Visualization

COS 323

Many slides based on CHI 2003 tutorial by Marti Hearst
and on Jeff Heer's CS 160 slides (2004)

What is Information Visualization?

"Transformation of the symbolic into the geometric"

(McCormick et al., 1987)

"... finding the artificial memory that best supports our natural means of perception."

(Bertin, 1983)

"The depiction of information using spatial or graphical representations, to facilitate comparison, pattern recognition, change detection, and other cognitive skills by making use of the visual system." (Hearst, 2003)

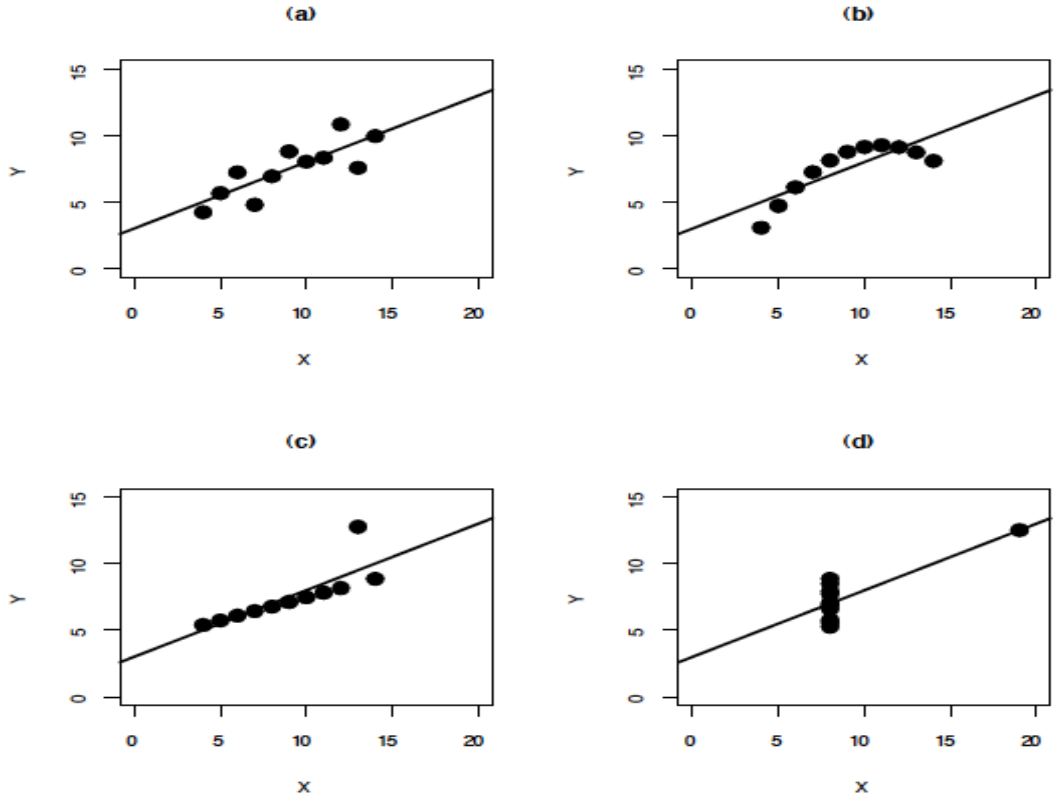
Information Visualization

- Problem
  - How to understand datasets?

Dataset 1		Dataset 2		Dataset 3		Dataset 4	
x	*y*	*x*	*y*	*x*	*y*	*x*	*y*
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.10	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.10	4	5.39	19	12.50
12	10.84	12	9.13	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89

Information Visualization

- Problem
  - How to understand datasets?
    - How to understand big, multi-dimensional datasets??



Information Visualization

- Solution
  - Take advantage of the human perceptual system
  - Convert information into a graphical representation.
- Issues
  - How to convert abstract information into graphical form?
  - Do visualizations do a better job than other methods?

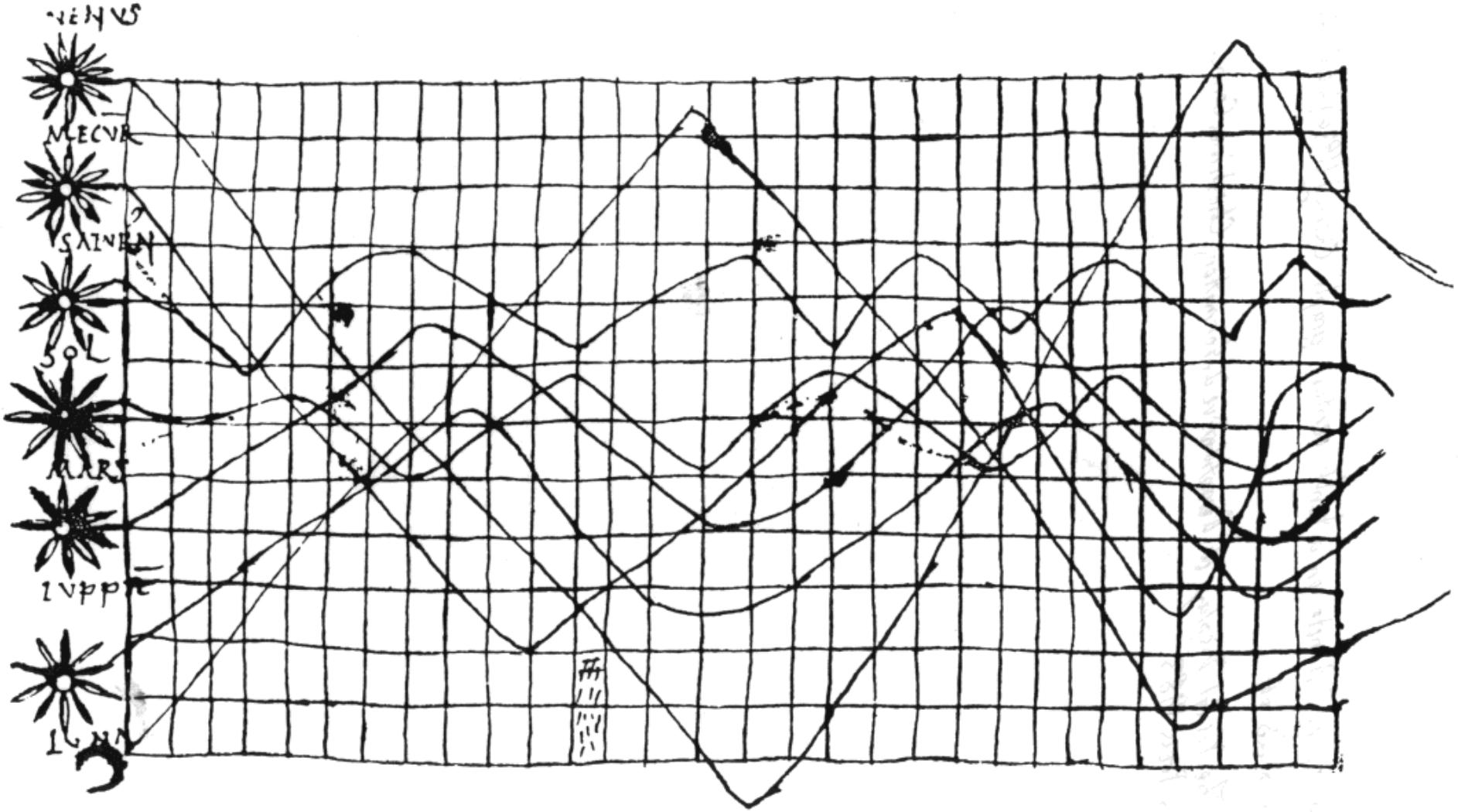
Goals of Information Visualization

- More specifically, visualization should:
  - Make large datasets coherent

    (Present huge amounts of information compactly)
  - Present information from various viewpoints
  - Present information at several levels of detail

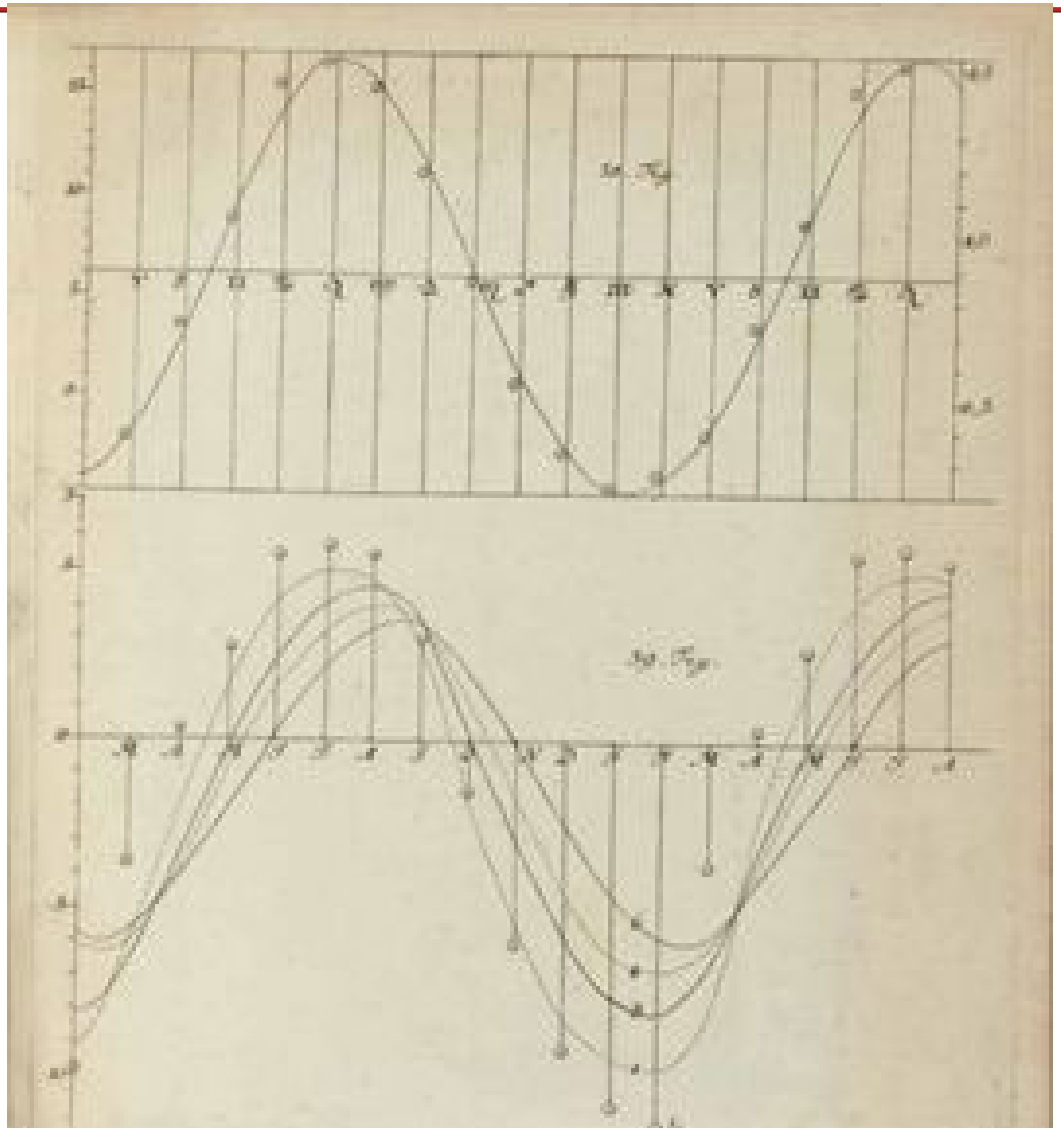
    (from overviews to fine structure)
  - Support visual comparisons
  - Tell stories about the data

