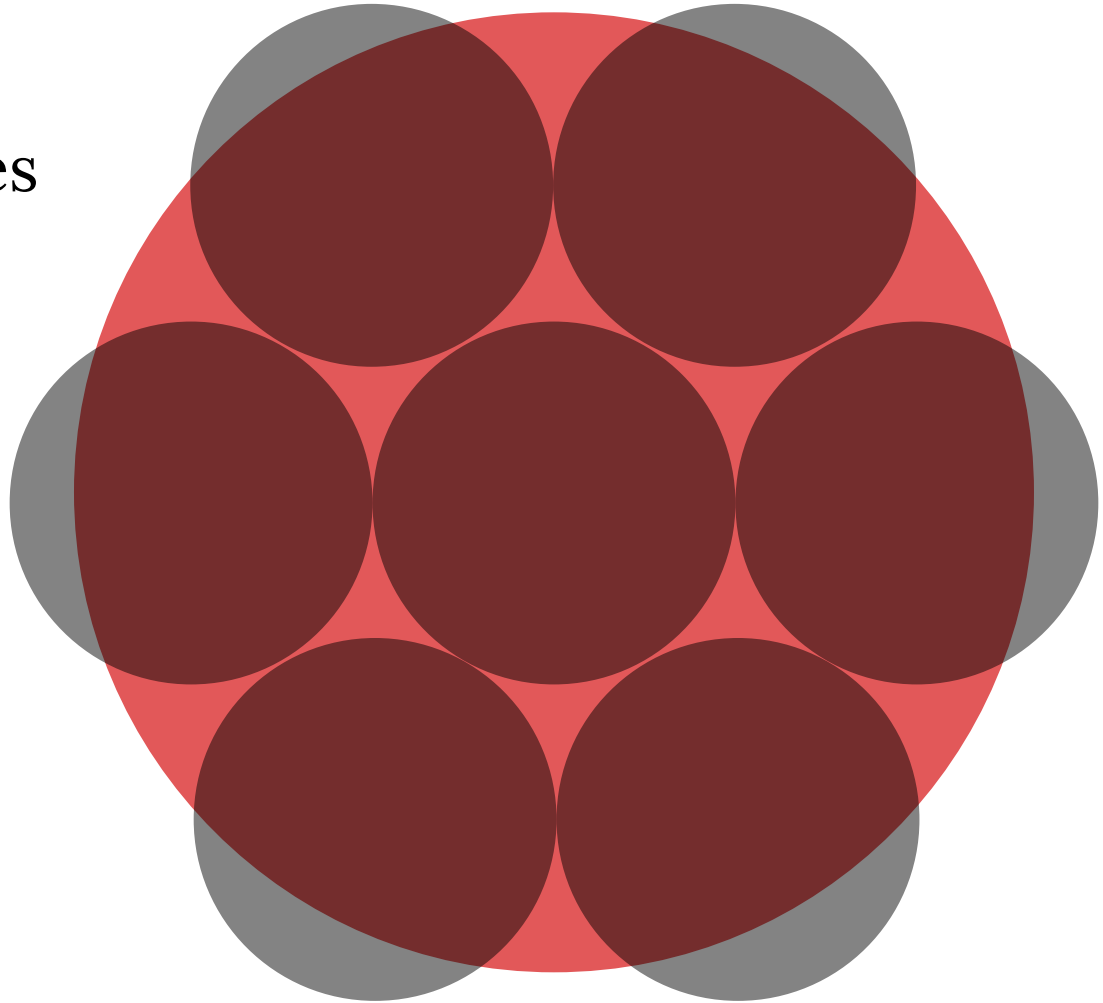
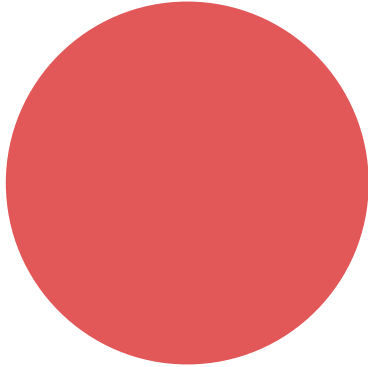
Compare **length** of bars



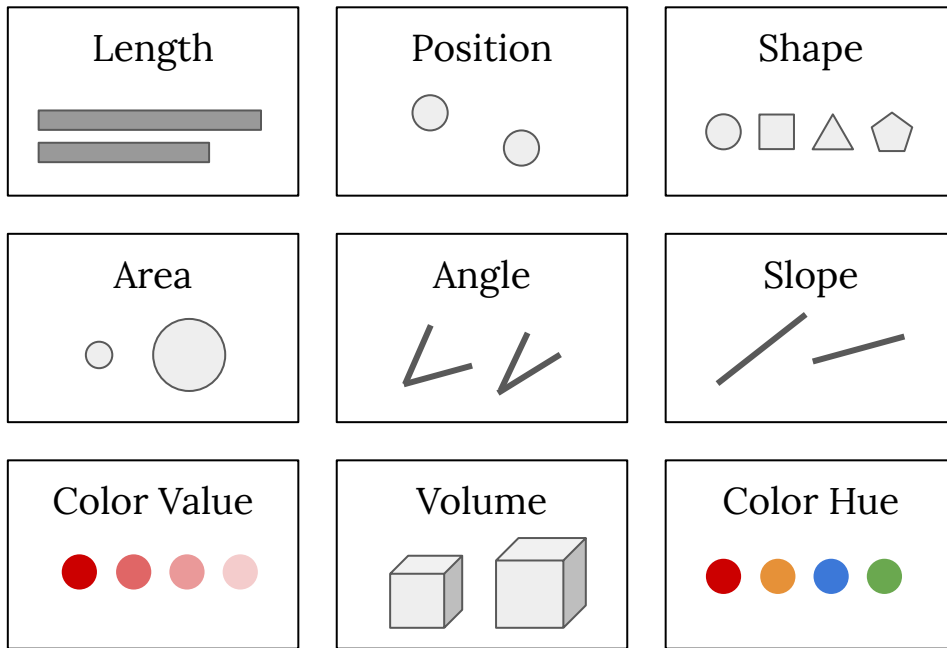
Compare **length** of bars



Compare **area** of circles



Visual Encoding Channels

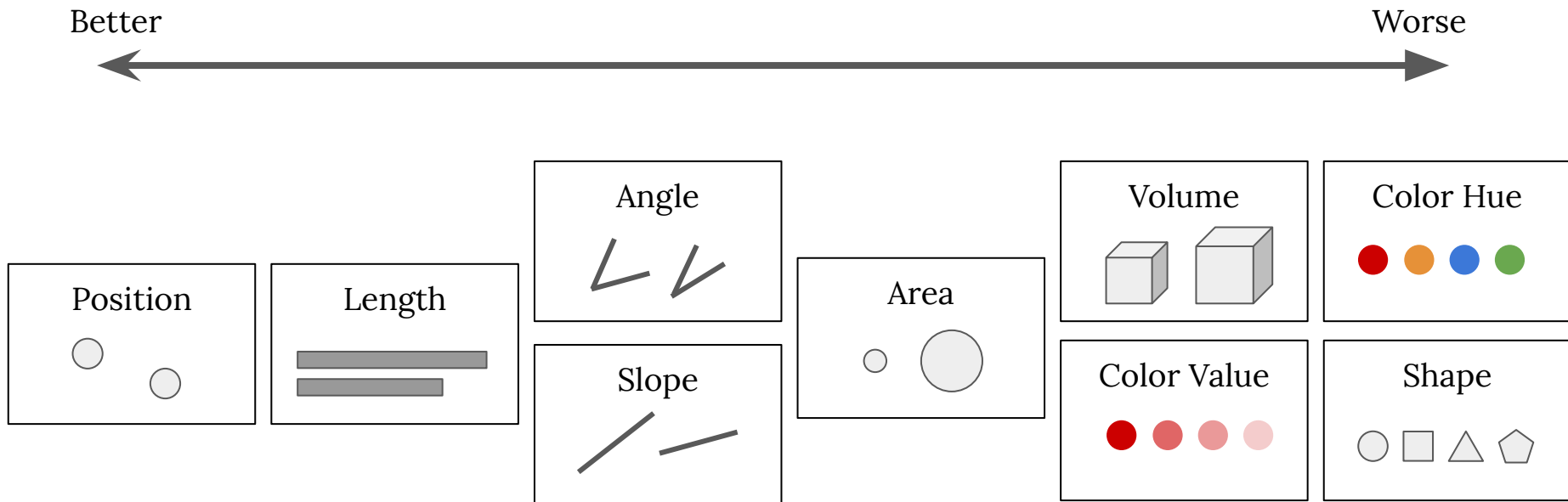


And many more ...

Accuracy ranking of quantitative perceptual tasks.

