



<http://www.di.unito.it/~ruffo>



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Prof. Giancarlo Ruffo - Università degli Studi di Torino (Italy)



di.unito.it

Visual Analytics/Data Visualisation

Introduzione alla Data Visualisation

Torino, 22 / 05 / 2020

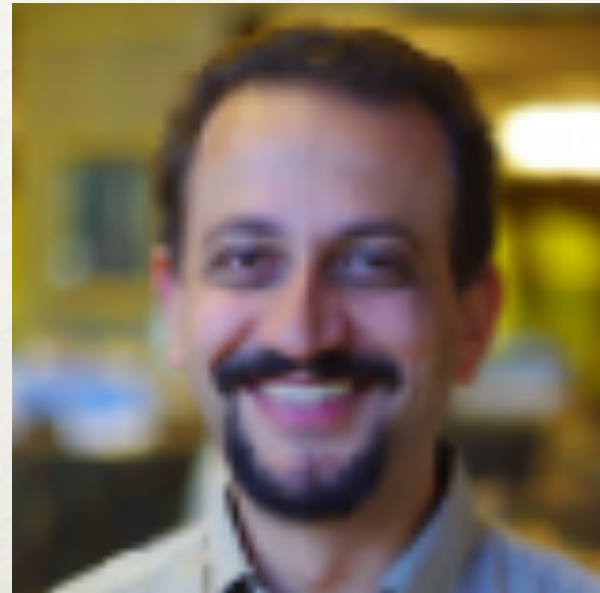
http://www.di.unito.it/~ruffo/talks/2020_May_CIM40.pdf

**+ COMPETENCE
INDUSTRY
MANUFACTURING
4.0**

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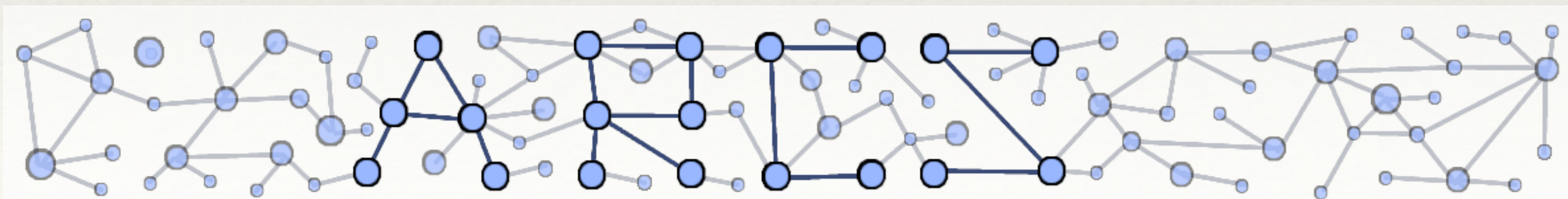
Profilo



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 - ❖ **webex** virtual room: <https://unito.webex.com/meet/giancarlo.ruffo>
 - ❖ socio fondatore **NetAtlas** s.r.l. (dal 2013): <http://www.netatlas.it>
 - ❖ Adjunct Professor: **Indiana University**
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Lezione 1 - Agenda

- ❖ Visualizzare dati
- ❖ Il test dello Scimpanzé
- ❖ Percezioni e distorsioni (cognitive e statistiche)
- ❖ Integrità grafica
- ❖ Valutazione e design
- ❖ Tecnologie abilitanti
- ❖ Riferimenti

Visualizzare dati

Il potere della visualizzazione dati

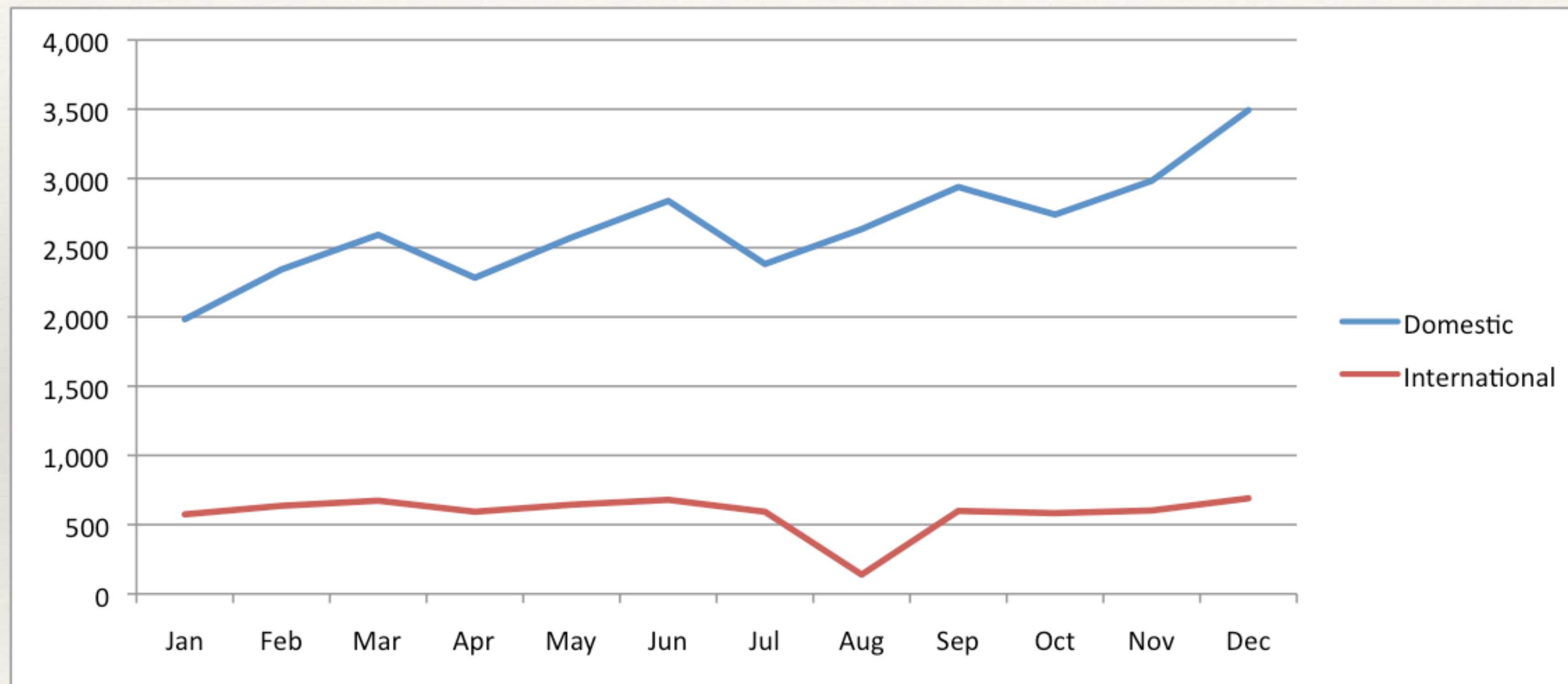
Le tabelle piene di informazioni funzionano perfettamente se abbiamo dei valori precisi e rendono facile l'identificazione di dati individuali

2007 Sales Revenue
(U.S. dollars in thousands)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Domestic	1983	2343	2593	2283	2574	2838	2382	2634	2938	2739	2983	3493
International	574	636	673	593	644	679	593	139	599	583	602	690
	\$2,557	\$2,979	\$3,266	\$2,876	\$3,218	\$3,517	\$2,975	\$2,773	\$3,537	\$3,322	\$3,585	\$4,183

Cosa fare quando vogliamo confrontare i dati, trovare “pattern”, tendenze, relazioni, etc.?

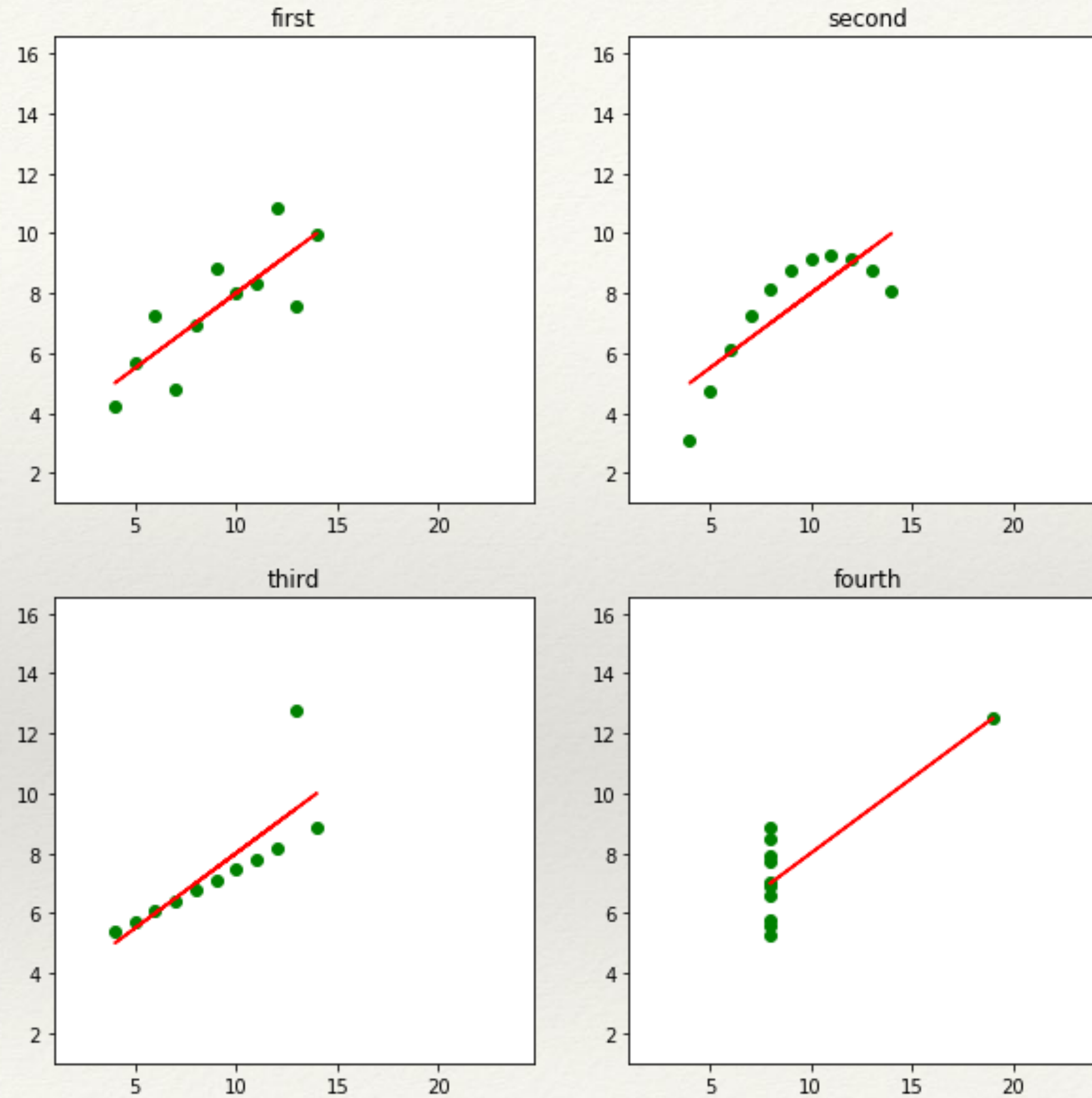
2007 Sales Revenue (esempio)



Anscombe's Quartet

	Group 1	Group 2	Group 3	Group 4
mean(x)	9.00	9.00	9.00	9.00
mean(y)	7.50	7.50	7.50	7.50
var(x)	11.00	11.00	11.00	11.00
var(y)	4.13	4.13	4.12	4.12
correlation	0.82	0.82	0.82	0.82
lm intercept	3.00	3.00	3.00	3.00
lm x effect	0.50	0.50	0.50	0.50

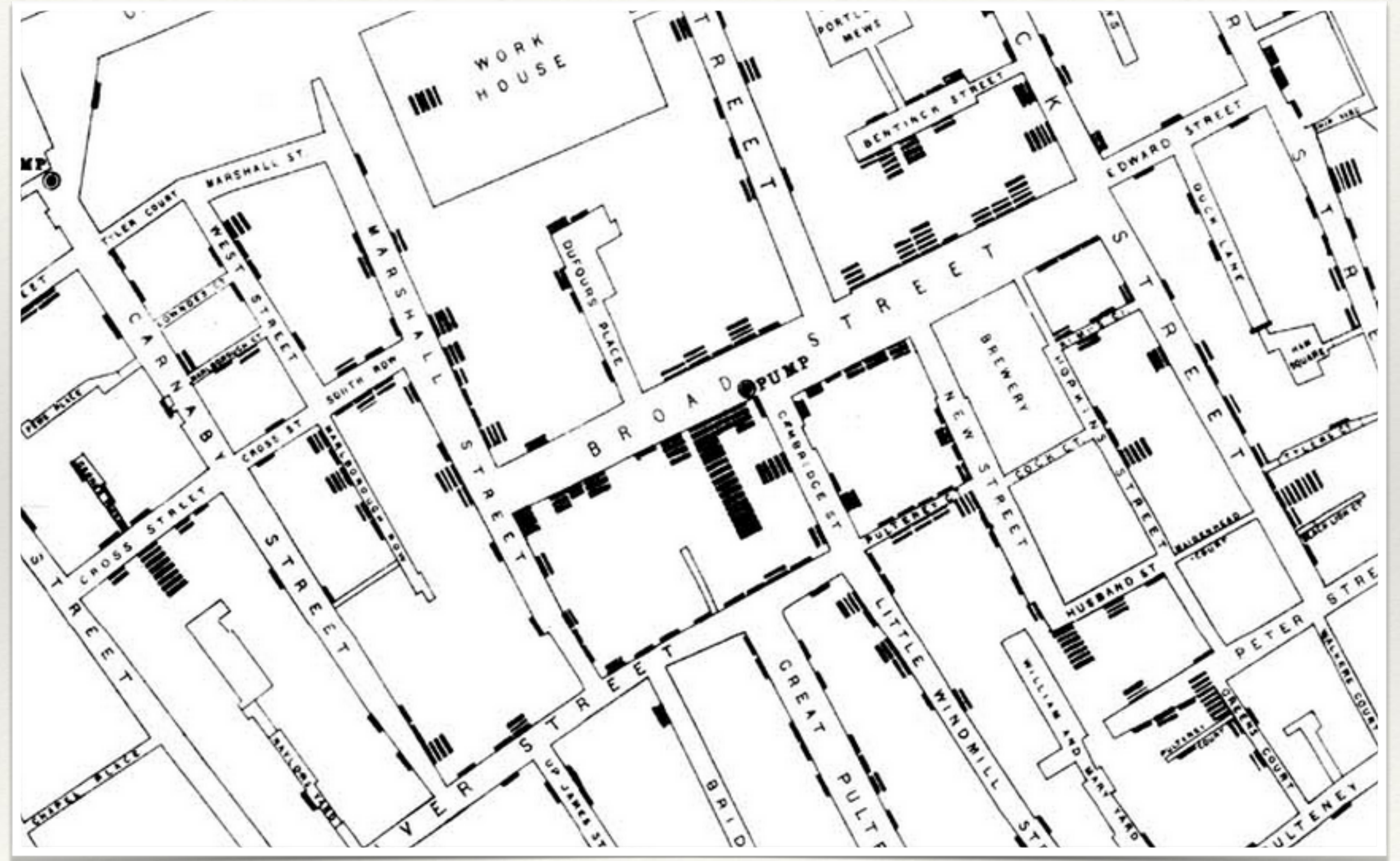
The Anscombe's Quartet



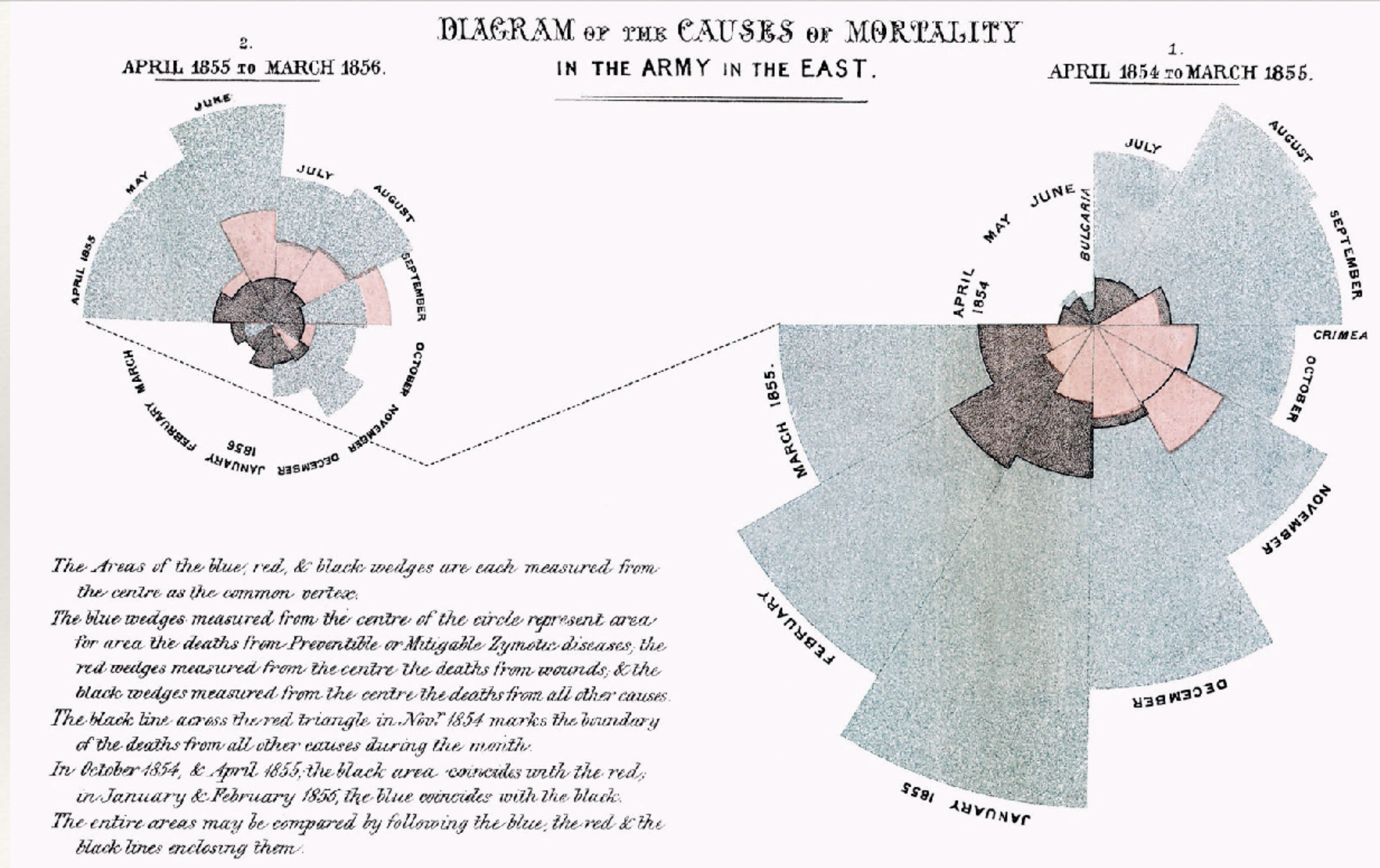
Epidemie e dati

- ❖ John Snow e "data journalism": la mappa del colera che ha cambiato il mondo

<http://www.theguardian.com/news/datablog/2013/mar/15/john-snow-cholera-map>



Florence Nightingale's Rose Diagram



- ❖ Le “visualizzazioni” ci aiutano ad interpretare dati e numeri.
- ❖ I numeri sono “fatti”, “osservazioni”. Non possono mentire
- ❖ Ma...

Il test dello scimpanzè

"The best stats you've ever seen", Hans Rosling



https://www.ted.com/talks/hans_rosling_shows_the_best_stats_you_ve_ever_seen

The chimpanze test

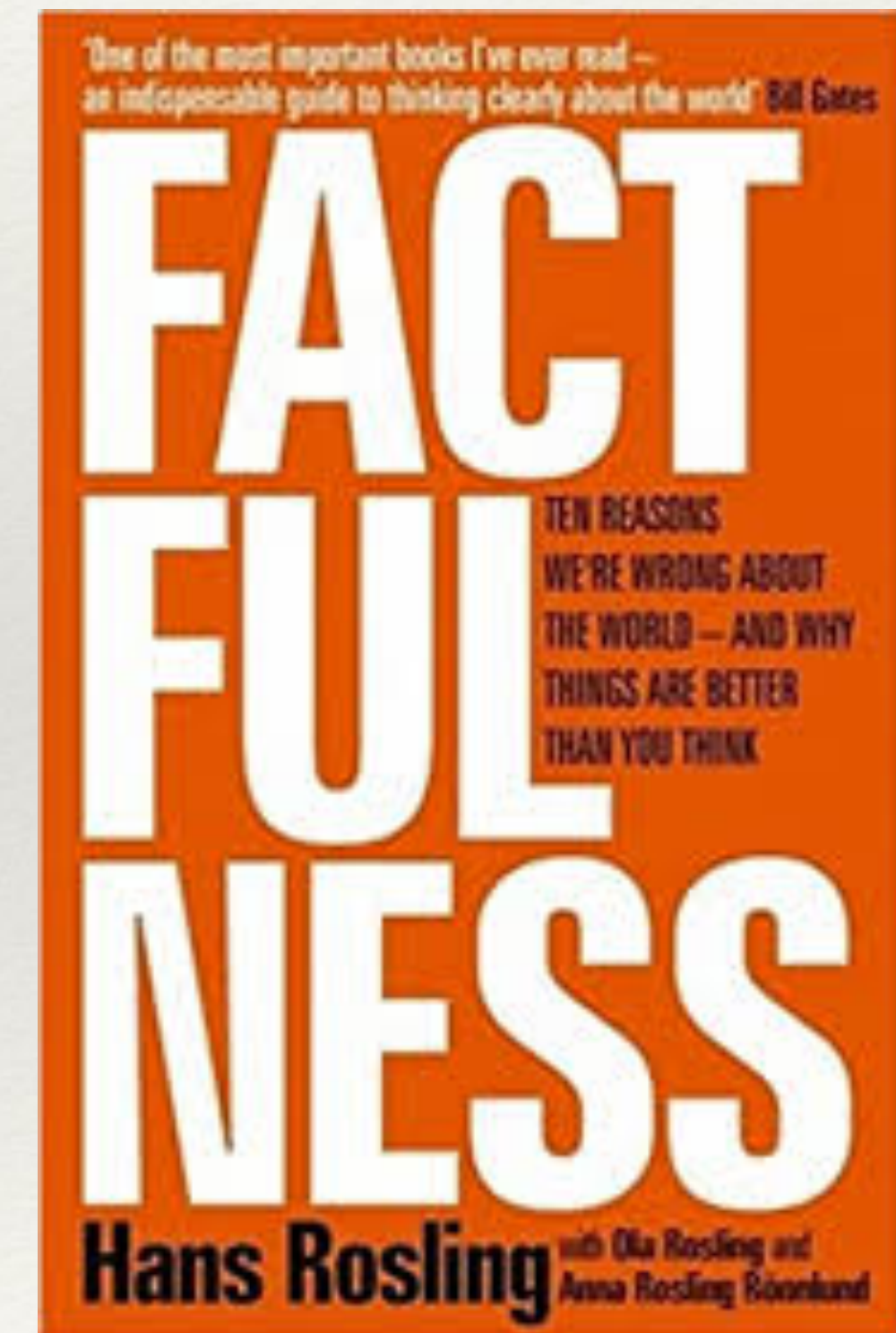
- ❖ I **nostri pregiudizi** peggiorano la nostra capacità di analisi
- ❖ Dobbiamo approcciare la visualizzazione e la comunicazione scientifica nel modo più “onesto” possibile: prima ancora di mentire agli altri, rischiamo di mentire a noi stessi.
- ❖ ... non abbiamo neanche iniziato a parlare dei limiti della nostra percezione.

Lezione #1

Non fidatevi dei vostri pregiudizi e fate parlare i dati
(senza torturarli)

*“LET MY DATASET CHANGE YOUR
MINDSET”*

Hans Rosling
(1948-2017)



Percezione e distorsioni (cognitive e statistiche)

Usare la visualizzazione in modo efficace

“We must do more than simply display data graphically: we must understand how visual perception works and then present data visually in ways that follow the rules”

Stephen Few, Now You See It, Analytics Press

Chapter 3: Thinking with our eyes

Cosa possiamo percepire?

- percepiamo un intero oggetto nella sua totalità, ma possiamo anche percepirlo come composto di diverse proprietà visive
- posizione 2D, lunghezze, ampiezze, profondità, forma, colore orientamento, ...
- Possiamo potenzialmente “catturare” molti valori in una sola volta (i valori possono essere combinati in “pattern”)

Quanti 3 vedete nella sequenza sottostante?

24813481187116715541388198443771347915641531845305848641
23475789411484122238814691613548048407890877078678751211
86584234044377134791564153184530584864123475789411484122
23881469161354804840789087707867875121186584234018874276

Quanti 3 vedete nella sequenza sottostante?

24813481187116715541388198443771347915641531845305848641
23475789411484122238814691613548048407890877078678751211
86584234044377134791564153184530584864123475789411484122
23881469161354804840789087707867875121186584234018874276

Lezione #2

“Non limitiamoci a tutto quello che possiamo vedere. La percezione visiva è selettiva ed è giusto che sia così, dato che ci obbliga a concentrarci su ciò che potrebbe sopraffarci. La nostra attenzione si focalizza spesso su ciò che si differenzia dall'ordinario.”

Cosa vedete qui?



Cos'altro vedete qui?



Okay, c'è una rosa. Cos'altro vedete dentro la rosa?



Okay, facciamo tutti uno sforzo per vedere un **delfino** dentro la rosa...



Lezione #3

“I nostri occhi sono “guidati” da figure familiari. Vediamo ciò che conosciamo e ci aspettiamo di vedere”



<https://www.youtube.com/watch?v=oH6yOc606uQ>

Lezione #4

“La memoria gioca un ruolo fondamentale nella cognizione umana, ma la memoria utile è estremamente limitata”

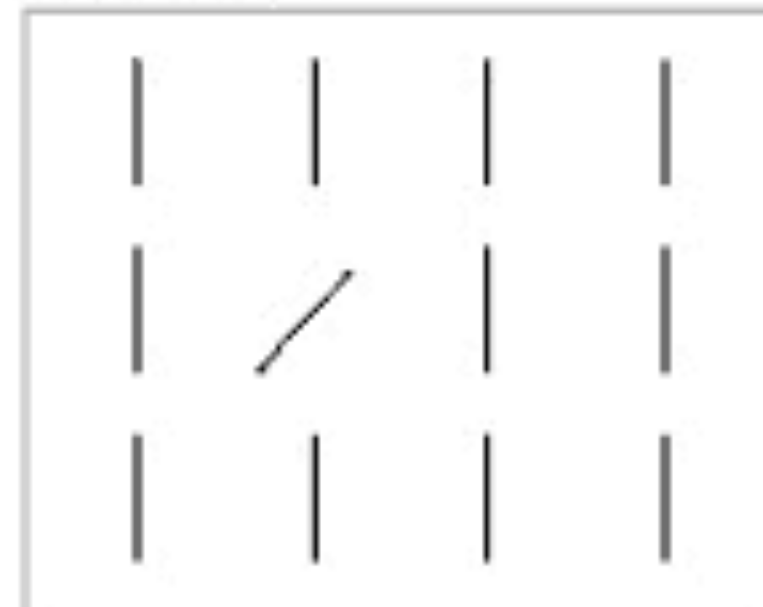
Attributi “pre-attentive”

- ❖ Quattro categorie
 - ❖ Colori
 - ❖ Forme
 - ❖ Posizioni
 - ❖ Animazioni

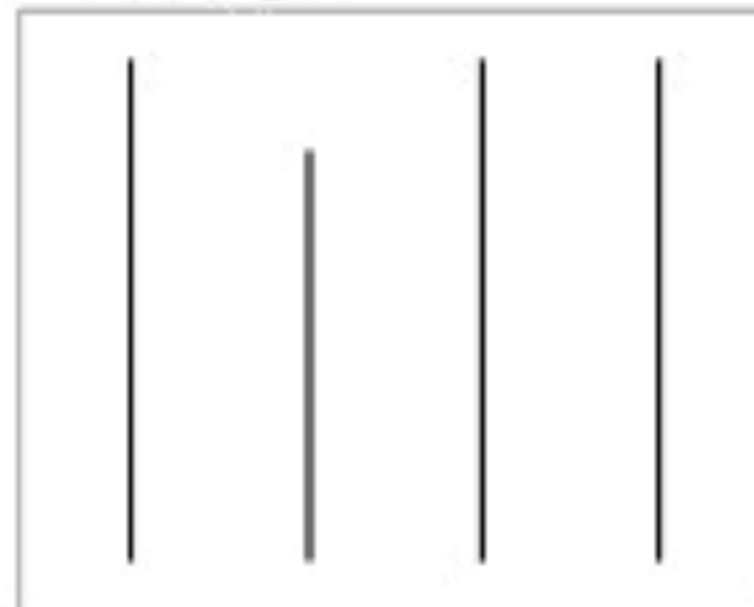
- ❖ Associa valori e dati ad attributi “pre-attentive” con cautela:
 - ❖ Non creare DISTRAZIONI dai dati
 - ❖ Tieni in considerazione la memoria a breve termine