An Early Visualization

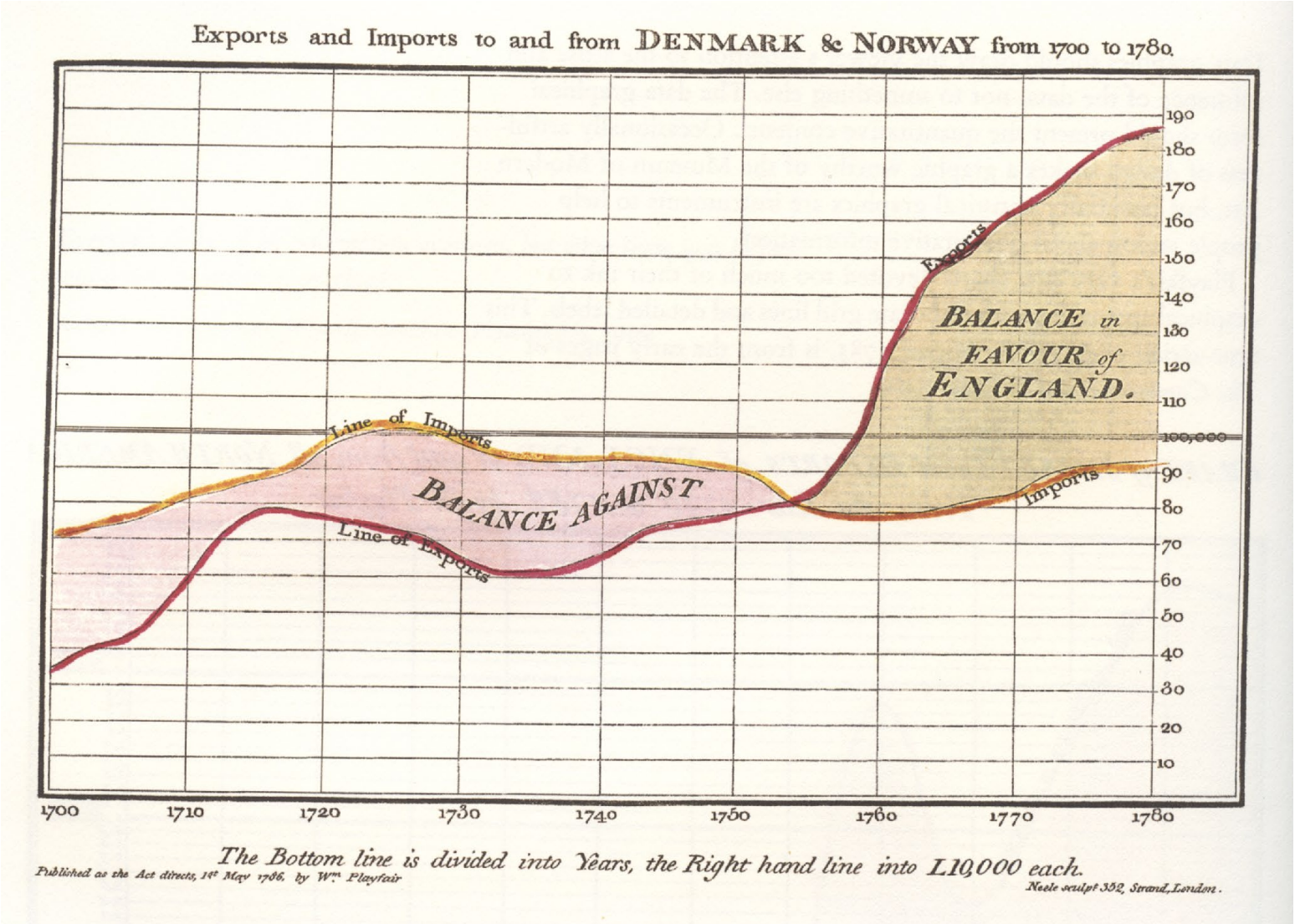


Time series appears in scientific writing in late 1700s

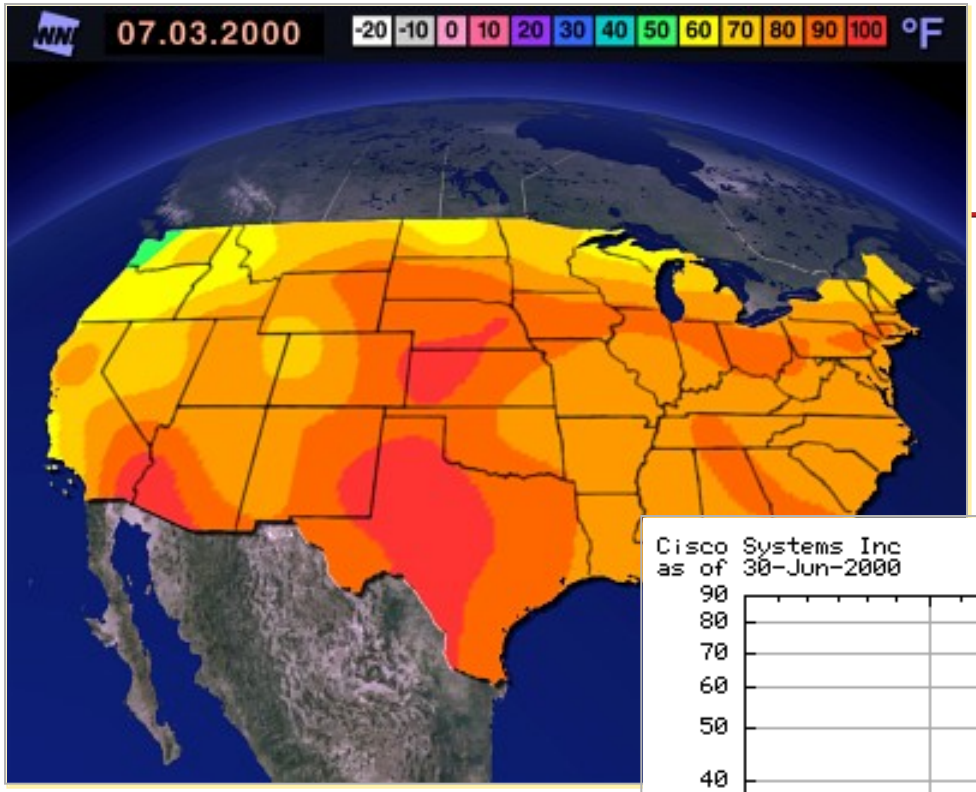
- Lambert's *Pyrometrie, 1779*



William Playfair

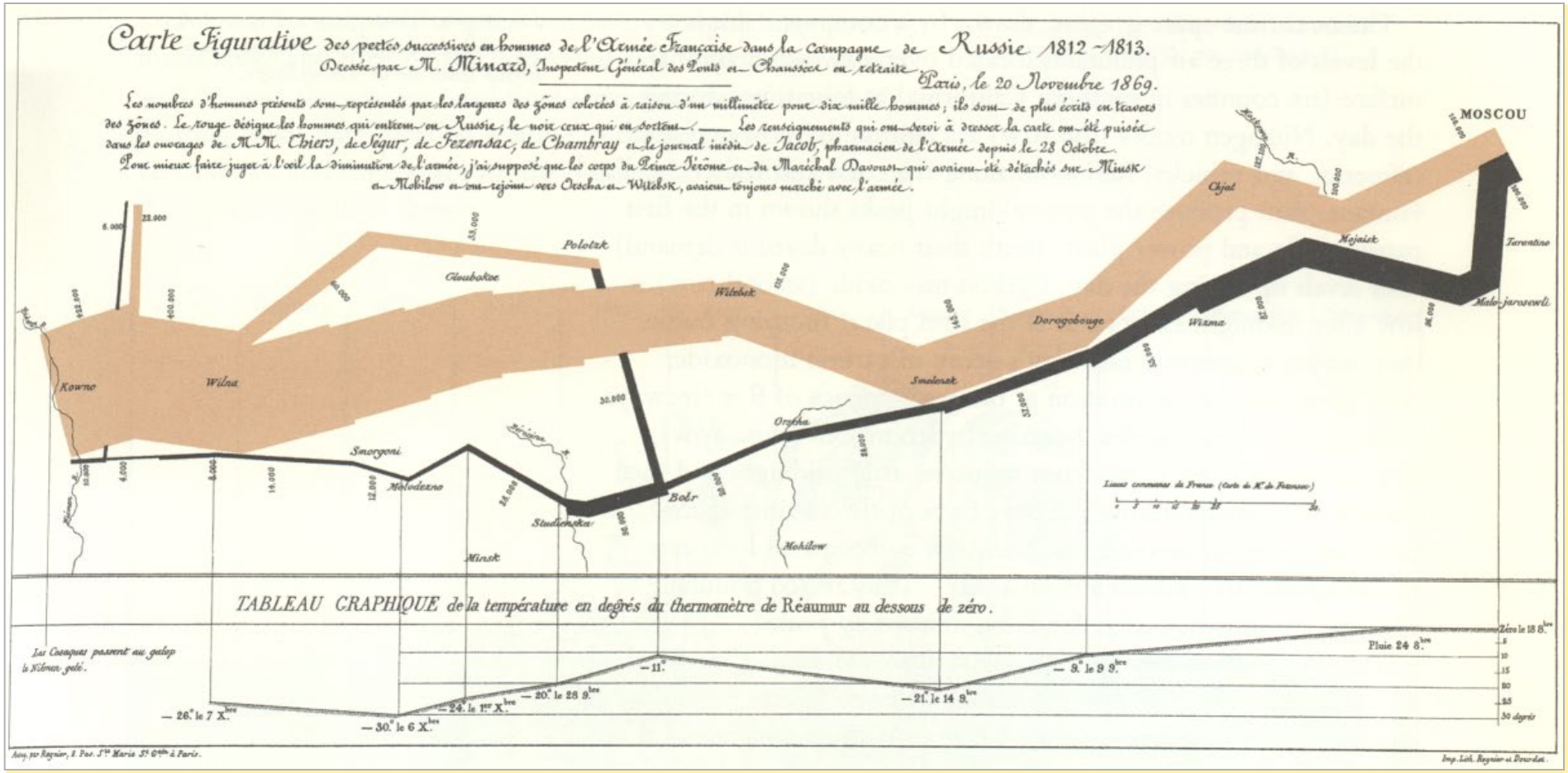


Visualization Success Stories



yahoo.com

Napoleon's 1812 March by Charles Joseph Minard

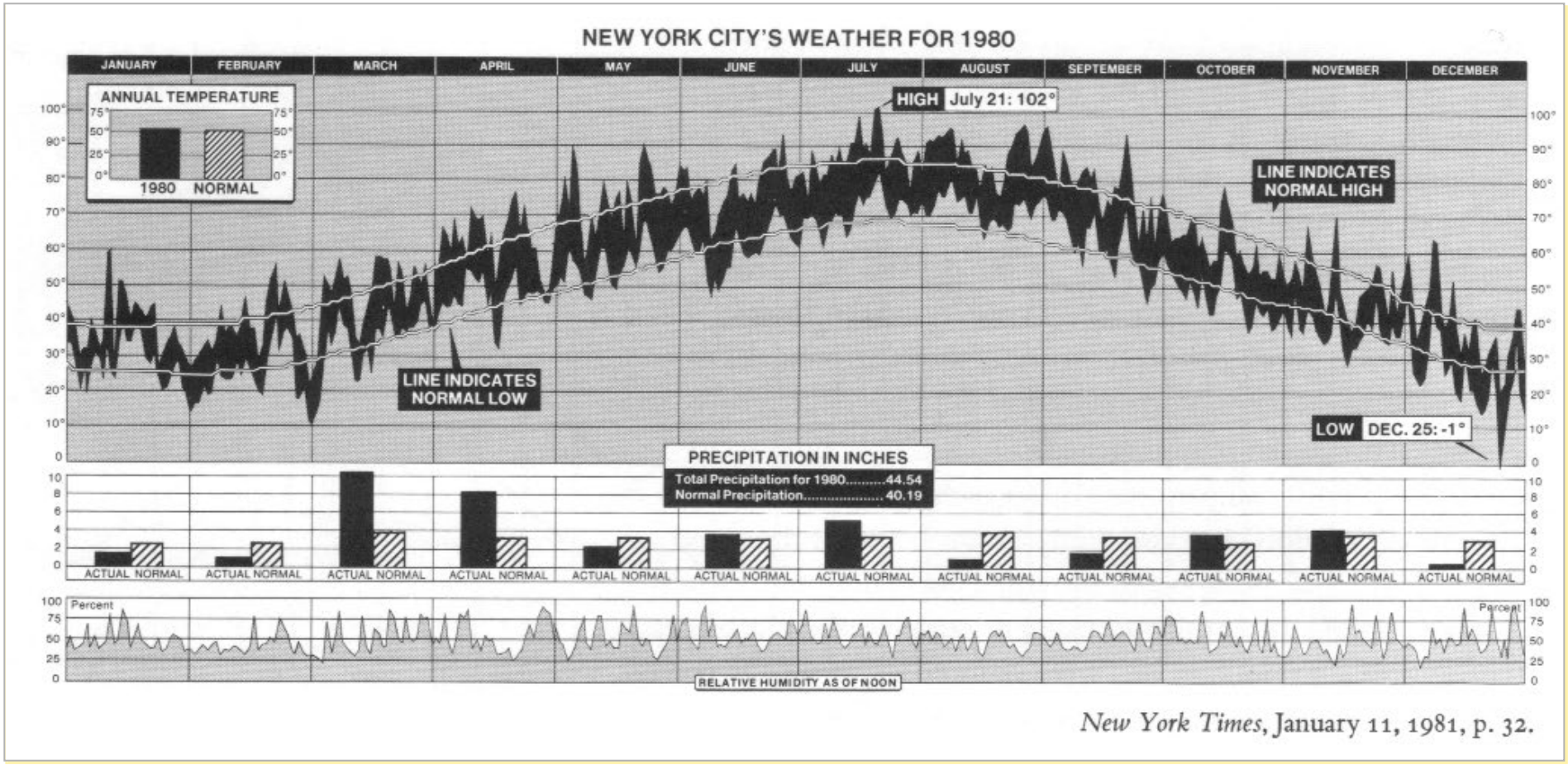


Variables shown:

- size of army
- direction