Better

Worse





Data Models



Nominal:

- Labels and Categories
- Example: Pill Shape
- Operations: =, $\neq$





Nominal:

- Labels and Categories
- Example: Pill Shape
- Operations: $=$, $\neq$

Ordinal:

- Ordered Sets
- Example: Drug Schedule
- Operations: $=$, $\neq$, $<$, $>$



Nominal:

- Labels and Categories
- Example: Pill Shape
- Operations: $=$, $\neq$

Ordinal:

- Ordered Sets
- Example: Drug Schedule
- Operations: $=$, $\neq$, $<$, $>$

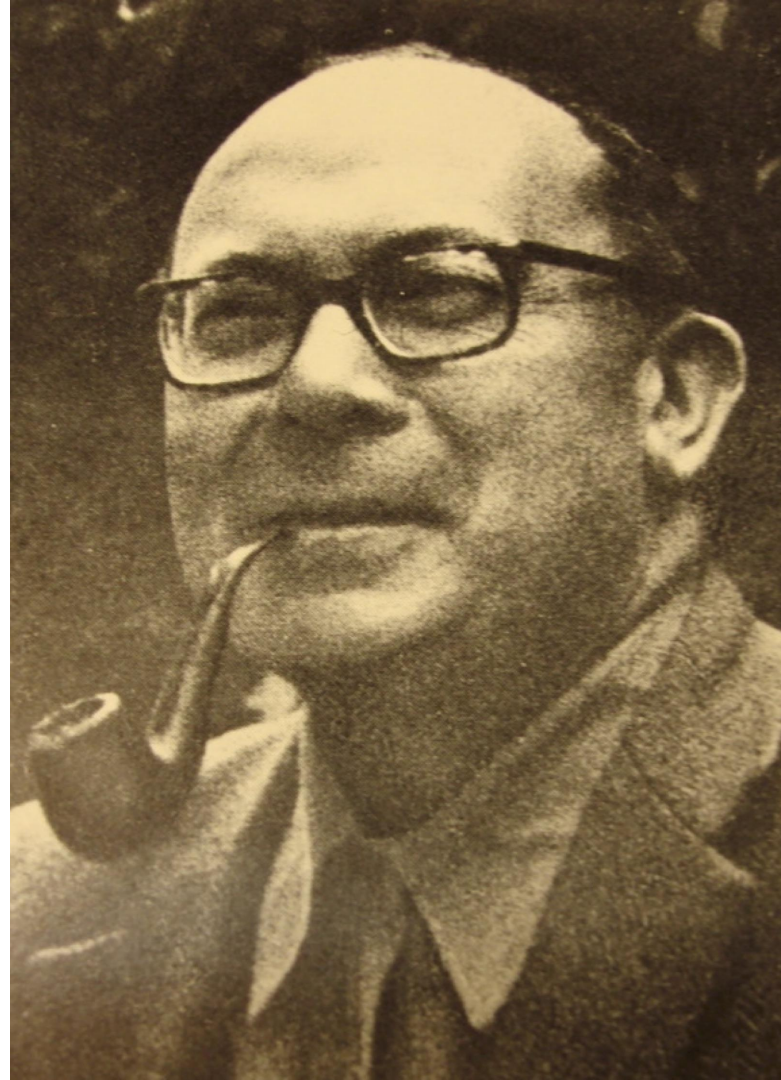
Quantitative:

- Numerical Measurement
- Example: Dosage
- Operations: $=$, $\neq$, $<$, $>$, $-$, $\%$

JACQUES BERTIN

Semiology of Graphics

*diagrams
networks
maps*



JACQUES BERTIN

Semiology of Graphics

diagrams
networks
maps



LES VARIABLES DE L'IMAGE

	POINTS			LIGNES			ZONES	
XY 2 DIMENSIONS DU PLAN								
Z TAILLE								
VALEUR								

LES VARIABLES DE SÉPARATION DES IMAGES

GRAIN								
COULEUR								
ORIENTATION								
FORME								

JACQUES BERTIN

Semiology of Graphics

diagrams
networks
maps



LES VARIABLES DE L'IMAGE

	POINTS			LIGNES			ZONES	
XY								
2D Plane								
Z								
Size								
Color Value								

LES VARIABLES DE SÉPARATION DES IMAGES

Texture								
Color Hue								
Angle								
Shape								

Suitable for
Ordered Data

LES VARIABLES DE L'IMAGE

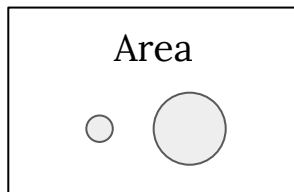
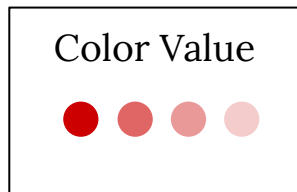
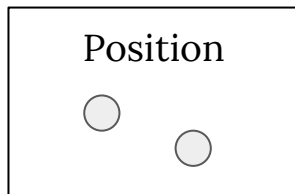
		POINTS			LIGNES			ZONES	
XY									
2D Plane									
z									
Size									
Color Value									

Suitable for
Unordered Data

LES VARIABLES DE SÉPARATION DES IMAGES

Texture									
Color Hue									
Angle									
Shape									

Suitable for
Ordered Data

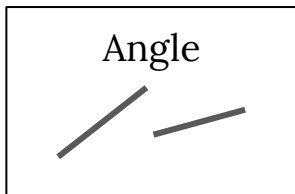
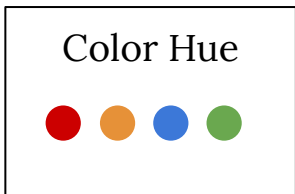
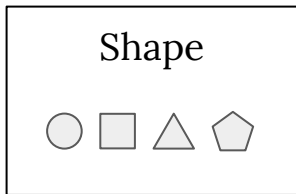


LES VARIABLES DE L'IMAGE

	POINTS			LIGNES			ZONES	
XY								
2D Plane								
z								
Size								
Color Value								

LES VARIABLES DE SÉPARATION DES IMAGES

Texture								
Color Hue								
Angle								
Shape								



Suitable for
Unordered Data

LES VARIABLES DE L'IMAGE

	POINTS			LIGNES			ZONES	
XY								
2D Plane								
z								
Size								
Color Value								

LES VARIABLES DE SÉPARATION DES IMAGES

Texture								
Color Hue								
Angle								
Shape								



Bertin's Levels of Organization

Position	N	O	Q
Size	N	O	Q
Color Value	N	O	q
Texture	N	o	
Color Hue	N		
Angle	N		
Shape	N		

Nominal
Ordinal
Quantitative
Note:
Q < **O** < **N**

Statistics and Computing

Leland Wilkinson

The Grammar of Graphics

Second Edition

 Springer



Statistics and Computing

Leland Wilkinson

The Grammar of Graphics

Second Edition

Grammar of Graphics

1. **Data**
2. **Transformations**
3. **Marks**
4. **Encoding** - mapping from fields to mark properties
5. **Scale** - functions that map data to visual scales
6. **Guides** - visualizations of scales (axes, legends, etc.)