Form

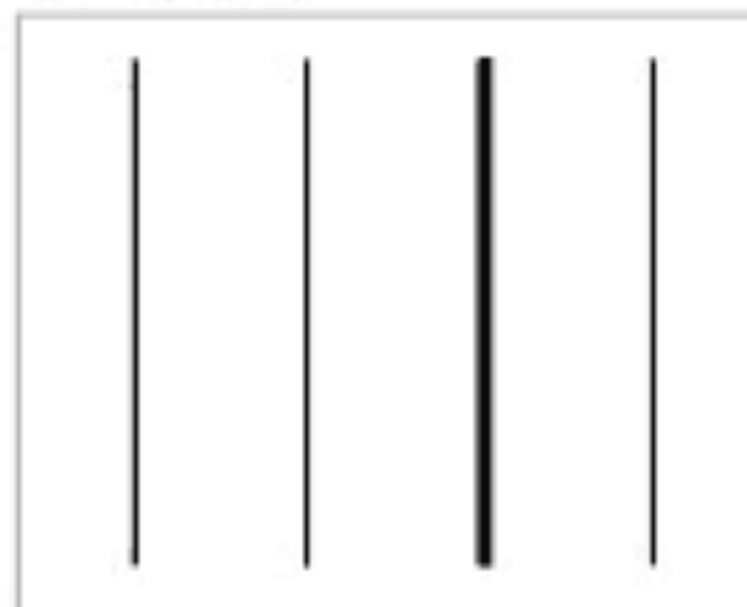
Orientation



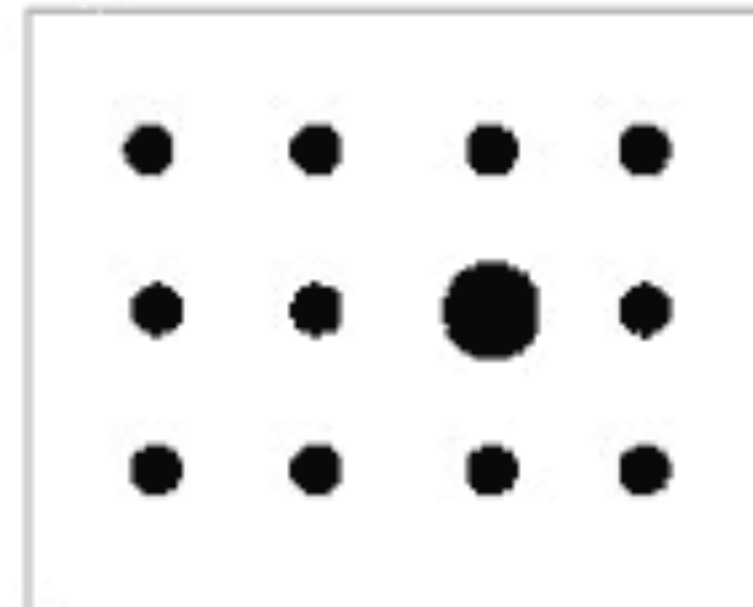
Line Length



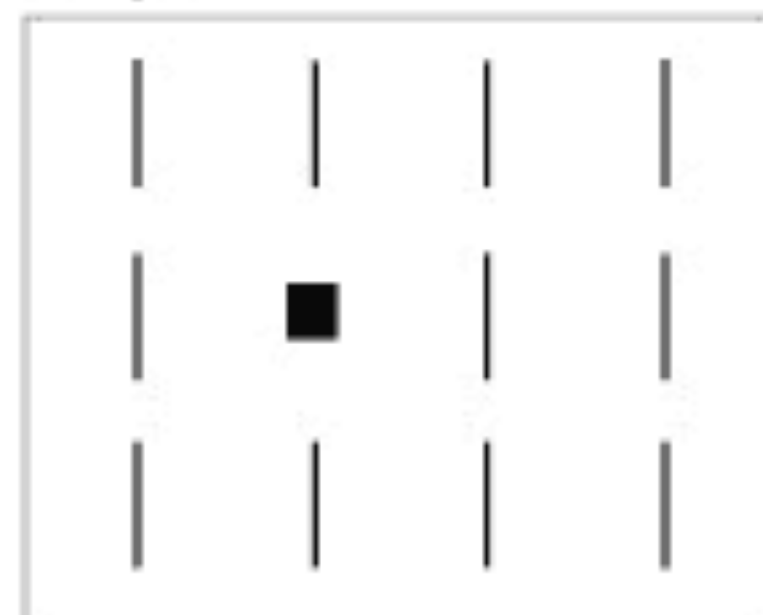
Line Width



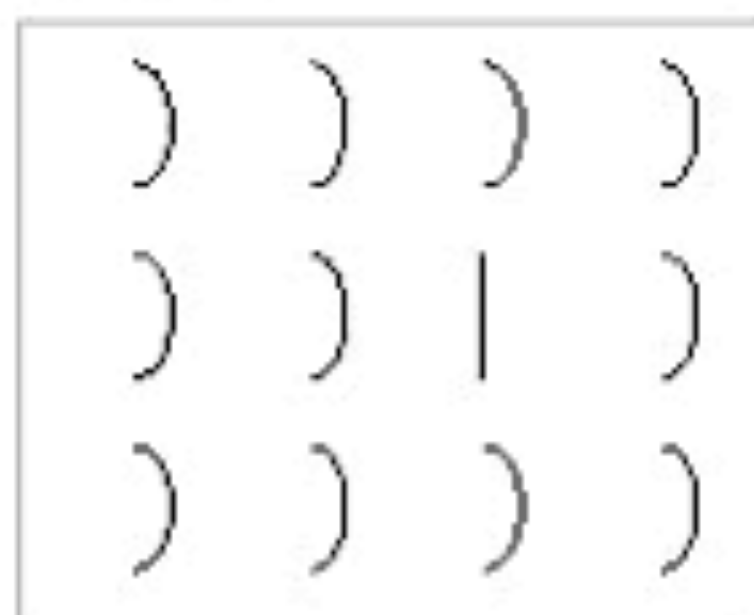
Size



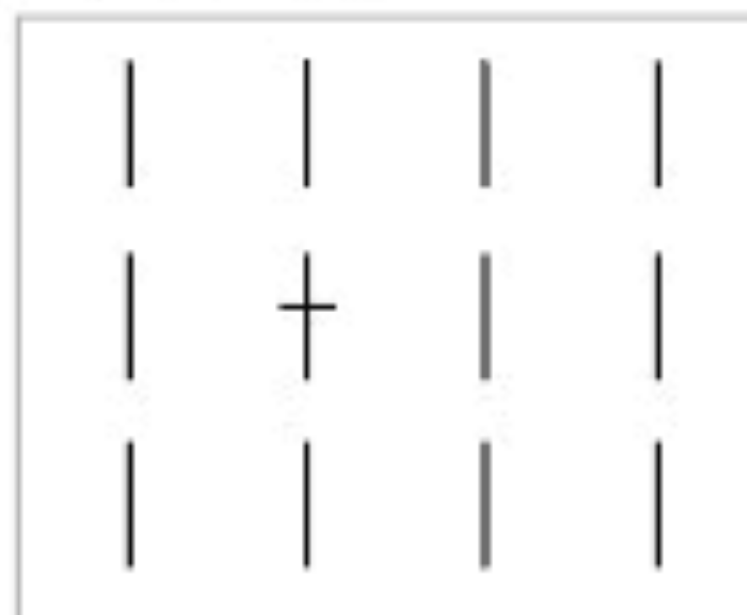
Shape



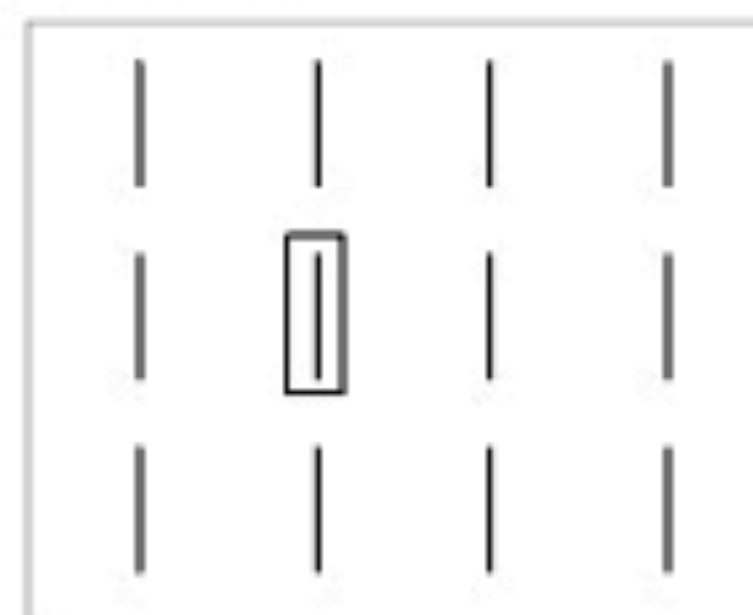
Curvature



Added Marks

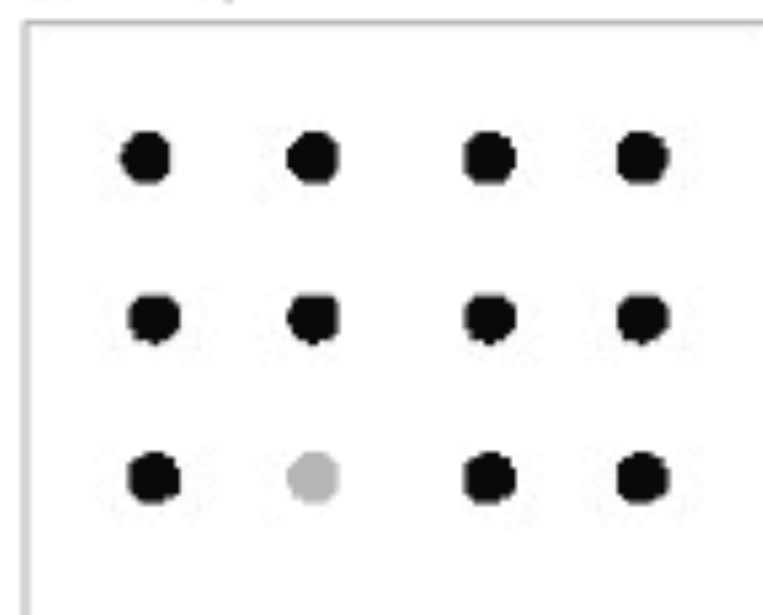


Enclosure

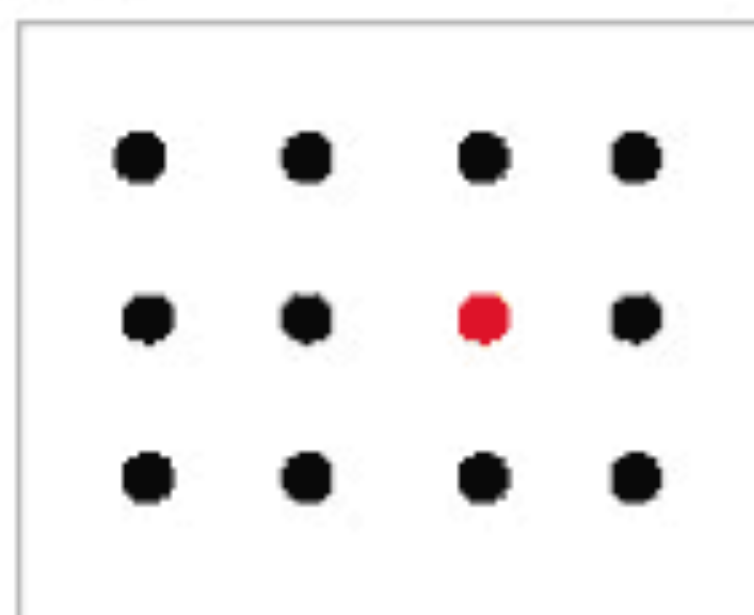


Color

Intensity

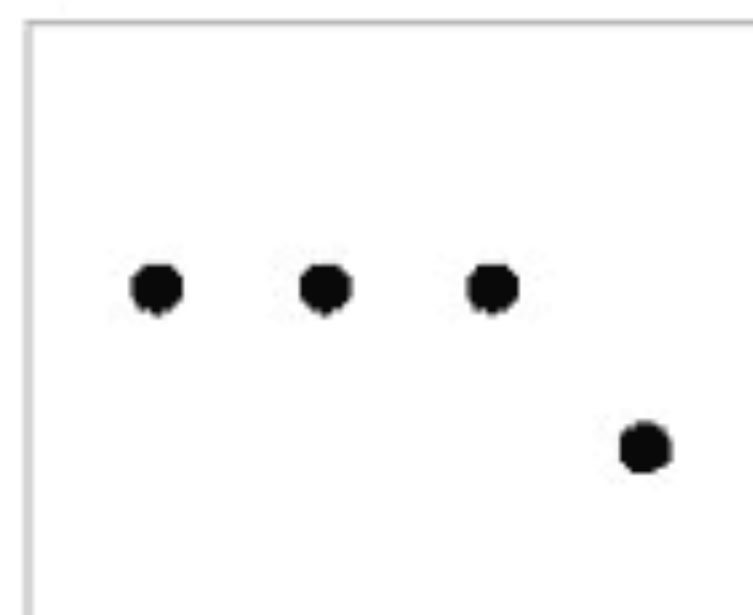


Hue

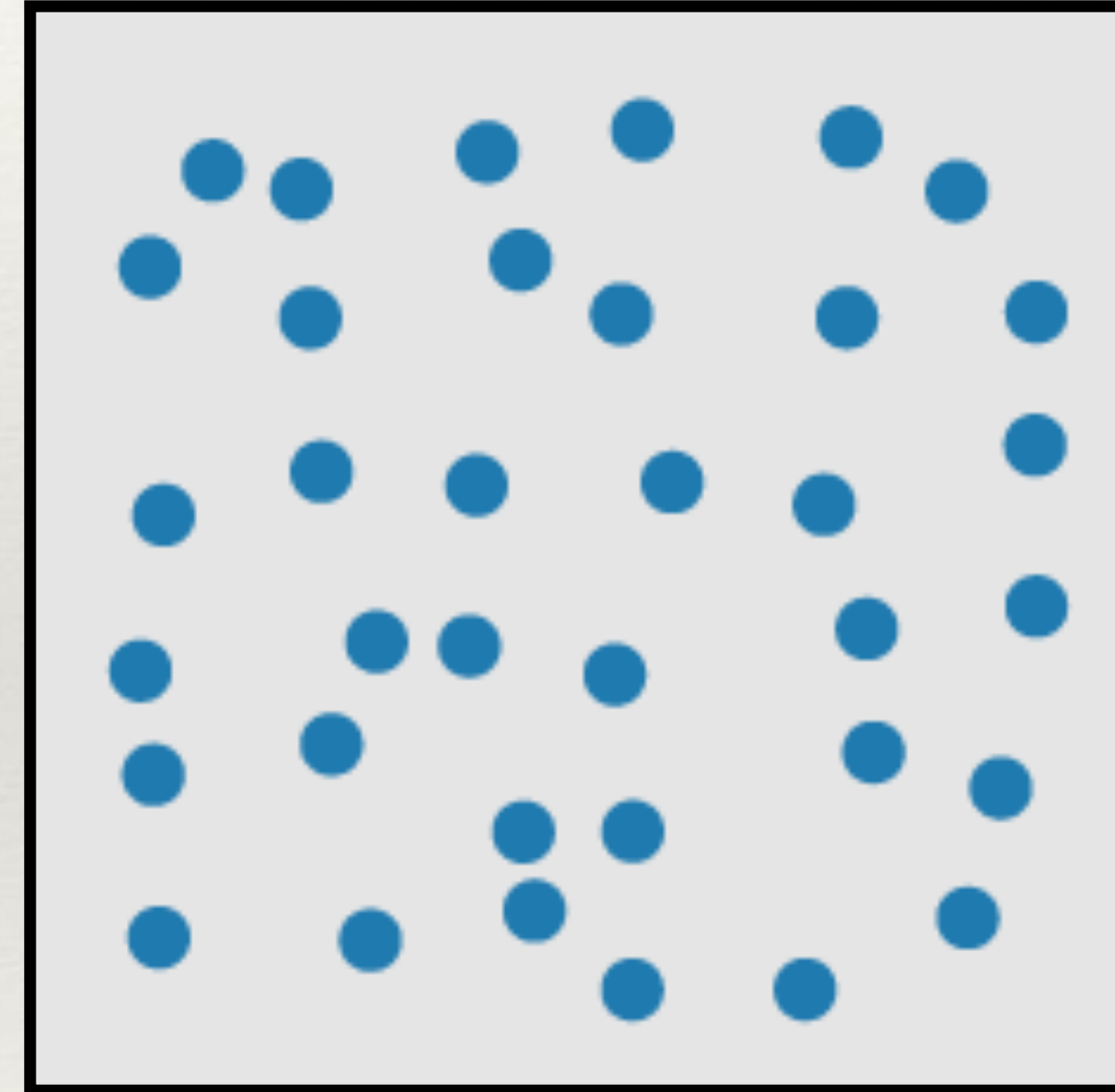
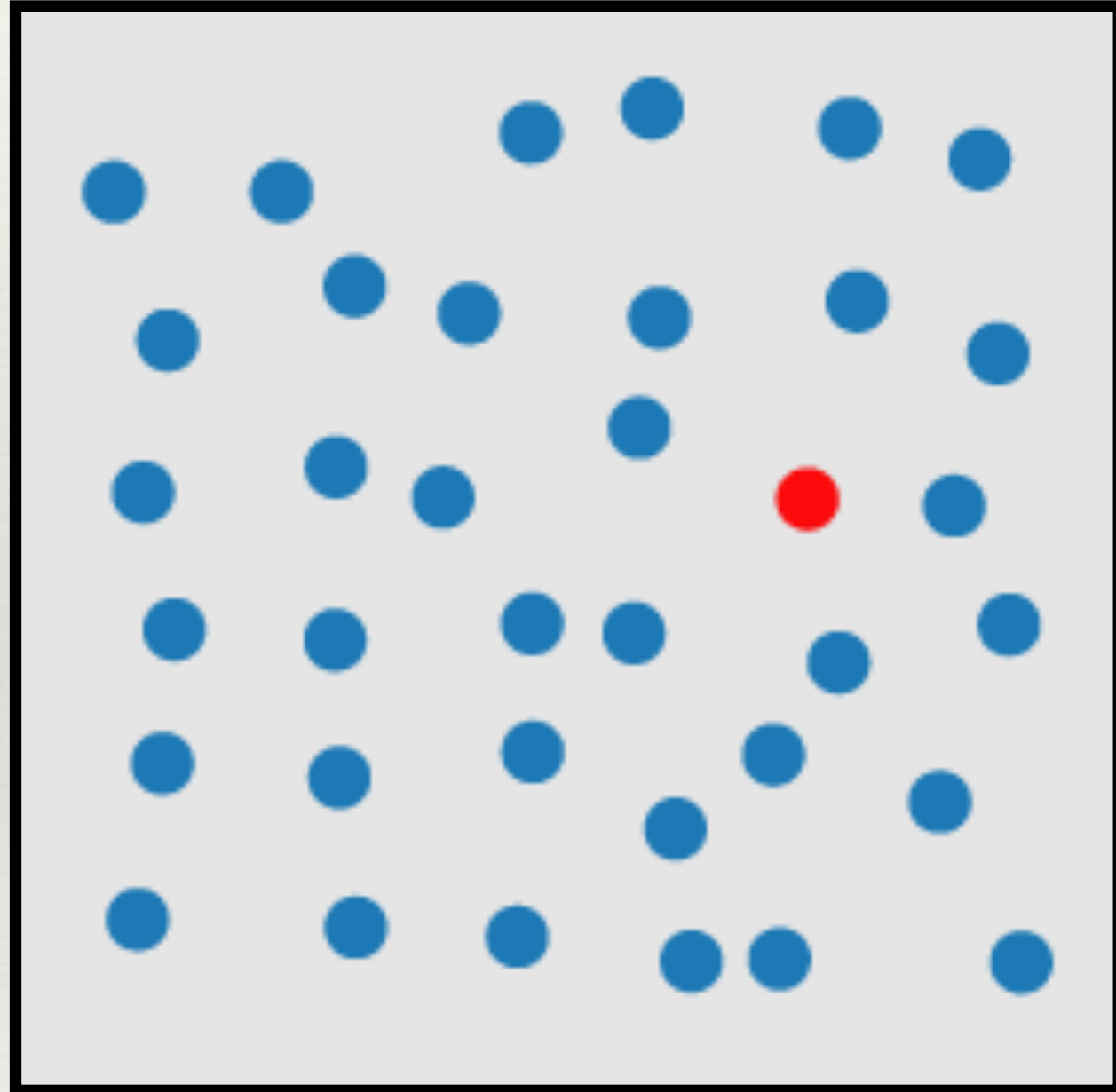


Spatial Position

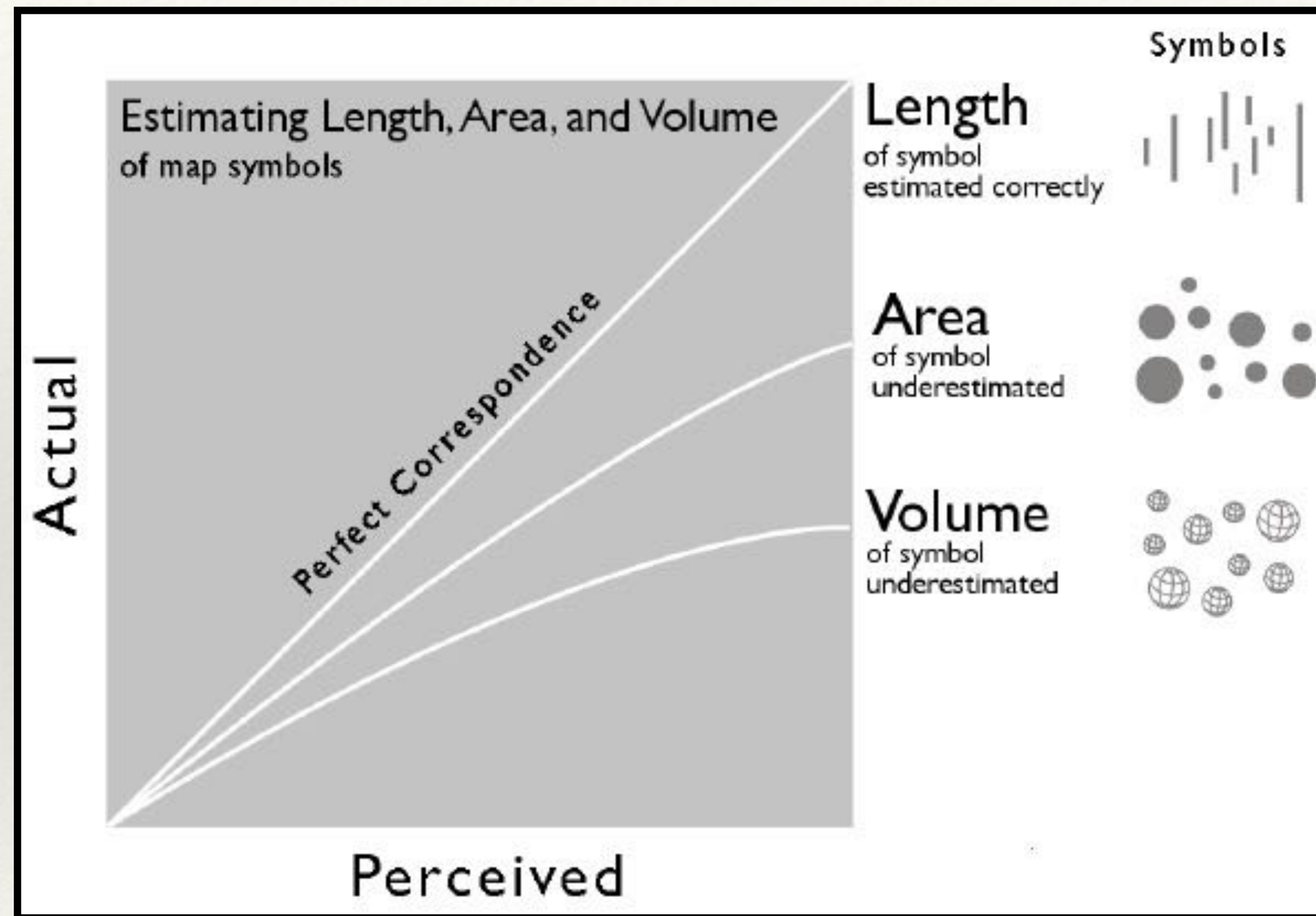
2-D Position



Esempio

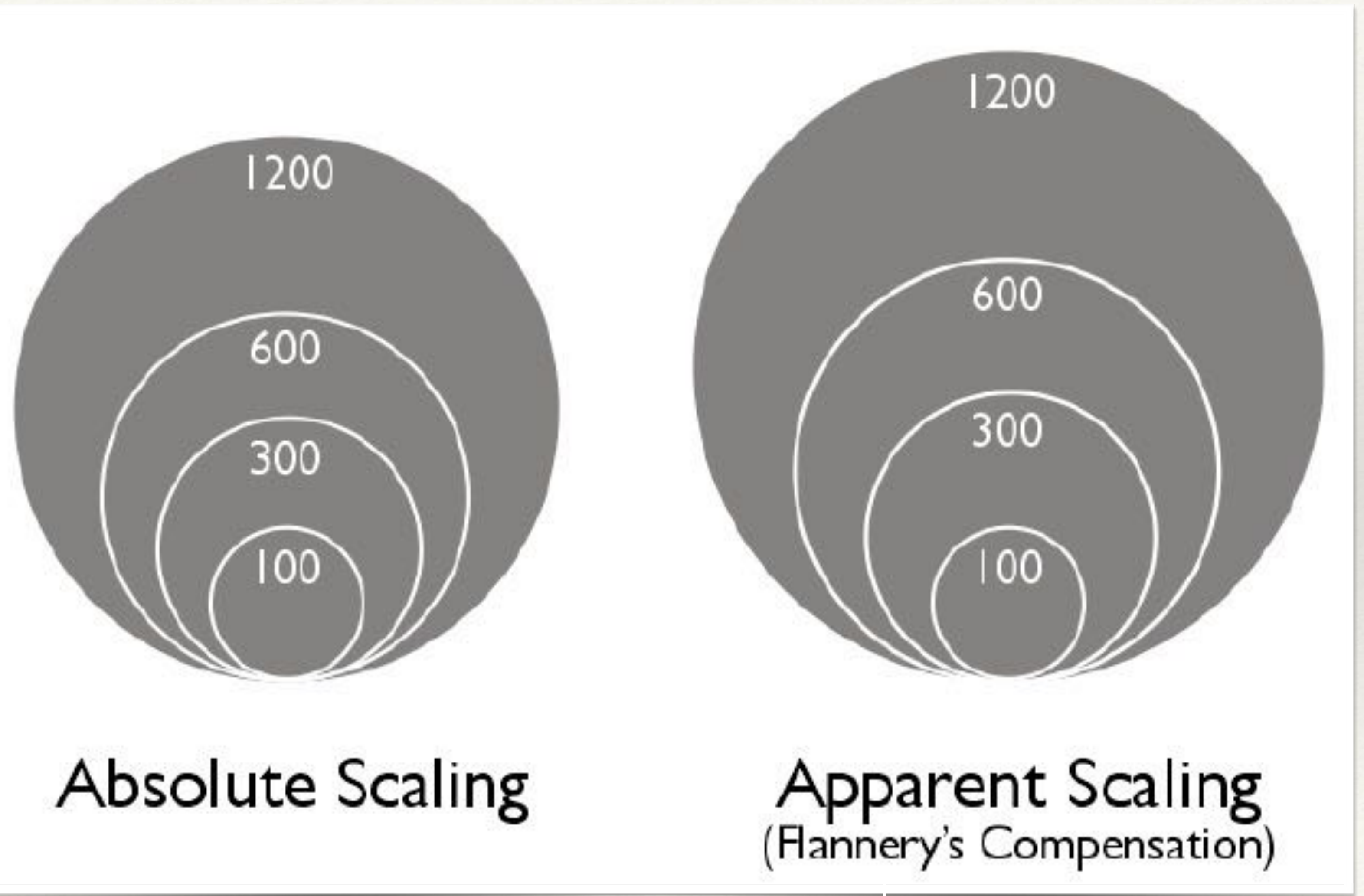


Forme



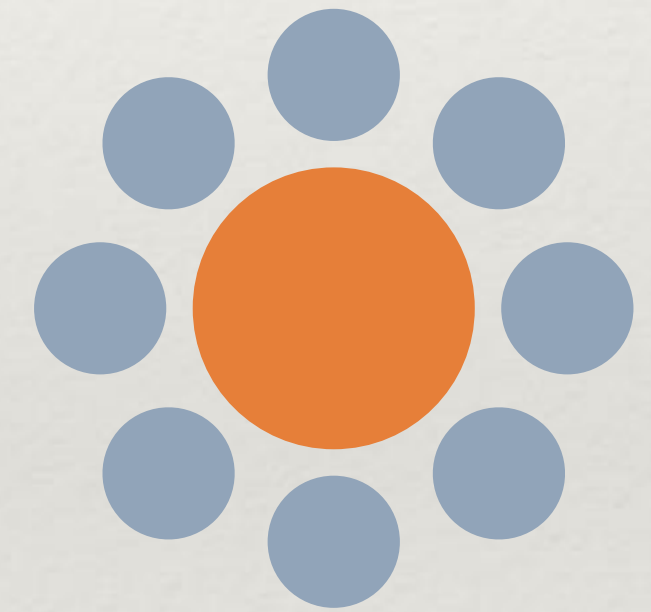
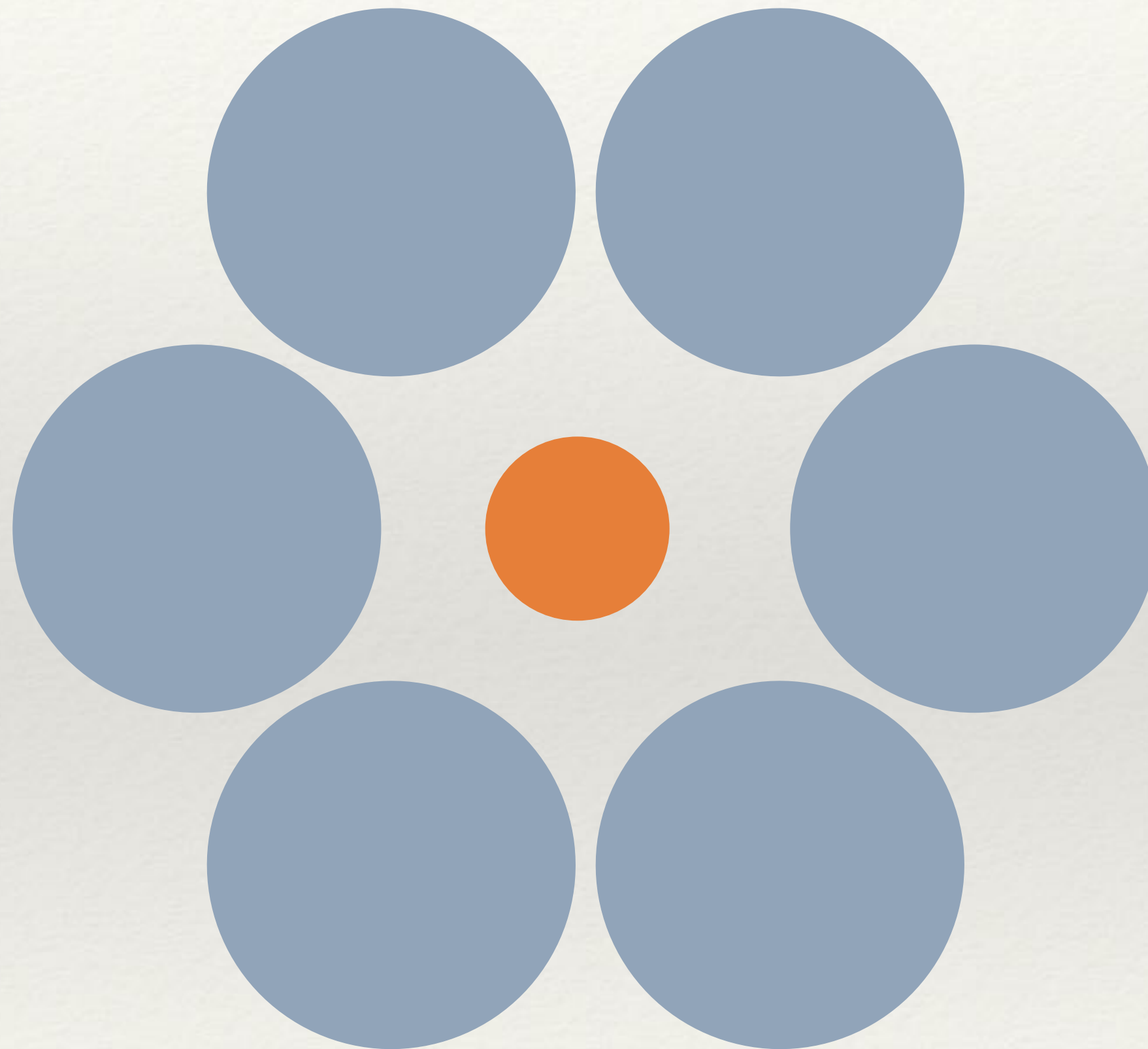
Forme

- ❖ Dimensioni effettive e percepite nei cerchi



Forme

- ❖ Dimensioni effettive e percepite nei cerchi



Animazioni

- ❖ Due attributi
 - ❖ Intermittenza (compare / scomparire)
 - ❖ Movimento (da una posizione all'altra)
- ❖ Uno dei modi più efficaci per attirare l'attenzione
- ❖ Molto spesso abusato nel marketing

Attenzione e movimento

https://www.youtube.com/watch?time_continue=2&v=vJG698U2Mvo

https://www.youtube.com/watch?v=IGQmdoK_ZfY

The Monkey Business Illusion

You are here: [Home](#) › The Monkey Business Illusion – A Great New Take On A Classic Psychology Study

The Monkey Business Illusion – A Great New Take On A Classic Psychology Study

by **Christopher Fisher, PhD** on [July 12, 2010](#) in **Cognition, Featured**



A new study finds that those who know that an unexpected event is likely to occur are no better at noticing other unexpected events – and may be even worse – than those who are not expecting the unexpected. The study, from Daniel Simons, a professor of psychology and in the Beckman Institute at the University of Illinois, appears this month as the inaugural paper in the new open access journal [i-Perception](#). **Test your own skill! Several videos from the study are embedded in this report.**

The study used a new video based on one used in a now-famous experiment conducted in the late 1990s by Simons and his collaborator, Christopher Chabris, now a psychology professor at Union College in New York. In the original video, two groups of people – some dressed in white, some in black – are passing basketballs back and forth. The study subjects were asked to count the passes among those dressed in white while ignoring the passes of those in black.