- latitude
- longitude
- temperature
- date

[Tufte]

NYC Weather



1888 numbers

[Tufte]

Visualization Success Story

Mystery: what is causing a cholera epidemic in London in 1854?

Visualization Success Story

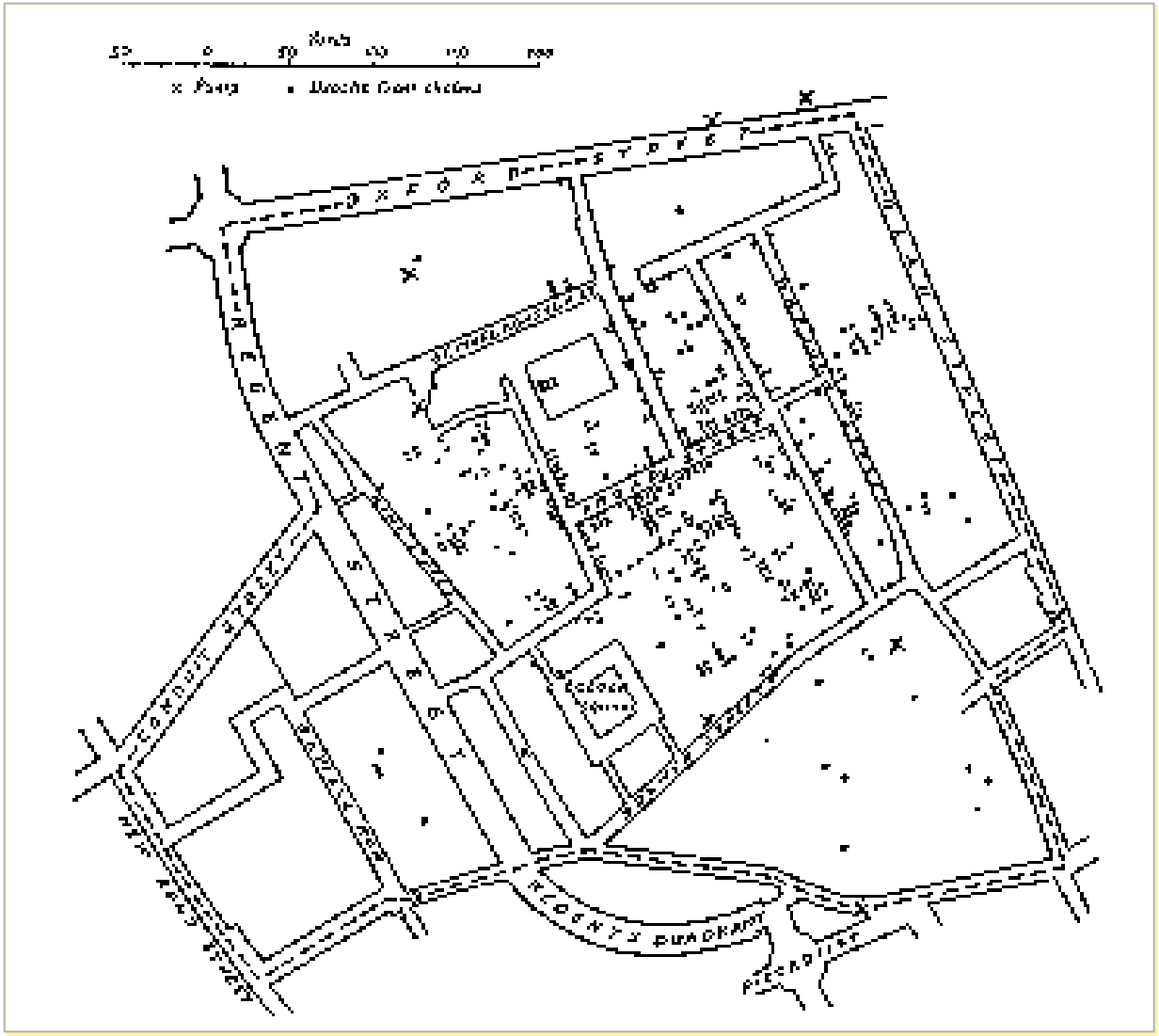
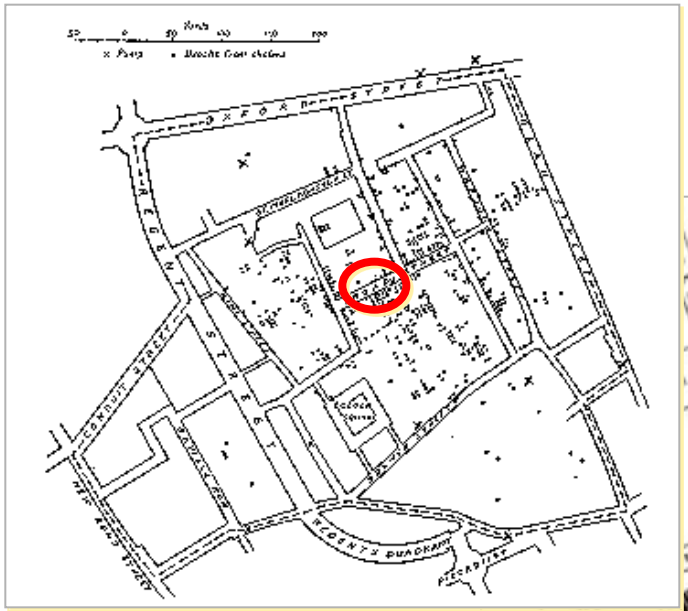


Illustration of John Snow's deduction that a cholera epidemic was caused by a bad water pump, circa 1854.

Dots indicate locations of deaths.