Building Blocks of Visualization



Part 3: Graphical Critique

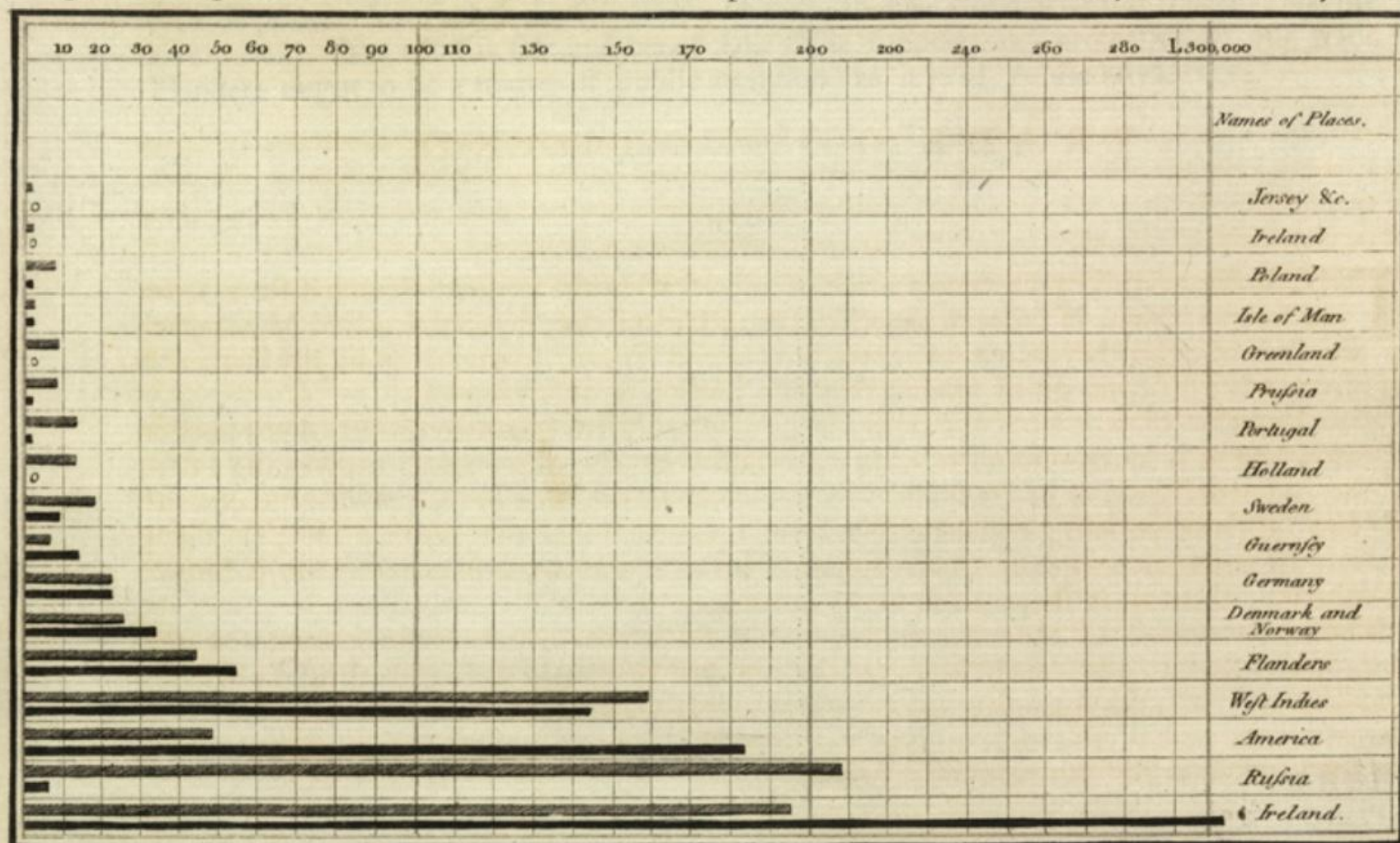




William Playfair

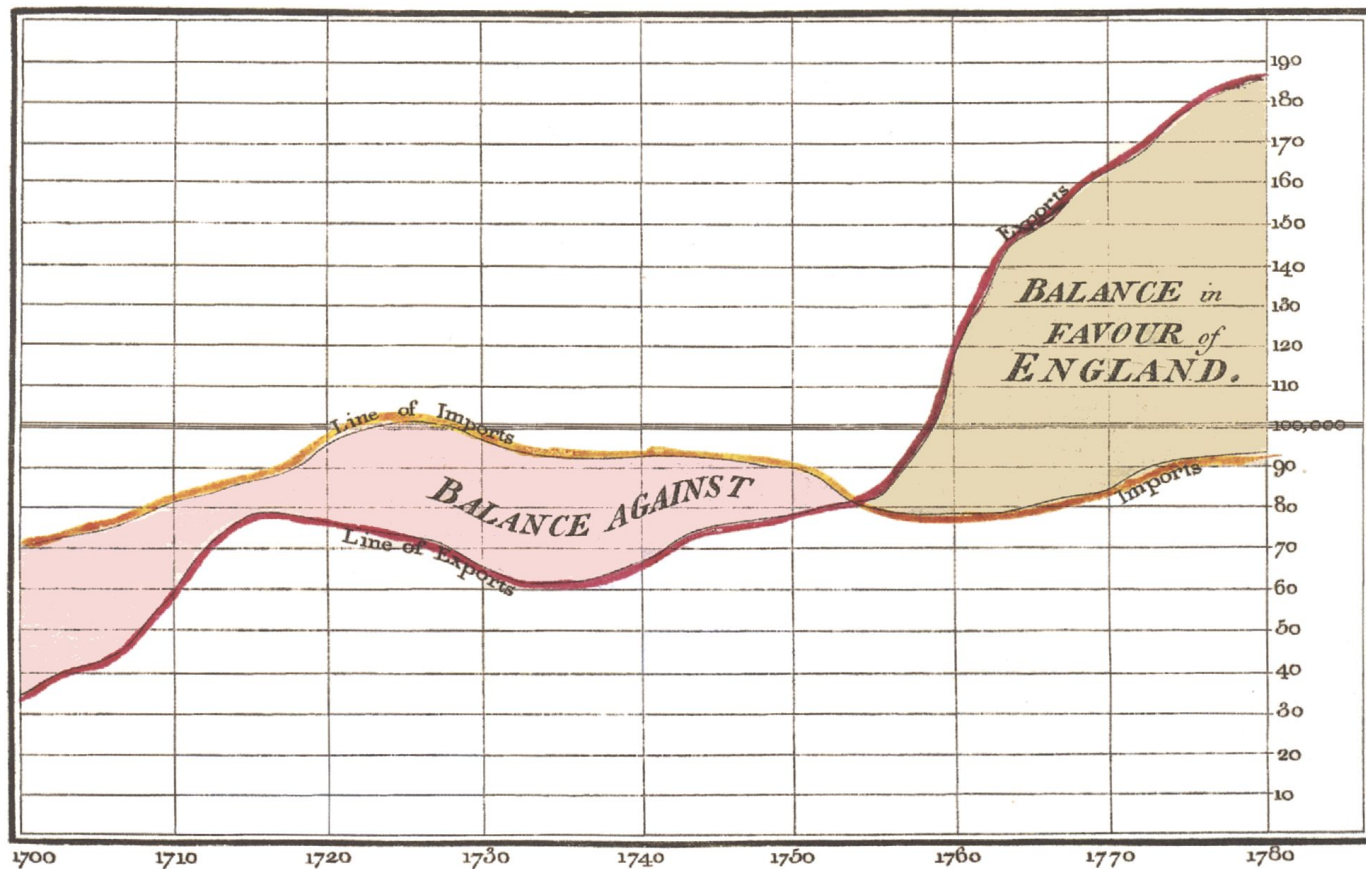
Most of modern statistical graphics can be traced back to William Playfair a Scottish engineer and political economist.

Exports and Imports of SCOTLAND to and from different parts for one Year from Christmas 1780 to Christmas 1781.



The Upright divisions are Ten Thousand Pounds each. The Black Lines are Exports the Ribbed lines Imports.

Exports and Imports to and from DENMARK & NORWAY from 1700 to 1780.

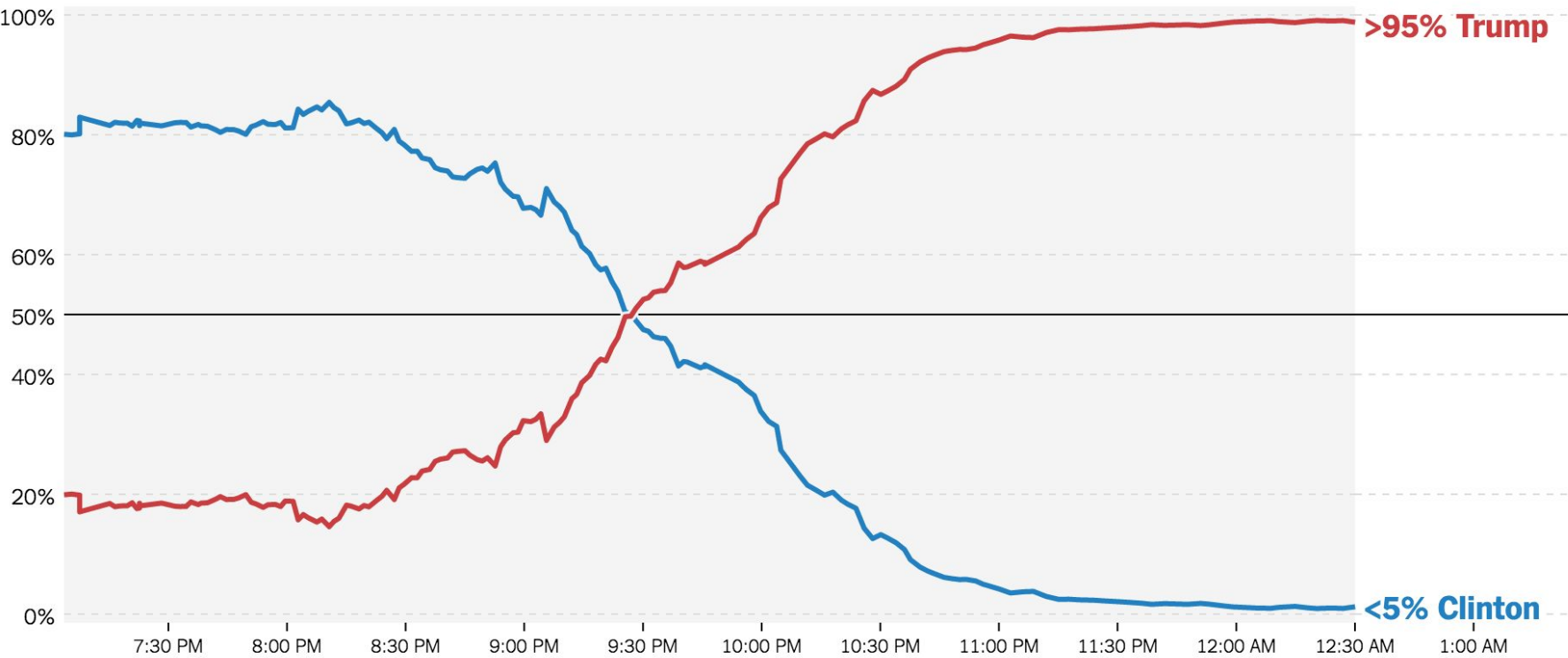


The Bottom line is divided into Years, the Right hand line into £10,000 each.