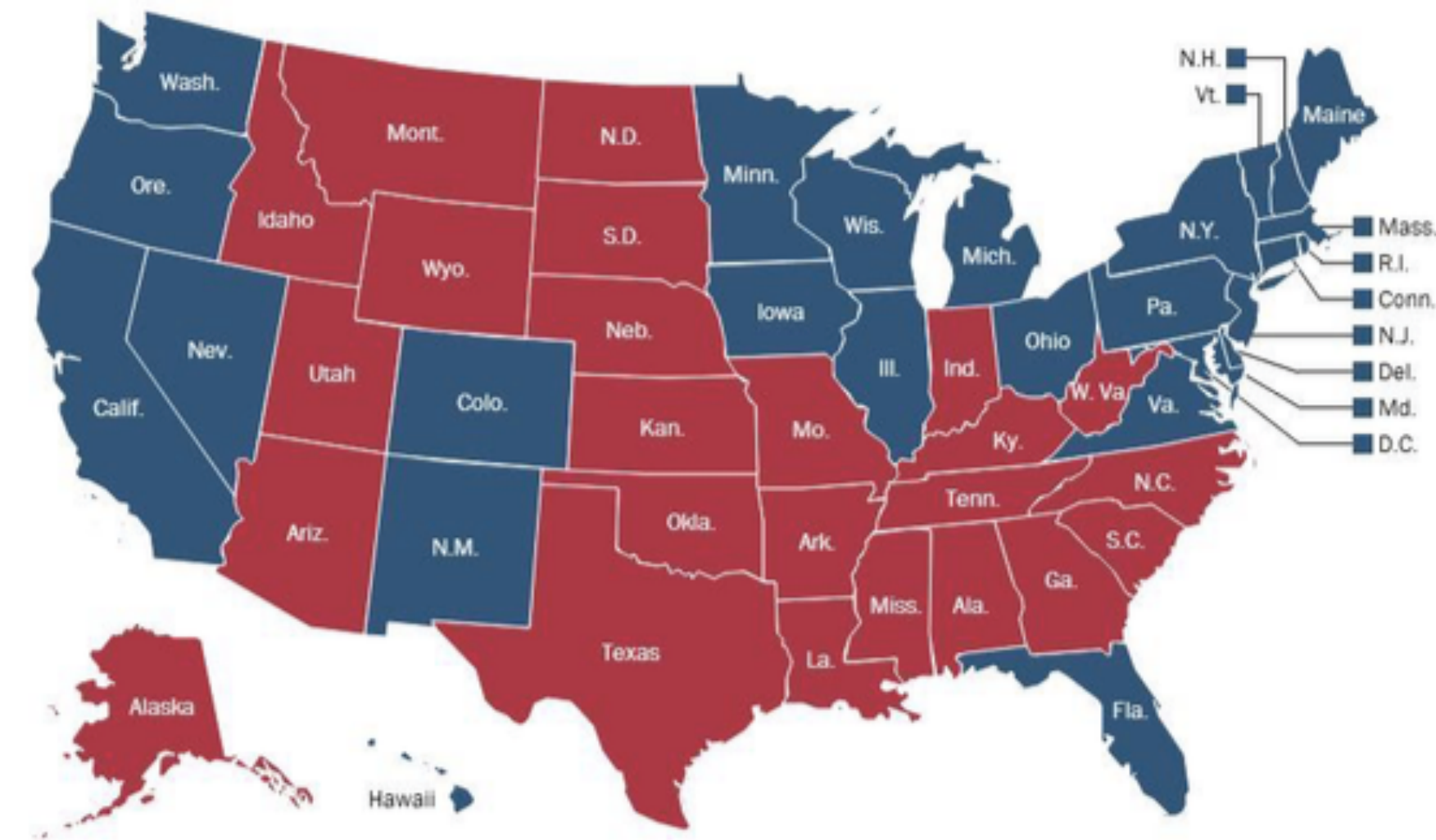
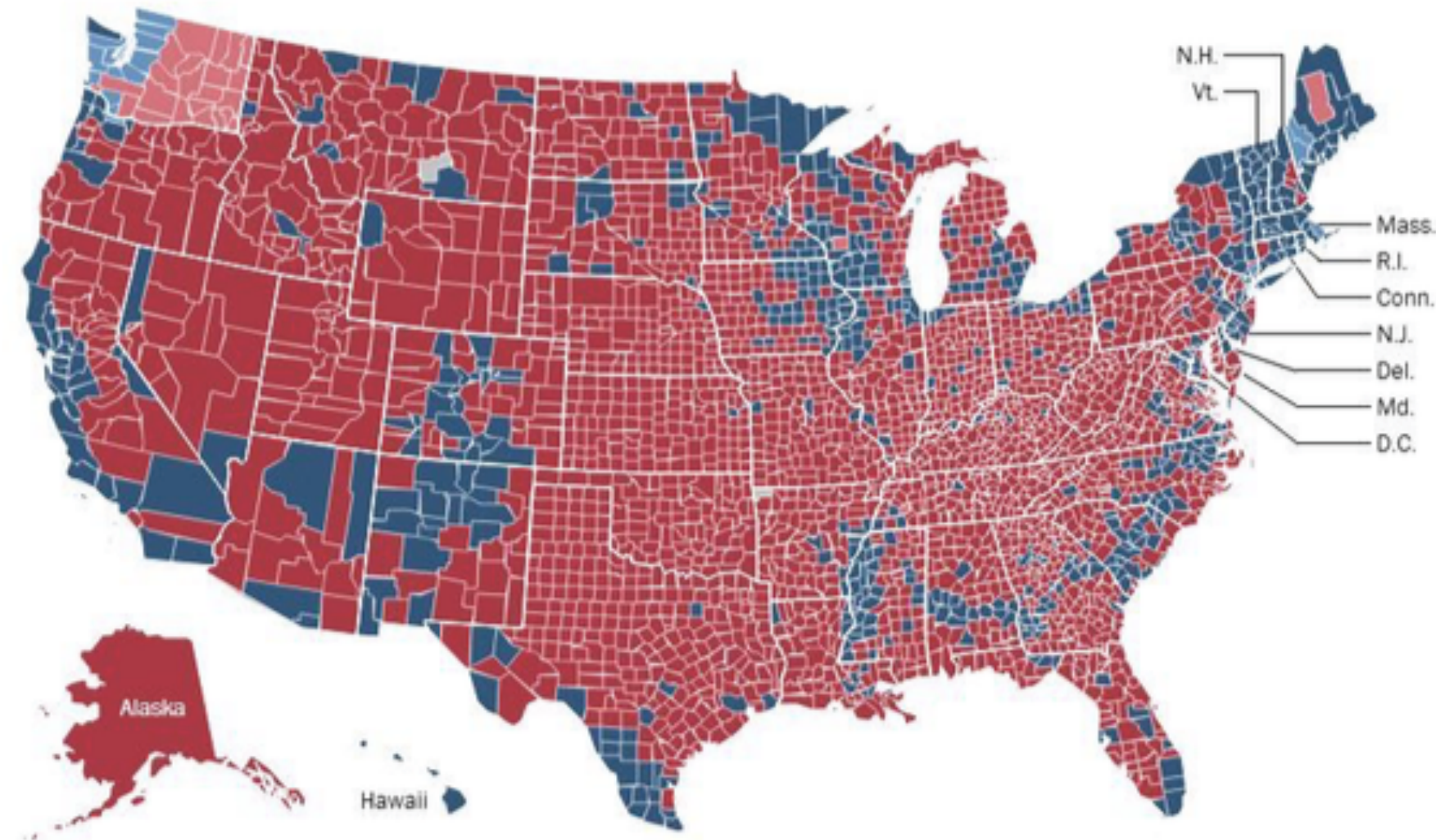
Test your own skill at this task:

<http://www.bmedreport.com/archives/14998>

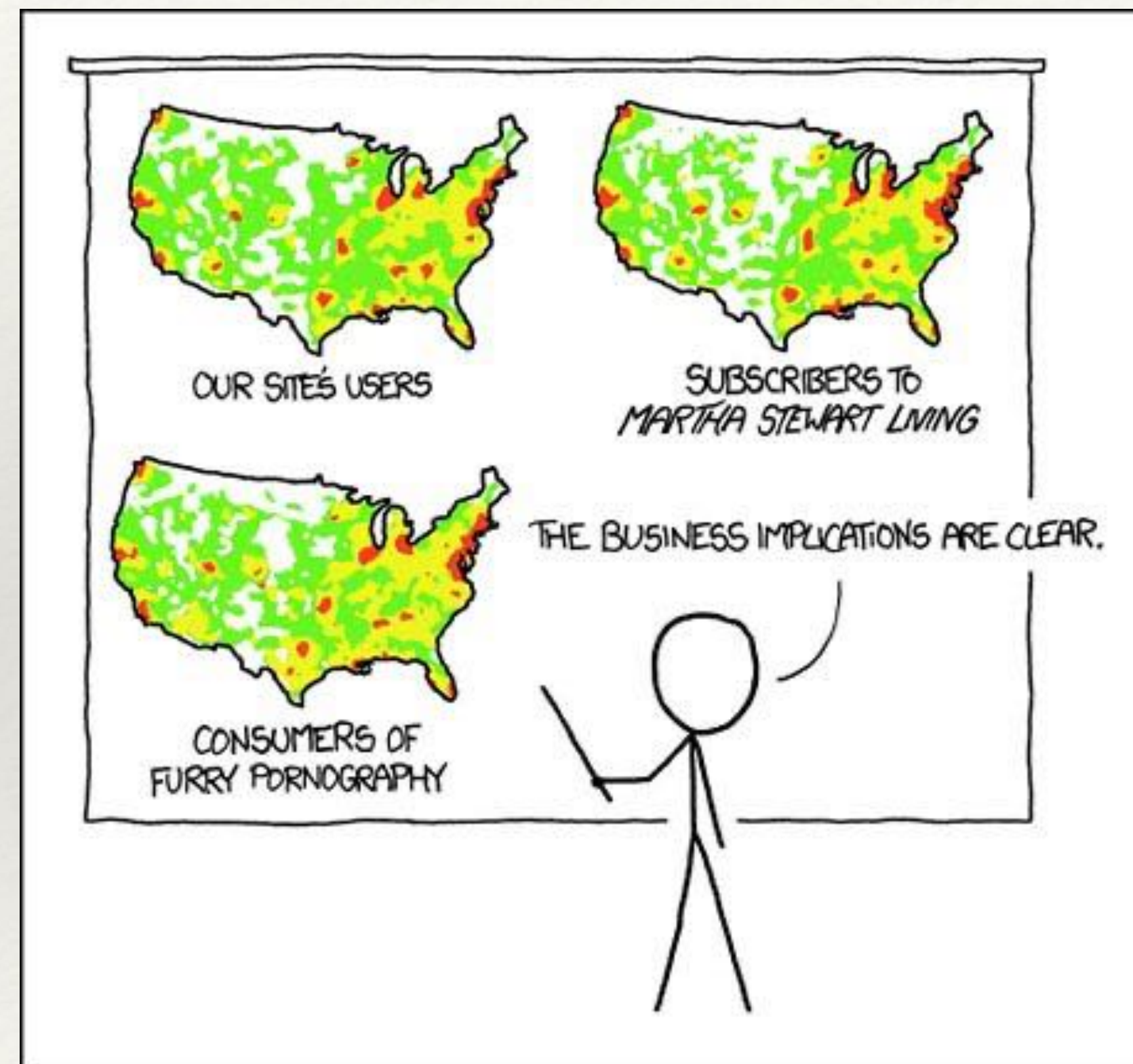
Lezione #5

“Usare attributi pre-attentive per valorizzare ed esaltare strutture che emergono dai dati, ma non esagerare. Inoltre, non fidatevi troppo di quello che l’occhio vede e vuole vedere”

Raccontare storie diverse con stessi dati

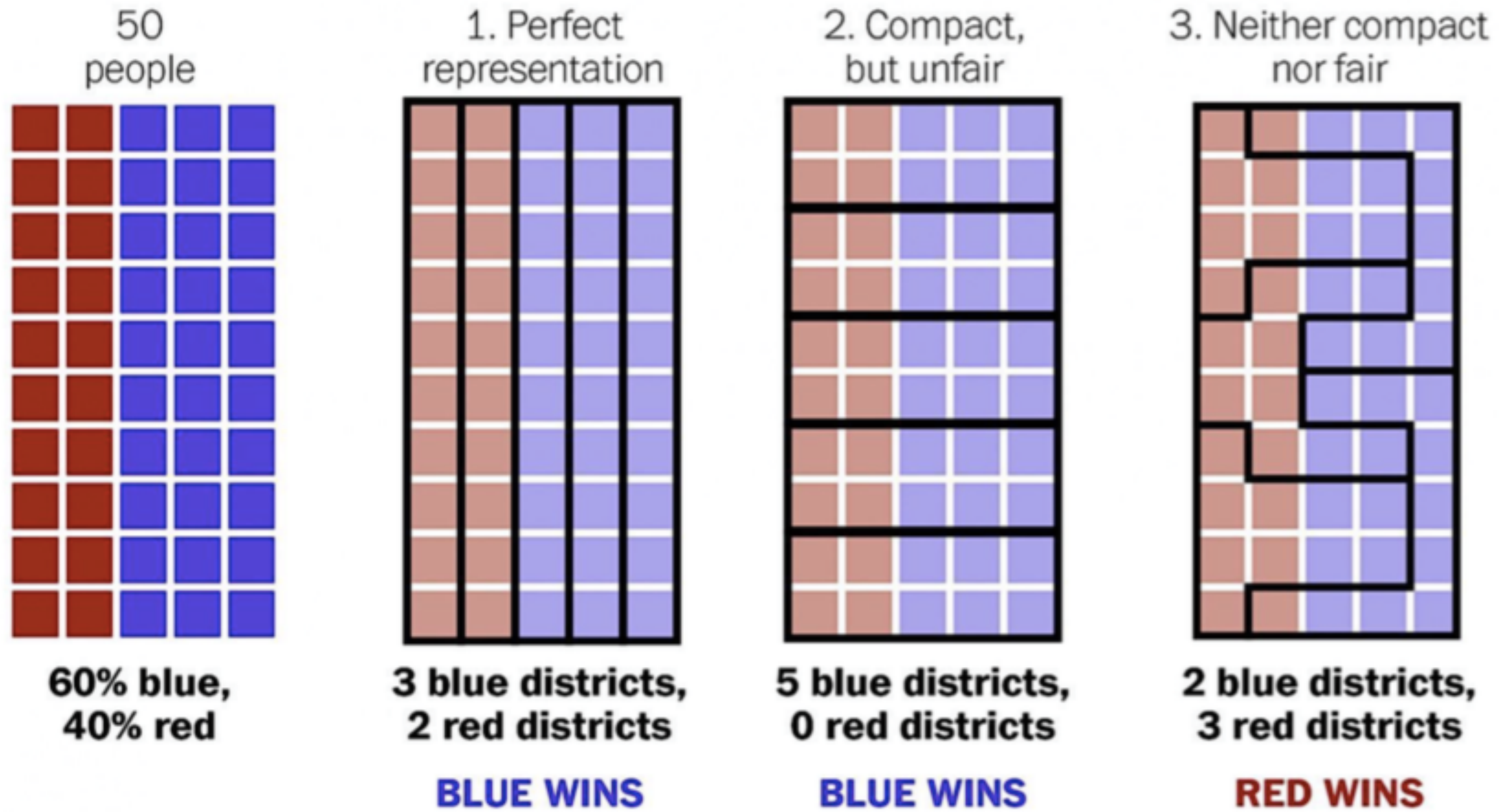


anche "mappe di calore" e dotmap hanno problemi

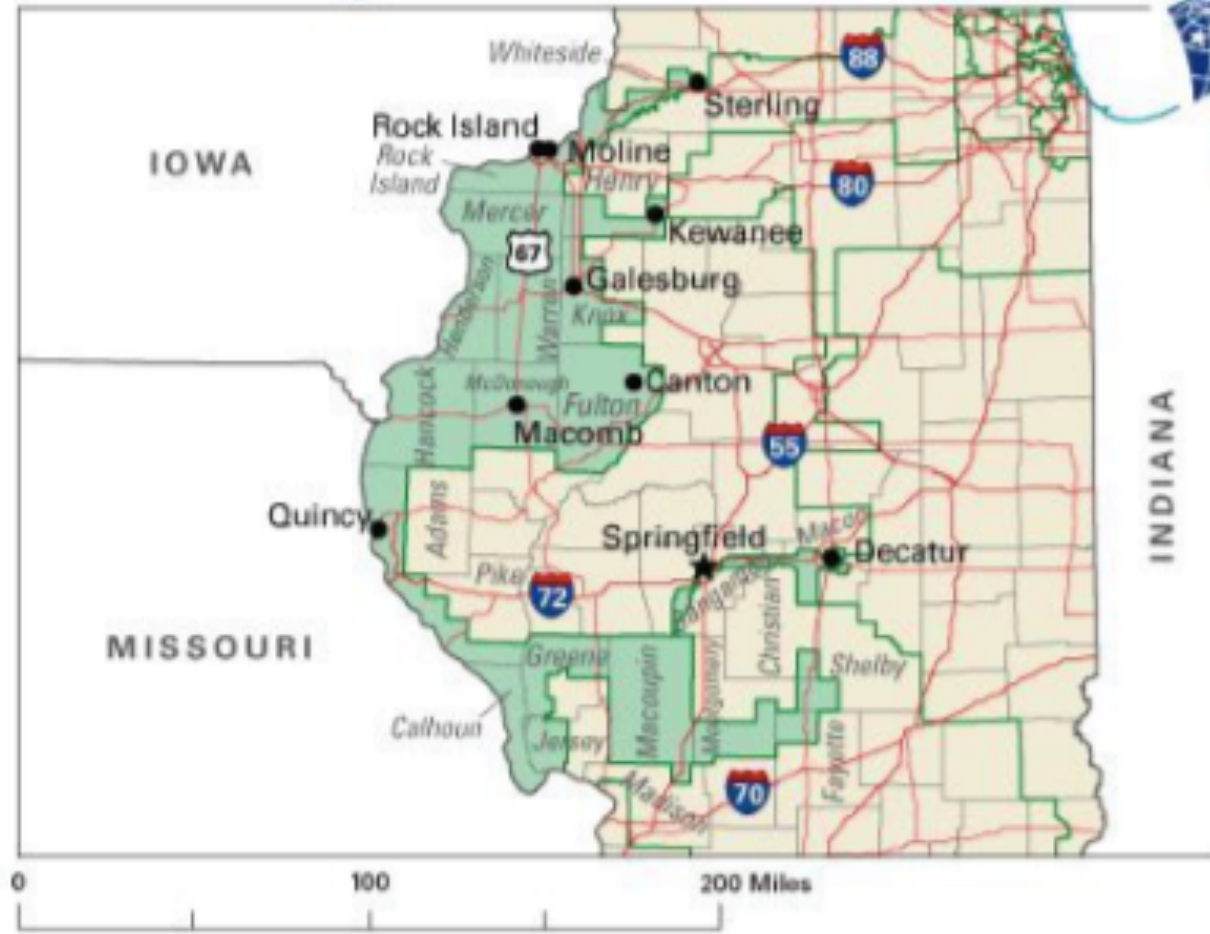


PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE
BASICALLY JUST POPULATION MAPS

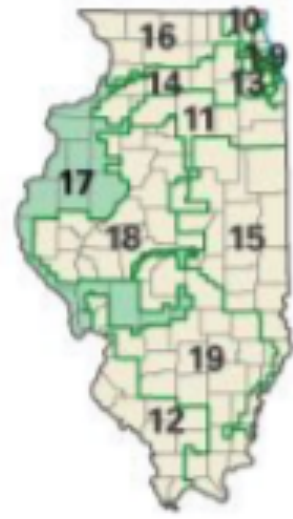
gerrymandering



Congressional District 17



17 Congressional District
Fulton County



Illinois (19 Districts)

Congressional District 2



2 Congressional District
Grand County

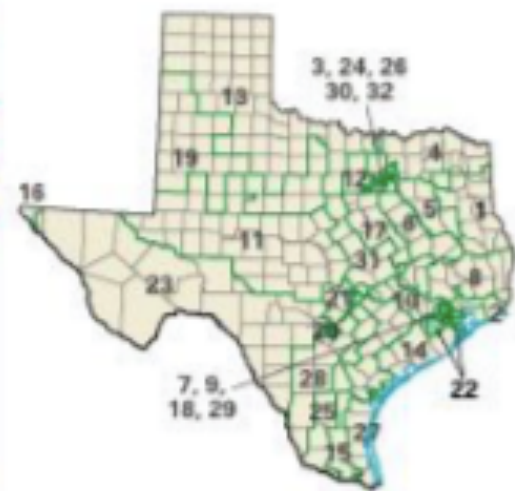


Utah (3 Districts)

Congressional District 22



22 Congressional District
Harris County



Texas (32 Districts)

Congressional District 12



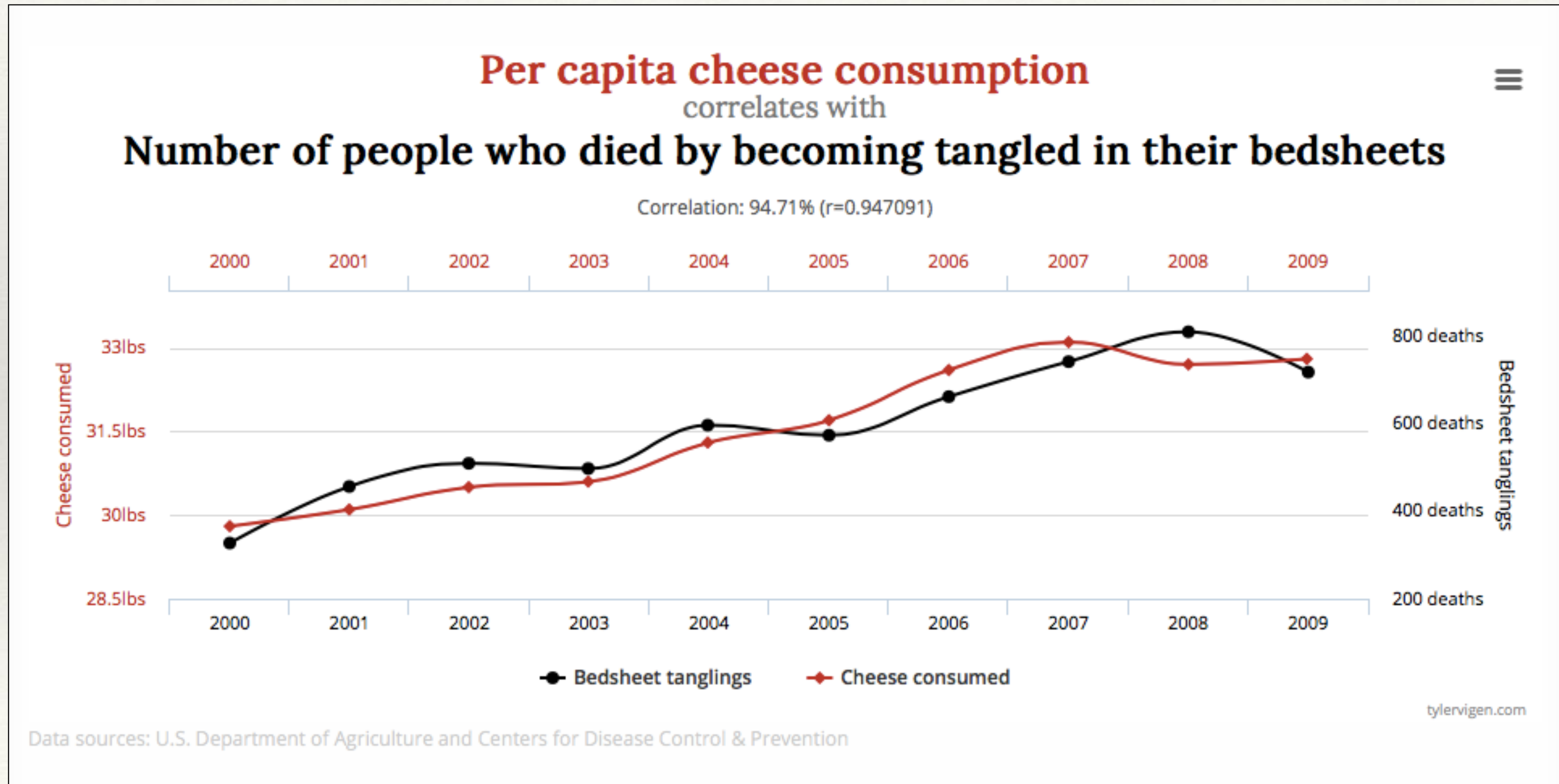
12 Congressional District
Rowan County



North Carolina (13 Districts)

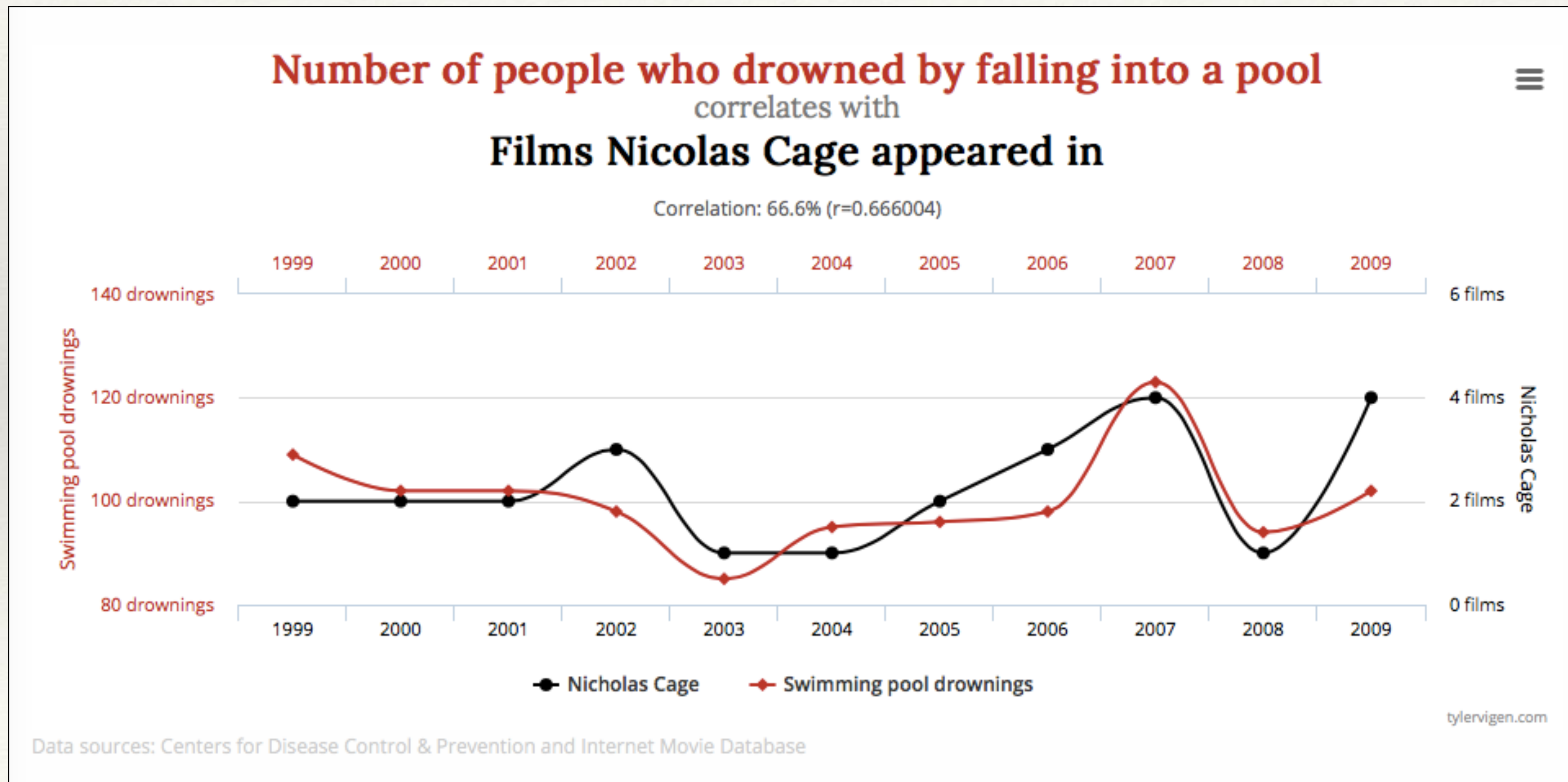
Correlazioni spurie

<http://www.tylervigen.com/spurious-correlations>



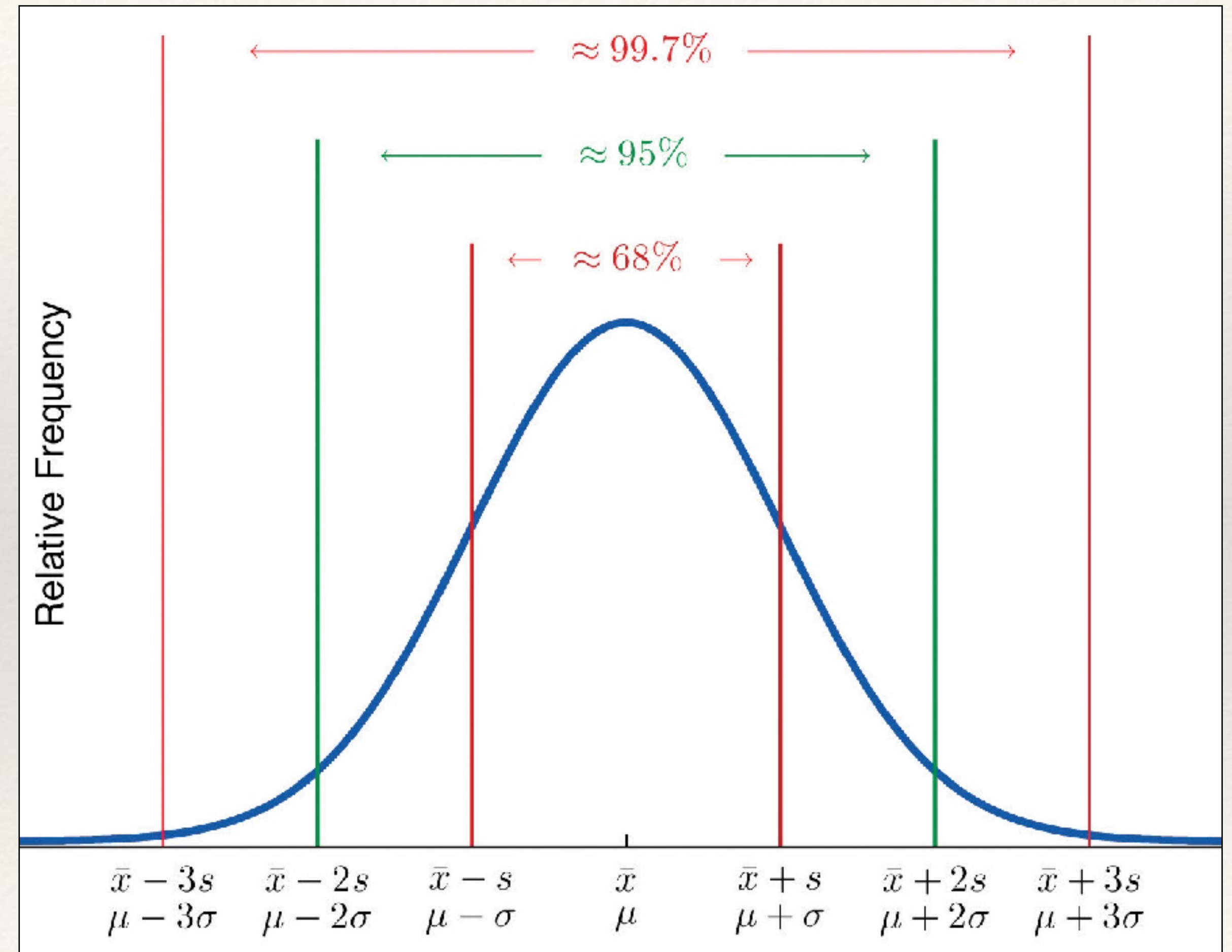
Correlazioni spurie

<http://www.tylervigen.com/spurious-correlations>



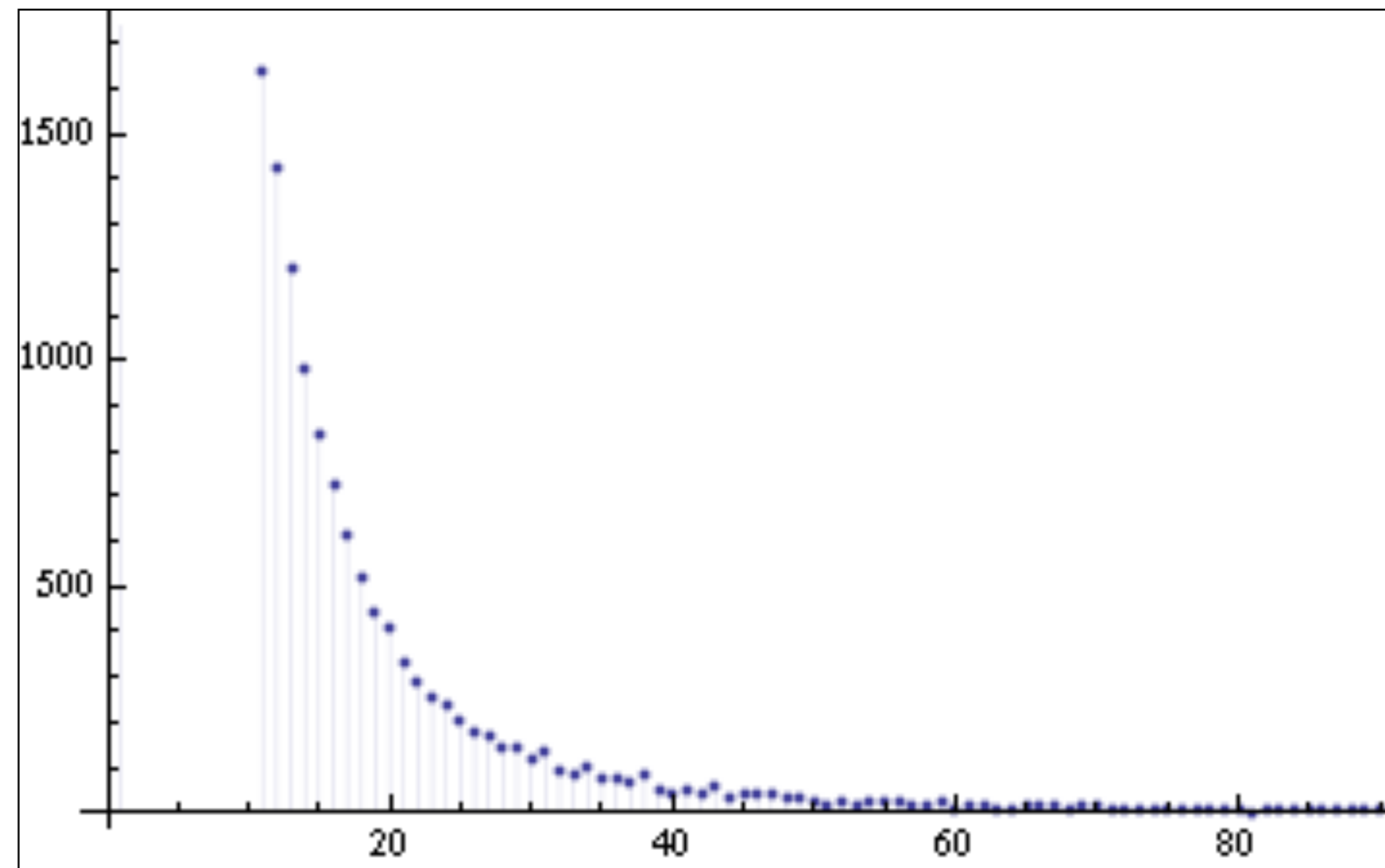
La media statistica

- ❖ Distribuzione delle altezze negli individui: la media ci aiuta a fare predizioni
- ❖ Ma attenzione, anche rimanendo alla statistica elementare, non c'è solo la media!



La media statistica

La media in questo caso non ha alcun valore statistico!