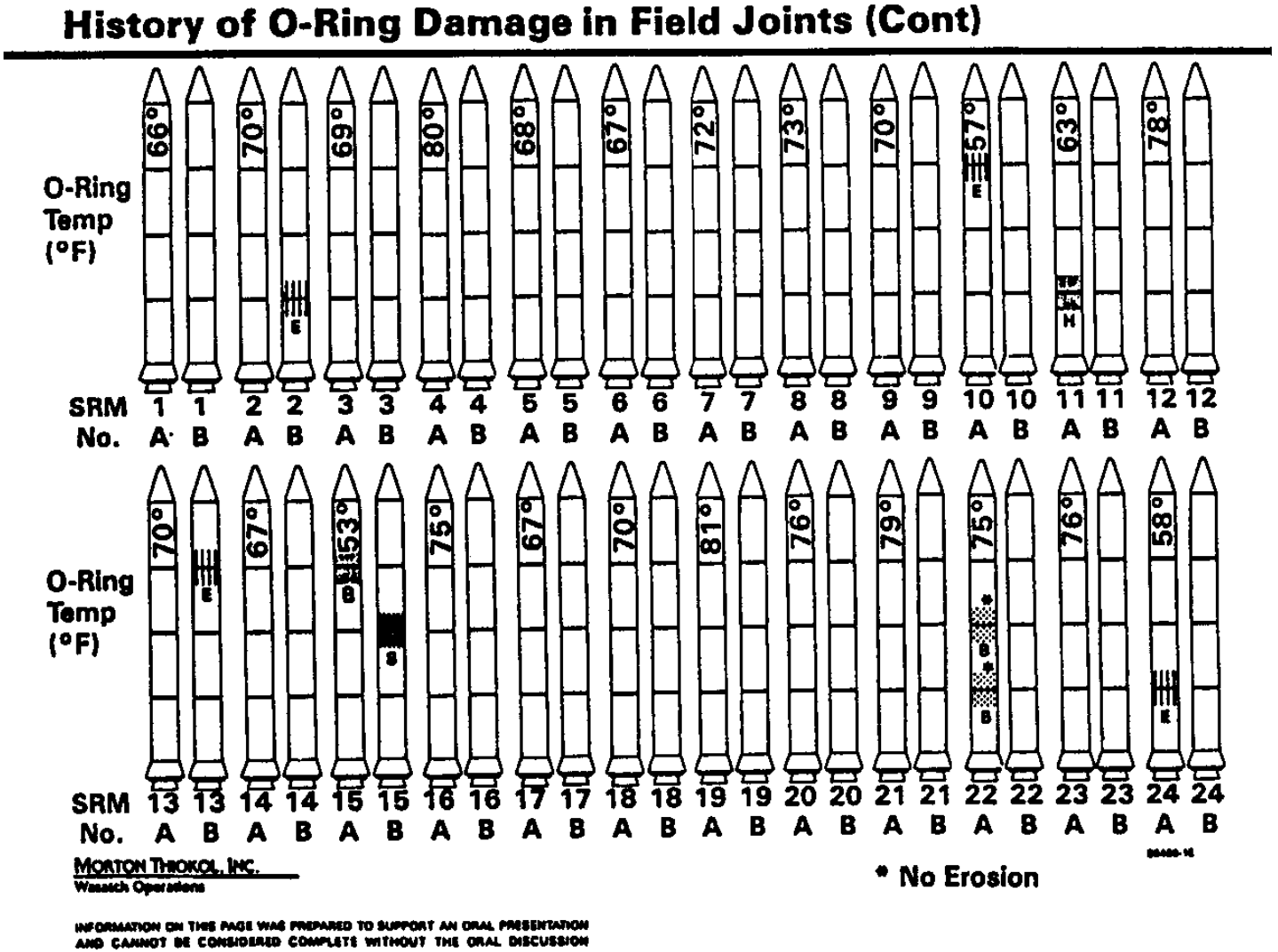
[Tufte]

Visualization Success Story



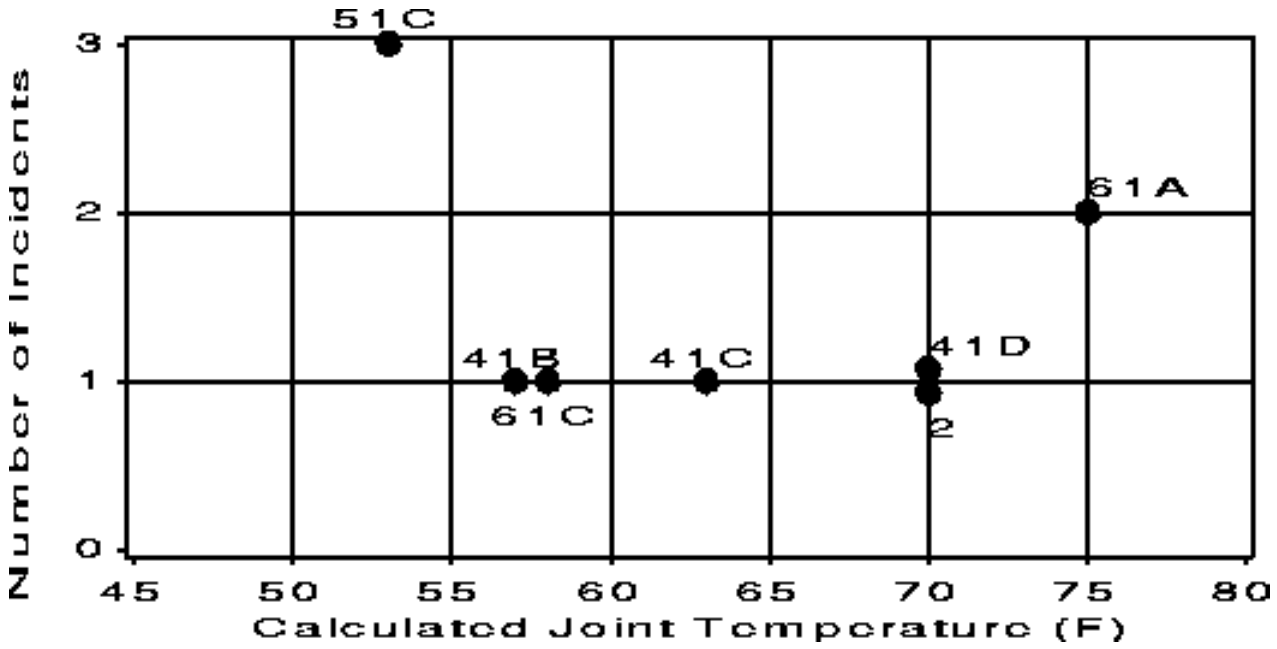
[Tufte]