Published as the Act directs, 14th May 1786. by W^m Playfair

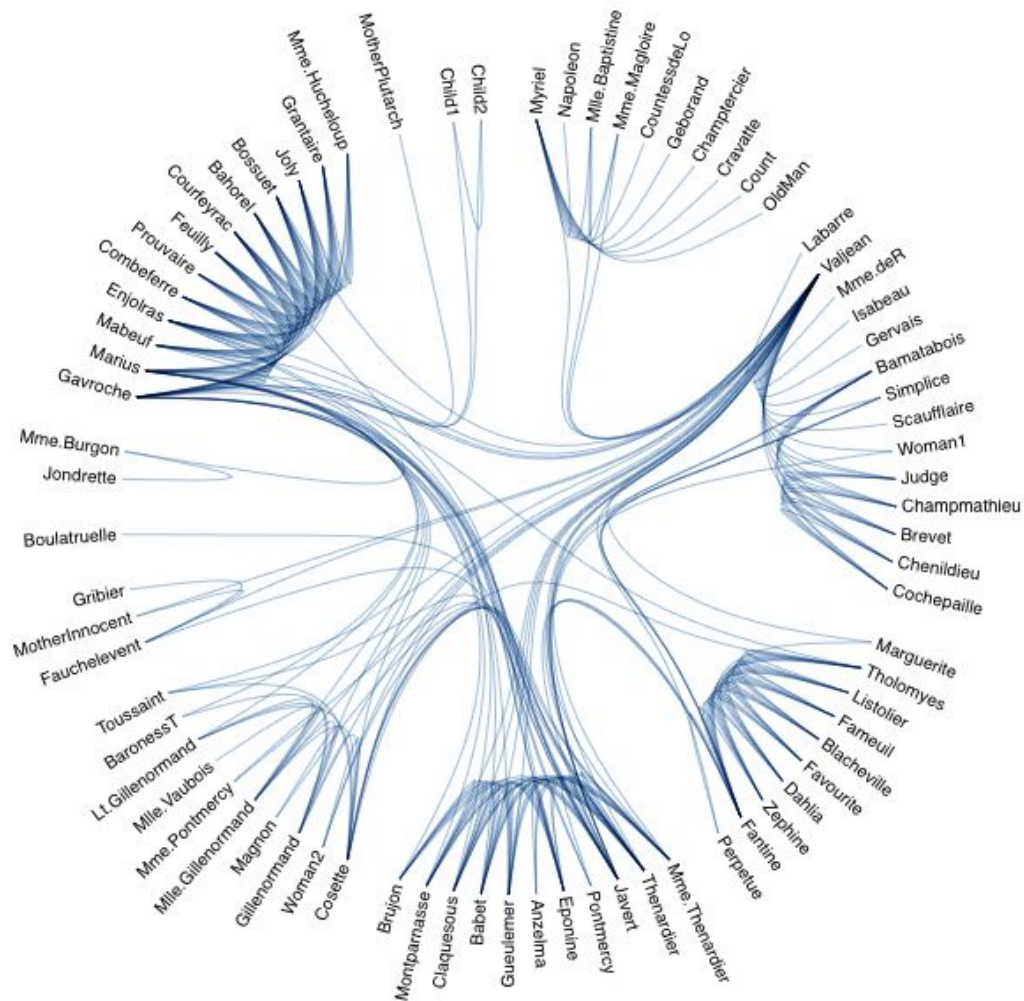
Neale sculp^t 352, Strand, London.

Chance of Winning Presidency



The heatmap displays the percentage of the population in each of the 50 US states that are members of the National Rifle Association (NRA) from 1928 to 2002. The y-axis lists the states, and the x-axis shows the years. The color scale ranges from blue (low membership) to red (high membership). The data shows a general trend of increasing NRA membership over time, with many states showing a shift from blue to yellow or red by the late 1990s and early 2000s. States like Alaska, Arizona, and Texas show particularly high membership percentages, while states like Connecticut and Hawaii show lower percentages.

Connectivity diagram of character in *Les Misérables*



Stephen Curry's 3-Point Record in Context: Off the Charts

By GREGOR AISCH and KEVIN QUEALY APRIL 16, 2016

This chart contains 752 lines — one for each N.B.A. player who finished in the top 20 in 3-point attempts made in each season since 1980. [Slitting it open](#) It is the Golden State Warriors' Stephen Curry, who finished the regular season with a record 402 3-pointers.

The record is an outlier that defies most comparisons, but here is one: It is the equivalent of hitting 103 home runs in a Major League Baseball season.

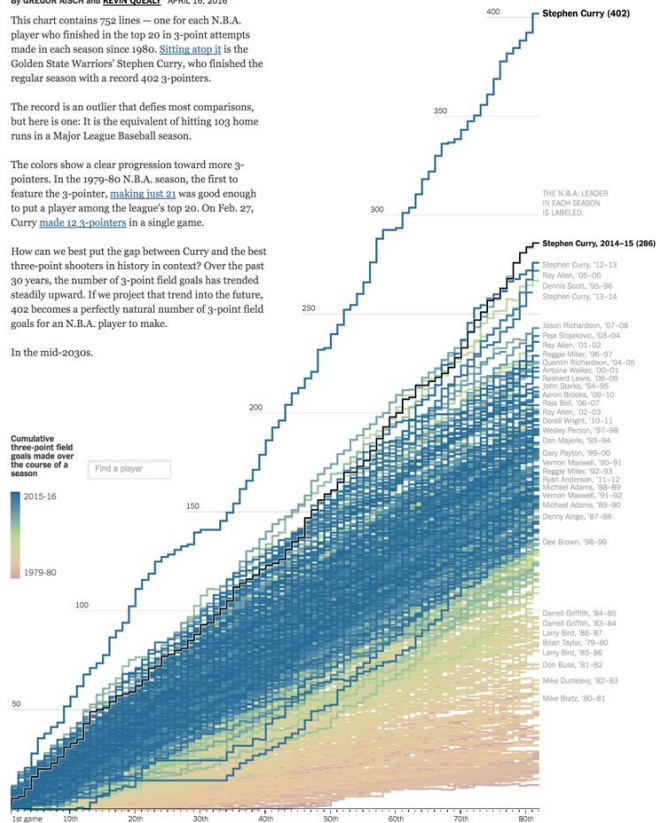
The colors show a clear progression toward more 3-pointers. In the 1979-80 N.B.A. season, the first to feature the 3-pointer, [making just 21](#) was good enough to put a player among the league's top 20. On Feb. 27, Curry [made 12 3-pointers](#) in a single game.

How can we best put the gap between Curry and the best three-point shooters in history in context? Over the past 30 years, the number of 3-point field goals has trended steadily upward. If we project that trend into the future, 402 becomes a perfectly natural number of 3-point field goals for an N.B.A. player to make.

In the mid-2030s.