In questo caso gli eventi estremi sono poco probabili, ma comunque MOLTO più probabili che con una curva a "campana"

esempio: Distribuzione della ricchezza

Esempio: climate change

- ❖ "Quest'anno anno abbiamo avuto le minime più basse degli ultimi anni: con questo freddo, come si fa a parlare di *riscaldamento globale?*"



Capire un fenomeno complesso da pochi eventi locali è sbagliato

Abbiamo bisogno di molto più contesto e di tante tante tante analisi

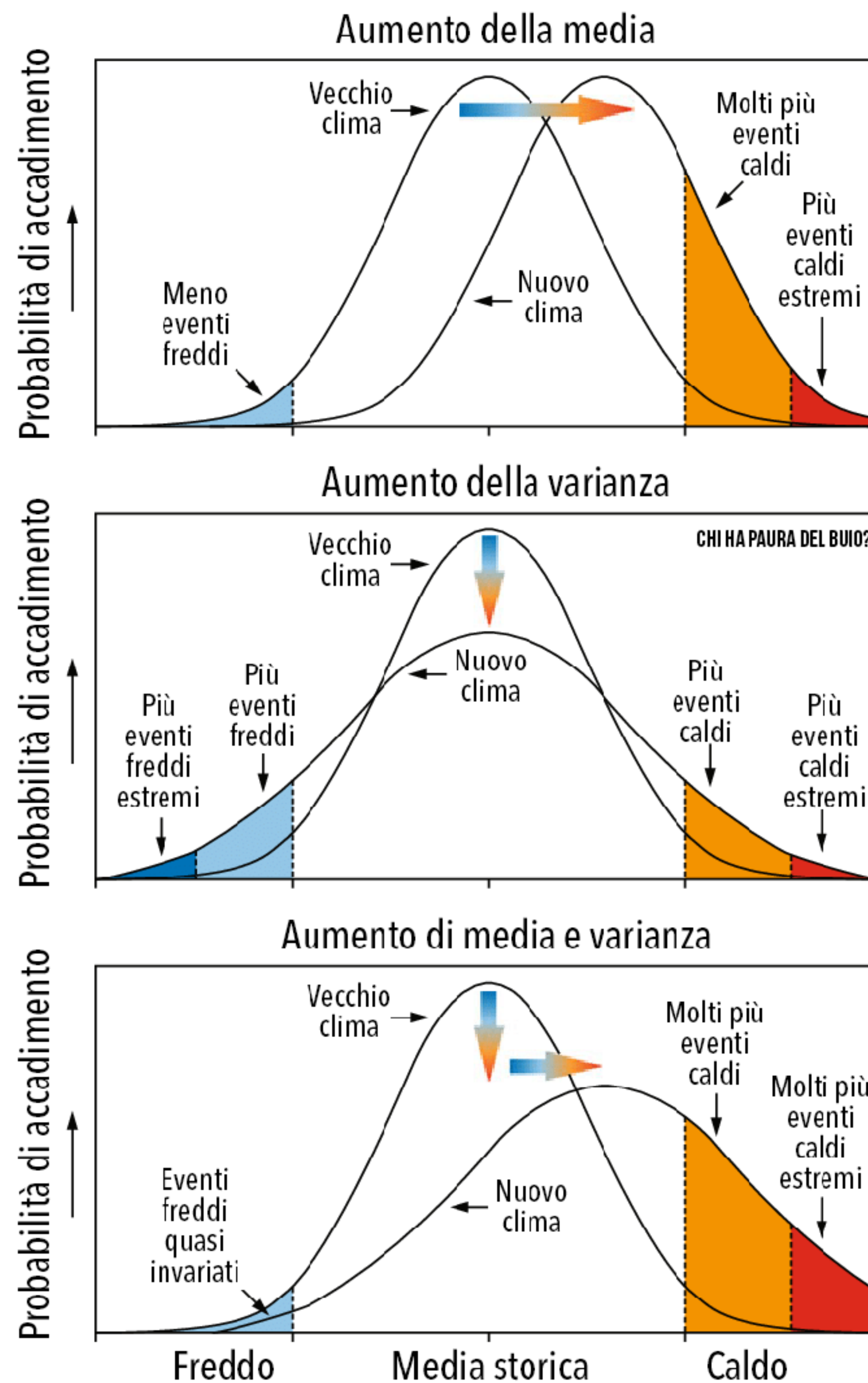
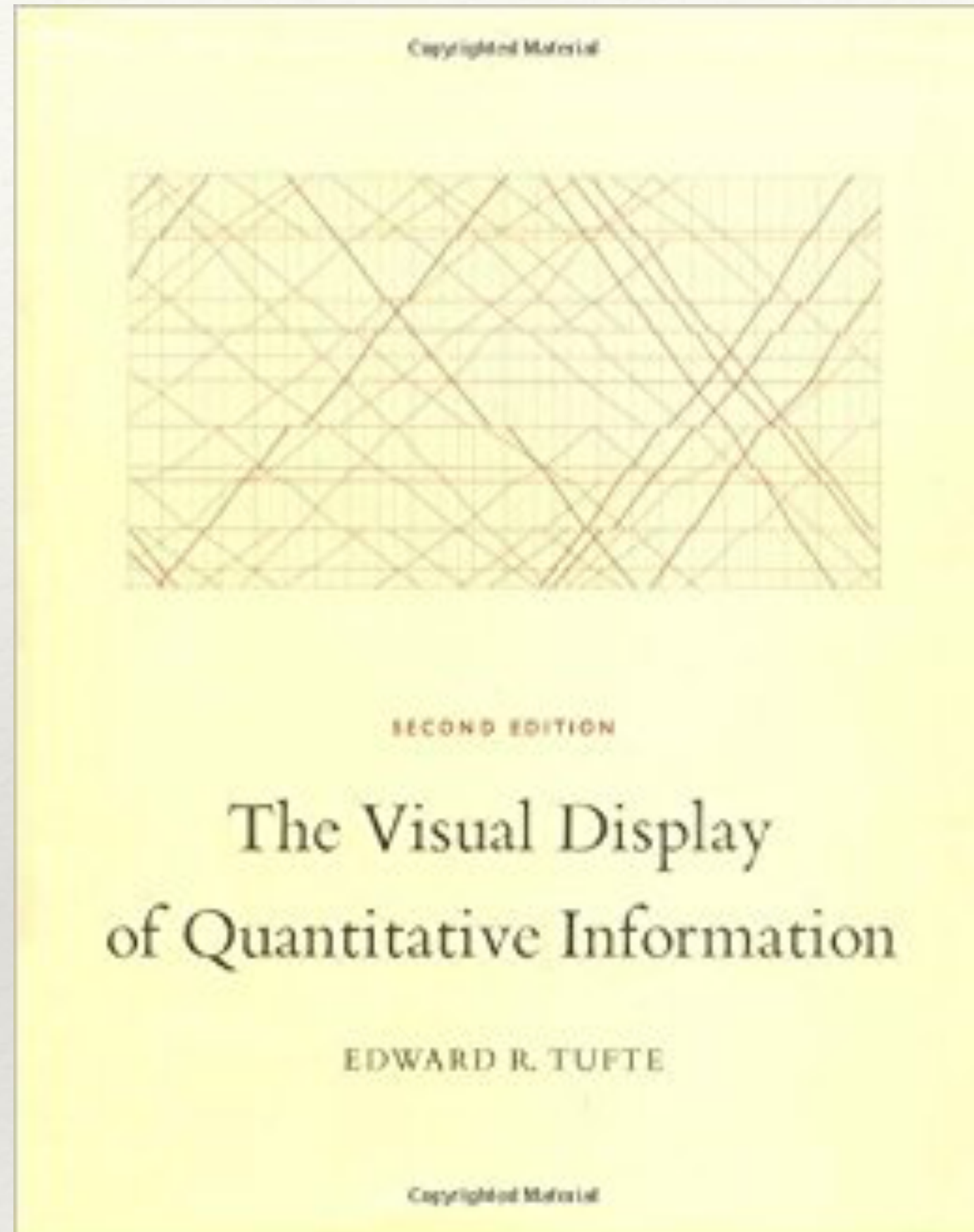


Immagine tratta da Olaf Jensen -
"Chi ha paura del buio?"

Lezione #6

“Non torturare i dati con una matematica sbagliata. Indici, misure, rappresentazioni e modelli per fare predizioni sono spesso utili, ma il rischio di usare strumenti non fondati matematicamente è altissimo e quasi mai i risultati sono ovvi”

Integrità grafica



The Visual Display of Quantitative Information
Edward R. Tufte

https://www.edwardtufte.com/tufte/books_vdqi

Lie Factor

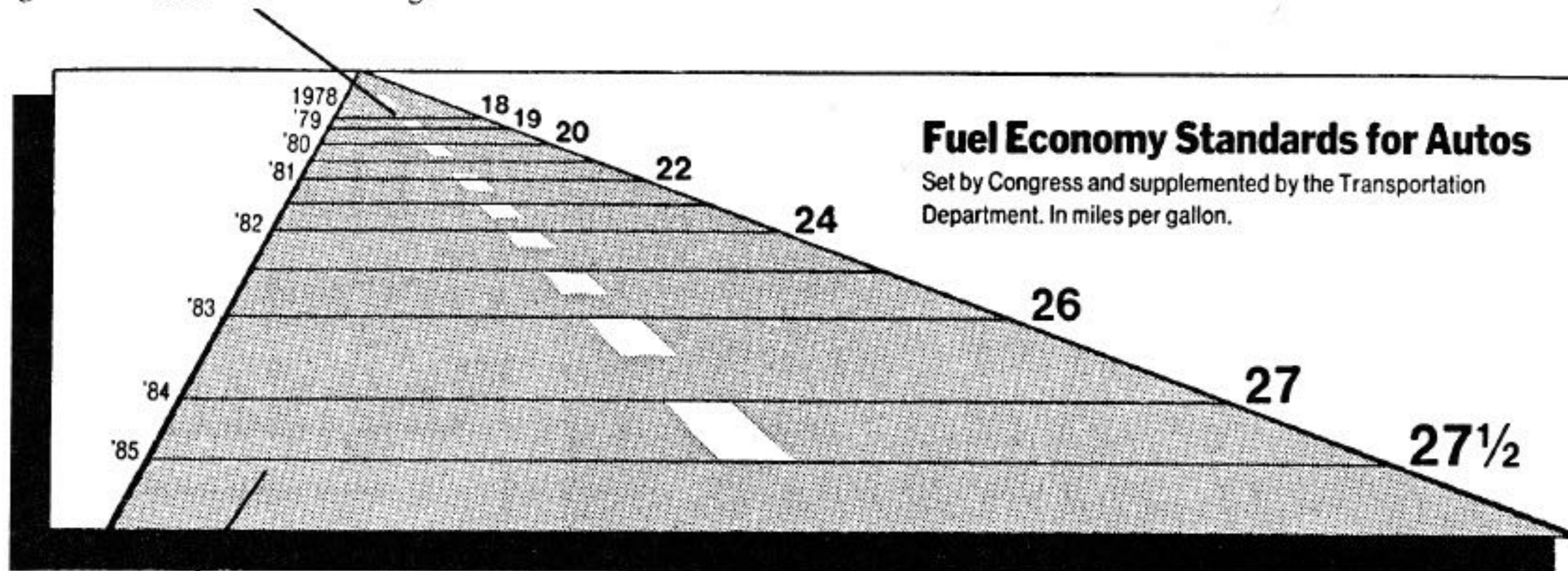
$$\text{Lie Factor} = \frac{\text{size of effect shown in graphic}}{\text{size of effect in data}}$$

Lie factor should be close to one
i.e. $1.05 > \text{Lie Factor} > 0.95$

VDQI Example (p57)

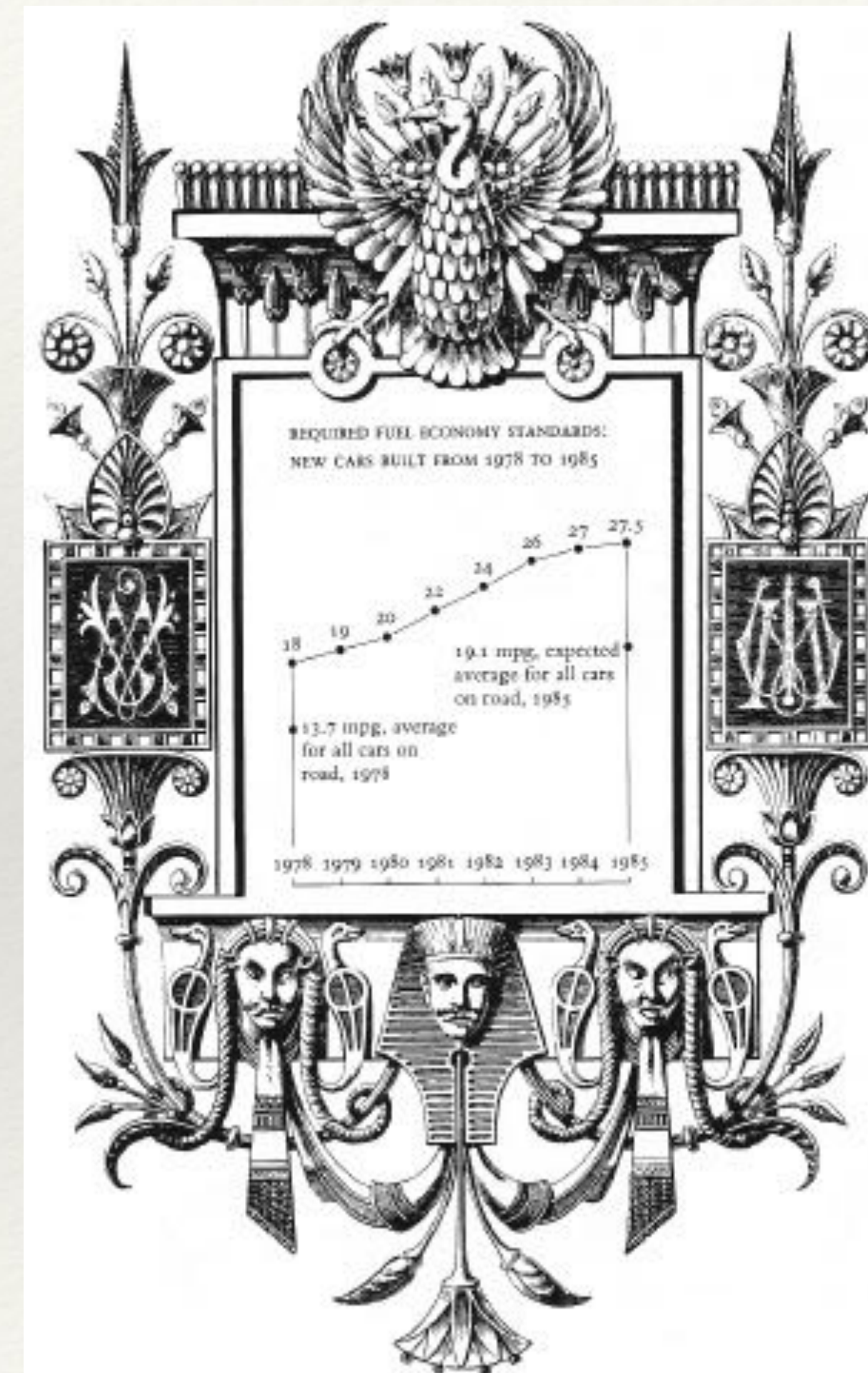
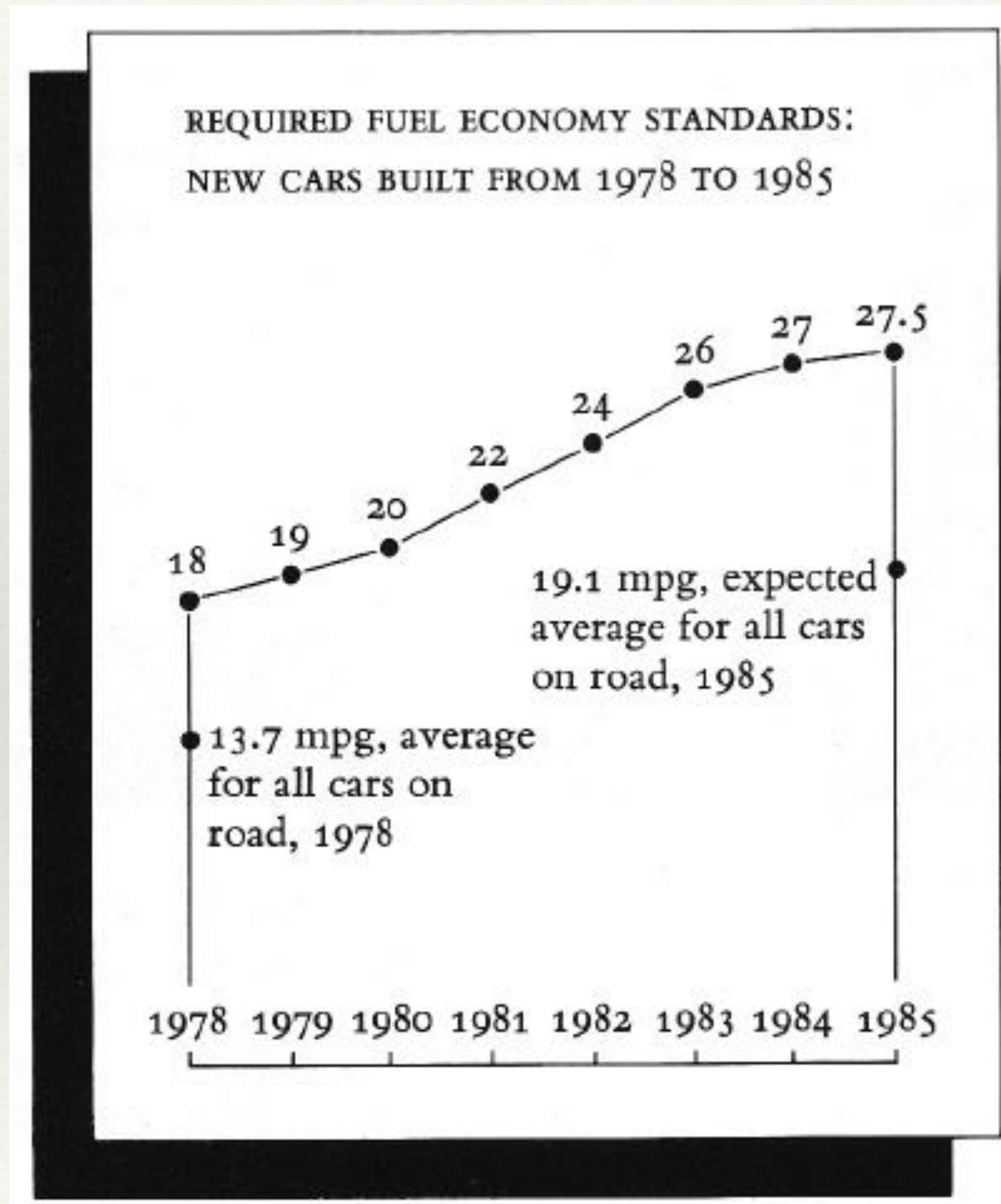
$$\frac{27.5-18.0}{18.0} = 0.53 \quad \frac{5.3-0.6}{0.6} = 7.83 \quad \text{Lie Factor} = \frac{7.83}{0.53} = 14.8$$

This line, representing 18 miles per gallon in 1978, is 0.6 inches long.



This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.

VDQI Example (p58) – No Lies!

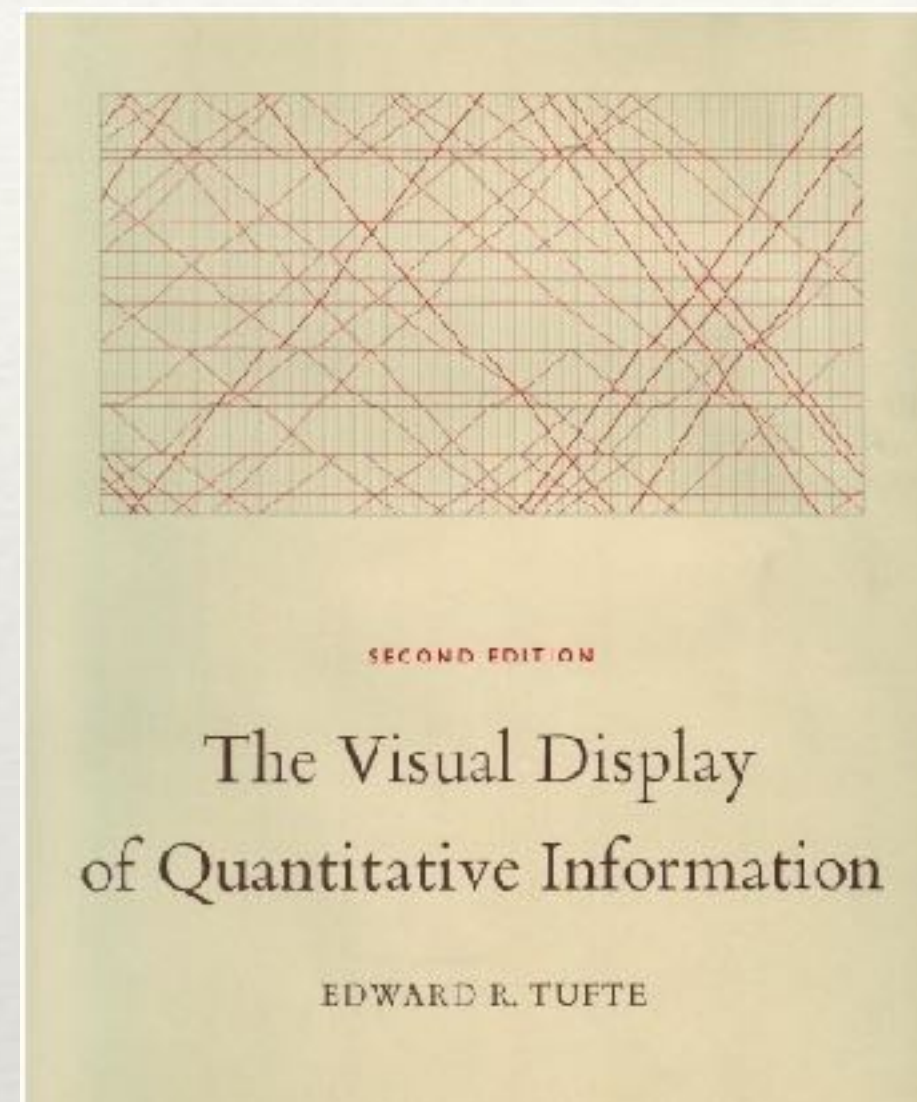


Lezione #7

“Non introdurre bugie nascondendosi dietro l’idea di migliorare l’estetica della infografica. Esistono misure molto efficaci ed oggettive che svelano l’inganno e la reputazione si perde in un baleno”

Valutazione e (re)design

Resources



The Visual Display of Quantitative Information
by Edward R. Tufte, Graphics Press, 2001

Graphical Redesign

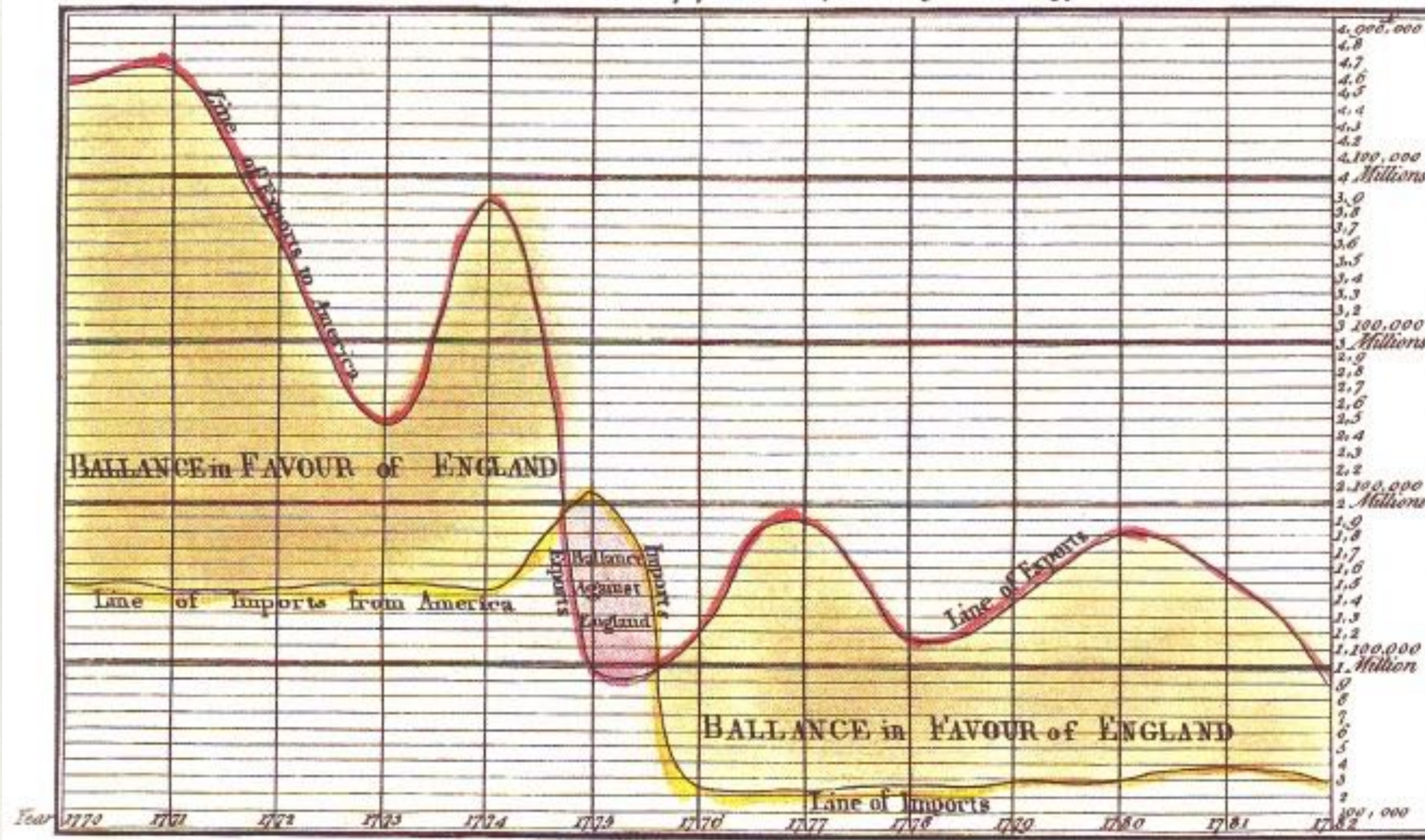
VDQI Chapter 4

“Above all else, show the data.”

–Edward Tufte

VDQI Example (p91)

*CHART of IMPORTS and EXPORTS of ENGLAND to and from all NORTH AMERICA
From the Year 1770 to 1782 by W. Playfair*

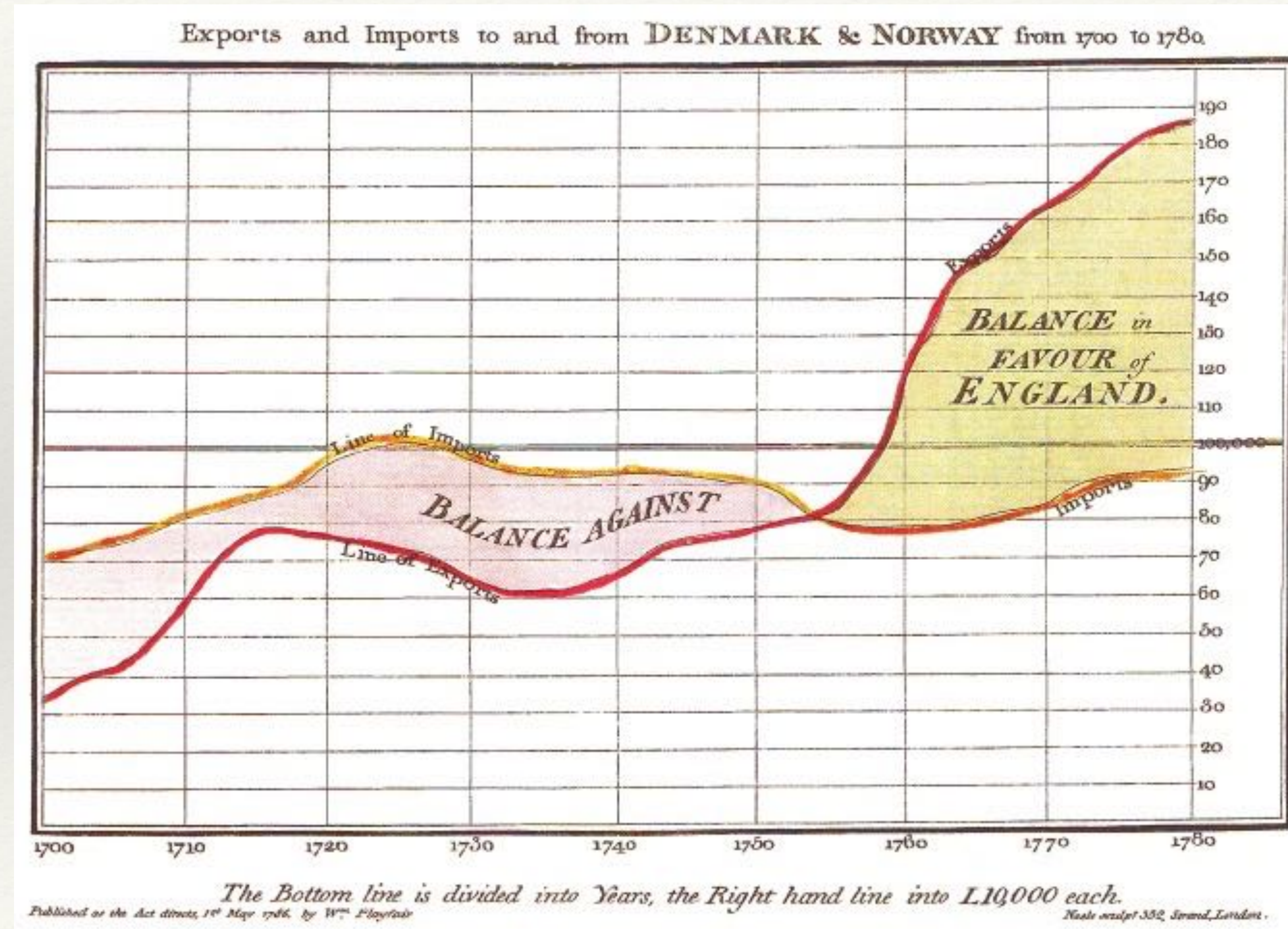


The Bottom Line is divided into Years the right-hand Line into HUNDRED THOUSAND POUNDS

J. Ainslie Sculp.

Published as the Act directs 20th Aug^r 1785.