Visualization Failure



Visualization Failure

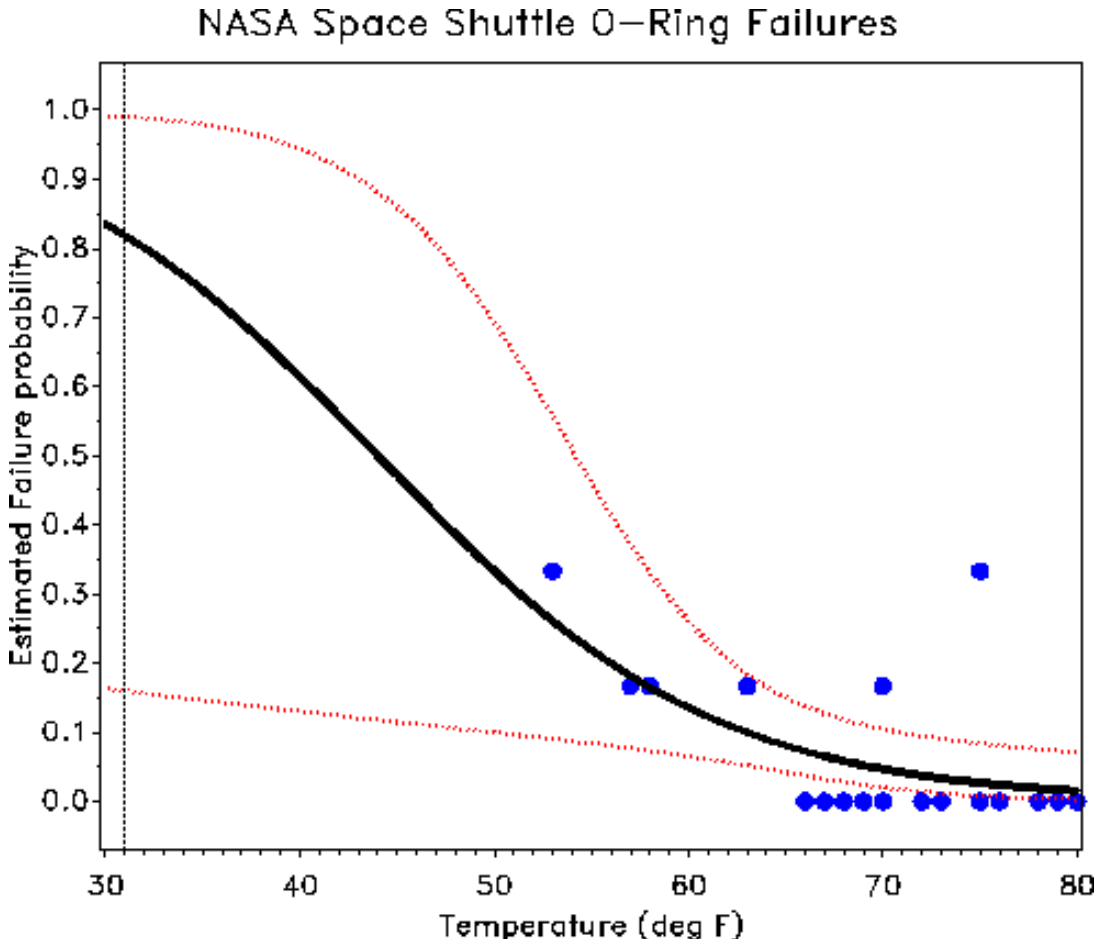
The visualization they made…



http://www.datavis.ca/gallery/missed.php

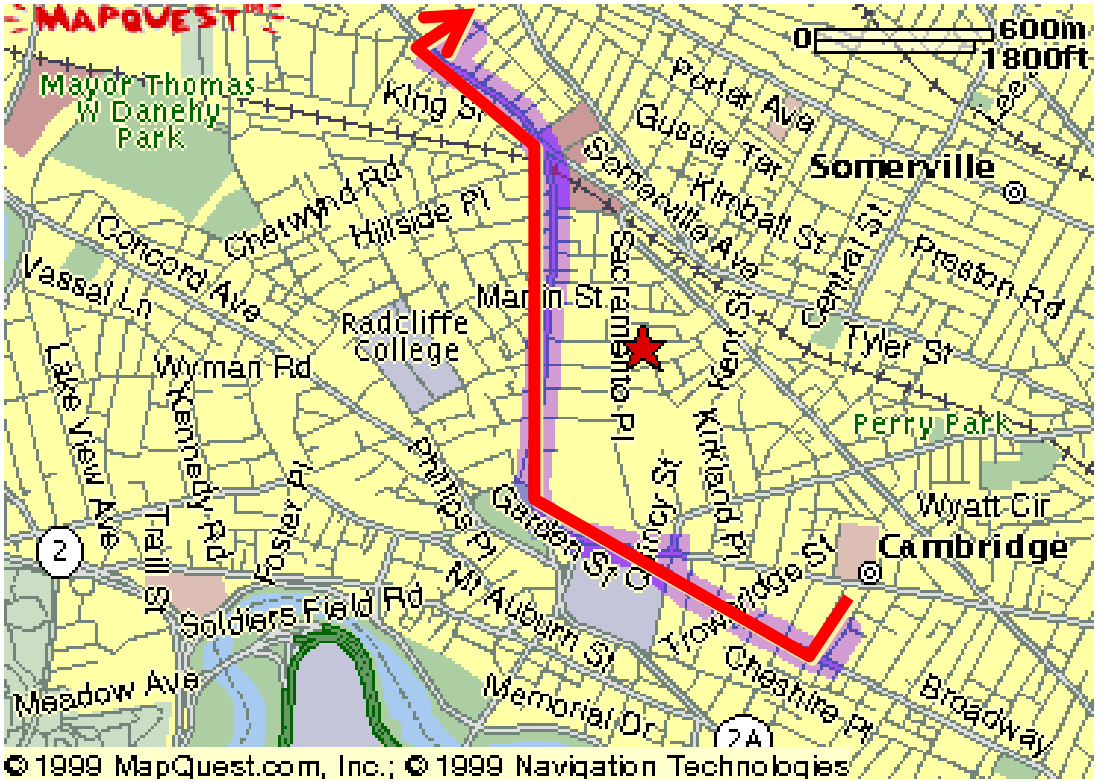
Visualization Failure

The one they should have made…



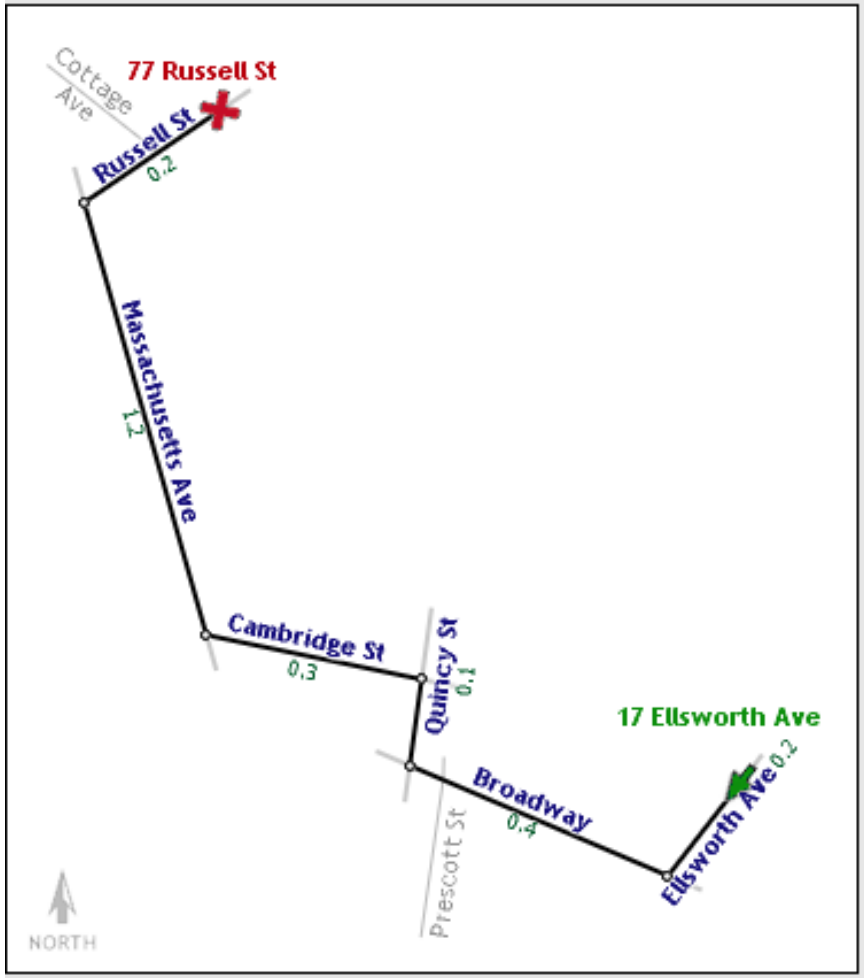
A Map Visualization circa 1999

1. Start out going Southwest on ELLSWORTH AVE
   Towards BROADWAY by turning right.
2: Turn RIGHT onto BROADWAY.
3. Turn RIGHT onto QUINCY ST.
4. Turn LEFT onto CAMBRIDGE ST.
5. Turn SLIGHT RIGHT onto
   MASSACHUSETTS AVE.
6. Turn RIGHT onto RUSSELL ST.



A more useful visualization

The estimated travel time is 5 minutes for 2.16 miles of travel, total of 6 steps.



	Directions	Elapsed Distance
1	Begin at **17 Ellsworth Ave** on **Ellsworth Ave** and go Southwest for 500 feet	0.1
2	Turn right on **Broadway** and go Northwest for 0.4 miles	0.5
3	Turn right on **Quincy St** and go North for 200 feet	0.5
4	Turn left on **Cambridge St** and go West for 0.3 miles	0.8
5	Bear right on **Massachusetts Ave,Mass Ave,RT-2A** and go North for 1.2 miles	2.0
6	Turn right on **Russell St** and go Northeast for 1000 feet to **77 Russell St**	2.2

see http://graphics.stanford.edu/papers/routemaps/

Why Visualization?

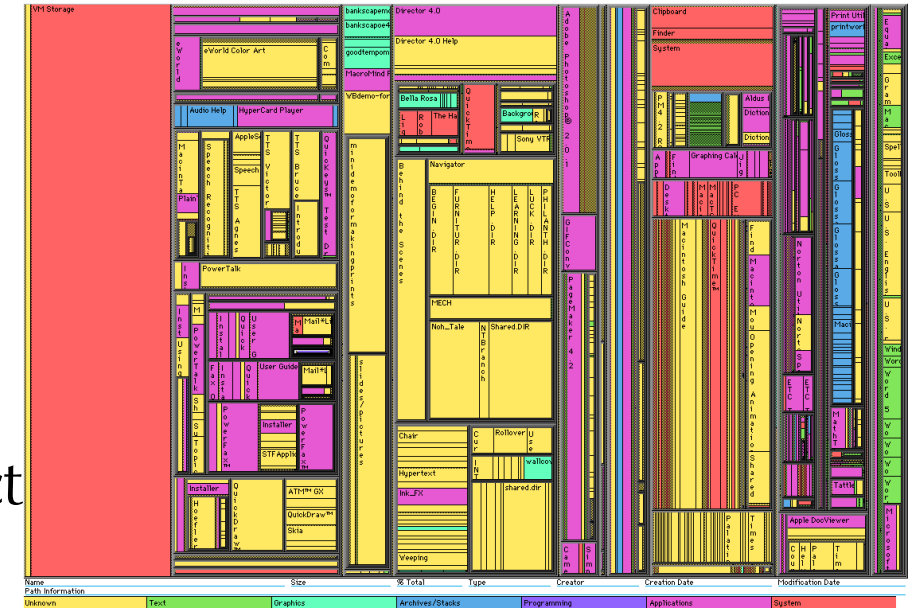
- Use the eye for pattern recognition; people are good at
  - scanning
  - recognizing
  - remembering images
- Graphical elements facilitate comparisons via
  - length
  - shape
  - orientation
  - texture
- Animation shows changes across time
- Color helps make distinctions
- Aesthetics help maintain interest

Two Different Primary Goals: Two Different Types of Viz

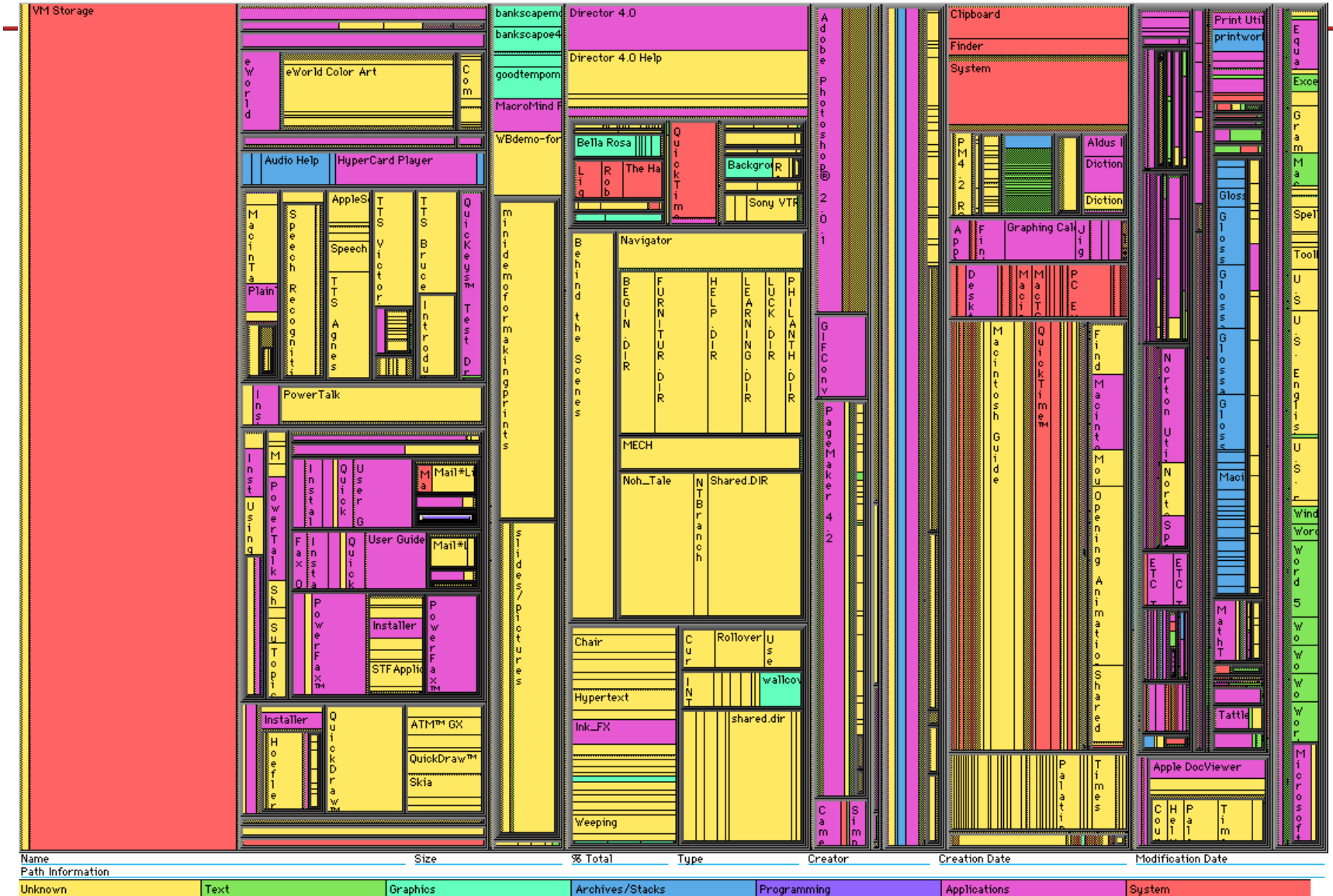
- Explore/Calculate
  - Analyze
  - Reason about Information
- Communicate
  - Explain
  - Make Decisions
  - Reason about Information

Case Study: The Journey of the TreeMap

- The TreeMap [Johnson & Shneiderman '91]
- Idea:
  - Show a hierarchy as a 2D layout
  - Fill up the space with rectangles representing object
  - Size on screen indicates relative size of underlying objects