Cumulative three-point goals made over the course of a season

Find a player

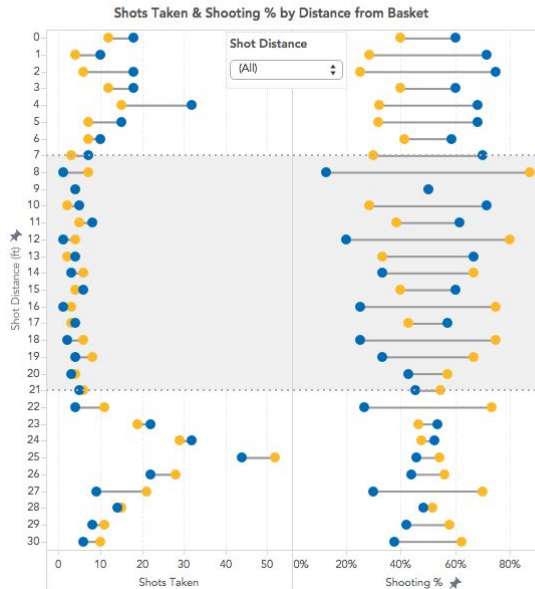


Stephen Curry Hates Mid-Range Jump Shots

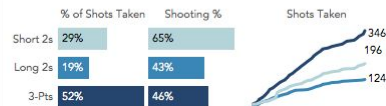
2015-16 Season Through Jan 9

Click a Shot Range or Shot Result to filter or highlight

Made Missed

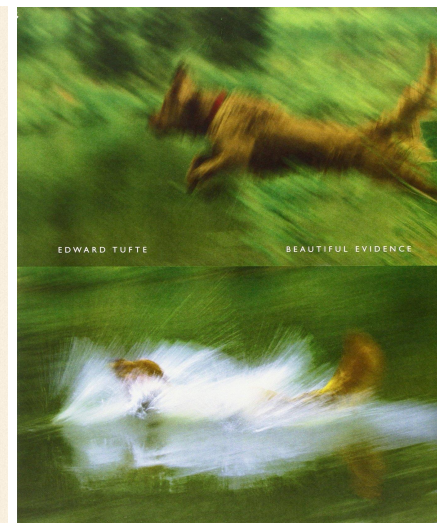
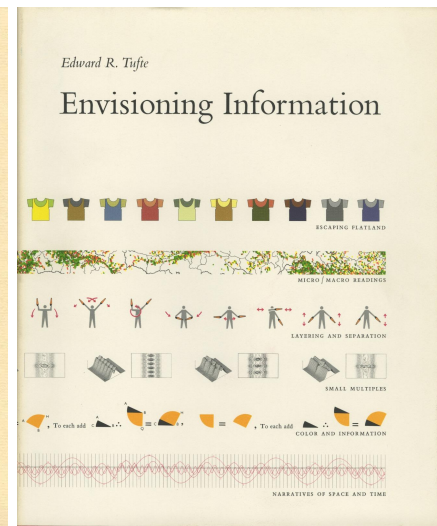
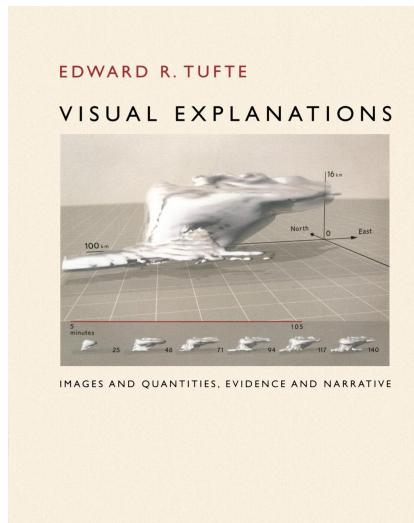
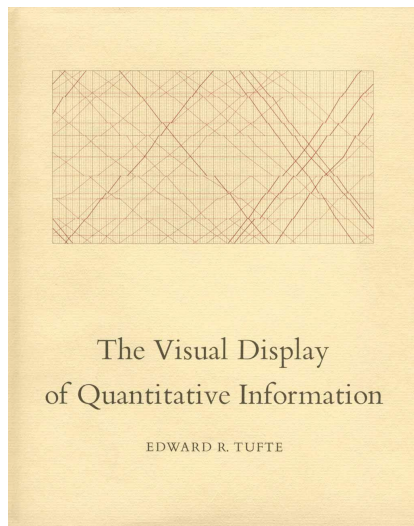


Shots Taken by Range



Data Visualization is Everywhere!

Edward Tufte



Edward Tufte



“Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.”

— Edward R. Tufte, *The Visual Display of Quantitative Information*

Edward Tufte



“Graphical excellence is that which gives to the viewer the **greatest number of ideas** in the **shortest time** with the **least ink** in the **smallest space**.”

— Edward R. Tufte, *The Visual Display of Quantitative Information*

Edward Tufte

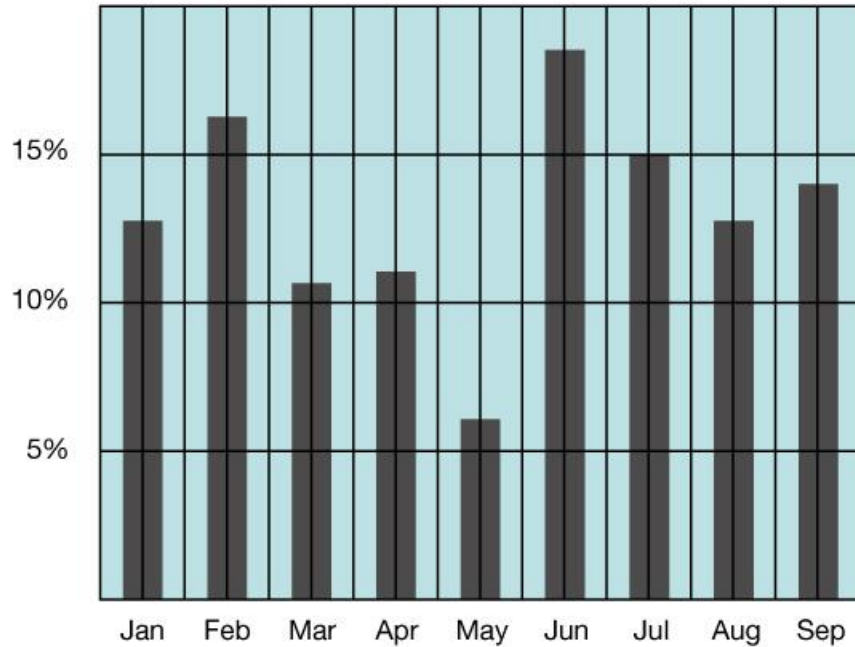


“Graphical excellence is that which gives to the viewer the **greatest number of ideas** in the **shortest time** with the **least ink** in the **smallest space**.”

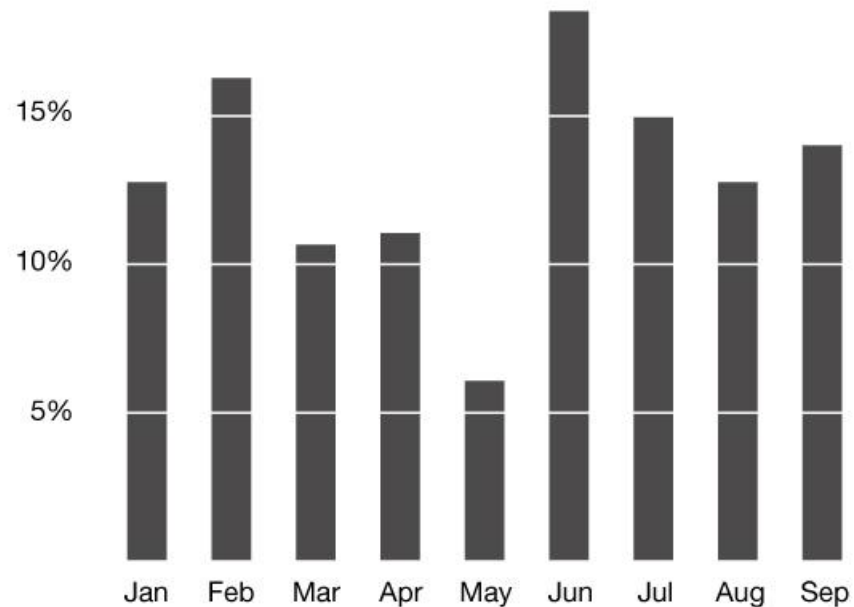
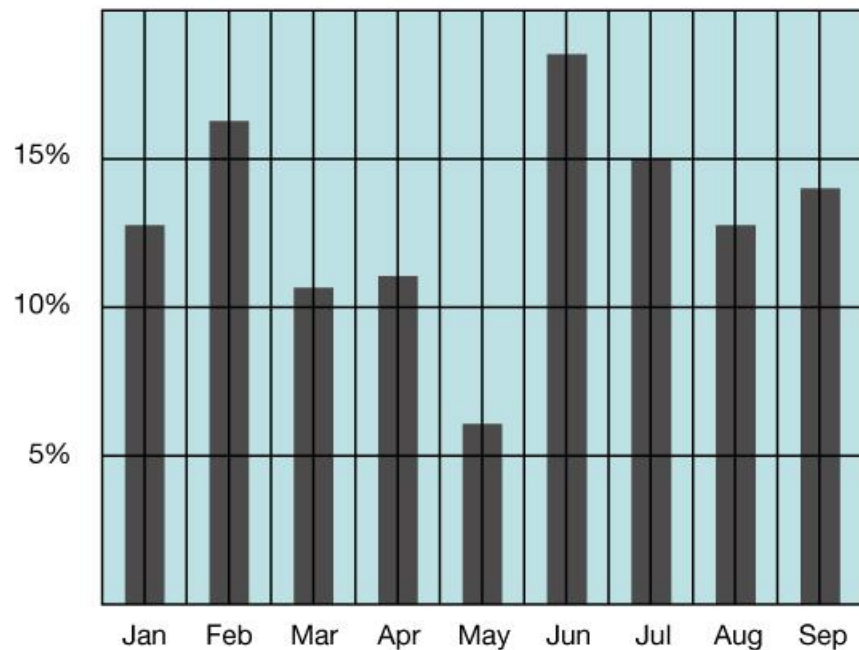
— Edward R. Tufte, *The Visual Display of Quantitative Information*

(within reason!)