VDQI Example (p91)



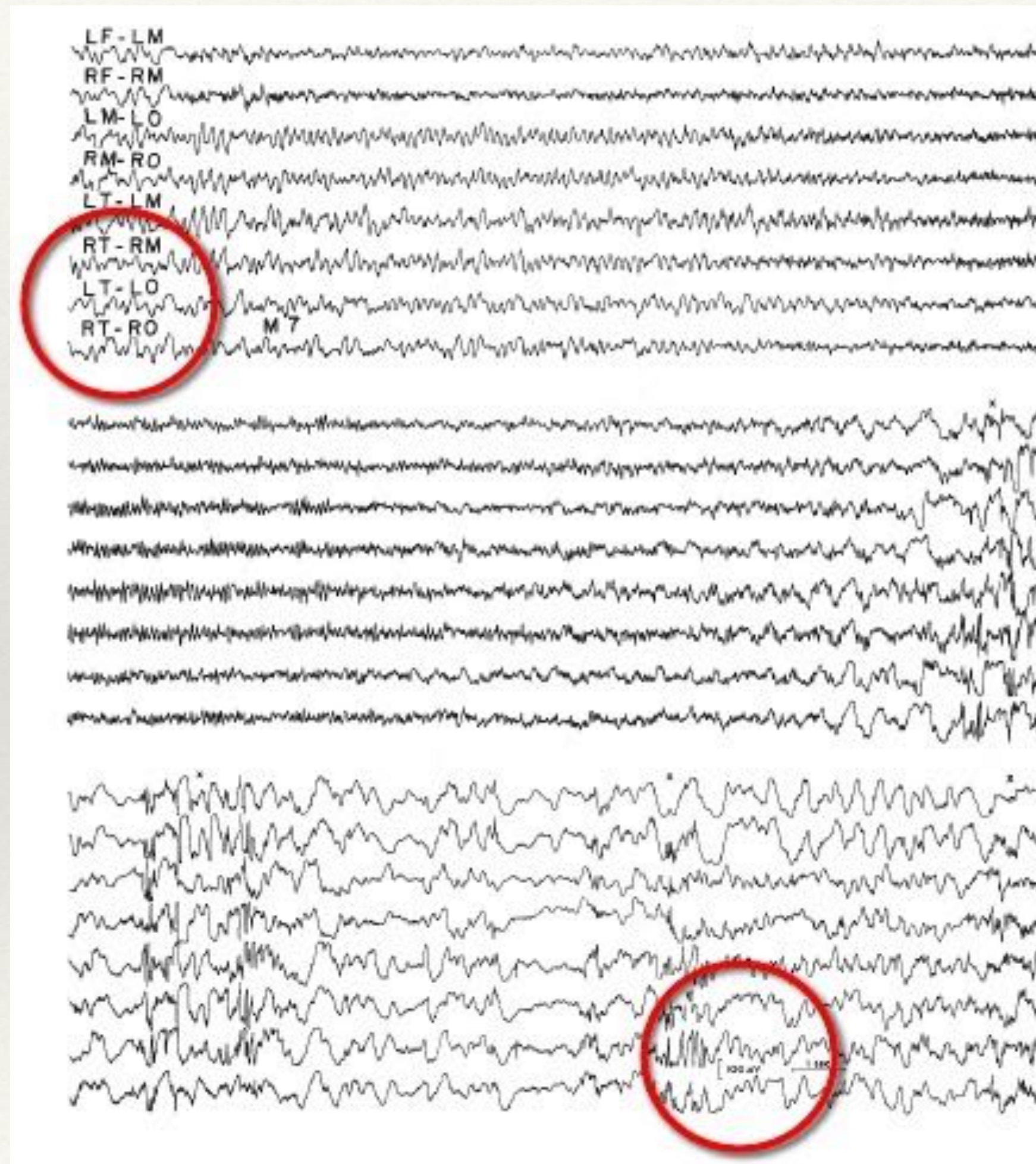
Data-Ink Ratio

$$\text{Data-Ink Ratio} = \frac{\text{data-ink}}{\text{total ink used in graphic}}$$

= proportion of a graphic's ink devoted to the non-redundant display of data-information

= 1.0 – proportion of a graphic that can be erased without loss of data-information

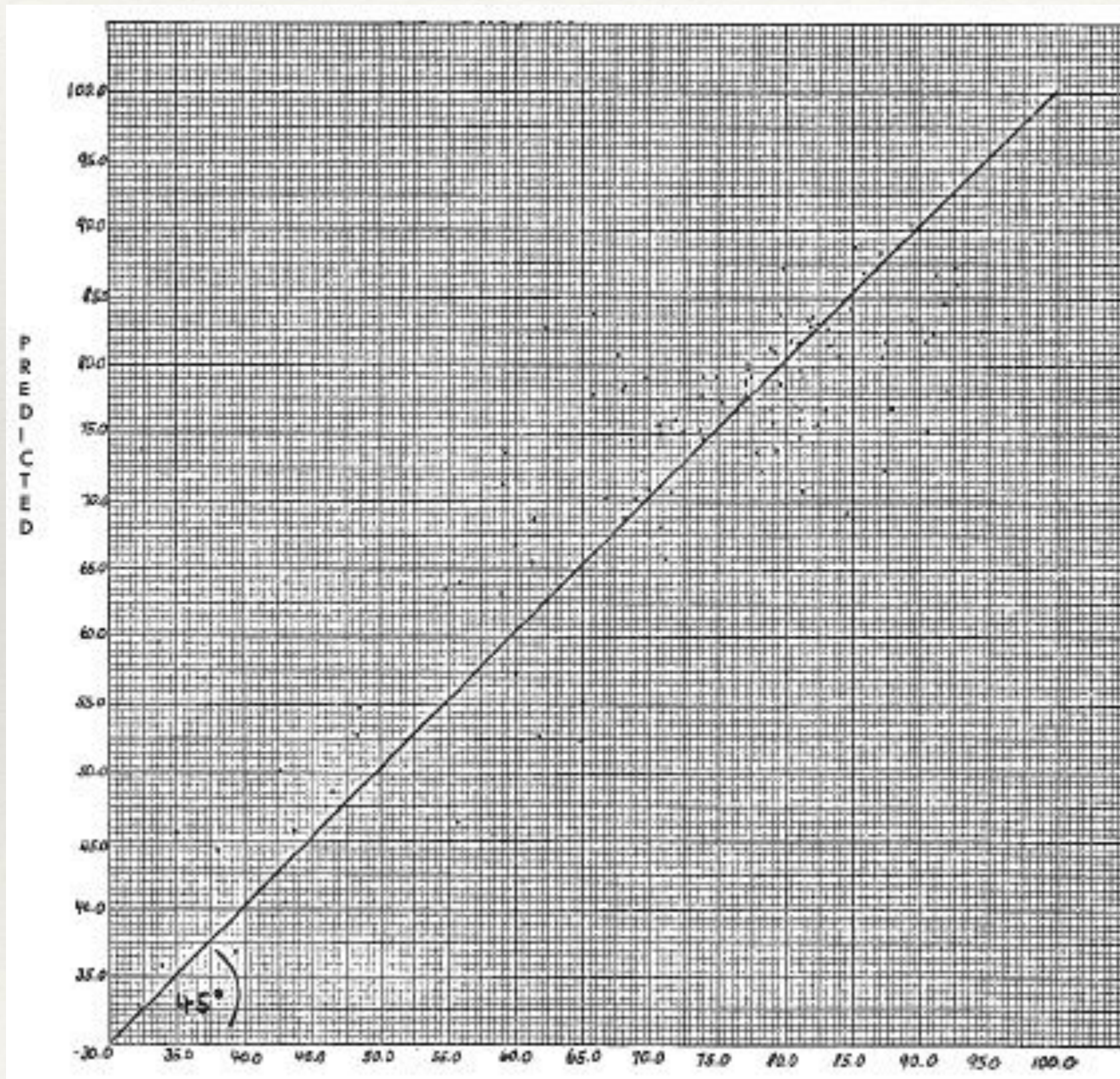
VDQI Example (p93)



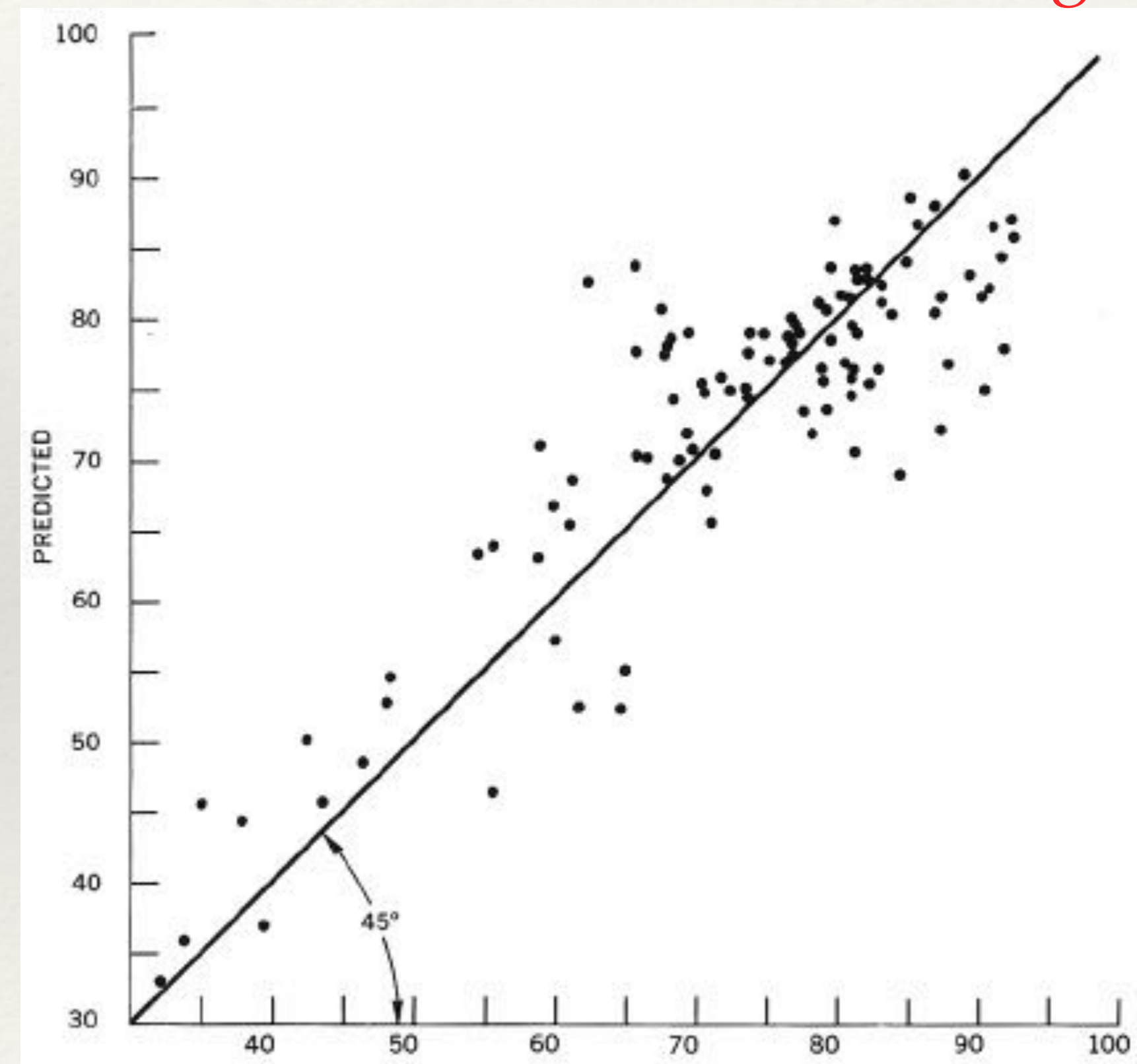
Nothing can be erased
without losing information

VDQI Example (p94)

data-ink:low



data-ink:high



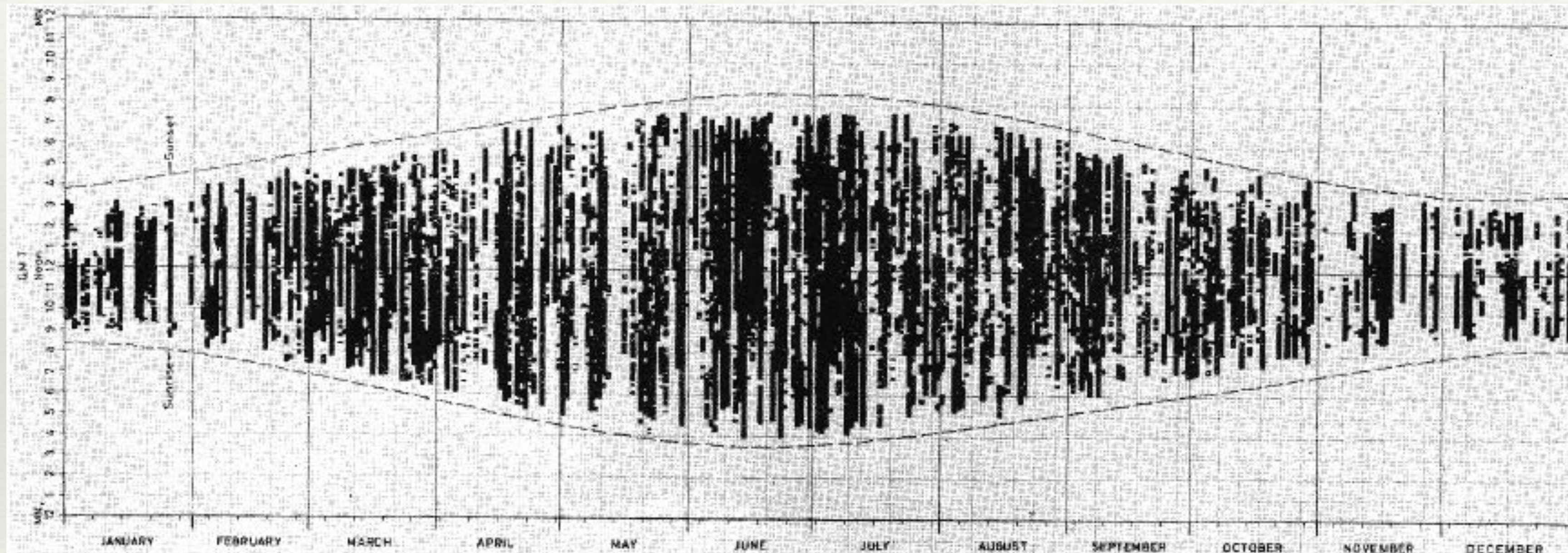
Data Density
VDQI Chapter 8

Data Density

$$\text{Data Density} = \frac{\text{number of entries in data matrix}}{\text{area of data graphic}}$$

VDQI Example (p163)

annual
sunshine record



1,000 numbers per
square inch

VDQI Example (p 160)

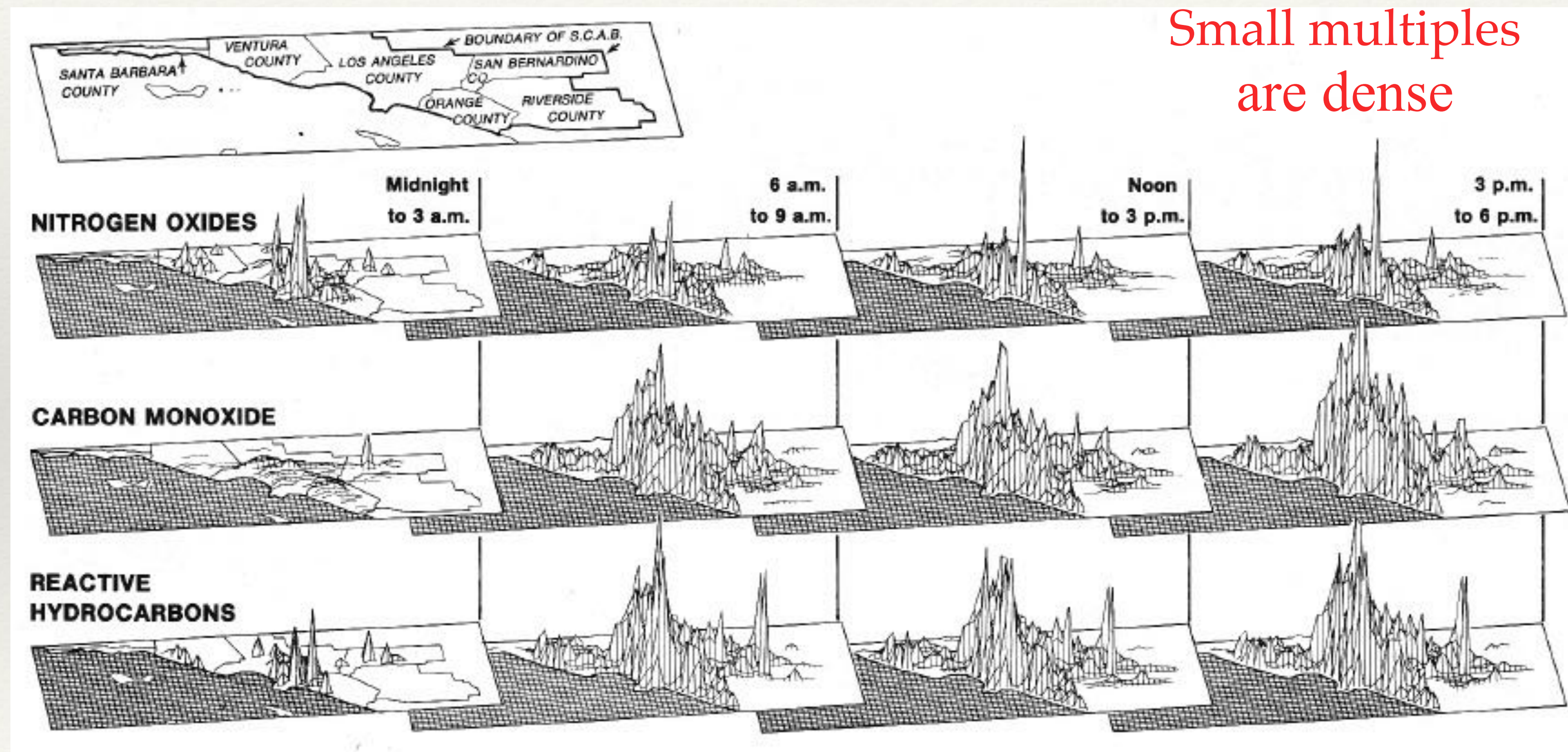
NO. 1450. STEEL PRODUCTS—NET SHIPMENTS, BY MARKET CLASSES: 1960 TO 1978
 [In thousands of short tons. Comprises carbon, alloy, and stainless steel. "N.e.c." means not elsewhere classified]

MARKET CLASS	1960	1965	1970	1973	1974	1975	1976	1977	1978
Total ¹	71,149	92,666	90,798	111,430	109,472	79,957	89,447	91,147	97,935
Steel for converting and processing.....	2,928	3,932	3,443	4,714	4,486	3,255	4,036	3,679	4,612
Independent forgers, n.e.c.....	841	1,250	1,048	1,213	1,339	1,098	952	998	1,192
Industrial fasteners ²	1,071	1,234	1,005	1,278	1,331	675	912	848	870
Steel service centers, distributors.....	11,125	14,813	16,025	20,383	20,400	12,700	14,615	15,346	17,333
Construction, incl. maintenance.....	9,664	11,836	8,913	10,731	11,360	8,119	7,508	7,553	9,612
Contractors' products.....	3,602	5,018	4,440	6,459	6,249	3,927	4,502	4,500	3,480
Automotive.....	14,610	20,123	14,475	23,217	18,928	15,214	21,351	21,490	21,253
Rail transportation.....	2,525	3,805	3,098	3,228	3,417	3,152	3,056	3,238	3,549
Freight cars, passenger cars, locomotives.....	1,763	2,875	2,005	1,997	2,097	1,794	1,428	1,709	2,188
Rails and all other ³	762	930	1,093	1,231	1,320	1,358	1,628	1,529	1,361
Shipbuilding and marine equip.....	622	1,051	859	1,019	1,339	1,413	969	869	845
Aircraft and aerospace.....	78	94	56	69	79	69	59	63	60
Oil and gas industries.....	1,759	1,936	3,550	3,405	4,210	4,171	2,653	3,650	4,140
Mining, quarrying, and lumbering.....	288	392	497	534	644	596	536	486	508
Agricultural, incl. machinery.....	1,003	1,483	1,126	1,772	1,859	1,429	1,784	1,743	1,805
Machinery, industrial equip., tools.....	3,958	5,873	5,169	6,351	6,440	5,173	5,180	5,566	5,992
Electrical equipment.....	2,078	2,985	2,694	3,348	3,242	2,173	2,671	2,639	2,811
Appliances, utensils, and cutlery.....	1,760	2,179	2,160	2,747	2,412	1,653	1,950	2,129	2,094
Other domestic commercial equip.....	1,959	2,179	1,778	1,990	1,941	1,390	1,813	1,846	1,889
Containers, packaging, shipping.....	6,429	7,331	7,775	7,811	8,218	6,053	6,914	6,714	6,595
Cans and closures.....	4,976	5,867	6,239	6,070	6,349	4,859	5,290	5,173	4,950
Ordnance and other military.....	165	289	1,222	918	654	405	219	193	207
Exports (reporting companies only)	2,563	2,078	5,985	3,138	3,961	1,755	1,839	1,076	1,224

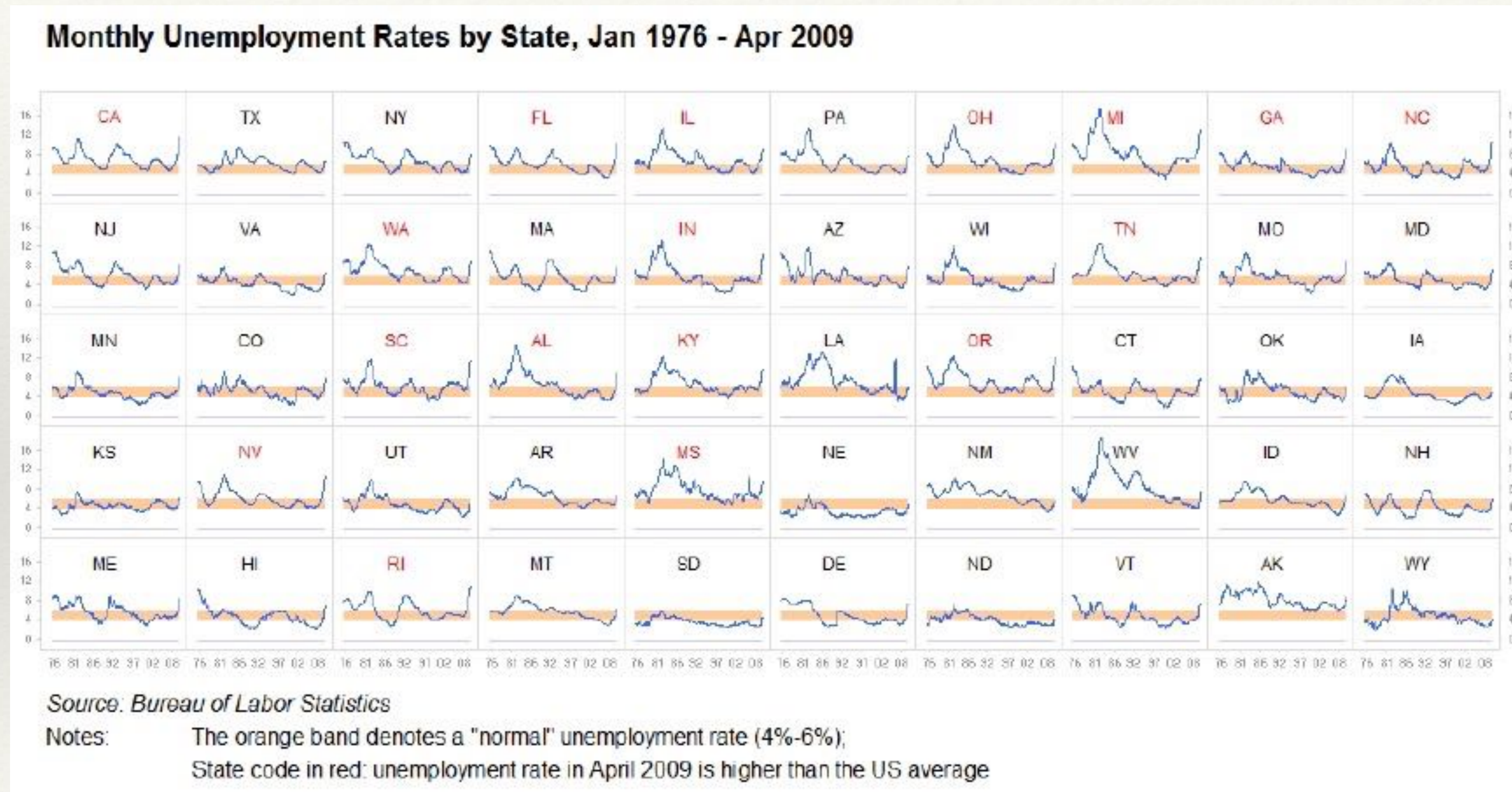
¹ Total includes nonclassified shipments, and, beginning 1970, data include estimates for a relatively small number of companies which report raw steel production but not shipments. ² Bolts, nuts, rivets, and screws.
³ Includes railways, rapid transit systems, railroad rails, trackwork, and equipment.

tables/matrices
are dense

VDQI Example (p42)



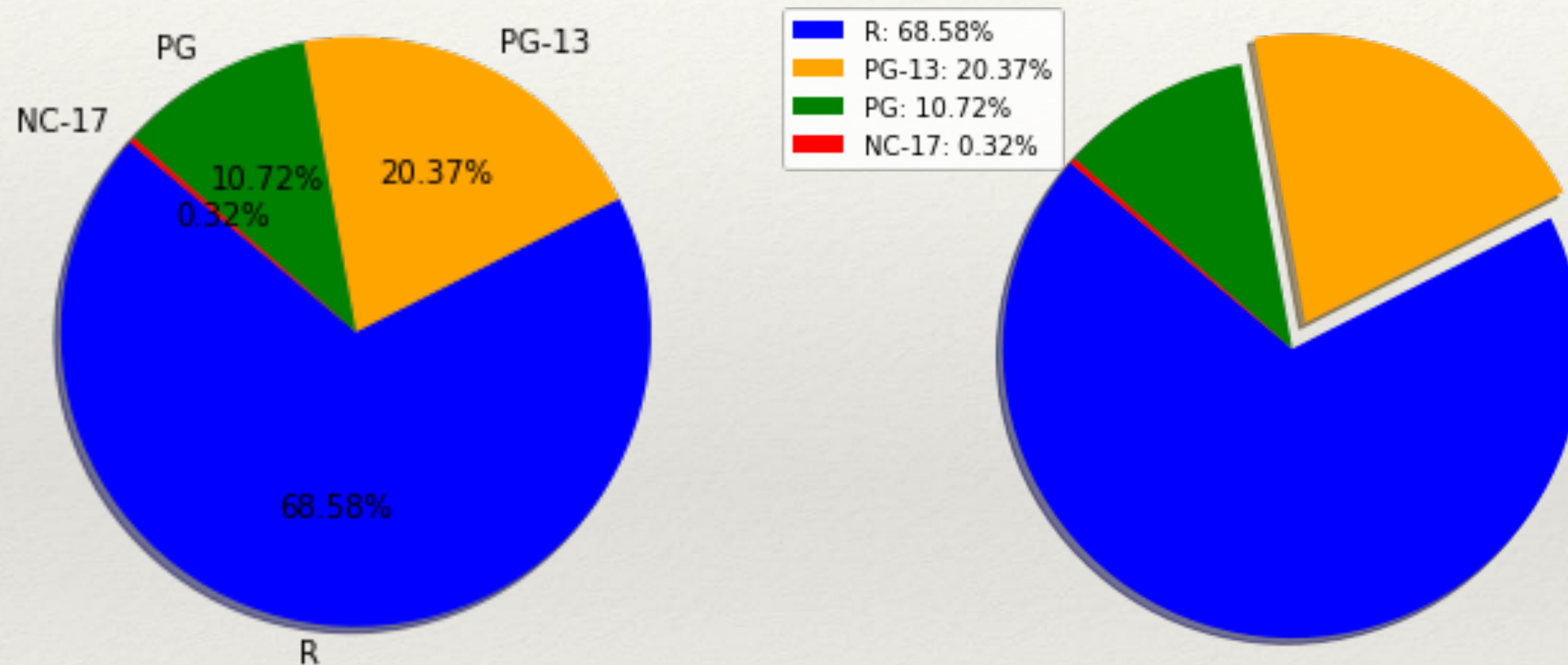
Small Multiples Example



Valutazione (punti essenziali)

- ❖ Lie Factor
 - ❖ Dimensione dell'effetto mostrato nel grafico in rapporto alla dimensione di quello stesso effetto nei dati
- ❖ Data-Ink Ratio
 - ❖ Proporzione di 'inchiostro' usato per mostrare informazione non ridondante
- ❖ Data Density
 - ❖ Quantità di dati in rapporto all'area del grafico

Valutiamo alcuni esempi: Pie Chart



Lie Factor: okay

Data Density: scarsa

Data / Inf Ratio: scarso

Confronti: pessimi

Scalabilità: pessima

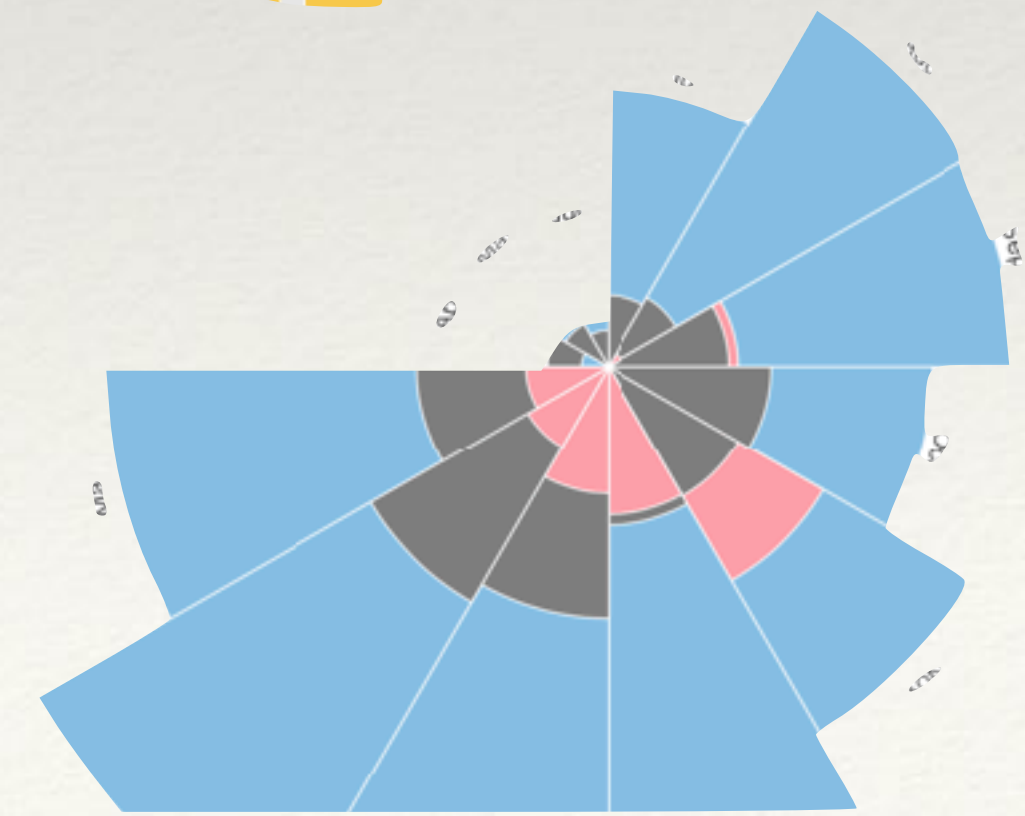
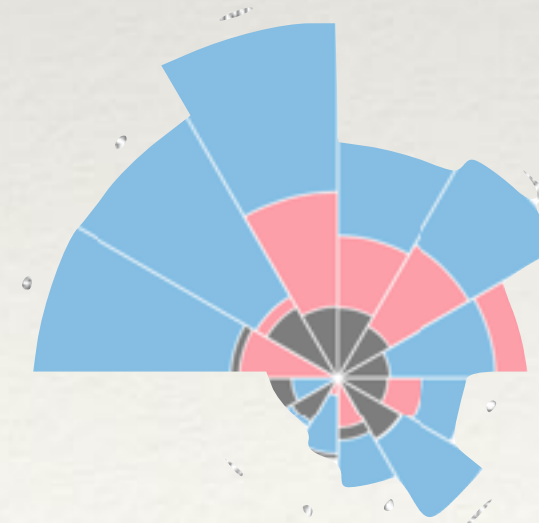
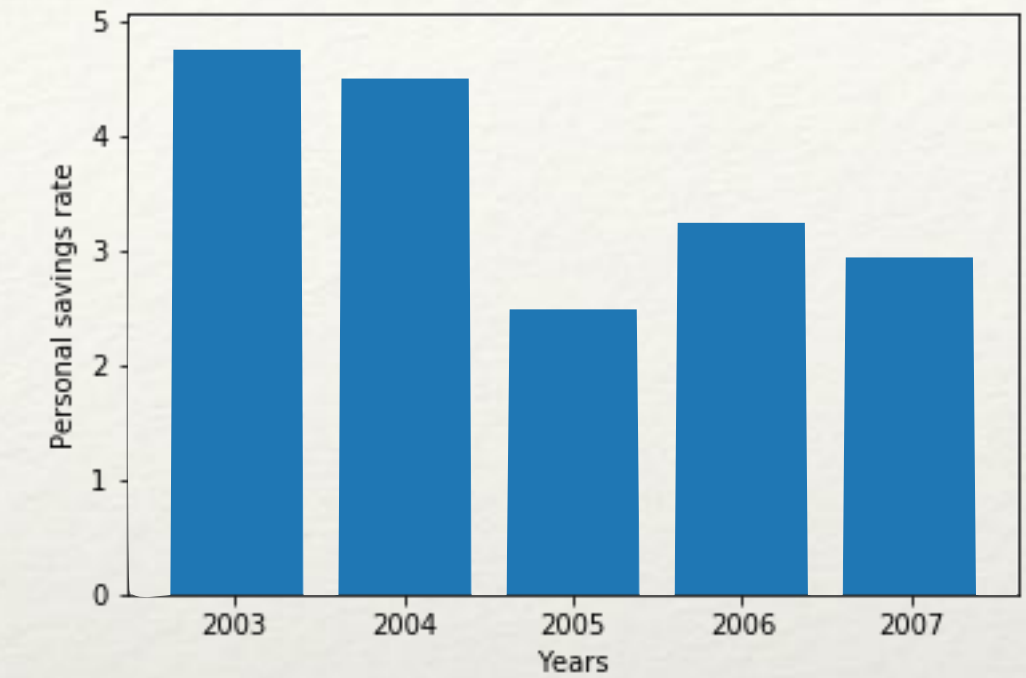
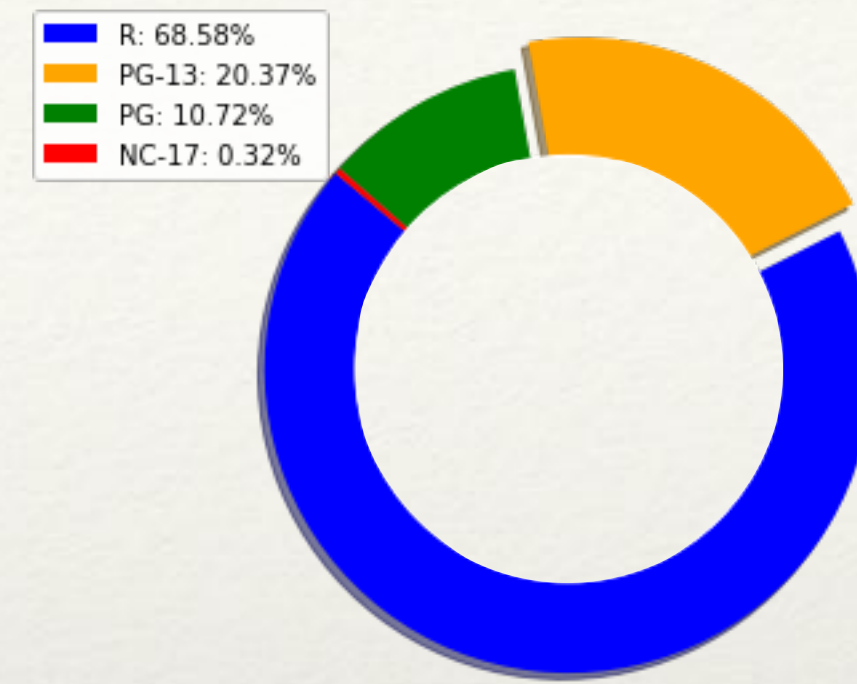
Alternative

https://datavizcatalogue.com/methods/donut_chart.html

https://datavizcatalogue.com/methods/bar_chart.html

https://datavizcatalogue.com/methods/sunburst_diagram.html

https://datavizcatalogue.com/methods/nightingale_rose_chart.html



Tecnologie abilitanti

Tools: Anaconda Distribution

[Products](#)[Why Anaconda?](#)[Solutions](#)[Resources](#)[Company](#)[Contact Us](#)[Download](#)