Early Treemap Applied to File System



Treemap Problems

- Too disorderly
  - Adjacency is meaningless
  - Aspect ratios uncontrolled, leads to lots of skinny boxes that clutter
- Color not (necessarily) used appropriately
- Wrong application
  - Don't need all this to just see the largest files

Successful Application of Treemaps

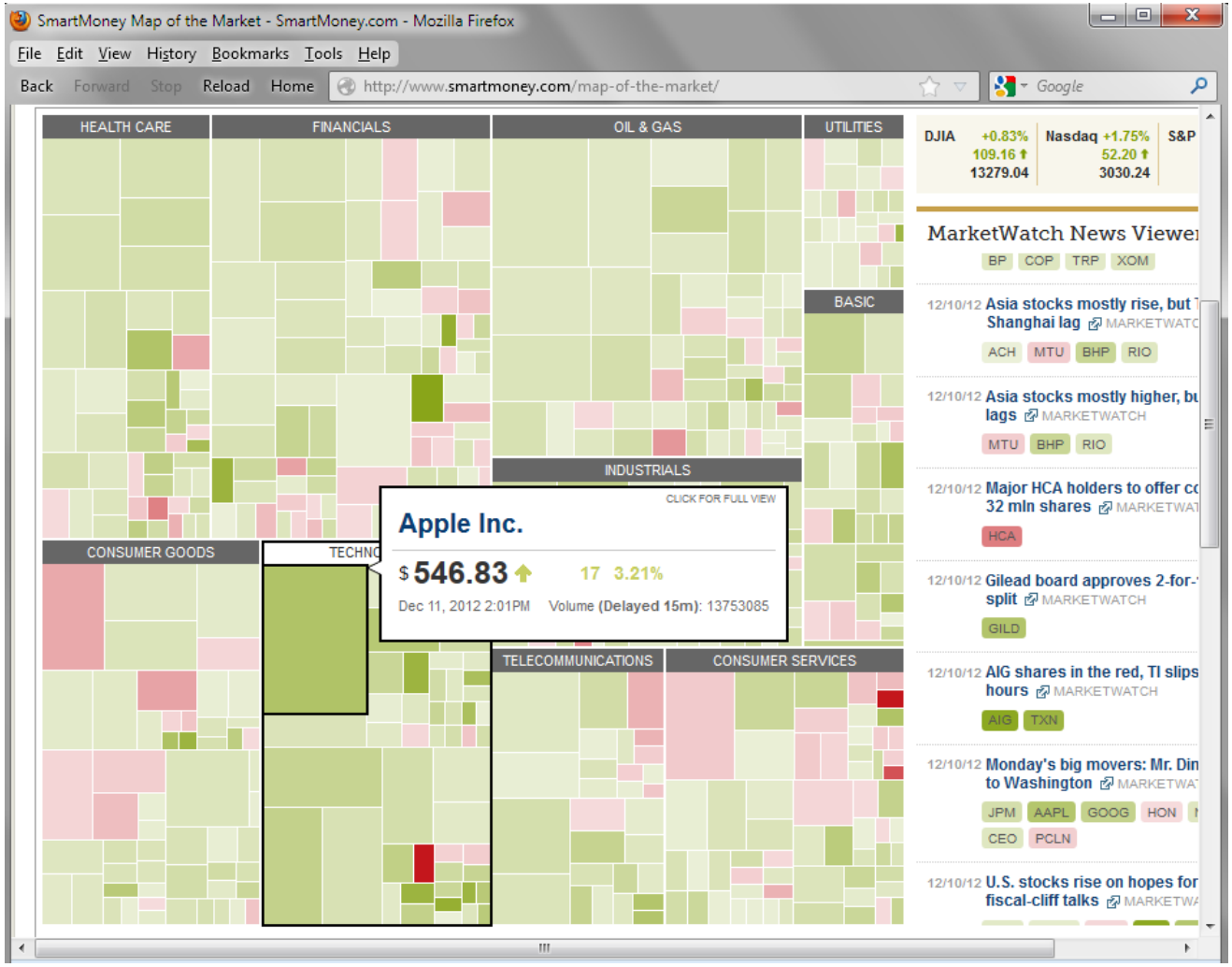
- Think more about the use
  - Break into meaningful groups
  - Fix items into a useful aspect ratio
- Use visual properties (e.g. color) properly
  - Use color to highlight and/or show relationships
- Provide interactivity
  - Access to the real data
  - Makes it into a useful tool

TreeMaps in Action

http://www.smartmoney.com/map-of-the-market

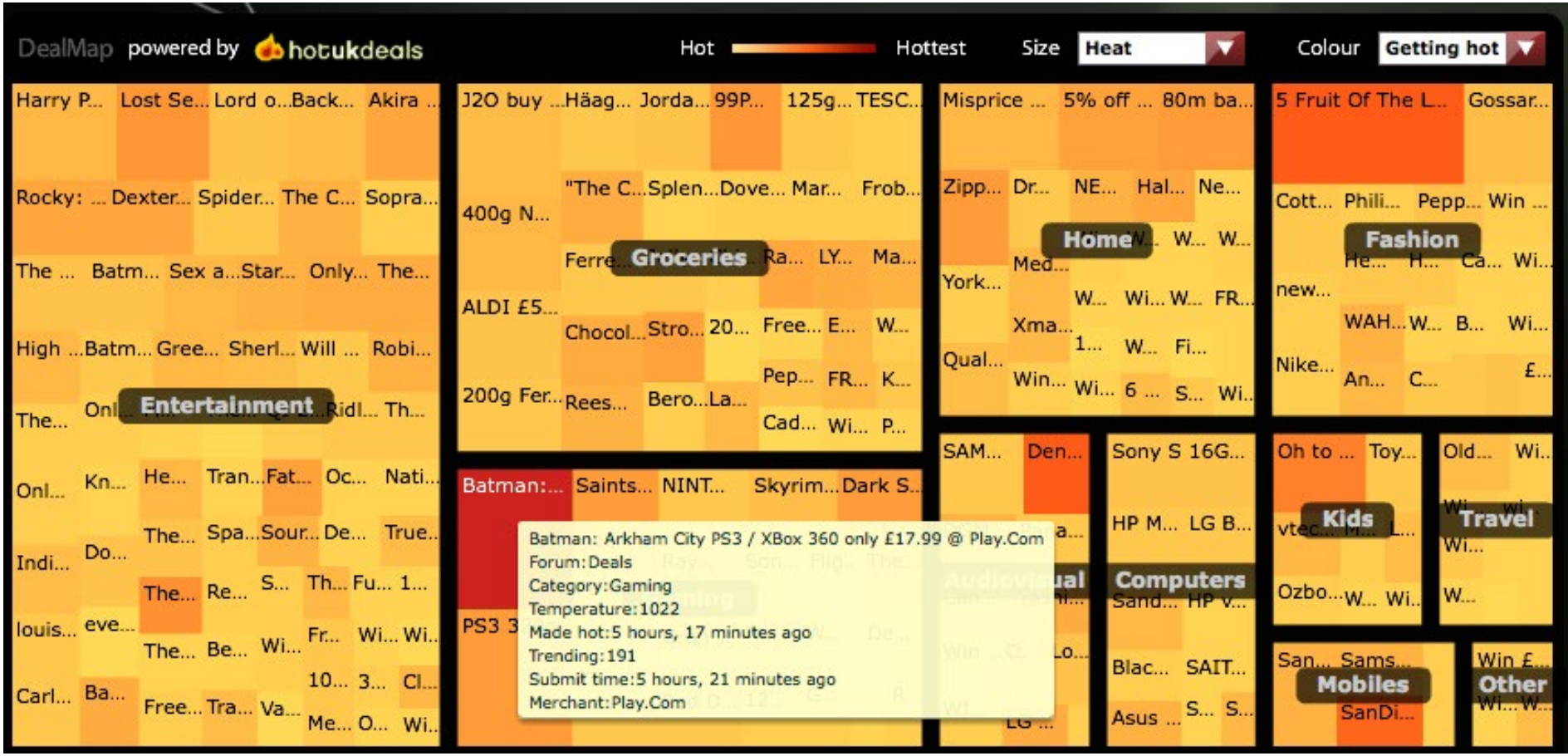
http://www.dealmapper.co.uk/

A Good Use of TreeMaps and Interactivity



http://www.smartmoney.com/marketmap

Deal Mapper


DealMap powered by hotukdeals
Hot
Hottest
Size
Heat
Colour
Getting hot
Entertainment
Groceries
Home
Fashion
Kids
Travel
Computers
Mobiles
Other
Batman: Arkham City PS3 / XBox 360 only £17.99 @ Play.Com
Forum:Deals
Category:Gaming
Temperature:1022
Made hot:5 hours, 17 minutes ago
Trending:191
Submit time:5 hours, 21 minutes ago
Merchant:Play.Com

Analysis vs. Communication

- MarketMap's use of TreeMaps allows for sophisticated analysis

- DealMapper's use of TreeMaps is more for presentation and communication

Visual Principles

Visual Principles

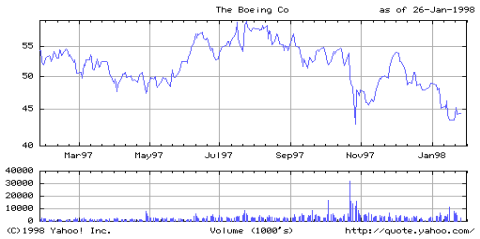
- Types of visual representations
- Pre-attentive Properties
- Relative expressiveness of visual cues
- Visual illusions
- Tufte's notions
  - Graphical Excellence
  - How to Lie with Visualization
  - Data-Ink Ratio Maximization

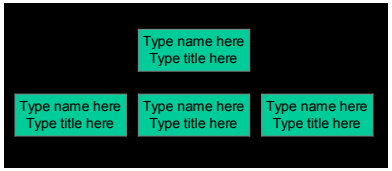
References for Visual Principles

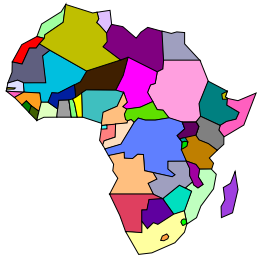
- Kosslyn: Types of Visual Representations
- Lohse et al: How do people perceive common graphic displays
- Bertin, MacKinlay: Perceptual properties and visual features
- Tufte/Wainer: How to mislead with graphs