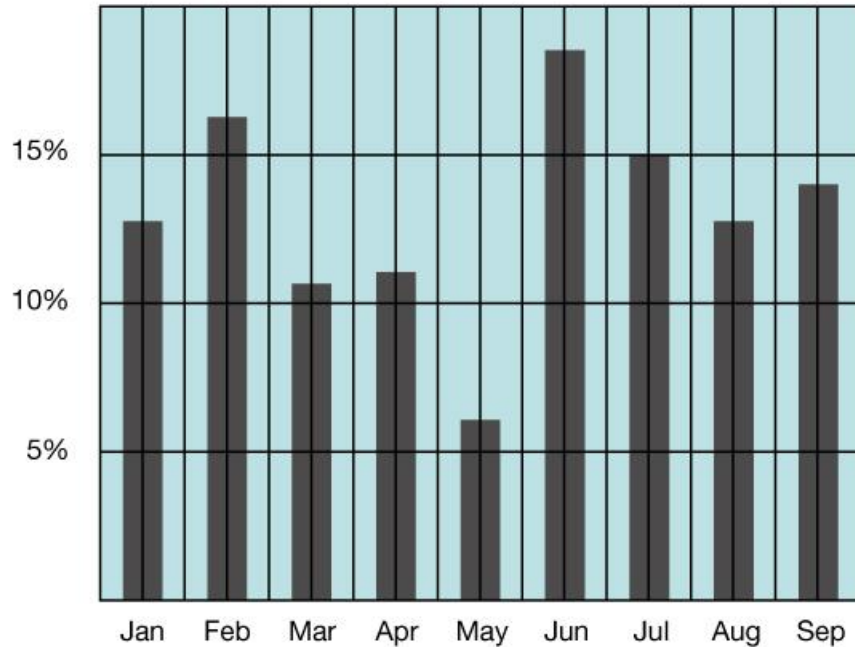
Data to Ink Ratio



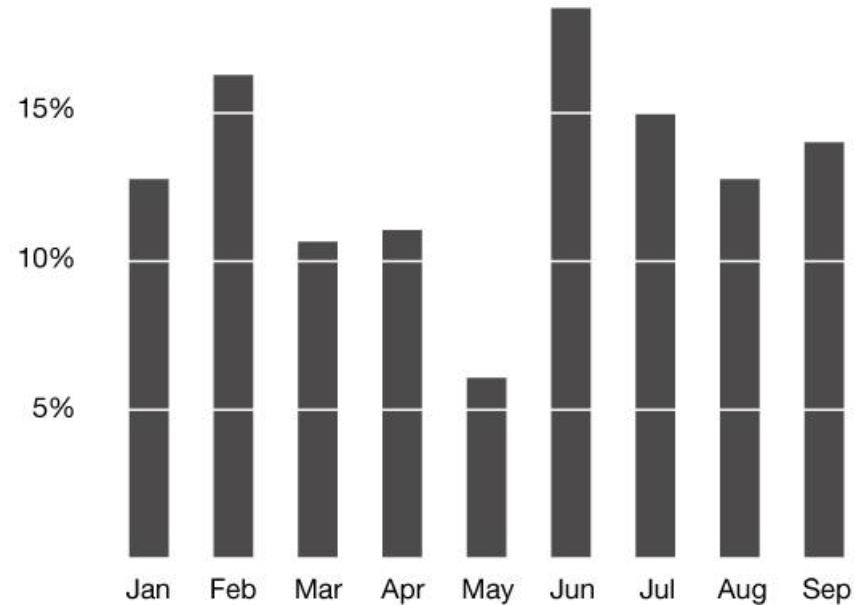
Data to Ink Ratio



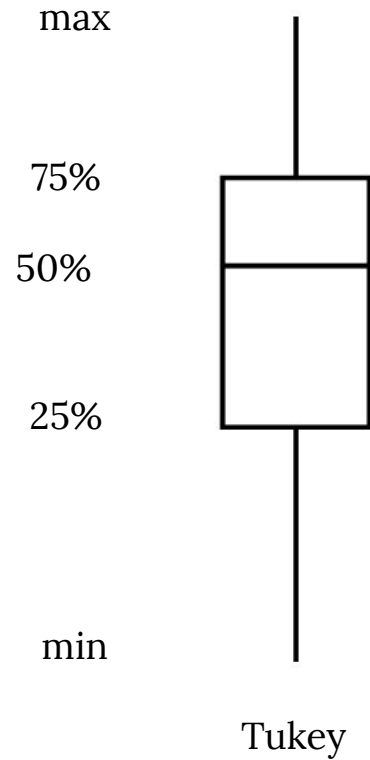
Data to Ink Ratio



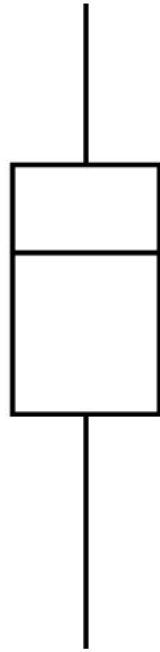
Reasonable?



Data to Ink Ratio



Data to Ink Ratio



Tukey

Data to Ink Ratio

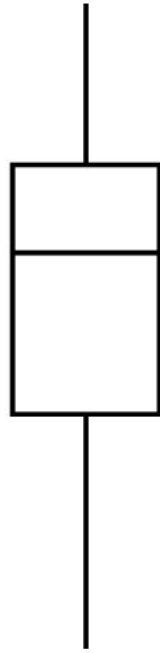


Tukey



Tufte #1

Data to Ink Ratio



Tukey

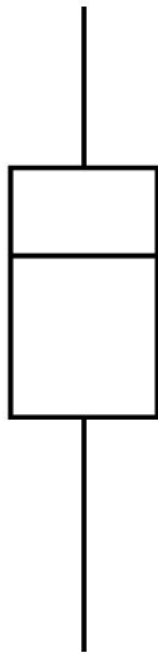


Tufte #1



Tufte #2

Data to Ink Ratio



Tukey



Tufte #1



Tufte #2

Unreasonable?

Sparklines



“A sparkline is a small intense, simple, word-sized graphic with typographic resolution ...”

- Edward Tufte, *Beautiful Evidence*, p. 46-63.

28 day summary with change over previous period

Tweets

66 ↓21.4%



Tweet impressions

1.4M ↑5.1%



Profile visits

21.9K ↓9.1%



Mentions

447 ↓9.3%



Followers

56.8K ↑1,143



Small Multiples

“At the heart of quantitative reasoning is a single question: **Compared to what?**”

Small multiple designs answer directly by visually enforcing comparisons of changes, of the differences among objects, of the scope of alternatives.”

- Edward Tufte,
Envisioning Information, p. 67



Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Ségur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.