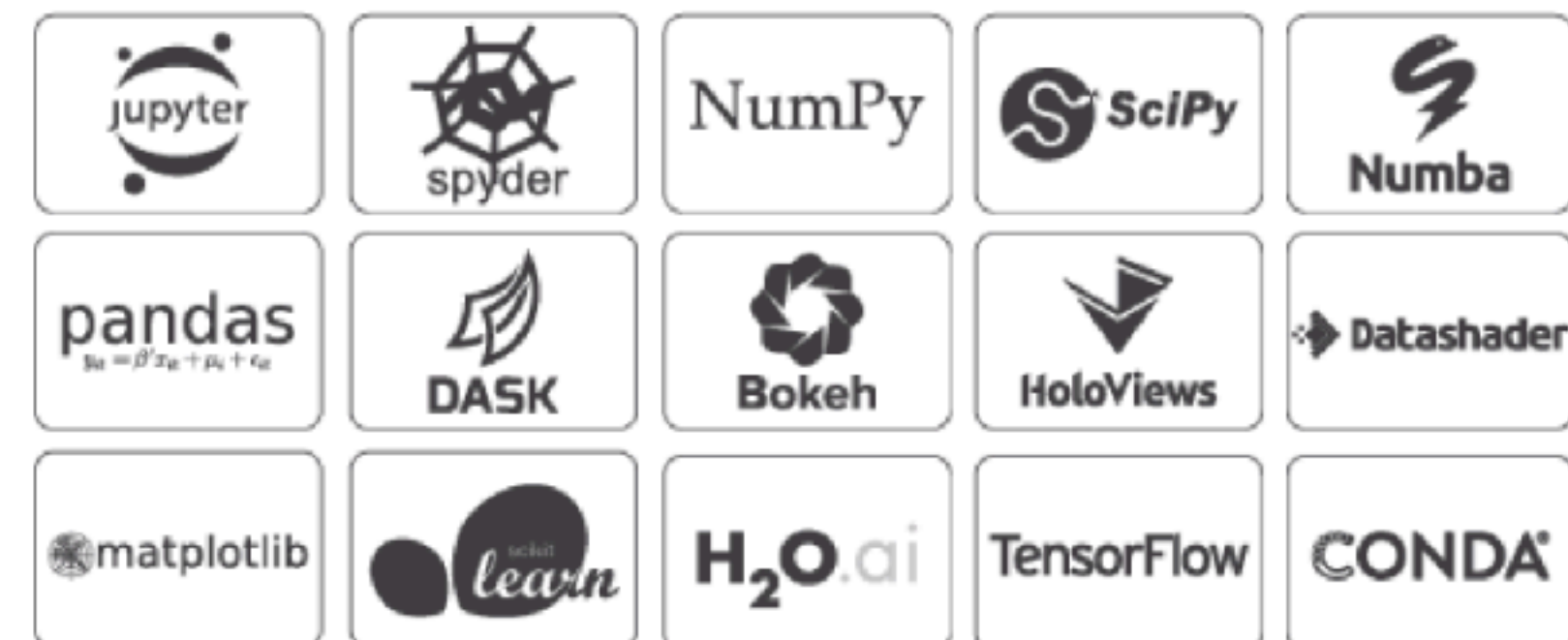
Anaconda Distribution

The World's Most Popular Python/R Data Science Platform

[Download](#)

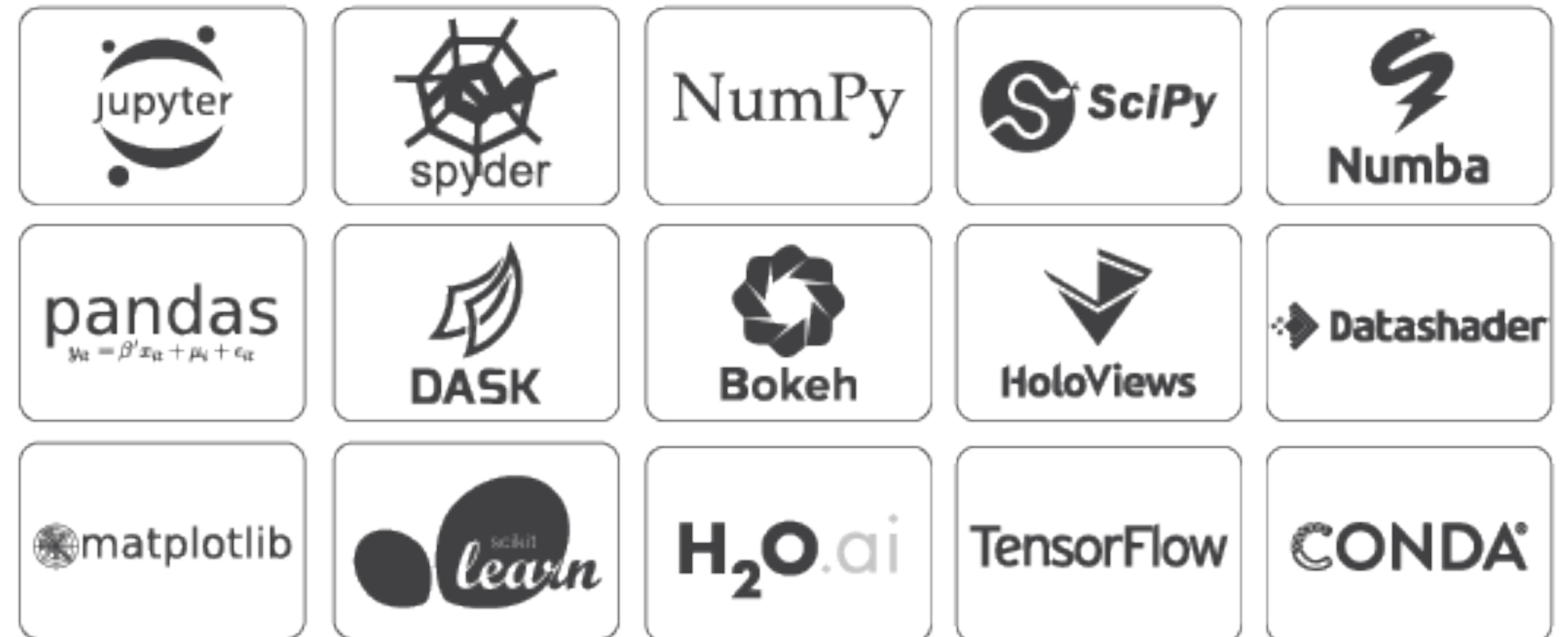
The open-source [Anaconda Distribution](#) is the easiest way to perform Python/R data science and machine learning on Linux, Windows, and Mac OS X. With over 19 million users worldwide, it is the industry standard for developing, testing, and training on a single machine, enabling *individual data scientists* to:

- Quickly download 7,500+ Python/R data science packages
- Manage libraries, dependencies, and environments with [Conda](#)
- Develop and train machine learning and deep learning models with [scikit-learn](#), [TensorFlow](#), and [Theano](#)
- Analyze data with scalability and performance with [Dask](#), [NumPy](#), [pandas](#), and [Numba](#)
- Visualize results with [Matplotlib](#), [Bokeh](#), [Datashader](#), and [Holoviews](#)



Tools: iPython, Jupyter, R Studio, and more

IP[y]: IPython
Interactive Computing

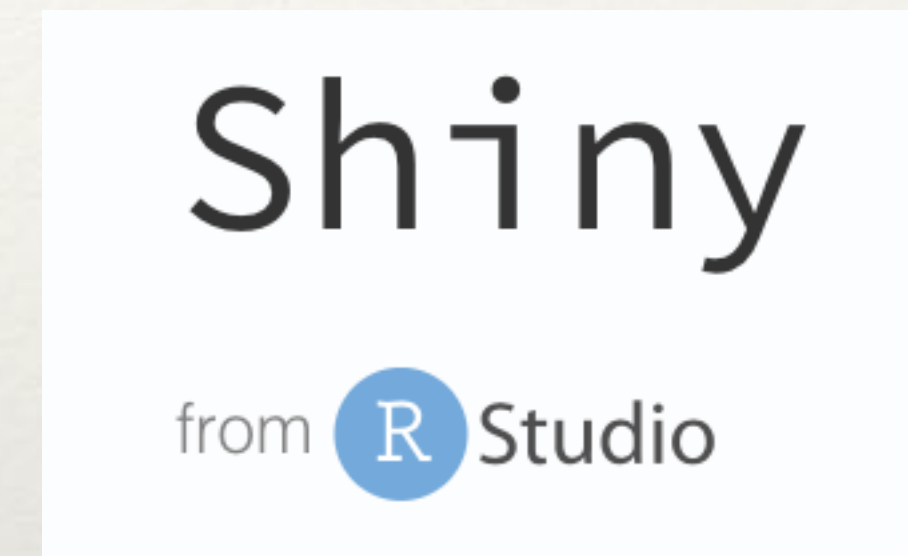


Interactive and animated viz (apart from d3)



Bokeh is an interactive visualization **Python library** for modern web browsers. It provides elegant, concise construction of versatile graphics, and affords high-performance interactivity over large or streaming datasets. Bokeh can help anyone who would like to quickly and easily make interactive plots, dashboards, and data applications.

<https://docs.bokeh.org/en/latest/#>



Shiny is an **R package** that makes it easy to build interactive web apps straight from R. You can host standalone apps on a webpage or embed them in **R Markdown** documents or build **dashboards**. You can also extend your Shiny apps with **CSS themes**, **htmlwidgets**, and JavaScript **actions**.

<https://shiny.rstudio.com>

Terminology

- ❖ Data Visualization
- ❖ Scientific Visualization
- ❖ Information Visualization
- ❖ Statistical Graphics
- ❖ Visual Analytics
- ❖ Information Dashboards
- ❖ Infographics

Terminology

- ❖ Differences between terms are often fuzzy
 - ❖ Information visualization versus infographics
- ❖ Differences between terms are sometimes highly contested
 - ❖ Information visualization versus statistical graphics
- ❖ Differences often come down to two aspects
 - ❖ Type of data being visualized
 - ❖ Why data is being visualized

Data Visualization

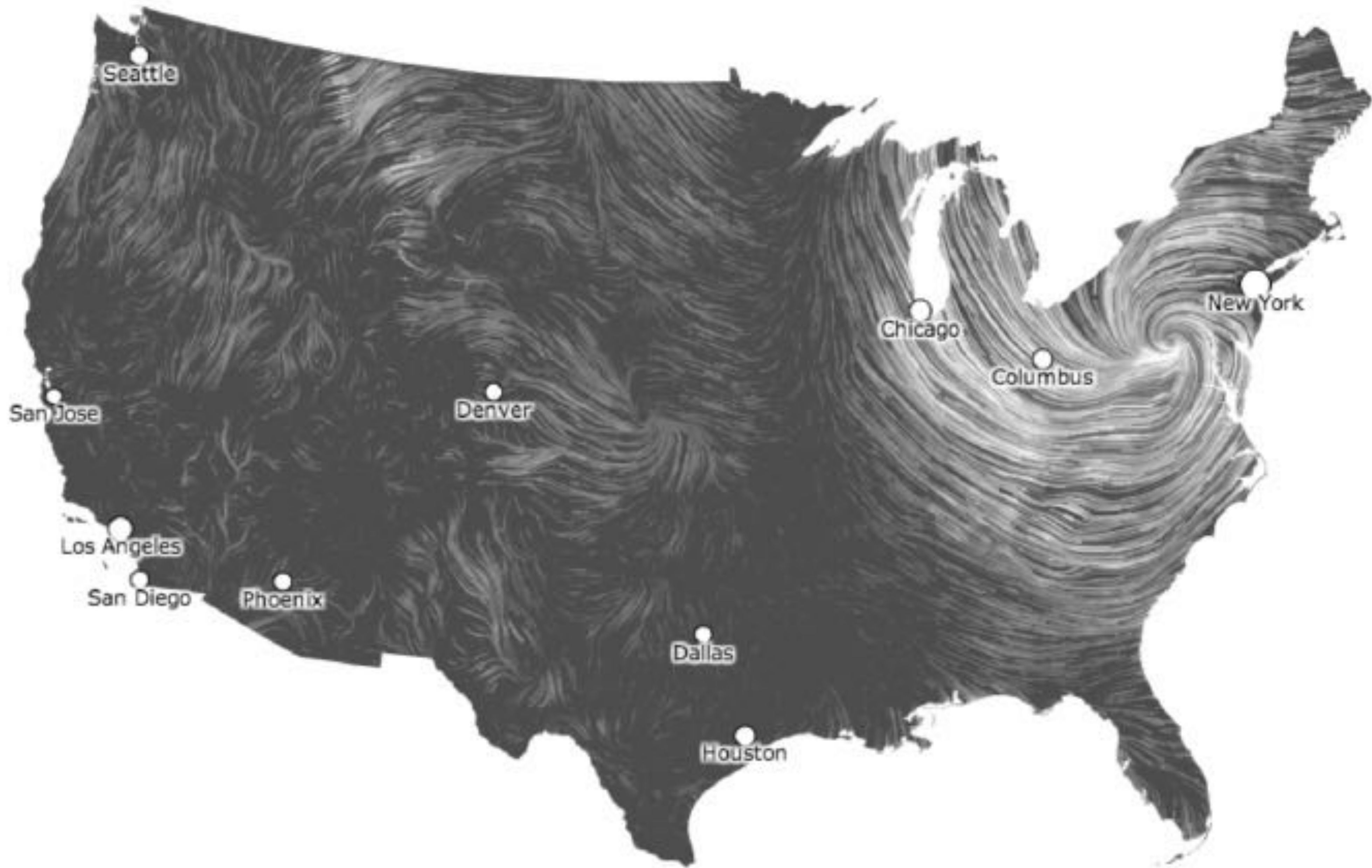
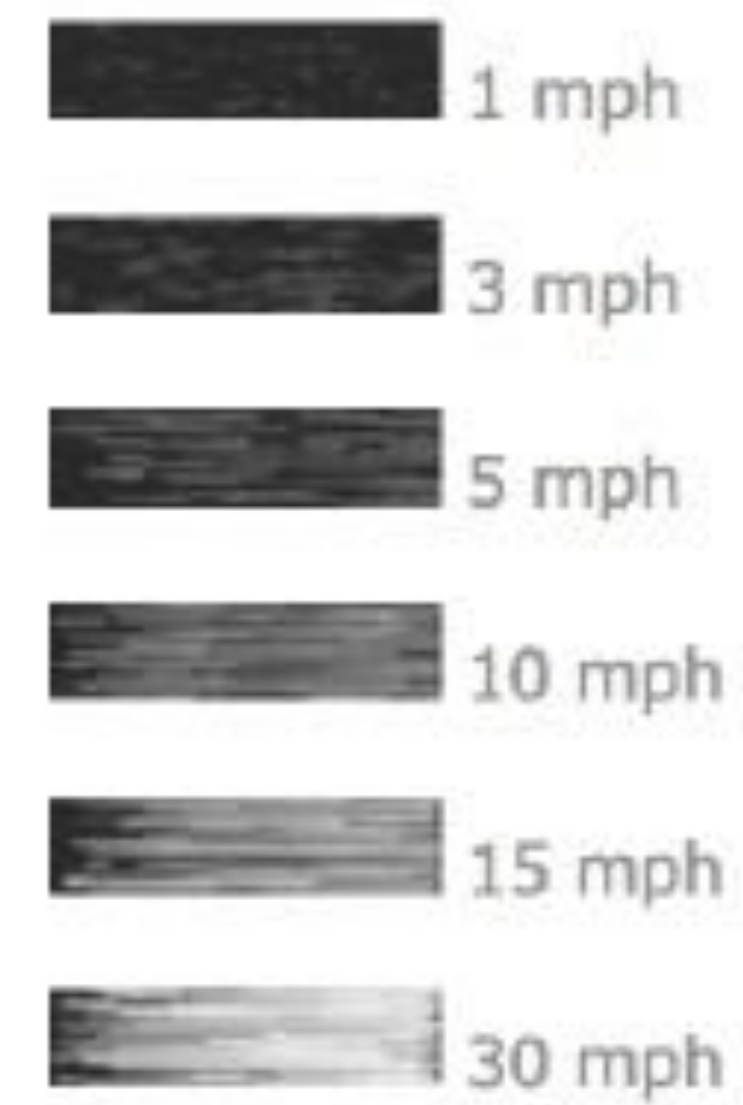
- ❖ Definition
 - ❖ Communicates non-visual data visually
 - ❖ Result should be readable and recognizable*
- ❖ Two Subfields
 - ❖ Scientific visualization
 - ❖ Information visualization
- ❖ Transforms raw data into information

October 30, 2012

6:59 am EST

(time of forecast download)

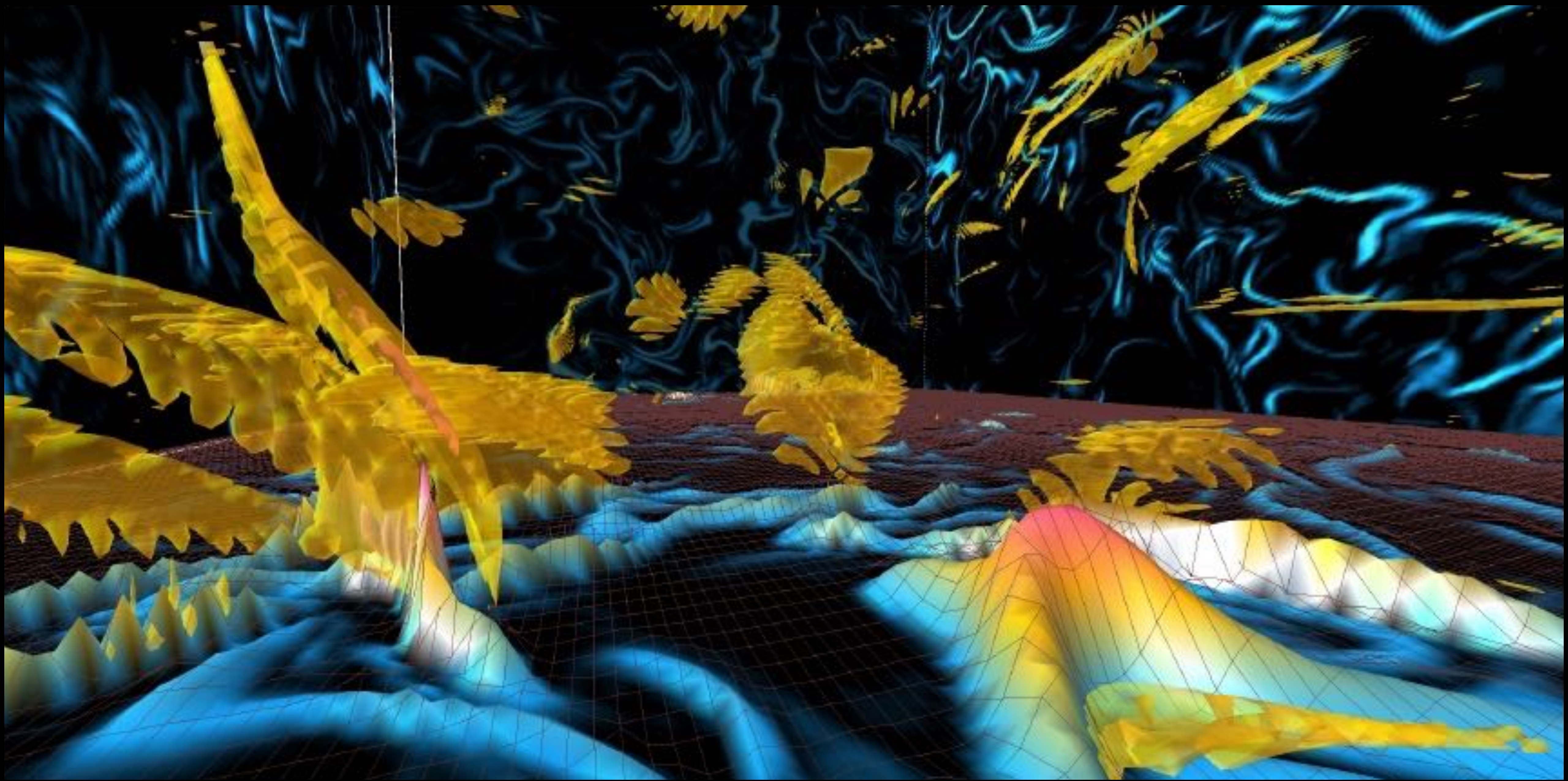
top speed: **39.7 mph**
average: **8.4 mph**



<http://hint.fm/wind/gallery/oct-30.js.html>

Scientific Visualization

- ❖ Type of Data
 - ❖ Scientific data (objects exist in 1D, 2D, or 3D space)
 - ❖ Often scalar or vector fields from computer simulations
- ❖ Primary Purpose
 - ❖ Aims to convey scientific data accurately
 - ❖ Aims to reveal underlying structure in data
 - ❖ Aims to encourage exploration of data (interactivity)

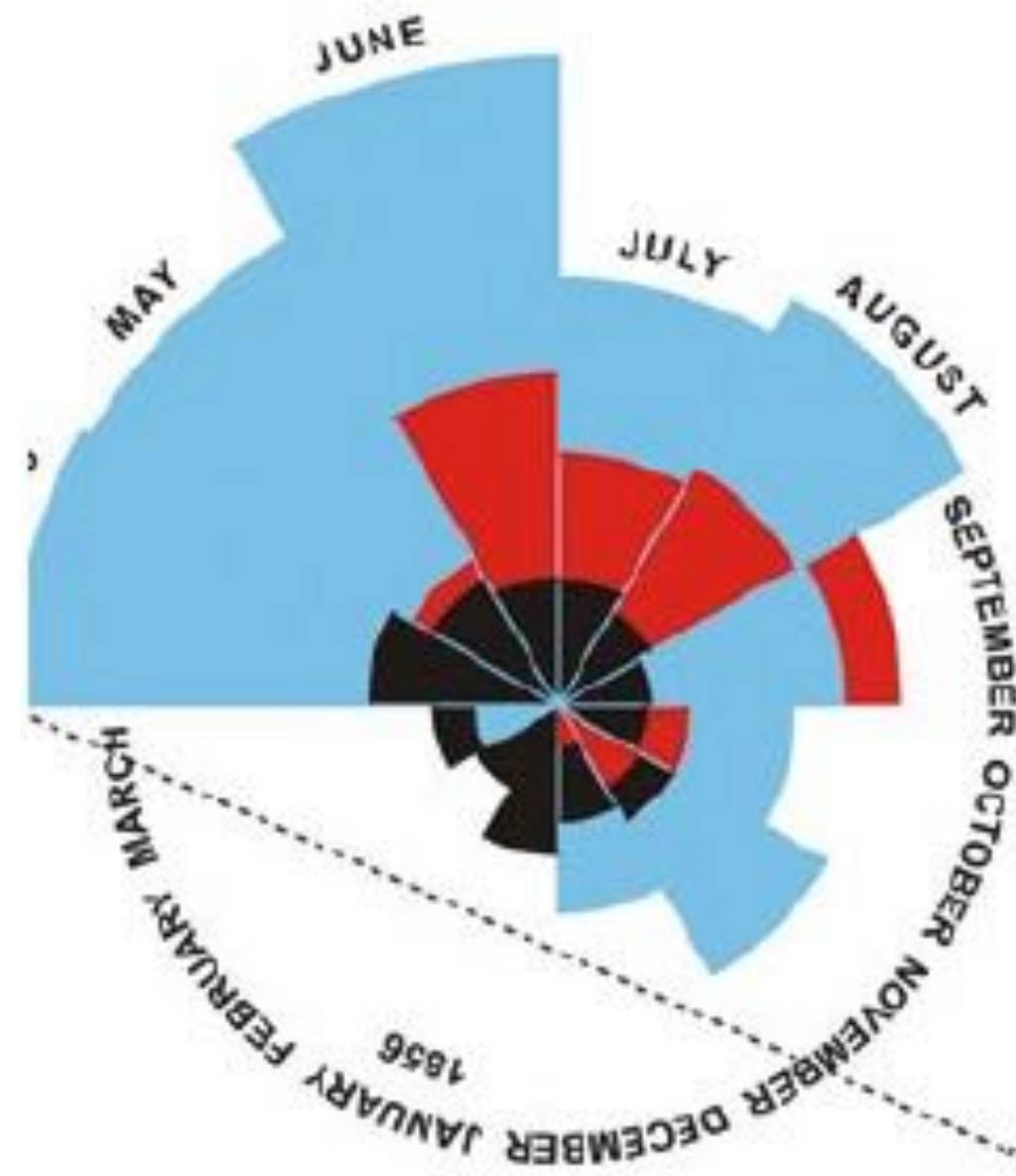


Information Visualization

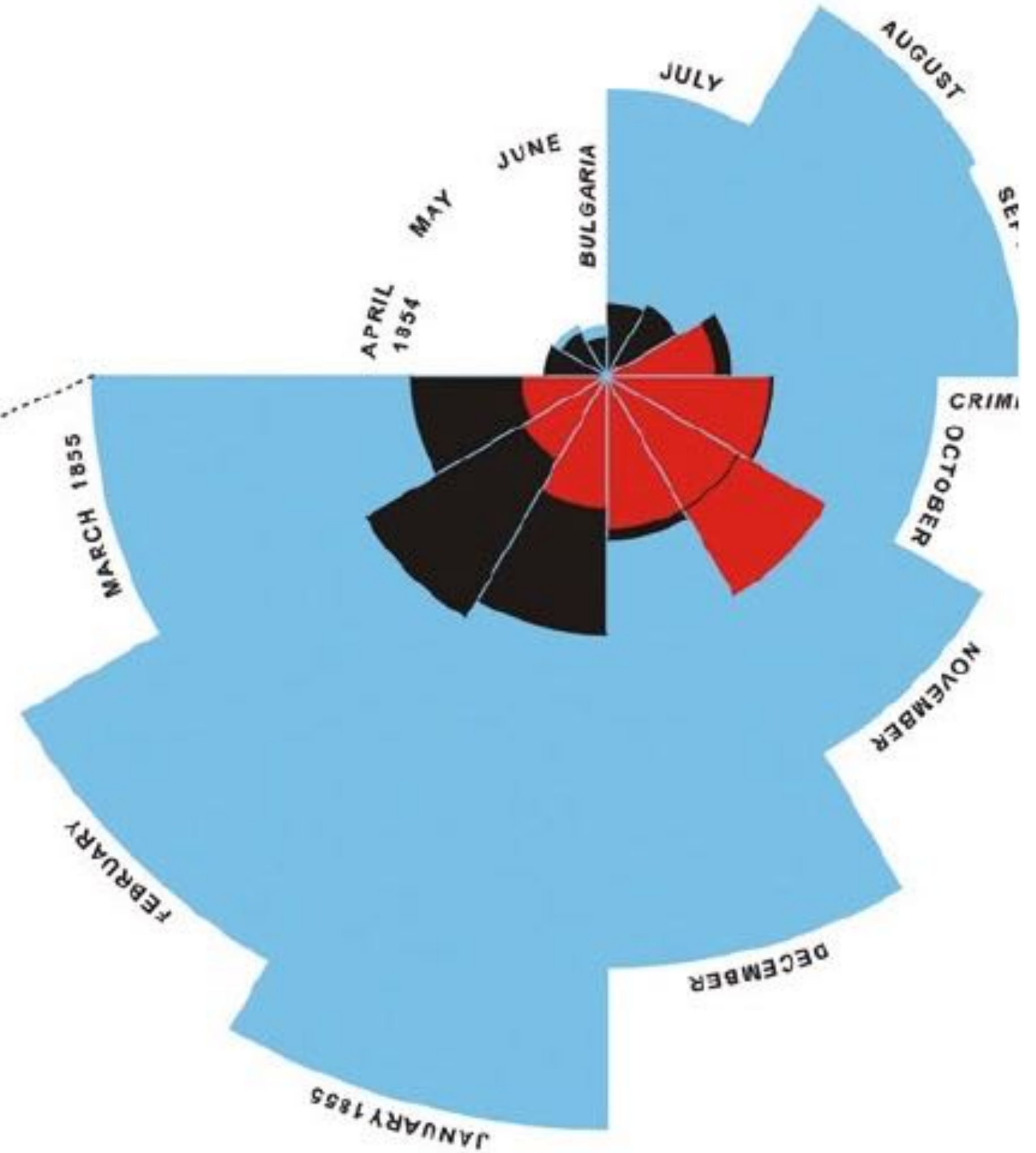
- ❖ Type of Data
 - ❖ Abstract data (has no inherent physical form)
 - ❖ May be numerical, categorical, temporal, geospatial, or text data
- ❖ Primary Purpose
 - ❖ Aims to convey abstract data accurately
 - ❖ Aims to reveal underlying structure in data
 - ❖ Aims to encourage exploration of data (interactivity)
 - ❖ Aims to display data aesthetically

DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST.

2.
APRIL 1855 TO MARCH 1856.



1.
APRIL 1854 TO MARCH 1855



The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex

The blue wedges measured from the centre of the circle represent area for area the deaths from Preventable or Mitigable Zymotic Diseases, the red wedges measured from the centre the deaths from wounds, & the black wedges measured from the centre the deaths from all other causes

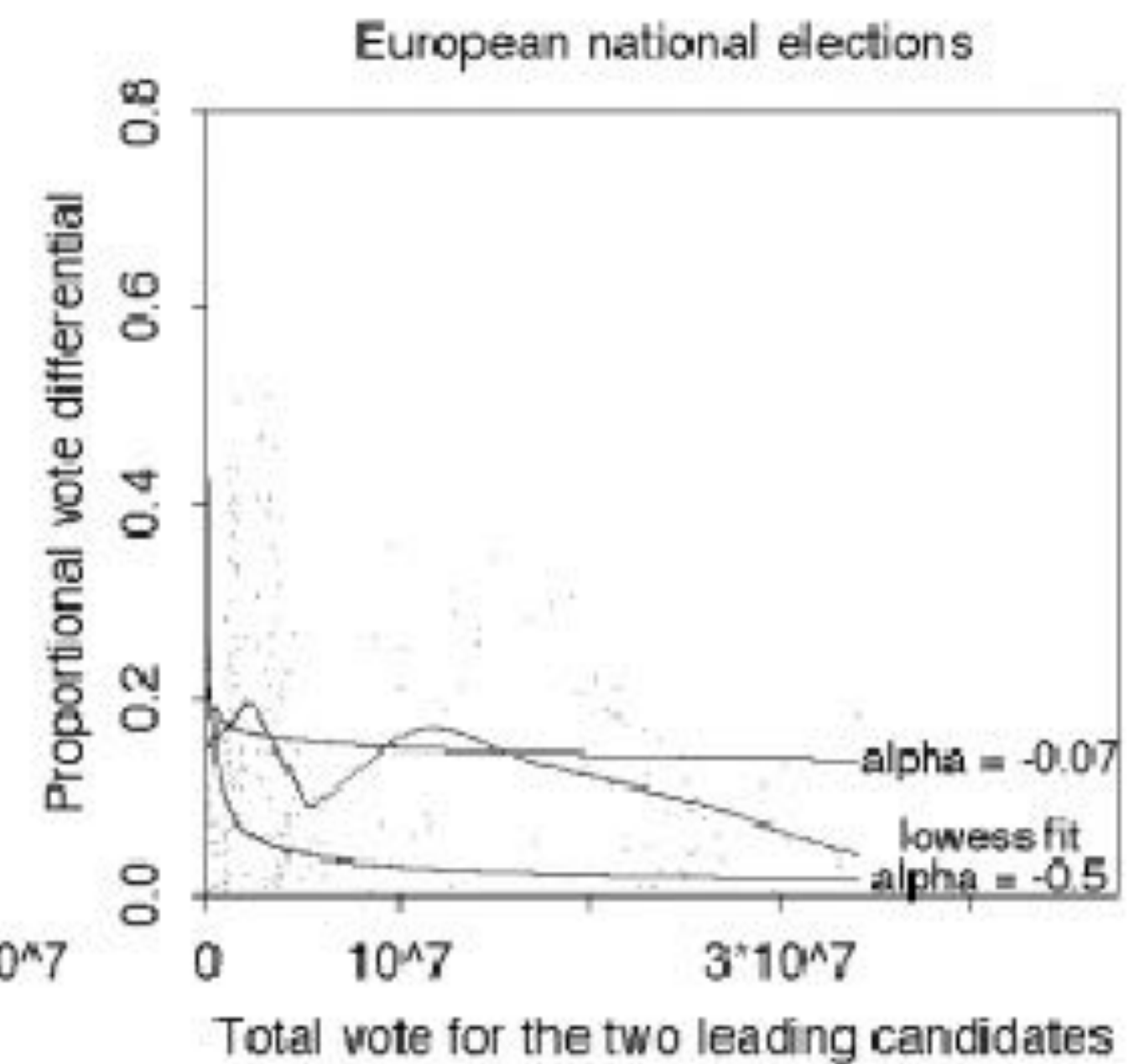
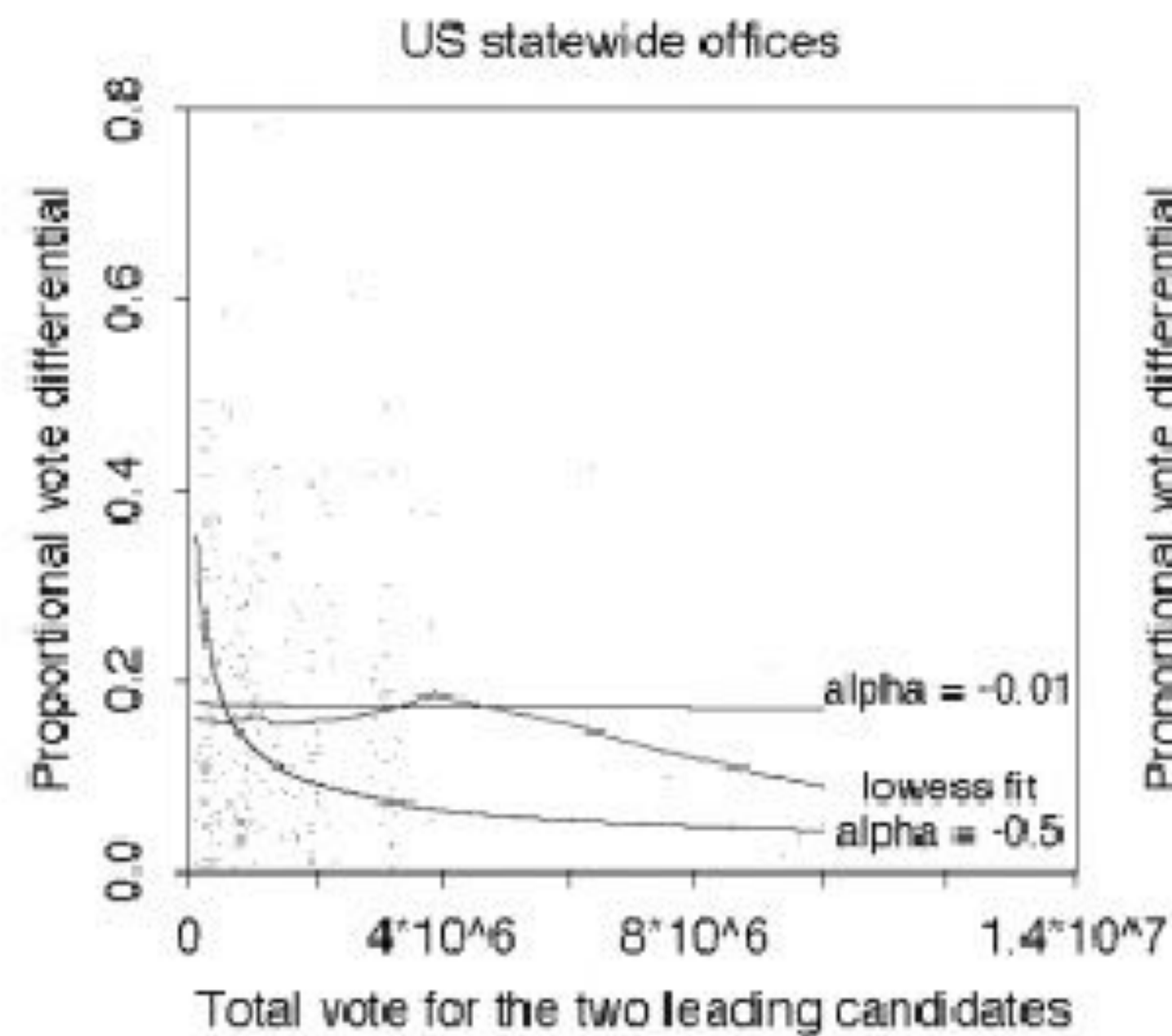
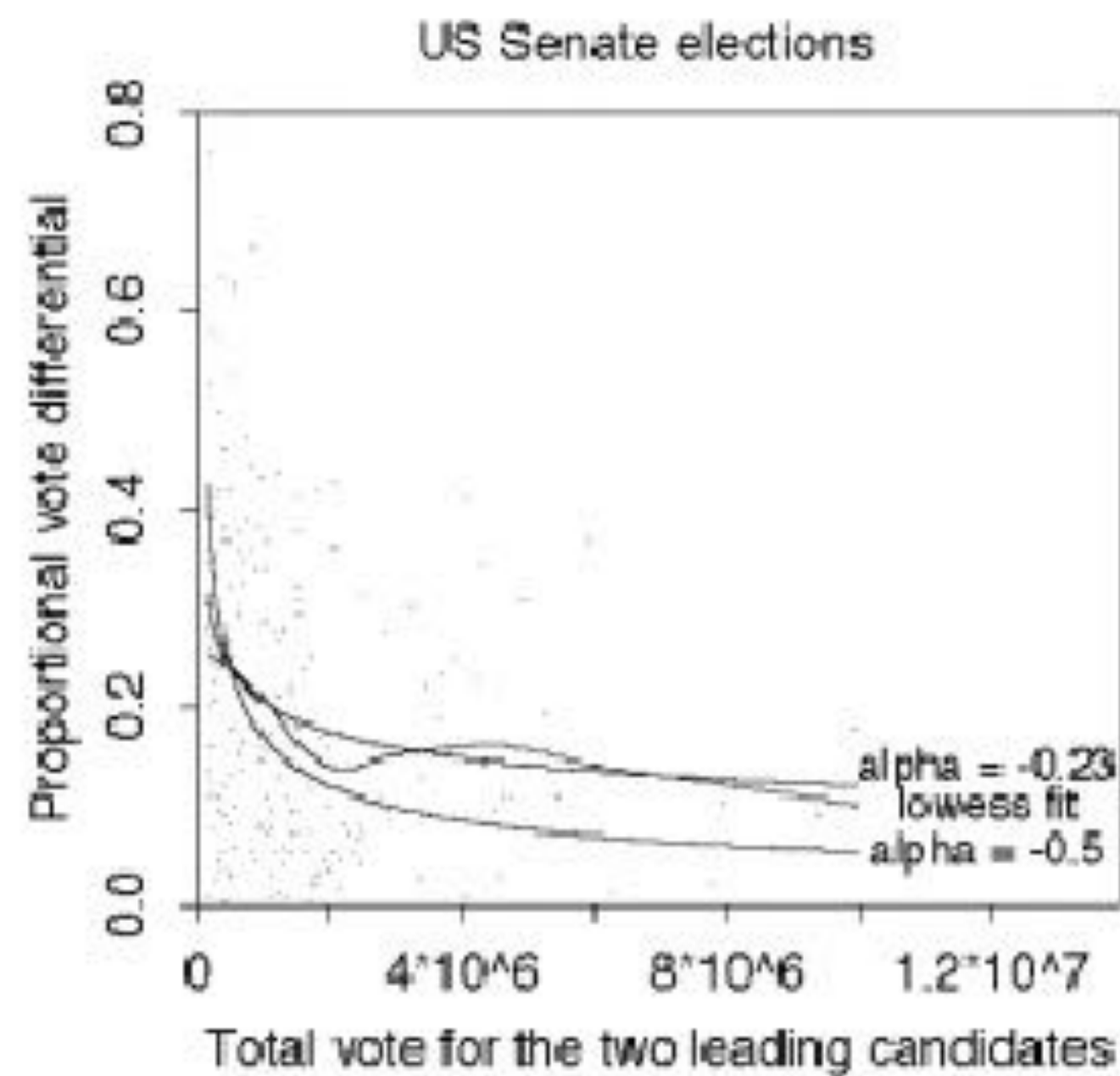
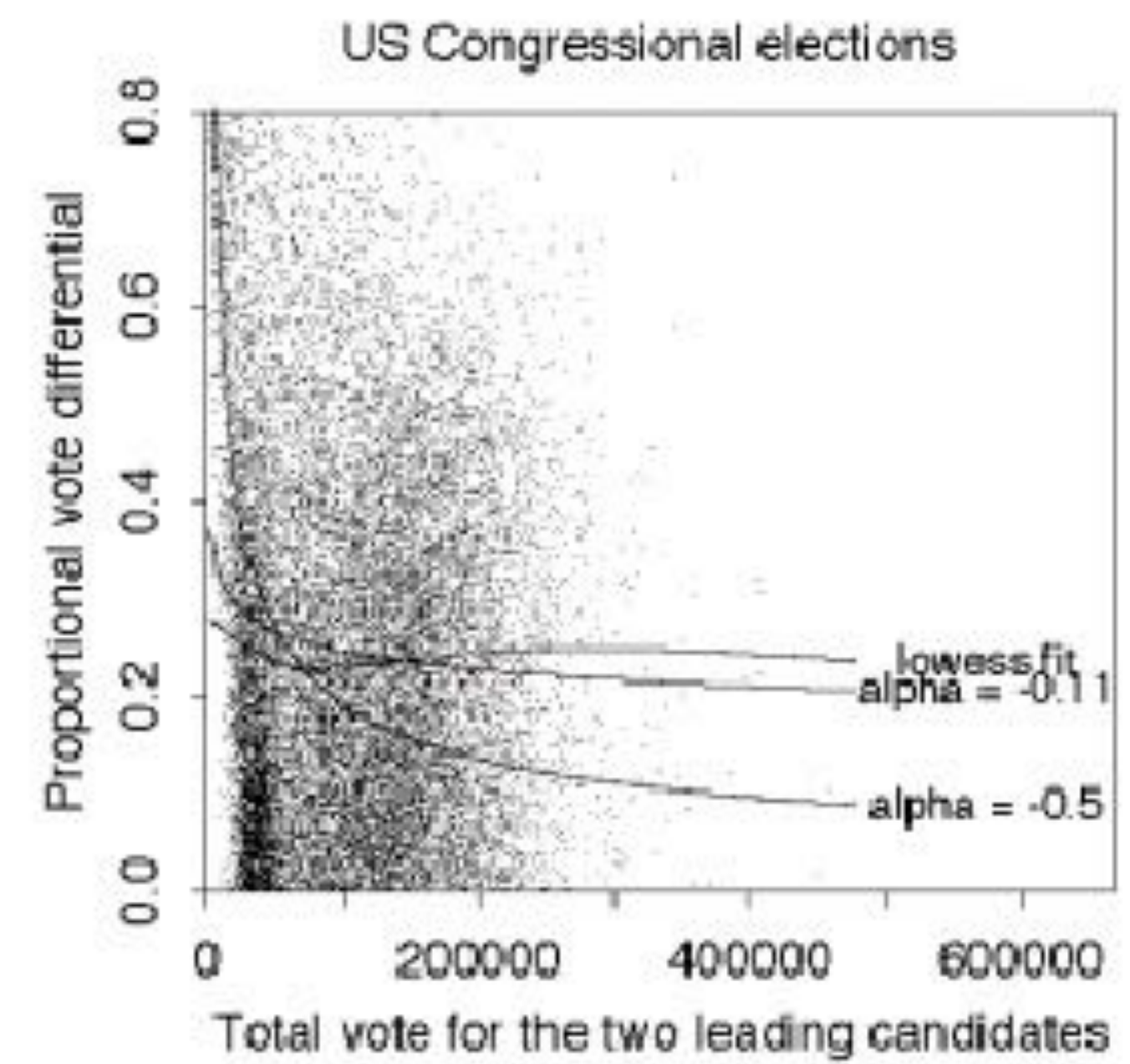
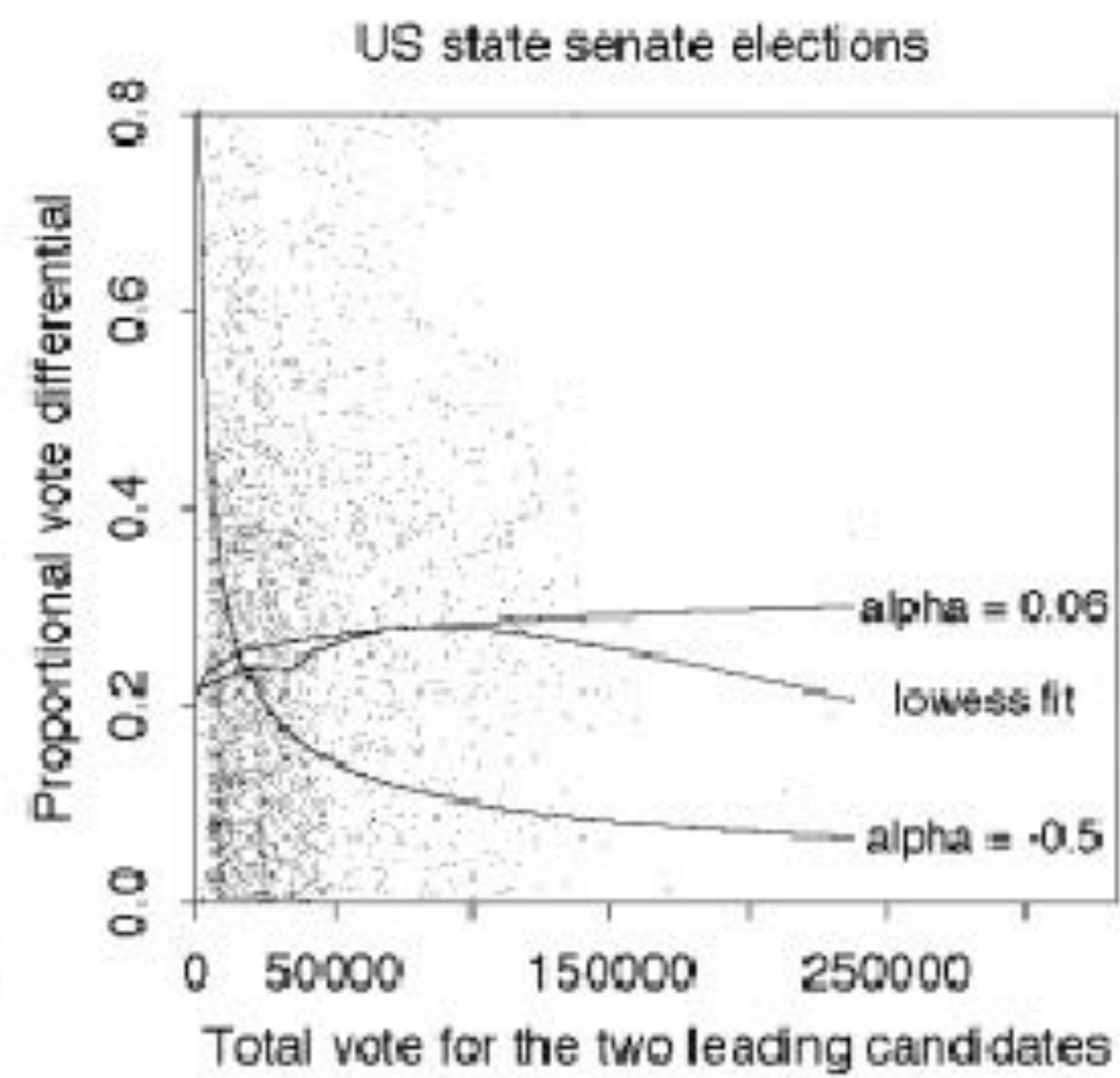
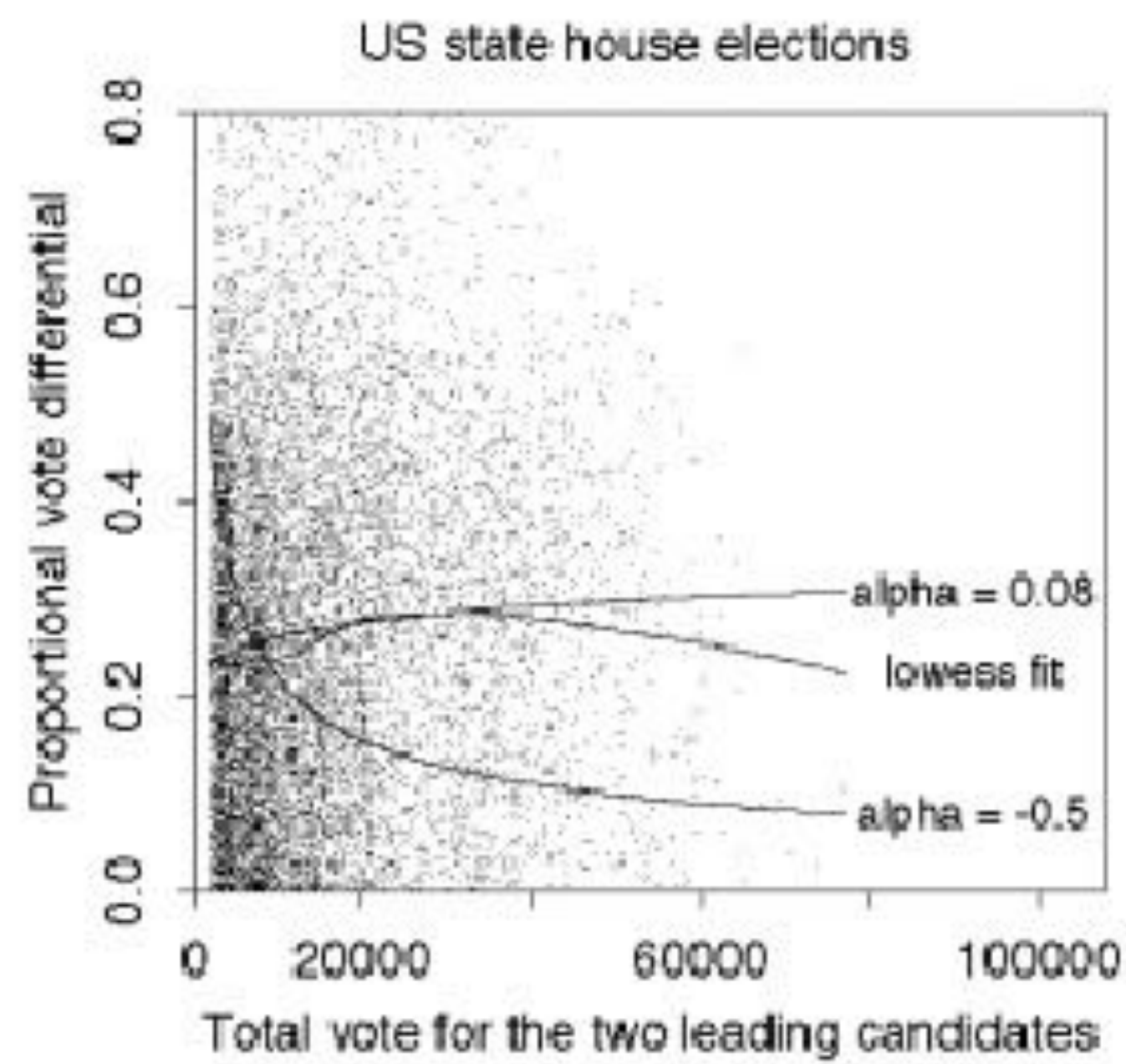
The black line across the red triangle in Nov' 1854 marks the boundary of the deaths from all other causes during the month

In October 1854, & April 1855, the black area coincides with the red, in January & February 1855, the blue coincides with the black

The entire areas may be compared by following the blue, the red & the black lines enclosing them. ©hugh-small.co.uk

Statistical Graphics

- ❖ Type of Data
 - ❖ Abstract data
 - ❖ Mostly statistical, quantitative, or numerical data
- ❖ Primary Purpose
 - ❖ Aims to convey data accurately
 - ❖ Aims to convey underlying structure in data
- ❖ Not Emphasized
 - ❖ May not be aesthetically pleasing
 - ❖ May not encourage exploration or be interactive



Visual Analytics

- ❖ Type of Data
 - ❖ Abstract data
- ❖ Primary Purpose
 - ❖ Aims to answer a specific question (goal-oriented)
 - ❖ Aims to support analytical reasoning with interactive visual interfaces
- ❖ Not Emphasized
 - ❖ May not be aesthetically pleasing
 - ❖ May not be constrained by a single display



Information Dashboards

- ❖ Type of Data
 - ❖ Abstract data
 - ❖ Temporal data or time series
- ❖ Primary Purpose
 - ❖ Aims to convey large amount of information quickly
 - ❖ Aims to convey outliers and trends at a glance
- ❖ Not Emphasized
 - ❖ May be extremely dense

Class: Algebra 1
May 1st, 2012

— Current grade
+ Target grade
■ Previous year

Last 5yrs Standardized Math Assessments

Last 5 assignments

Assignments Completed Late

○ Days tardy / + Days absent

Disc. referrals
● last term
● this term

Delentions
● last term
● this term

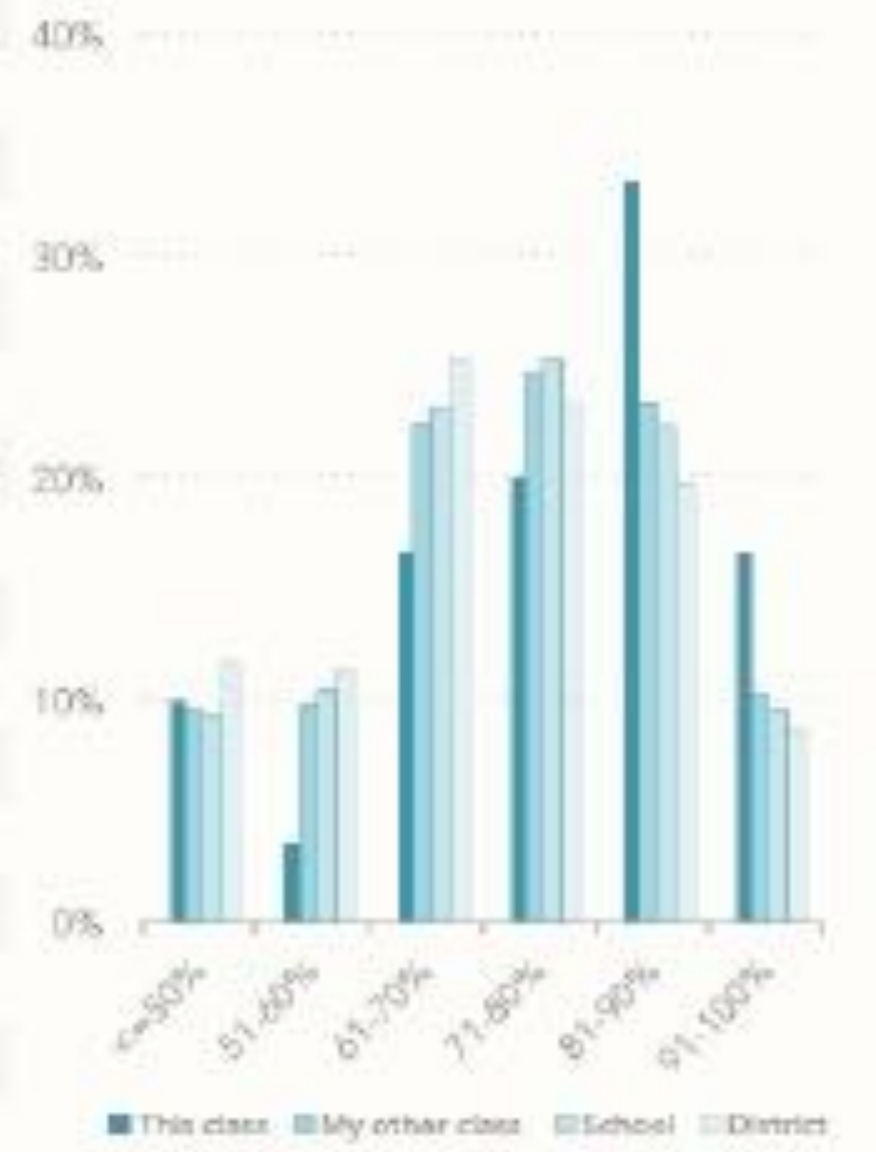
Class comparisons

Name	Current grade	Target grade	Previous year	Last 5yrs Standardized Math Assessments	Last 5 assignments	Assignments Completed Late	Days tardy / Days absent	Disc. referrals	Delentions
Bee Kim*	●	■	■	39%	61%	●●●	0/0	●●●	●●
Frederick Chandler	●	■	■	41%	68%	●●	0/0	●●●●	●●
Fiona Reeves†	■	■	■	47%	64%	●●●	1/8	●●	●
Christopher Murphy	■	■	■	55%	78%	●	3/2		
Anthony Harper†	■	■	■	62%	78%	●	0/3		
Brian Francis	■	■	■	67%	69%	●●	3/9		
Regan Pabrero	■	■	■	67%	72%	●	2/1		
Blaine Harper	■	■	■	71%	74%		1/4	●	●
George Smith	■	■	■	76%	76%	●	3/1	●●	●
Nikolas Mikhailovich*	■	■	■	63%	79%		1/1		
Kirsten Holmes	■	■	■	67%	72%		0/1	●	
James Martin	■	■	■	71%	75%	●	2/4		
Roshawn Dawson	■	■	■	78%	71%		0/6	●●	
Sarah Jameson	■	■	■	78%	89%	●	4/3	●●	●
Lawrence Parker	■	■	■	80%	91%		0/0	●●	●
Fariah Jackson	■	■	■	84%	88%		0/2		
Allison Perry	■	■	■	85%	91%		0/3		
Marie Garcia	■	■	■	72%	88%		4/3	●●	●
David Chenowith	■	■	■	80%	97%		5/3	●	
Samuel Miller	■	■	■	81%	84%		1/0		
Jalime Goss	■	■	■	82%	86%		0/4	●●	●
Xu Mei	■	■	■	83%	85%		0/2		
Jose Domingo	■	■	■	84%	84%		1/3		
Britta Jones	■	■	■	85%	77%		1/2		
Scott Ortiz	■	■	■	82%	81%	●	0/1		
Amela Singh	■	■	■	91%	99%		1/4	●	
James Snow	■	■	■	91%	97%		0/1		
Hannah Li	■	■	■	94%	94%		2/1		
Holly Norton	■	■	■	98%	100%		2/0		
Donald Chase	■	■	■	92%	95%		0/0	●	●

Latest standardized math assessment median score
40% 50% 60% 70% 80% 90% 100%



% of students with the following math assessment scores

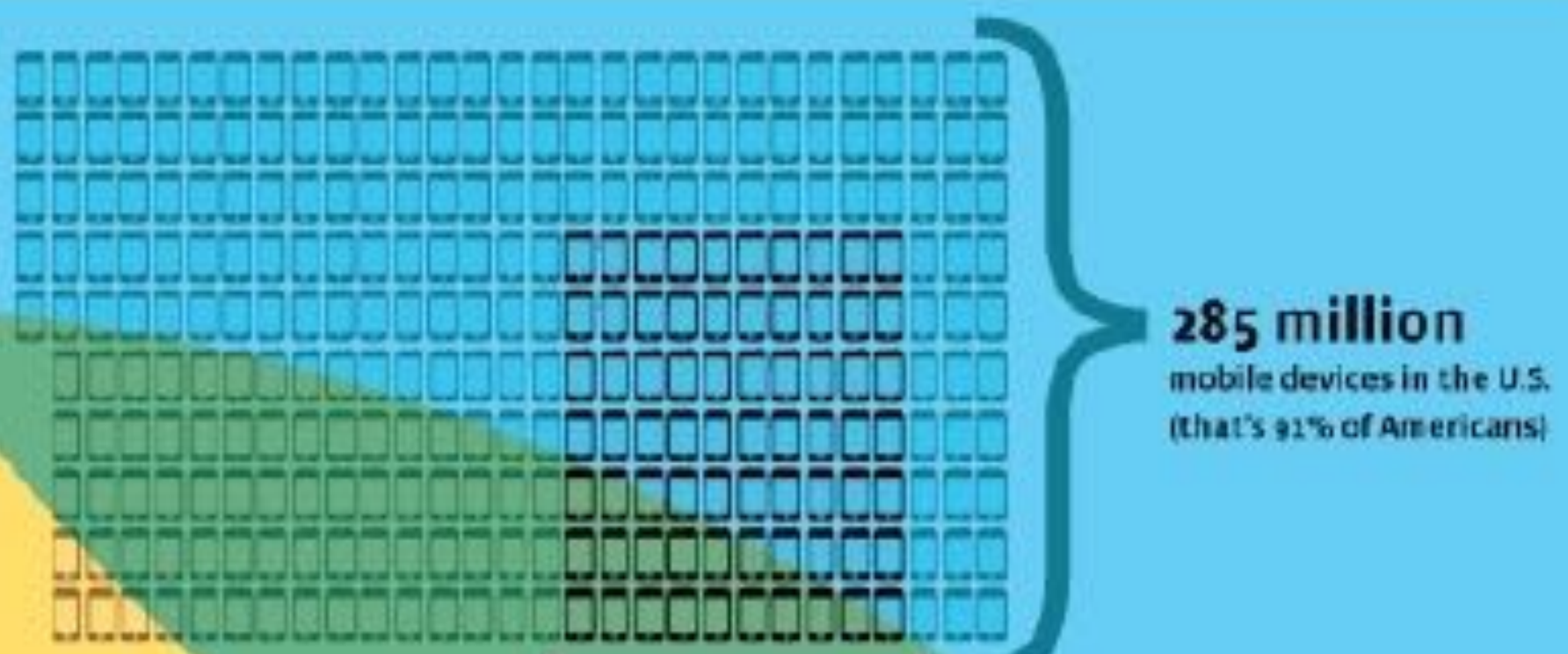


* No english language proficiency † Special education

Note: Assessment and assignment scores are being expressed as the percentage of points that were earned out of the total points possible.

Infographics

- ❖ Type of Data
 - ❖ Abstract data
- ❖ Primary Purpose
 - ❖ Aims to be eye-catching and capture attention
 - ❖ Aims to convey information quickly
- ❖ Not Emphasized
 - ❖ May not be accurate
 - ❖ May not use space efficiently
 - ❖ May not encourage exploration of data



97% of US households use email

66% of marketers are integrating social media with their e-mail marketing campaigns

Which social networks or tools are integrated into your e-mail marketing efforts?



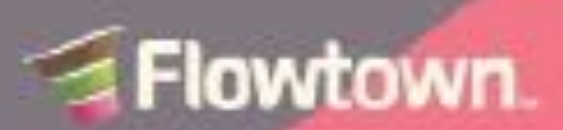
"Now is the time, if they haven't already, for marketers to start experimenting with mobile and social to find what works best for their organizations. They must remember however, that whatever they do to experiment should be a relevant, positive user experience, because if they can't provide that then it's better to provide no experience at all."

Mobile Devices

Email

The NEW Marketing Trifecta

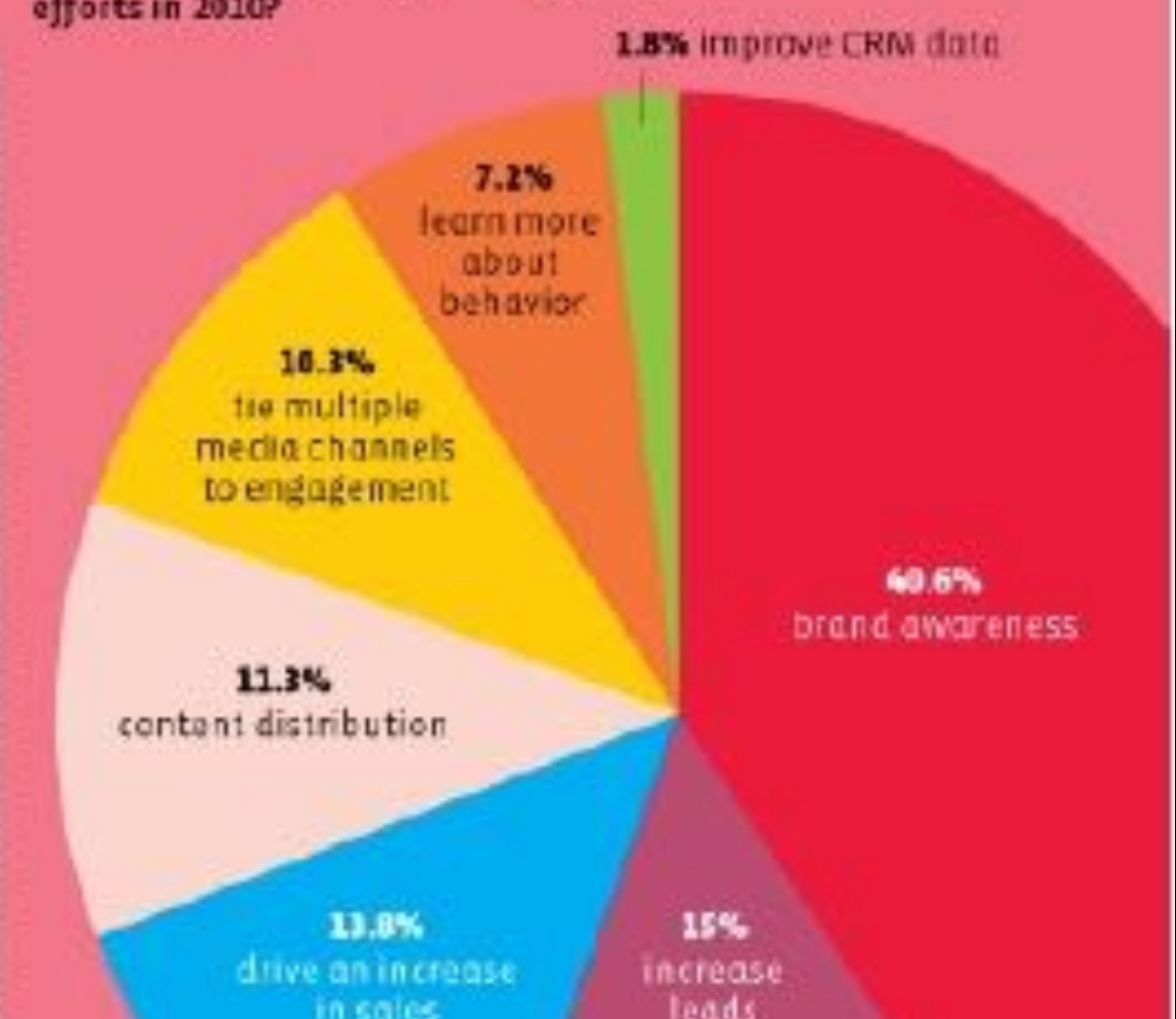
Social Media



"Not only are [mobile, social media, and email tactics] being widely used, but many are using a combination of all three - email on mobile devices, email within social networks and social networks on mobile devices."