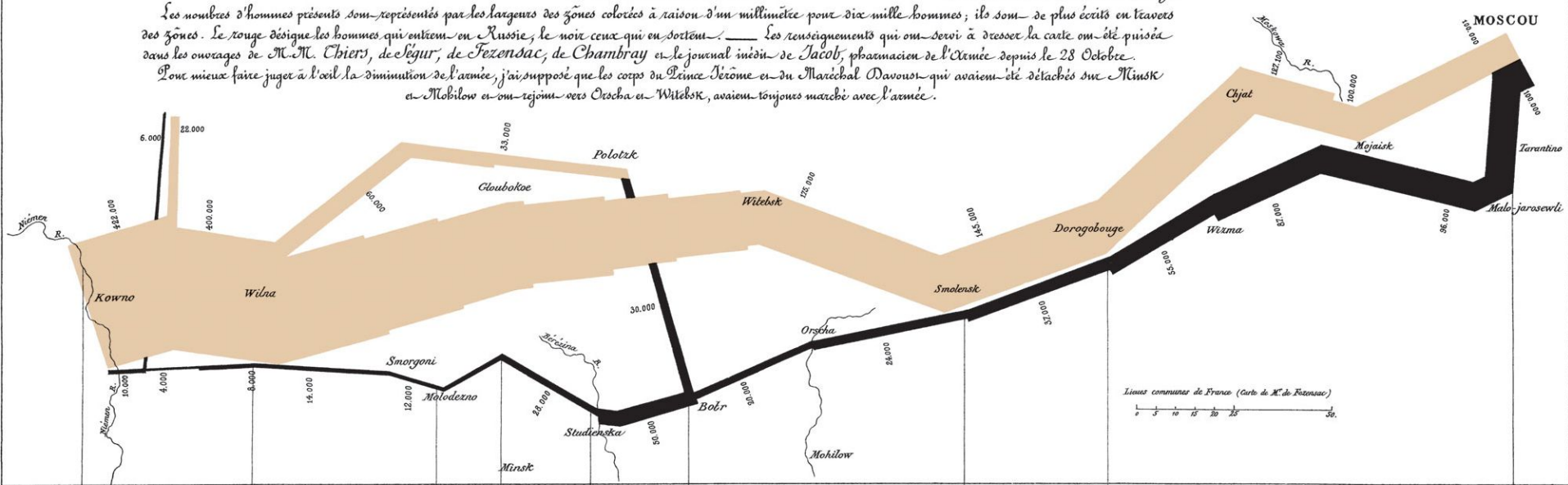
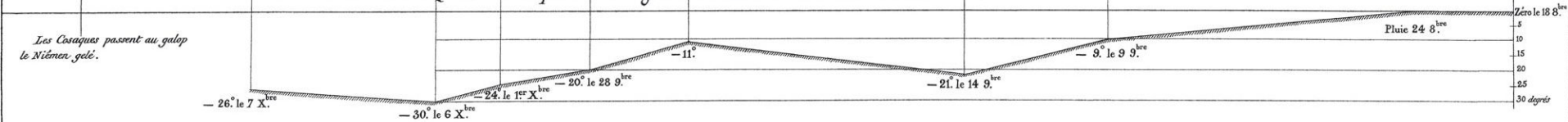


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

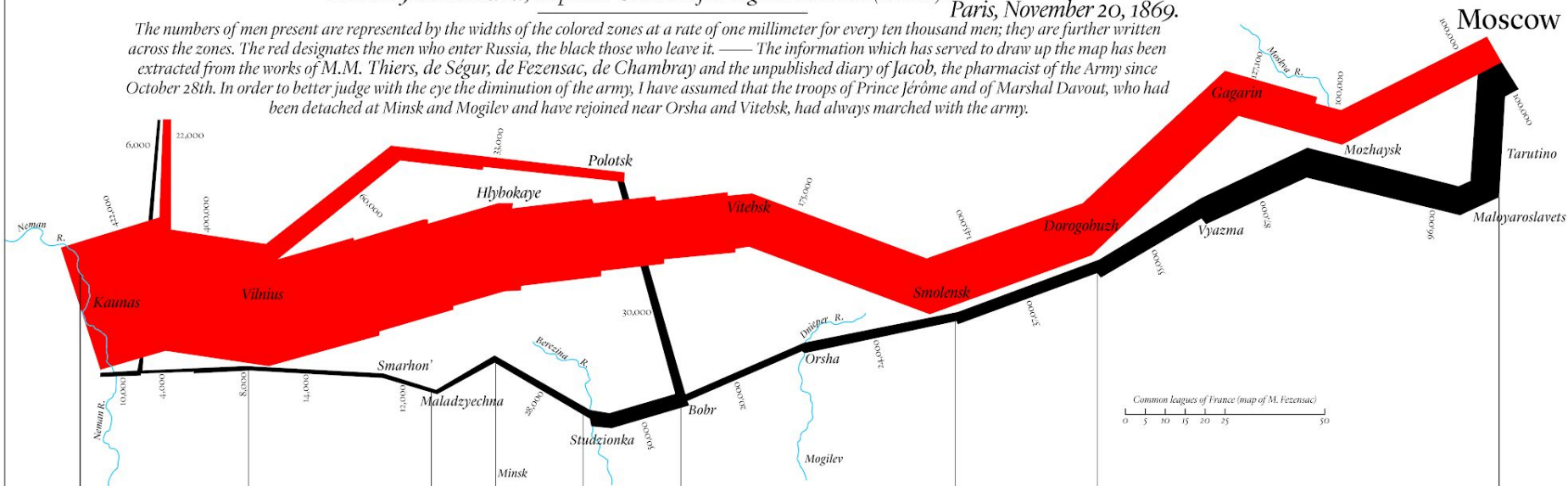


Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812 ~ 1813

Drawn by M. Minard, Inspector General of Bridges and Roads (retired).

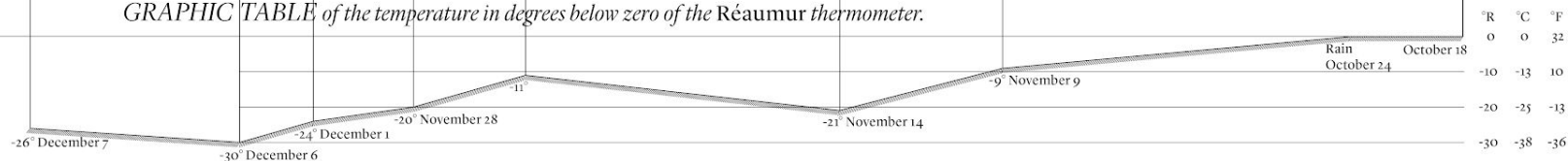
Paris, November 20, 1869.

The numbers of men present are represented by the widths of the colored zones at a rate of one millimeter for every ten thousand men; they are further written across the zones. The red designates the men who enter Russia, the black those who leave it. — The information which has served to draw up the map has been extracted from the works of M.M. Thiers, de Ségur, de Fezensac, de Chambray and the unpublished diary of Jacob, the pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and of Marshal Davout, who had been detached at Minsk and Mogilev and have rejoined near Orsha and Vitebsk, had always marched with the army.



GRAPHIC TABLE of the temperature in degrees below zero of the Réaumur thermometer.

The Cossacks pass the frozen Neman at a gallop.





**Yeah, well, that's
just, like, your
opinion, man.**



Part 4:
Practical Advice

Ten Simple Rules for Better Figures

By Nicolas P. Rougier

1. Know your audience
2. Identify your message
3. Adapt the figure to the support medium
4. Captions are not optional
5. Do not trust the defaults
6. Use color effectively
7. Do not mislead the reader
8. Avoid “Chartjunk”
9. Message trumps beauty
10. Get the right tool

OPEN ACCESS Freely available online

Editorial

Ten Simple Rules for Better Figures

Nicolas P. Rougier^{1,2,3*}, Michael Droettboom⁴, Phillip E. Bourne⁵

¹ INRIA Bordeaux Sud-Ouest, Talence, France, ² IUTB, UMR 5805 CNRS, Talence, France, ³ Institute of Neurodegenerative Diseases, UMR 5293 CNRS, Bordeaux, France, ⁴ Space Telescope Science Institute, Baltimore, Maryland, United States of America, ⁵ Office of the Director, The National Institutes of Health, Bethesda, Maryland, United States of America

Scientific visualization is classically defined as the process of graphically displaying scientific data. However, this process is far from direct or automatic. There are so many different ways to represent the same data: scatter plots, linear plots, bar plots, and pie charts, to name just a few. Furthermore, the same data, using the same type of plot, may be perceived very differently depending on who is looking at the figure. A more accurate definition for scientific visualization would be a graphical interface between people and data. In this short article, we do not pretend to explain everything about this interface; rather, we [1,2] for introductory work. Instead we aim to provide a basic set of rules to improve figure design and to explain some of the common pitfalls.

Rule 1: Know Your Audience

Given the definition above, problems arise when how a visual is perceived differs significantly from the intent of the conveyer. Consequently, it is important to identify, as early as possible in the design process, the audience and the message the visual is to convey. The graphical design of the visual should be informed by this intent. If you are making a figure for yourself and your direct collaborators, you can possibly skip a number of steps in the design process, because each of you knows what the figure is about. However, if you intend to publish a figure in a scientific journal, you should make sure your figure is correct and conveys all the relevant information to a broader audience. Student audiences require special care since the goal for that situation is to explain a concept. In that case, you may have to add extra information to make sure the concept is fully understood. Finally, the general public may be the most difficult audience of all since you need to design a simple, possibly approximated, figure that reveals only the most salient part of your research (Figure 1). This has proven to be a difficult exercise [3].