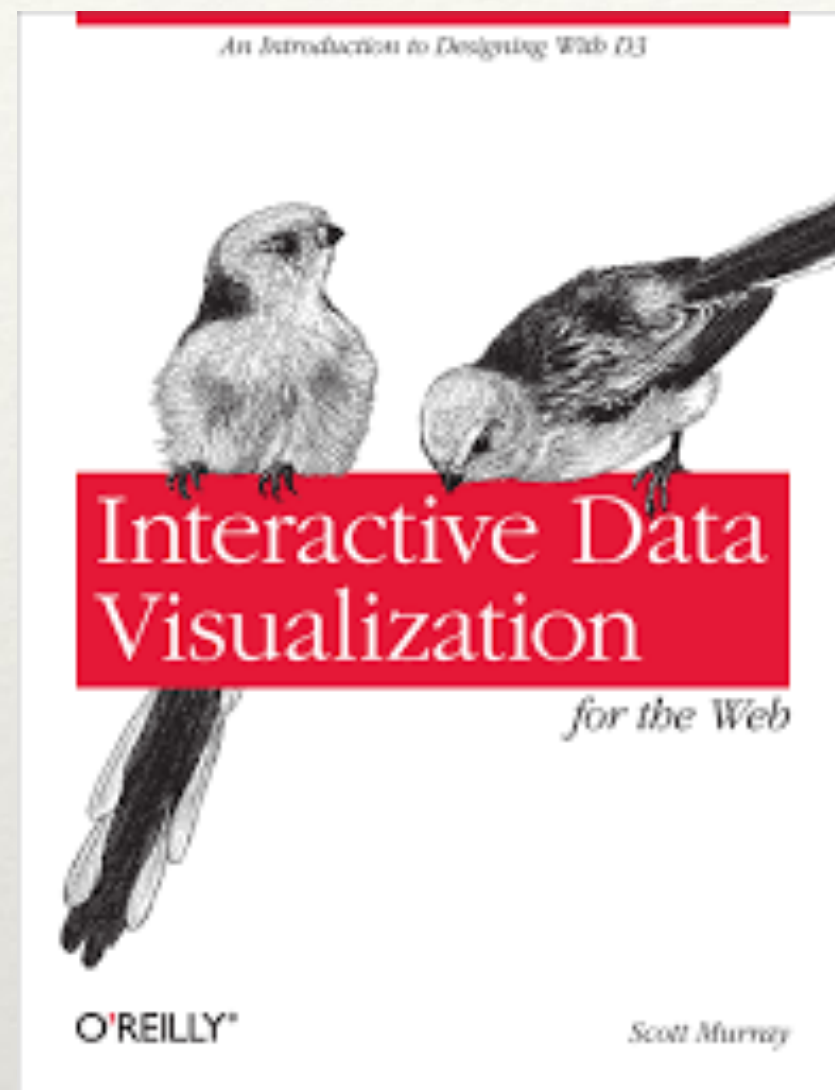
75% of internet connected homes use social networks (that's 61.5% of all U.S. households)

What is your company's primary goal for your social media efforts in 2010?



Libri e risorse bibliografiche

Libri "pratici"



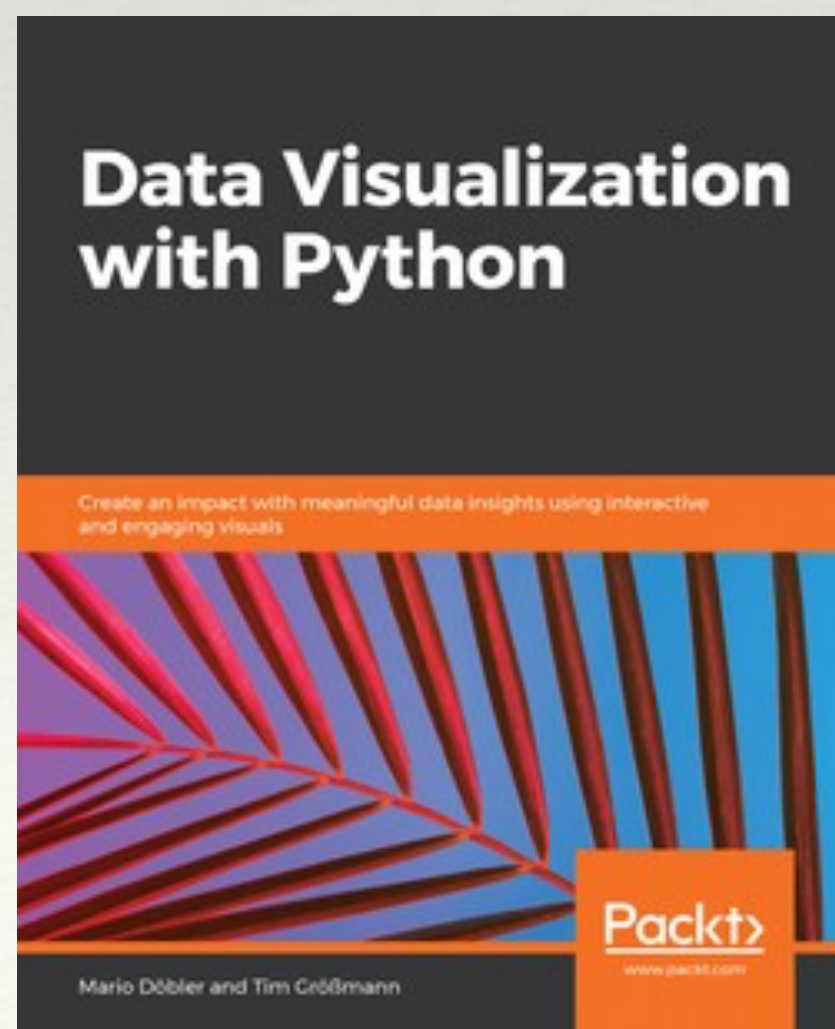
Scott Murray

Interactive Data Visualization for the Web

An Introduction to Designing with D3

O'Reilly, 2013

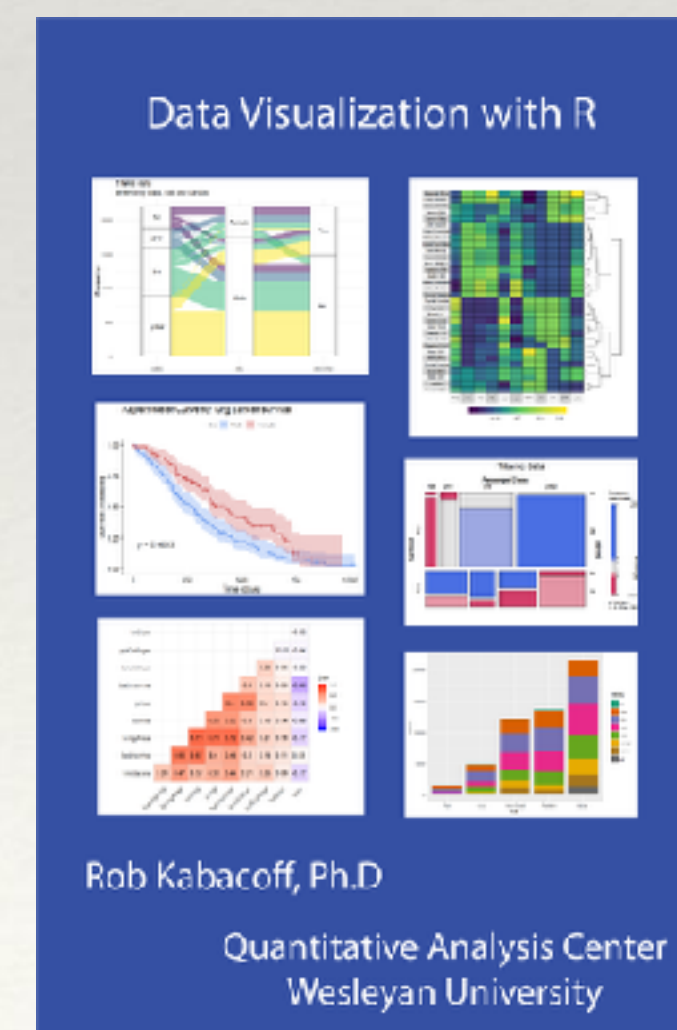
<http://chimera.labs.oreilly.com/books/12300000000345/index.html>



Tim Grobmann, Mario Dobler

Data Visualization with Python

O'Reilly, 2019



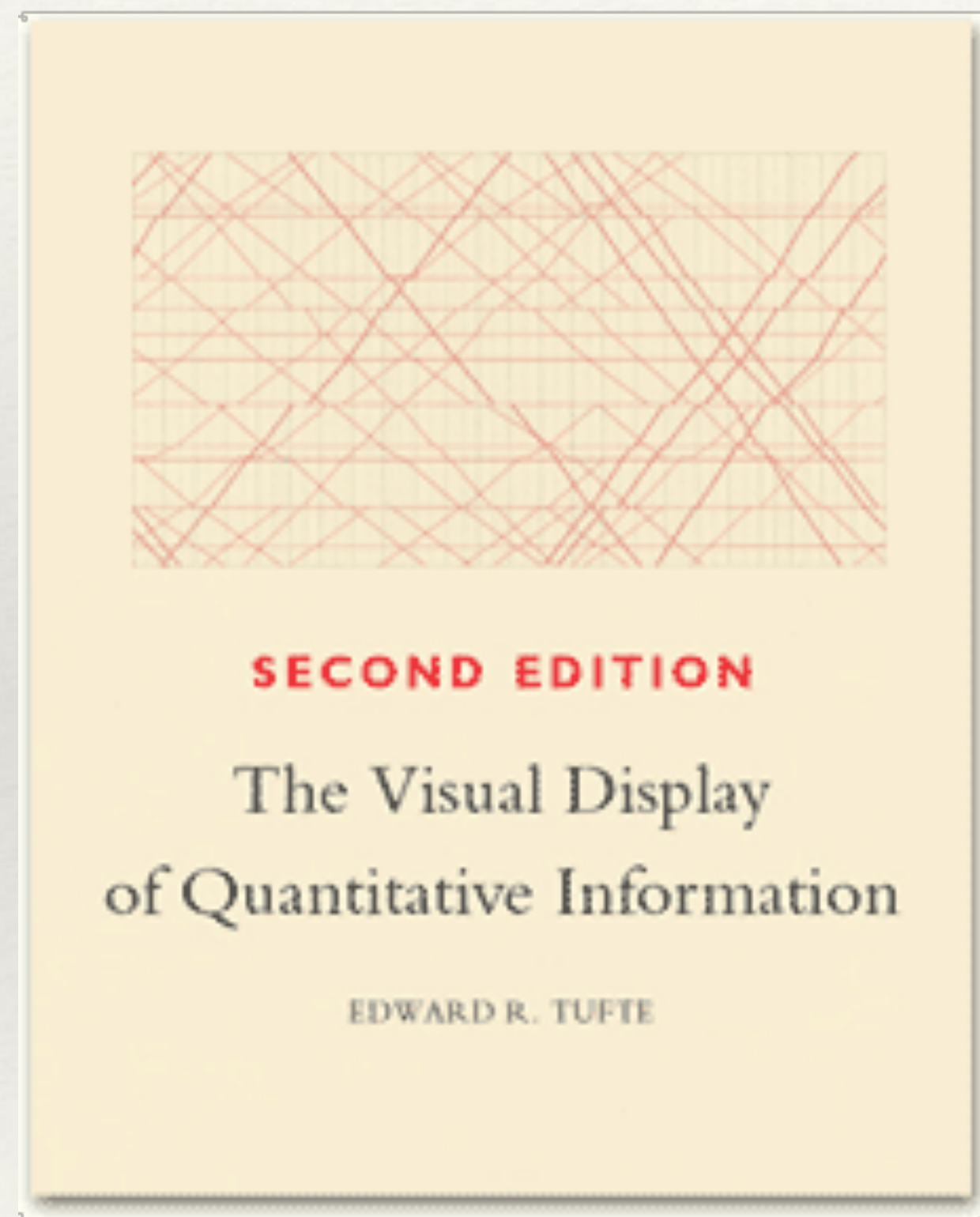
Rob Kabacoff

Data Visualization with R

licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

<https://rkabacoff.github.io/datavis/index.html>

Informazione quantitativa: la Bibbia



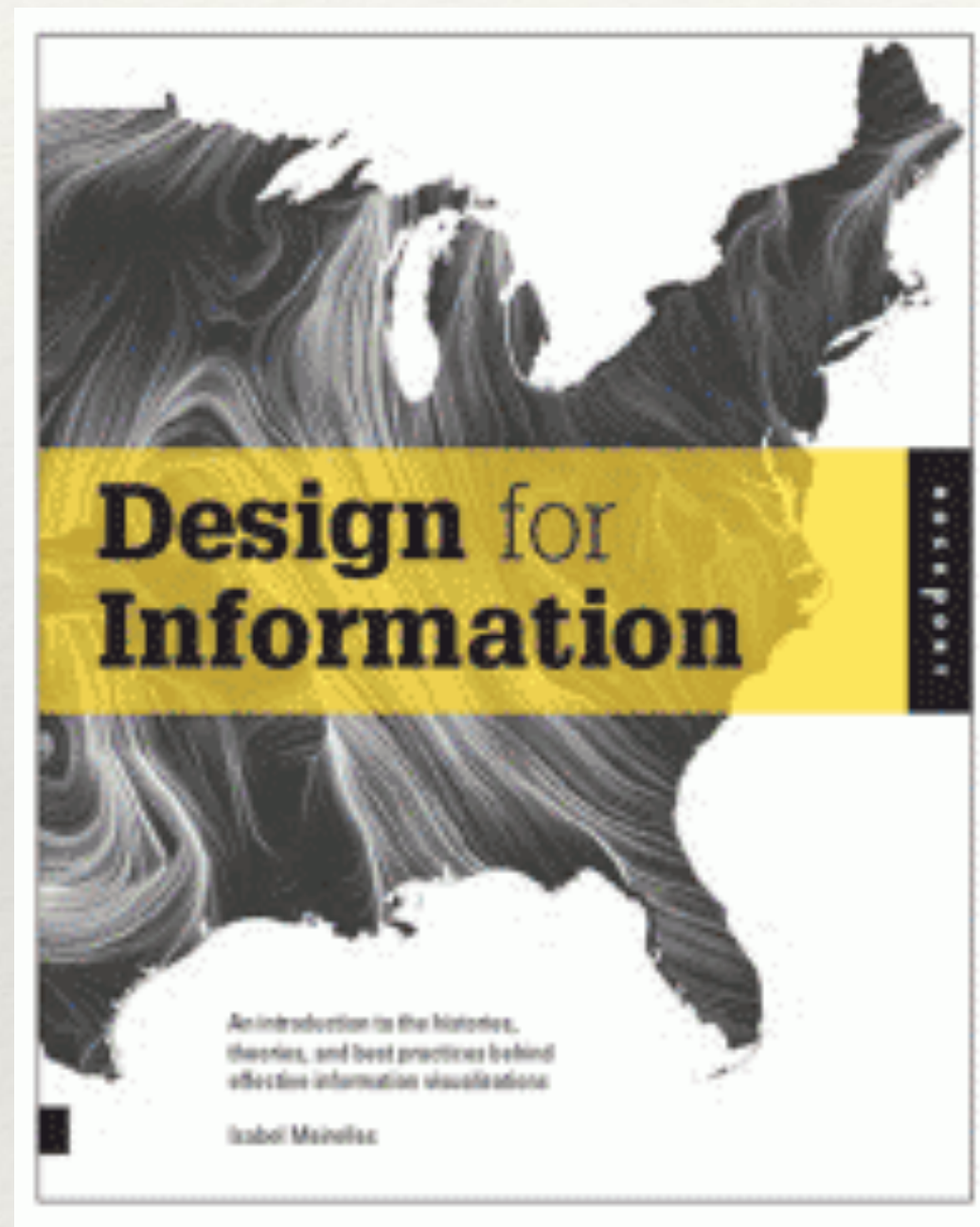
Edward R. Tufte

The Visual Display of Quantitative Information

Graphics Press, 2013

http://www.edwardtufte.com/tufte/books_vdqi

Information visualization



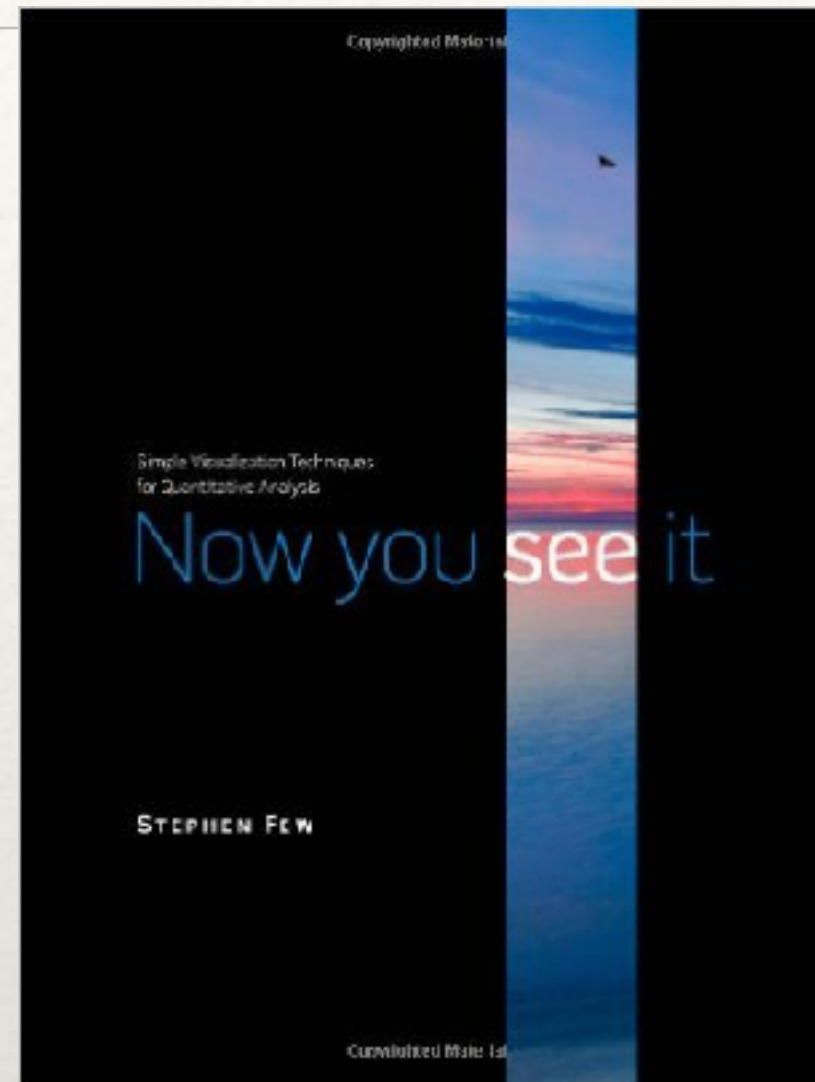
Isabel Meirelles

Design for Information

Rockport, 2013

<http://isabelmeirelles.com/book-design-for-information/>

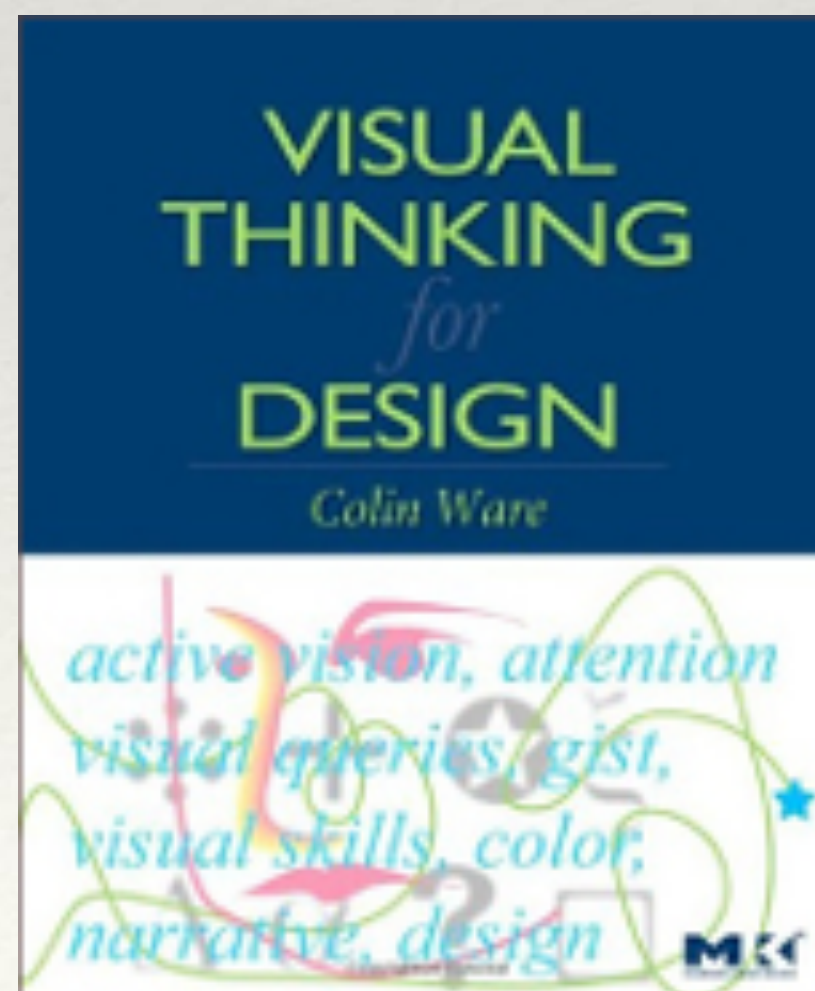
Principi percettivi per la visualizzazione



Stephen Few

Now You See It

Analytics Press, 2009

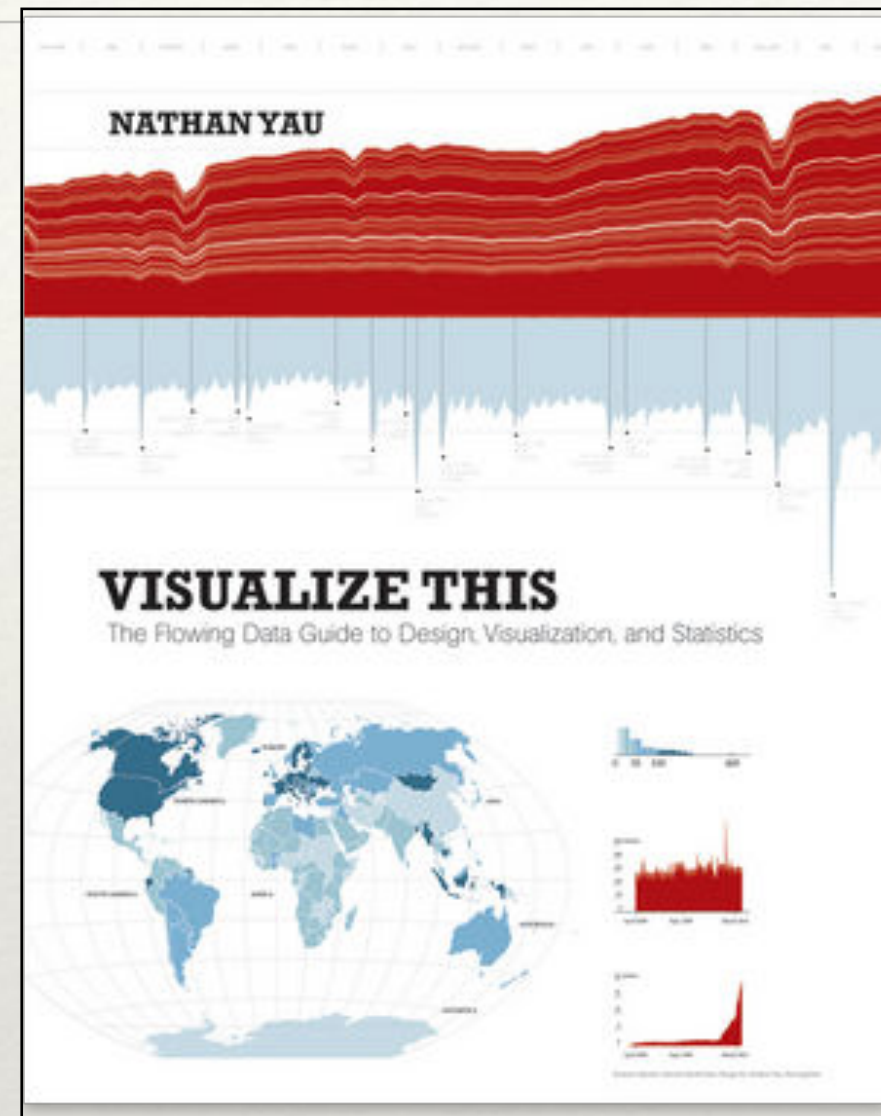


Colin Ware

Visual Thinking for Design

Morgan Kaufman, 2008

Data Visualization



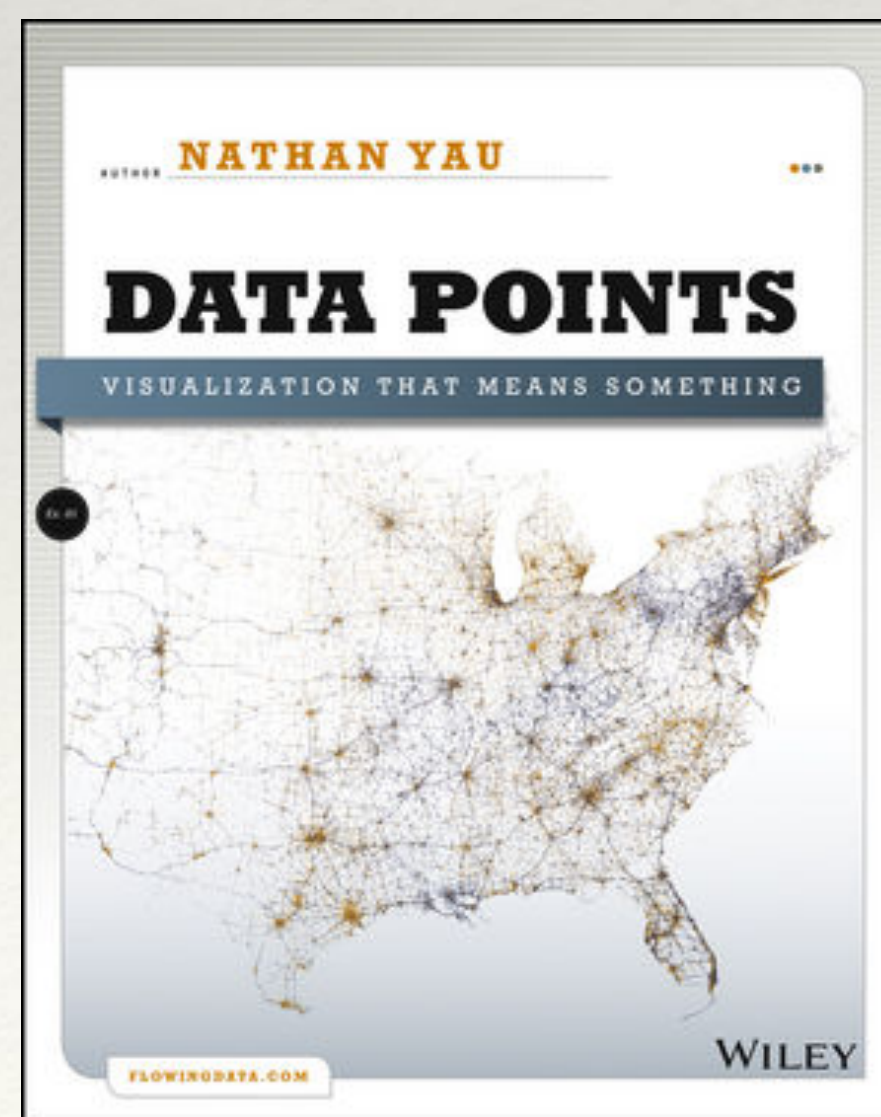
Nathan Yau

Visualize This

The FlowingData Guide to Design, Visualization,
and Statistics

Wiley, 2011

<http://flowingdata.com/>



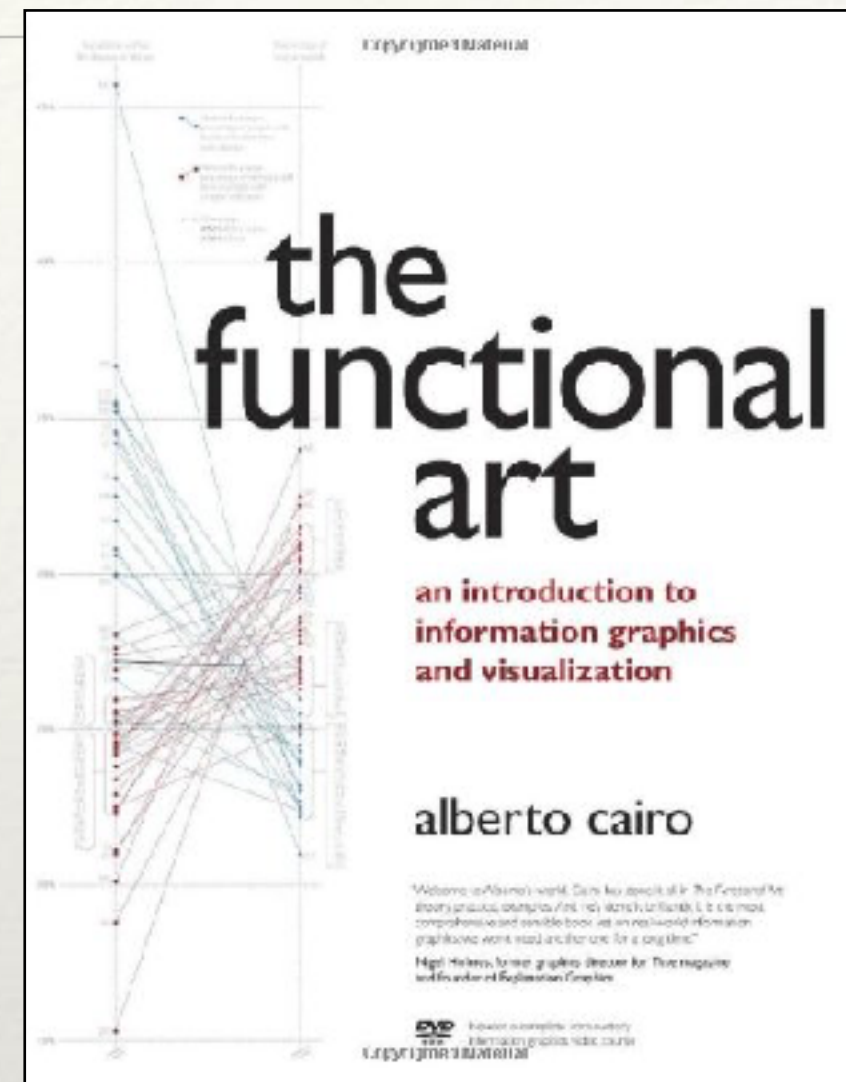
Nathan Yau

Data Points

Visualization That Means Something

Wiley, 2013

Data Journalism



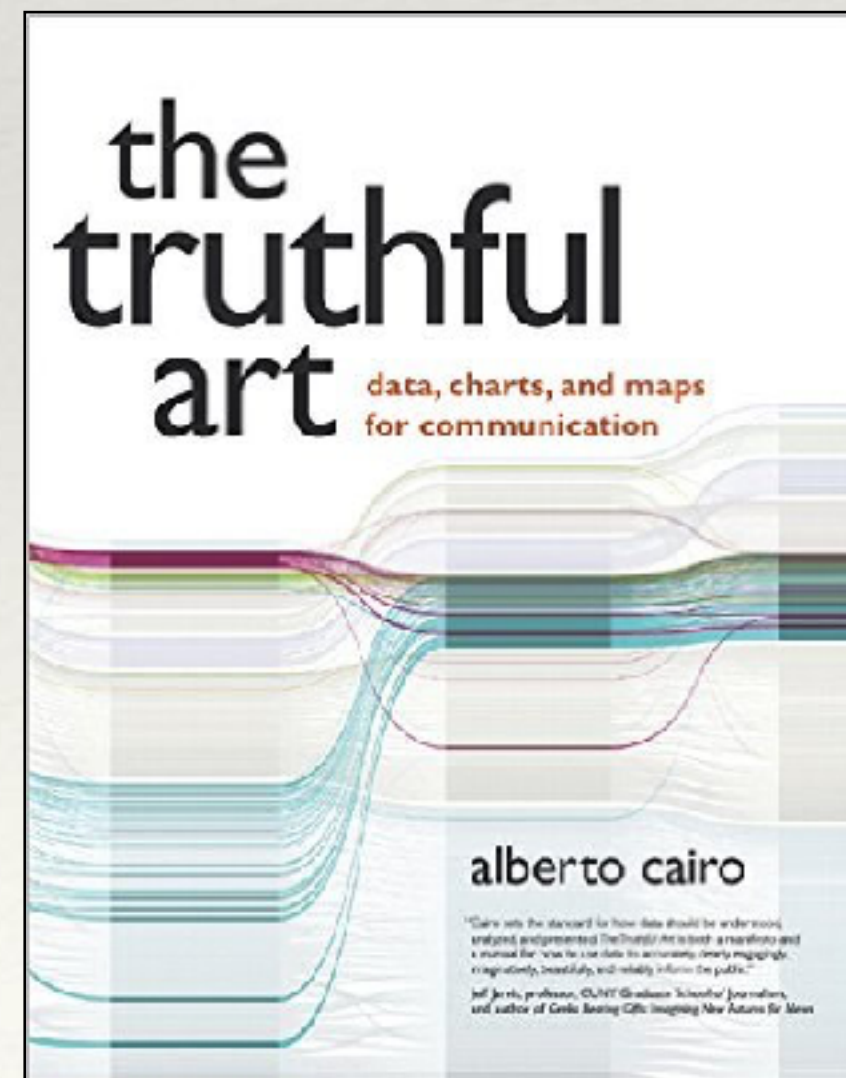
Alberto Cairo

The Functional Art

An Introduction to Information Graphics and Visualization

New Riders, 2013

<http://www.thefunctionalart.com/>



Alberto Cairo

The Truthful Art

Data, Charts, and Maps for Communication

New Riders, 2016

The data viz catalogue

The Data Visualisation Catalogue

About · Blog · Shop · Resources



Search by Function

View by List



Arc Diagram



Area Graph



Bar Chart



Box & Whisker Plot



Brainstorm



Bubble Chart





Questions?