Rule 2: Identify Your Message

A figure is meant to express an idea or introduce some facts or a result that would be too long (or nearly impossible) to explain only with words, be it for an article or during a time-limited oral presentation. In this context, it is important to clearly identify the role of the figure, i.e., what is the underlying message and how can a figure best express this message? Once clearly identified, this message will be a strong guide for the design of the figure, as shown in Figure 2. Only after identifying the message will it be worth the time to develop your figure, just as you would take the time to craft your words and sentences when writing an article only after deciding on the main points of the text. If your figure is able to convey a striking message at first glance, chances are increased that your article will draw more attention from the community.

Rule 3: Adapt the Figure to the Support Medium

A figure can be displayed on a variety of media, such as a poster, a computer monitor, a projection screen (as in an oral presentation), or a simple sheet of paper (as in a printed article). Each of these media represents different physical sizes for the figure, but more importantly, each of them also implies different ways of viewing and interacting with the figure. For example, during an oral presentation, a figure will be displayed for a limited time. Thus, the viewer must quickly understand what is displayed and what it represents while still listening to your explanation. In such a situation, the figure

must be kept simple and the message must be visually salient in order to grab attention, as shown in Figure 3. It is also important to keep in mind that during oral presentations, figures will be video-projected and will be seen from a distance, and figure elements must consequently be made thicker (lines) or bigger (points, text), colors should have strong contrast, and vertical text should be avoided, etc. For a journal article, the situation is totally different, because the reader is able to view the figure as long as necessary. This means a lot of details can be added, along with complementary explanations in the caption. If we take into account the fact that more and more people now read articles on computer screens, they also have the possibility to zoom and drag the figure. Ideally, each type of support medium requires a different figure, and you should abandon the practice of extracting a figure from your article to be put, as is, in your oral presentation.

Rule 4: Captions Are Not Optional

Whether describing an experimental setup, introducing a new model, or presenting new results, you cannot explain everything within the figure itself—a figure should be accompanied by a caption. The caption explains how to read the figure and provides additional precision for what cannot be graphically represented. This can be thought of as the explanation you would give during an oral presentation, or in front of a poster, but with the difference that you must think in advance about the questions people would ask. For example, if you have a bar plot, do not expect the

Citation: Rougier NP, Droettboom M, Bourne PE (2014) Ten Simple Rules for Better Figures. *PLoS Comput Biol* 10(9): e1003833. doi:10.1371/journal.pcbi.1003833

Editor: Scott Markel, Accelrys, United States of America

Published: September 11, 2014

This is an open-access article distributed under the terms of the [Creative Commons Attribution License](http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Funding: The authors received no specific funding for this article.

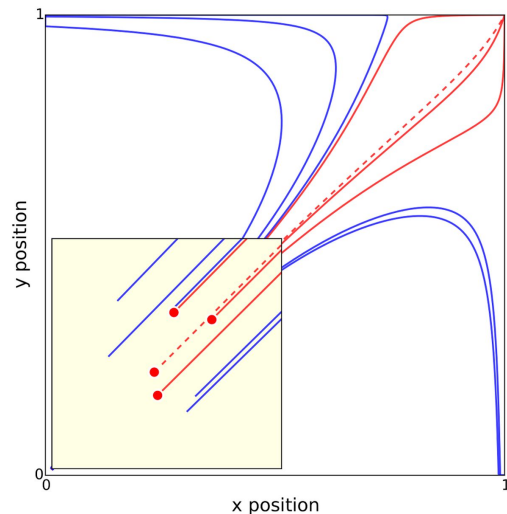
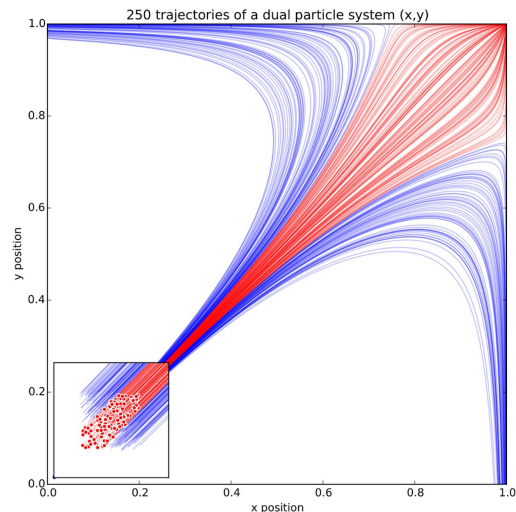
Competing Interests: The authors have declared that no competing interests exist.

* Email: Nicolas.Rougier@inria.fr

Ten Simple Rules for Better Figures

By Nicolas P. Rougier

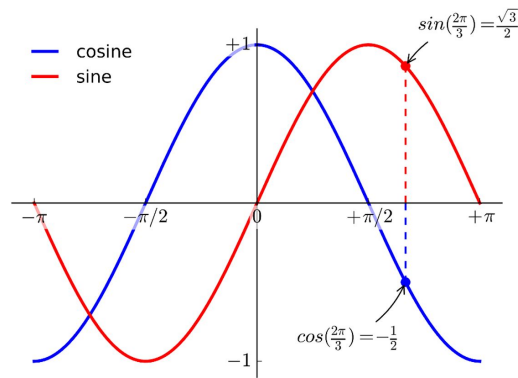
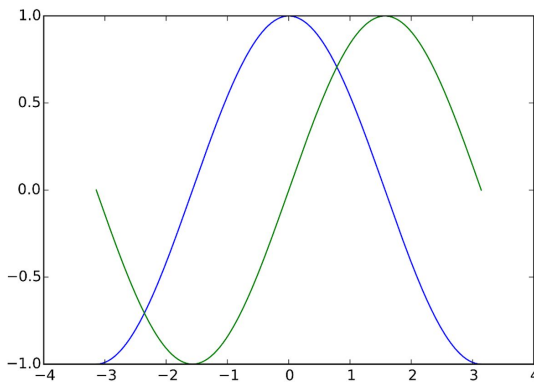
1. Know your audience
2. Identify your message
3. **Adapt the figure to the support medium**
4. Captions are not optional
5. Do not trust the defaults
6. Use color effectively
7. Do not mislead the reader
8. Avoid “Chartjunk”
9. Message trumps beauty
10. Get the right tool



Ten Simple Rules for Better Figures

By Nicolas P. Rougier

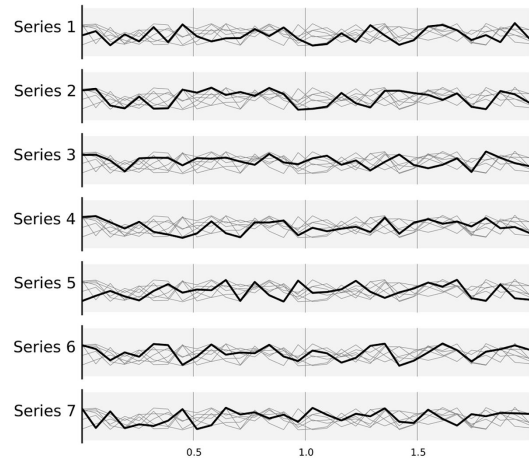
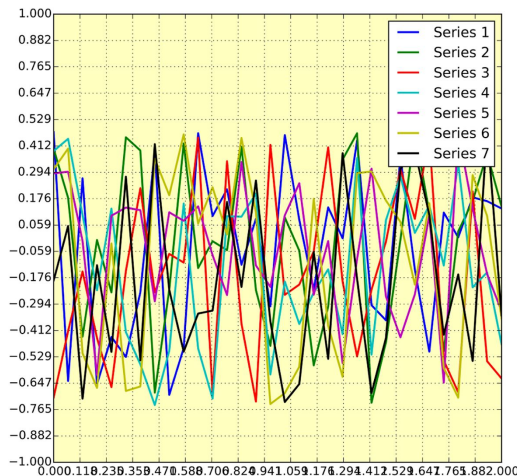
1. Know your audience
2. Identify your message
3. Adapt the figure to the support medium
4. Captions are not optional
- 5. Do not trust the defaults**
6. Use color effectively
7. Do not mislead the reader
8. Avoid “Chartjunk”
9. Message trumps beauty
10. Get the right tool



Ten Simple Rules for Better Figures

By Nicolas P. Rougier

1. Know your audience
2. Identify your message
3. Adapt the figure to the support medium
4. Captions are not optional
5. Do not trust the defaults
6. Use color effectively
7. Do not mislead the reader
- 8. Avoid “Chartjunk”**
9. Message trumps beauty
10. Get the right tool



Ten Simple Rules for Better Figures

By Nicolas P. Rougier

1. Know your audience
2. Identify your message
3. Adapt the figure to the support medium
4. Captions are not optional
5. Do not trust the defaults
6. Use color effectively
7. Do not mislead the reader
8. Avoid “Chartjunk”
9. Message trumps beauty
10. **Get the right tool**