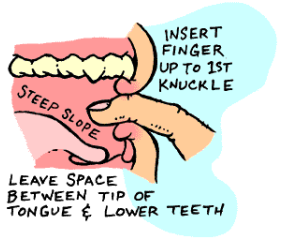
Types of Symbolic Displays

- Graphs
- Charts
- Maps
- Diagrams







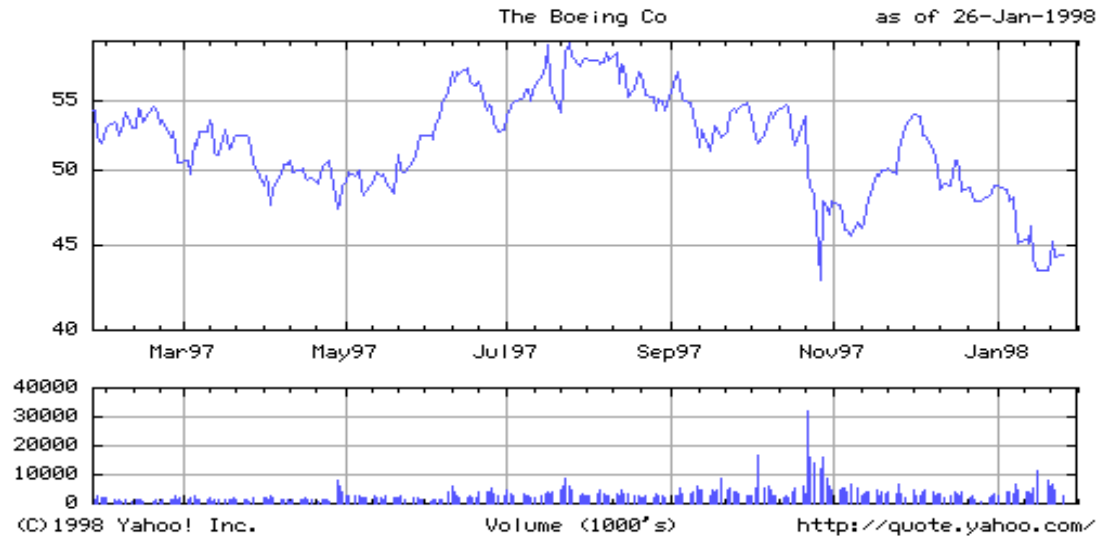


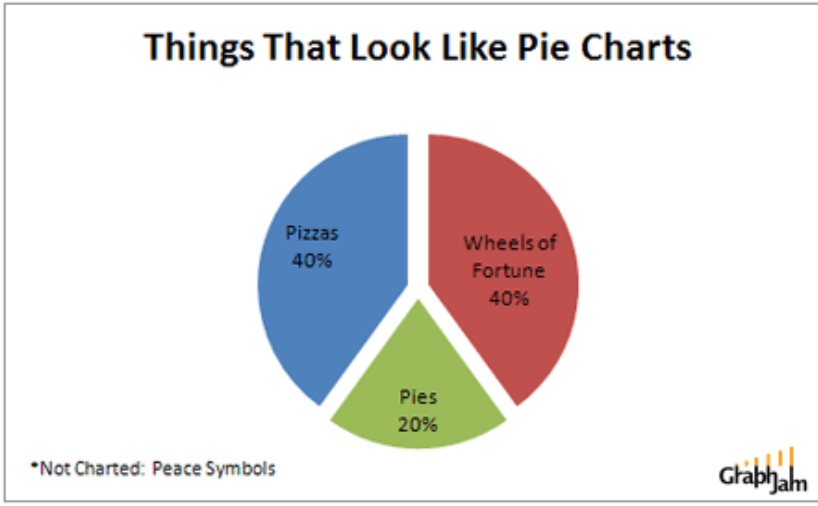
[Kosslyn]

Types of Symbolic Displays

Graphs

- requires scale
- values associated by symmetric "paired with" relation
- "Greater" is represented by bigger, higher, longer, etc.
- Examples: scatter-plot, bar-chart, pie chart





Types of Symbolic Displays

Charts

- discrete relations among discrete entities
- structure relates entities to one another
- lines and relative position serve as links
- Examples:

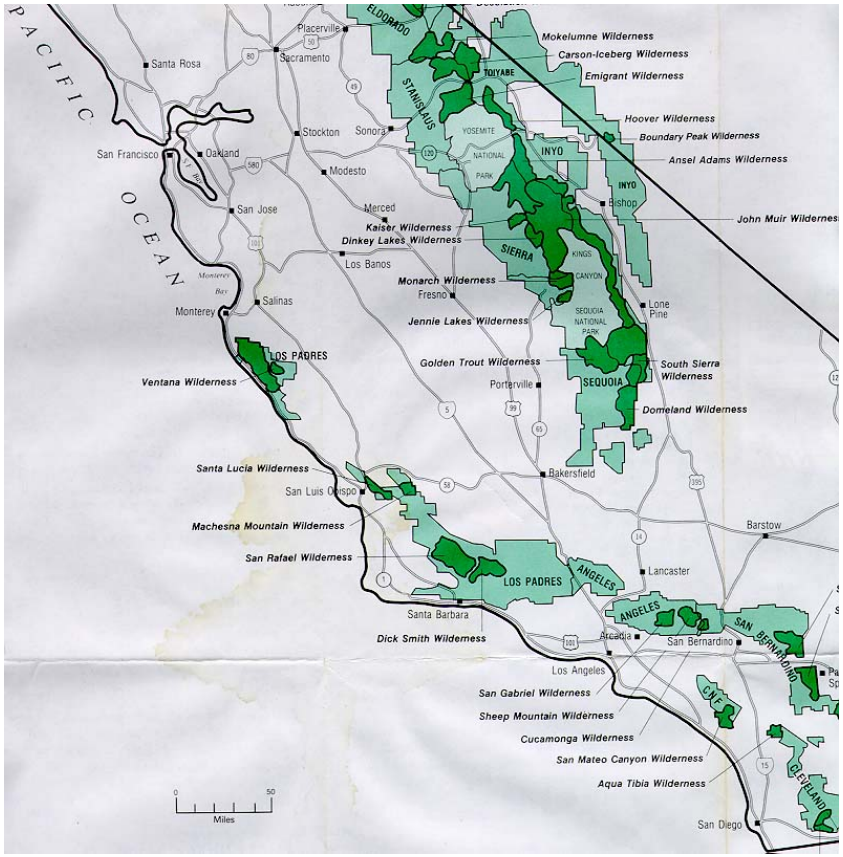
  family tree,
  flow chart,
  network diagram

Types of Symbolic Displays

Maps

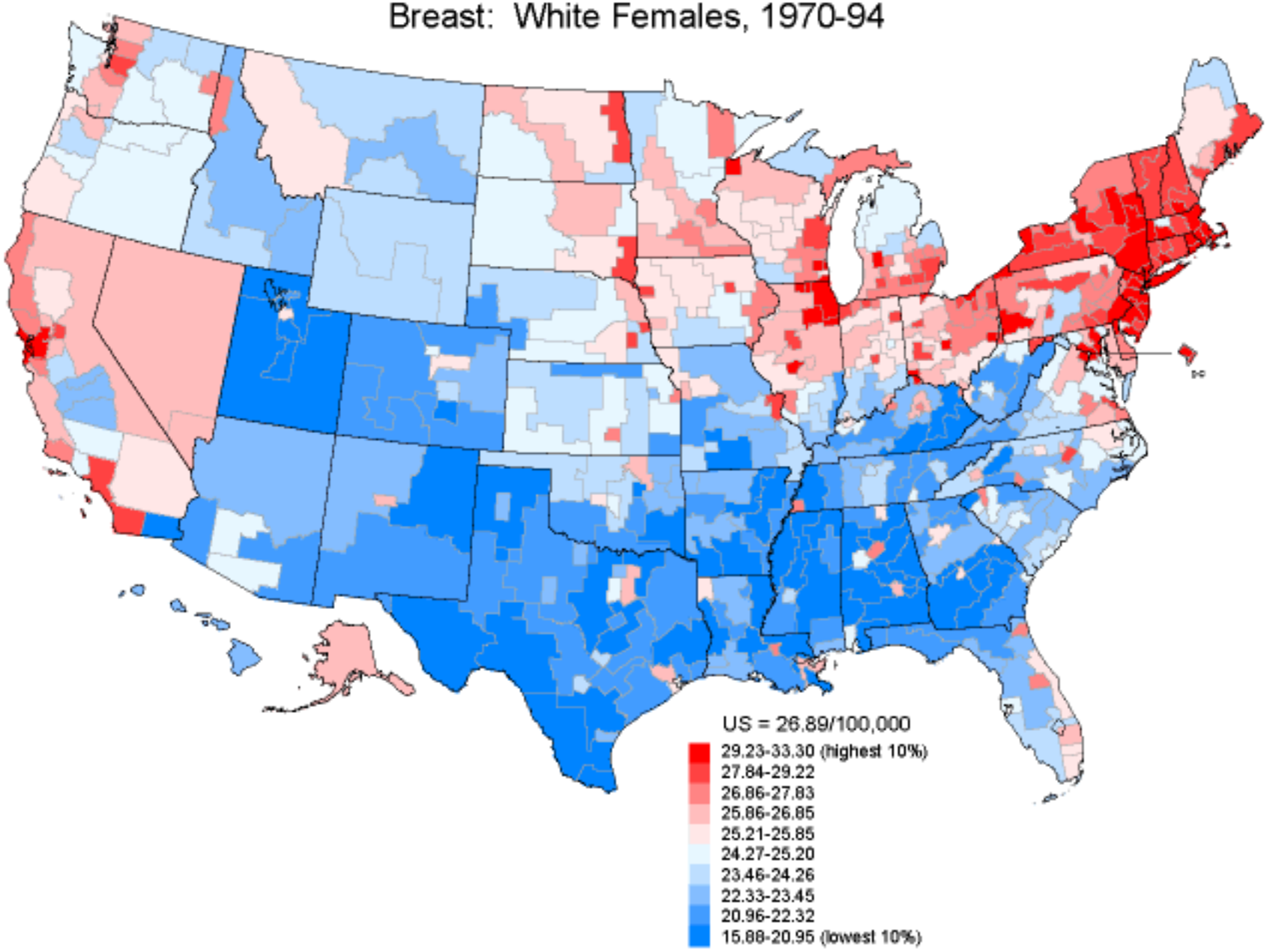
- internal relations determined (in part) by the spatial relations of what is pictured
- labels paired with locations
- Examples:

  physical maps,
  topographic maps,
  political maps,
  maps of census data



Cancer Mortality Rates by State Economic Area

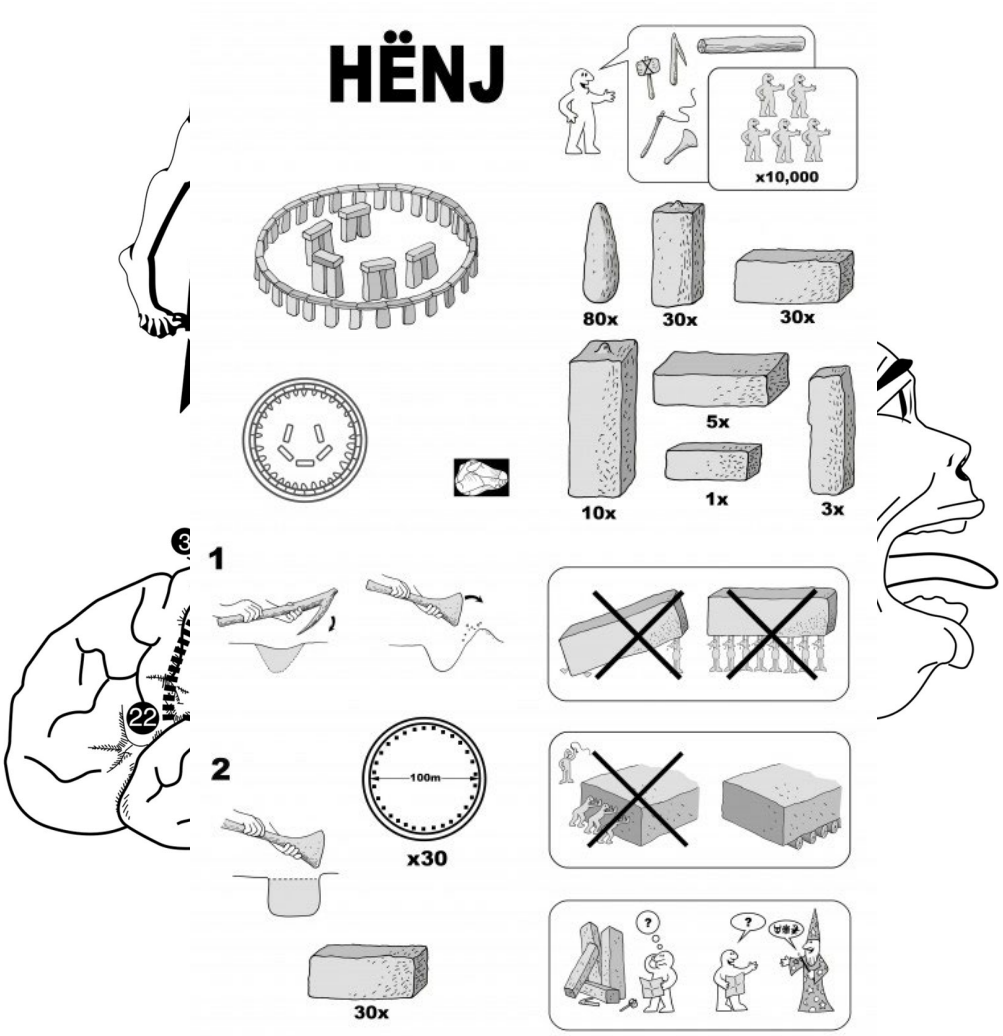
Breast: White Females, 1970-94



Types of Symbolic Displays

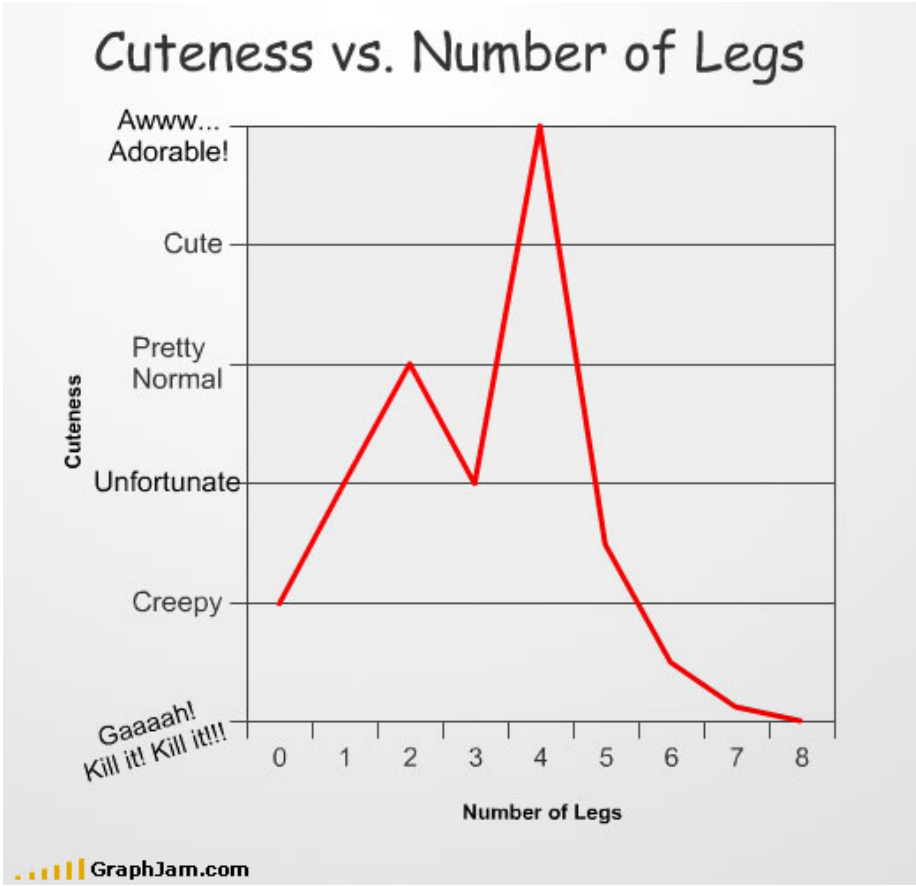
- Diagrams
  - schematic pictures of objects or entities
  - parts are symbolic (unlike photographs)
  - Examples:

    how-to illustrations, figures in a manual



Anatomy of a Graph [Kosslyn 89]

- Background
- Framework
  - kinds of measurements, scale, … (outer framework)
  - Includes grid lines (inner)
- Specifier
  - conveys information about entities represented by framework
  - maps parts of the framework to other parts of the framework
  - e.g., the red line ------->
- Labels
  - title, axes, tic marks, ...

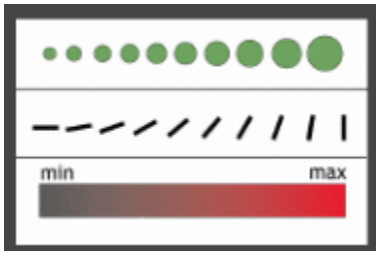


Basic Types of Data

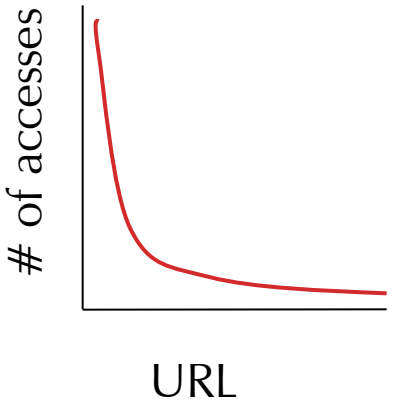
- Nominal (qualitative)
  - (no inherent order)
  - city names, types of diseases, ...

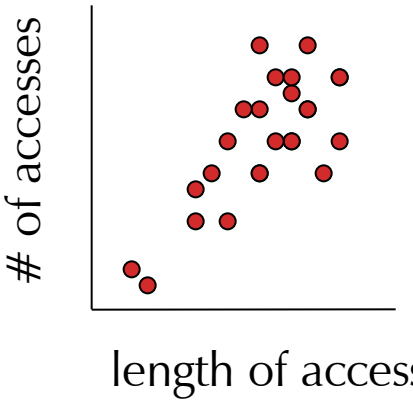
- Ordinal (qualitative)
  - (ordered, but not at measurable intervals)
  - first, second, third, …
  - cold, warm, hot

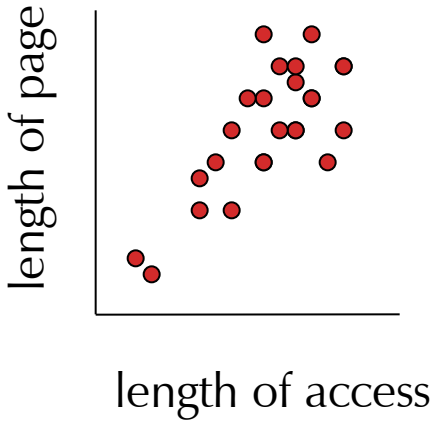
- Interval (quantitative)
  - list of integers or reals

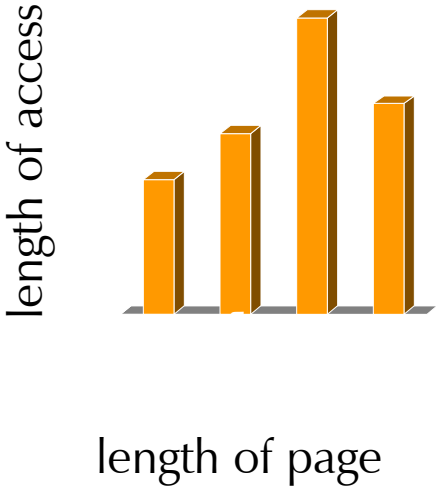


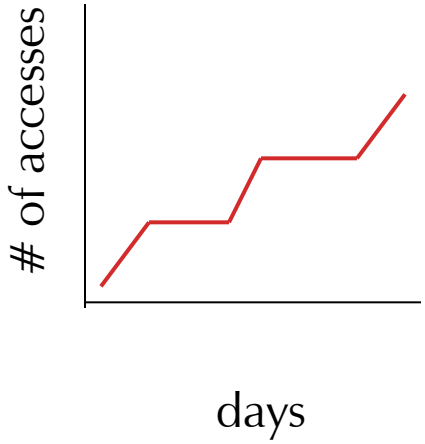
Common Graph Types

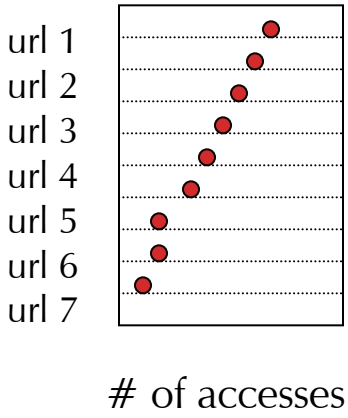












When to use which type?

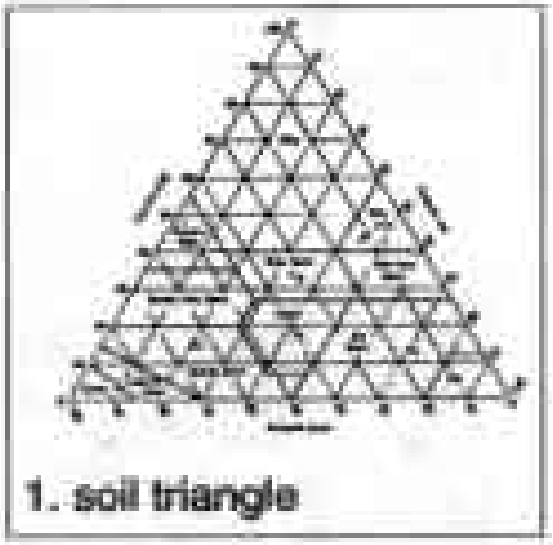
- Line graph
  - x-axis requires quantitative variable
  - Variables have contiguous values
  - familiar/conventional ordering among ordinals
- Bar graph
  - comparison of relative point values
- Scatter plot
  - convey overall impression of relationship between two variables
- Pie Chart?
  - Emphasizing differences in proportion among a few numbers

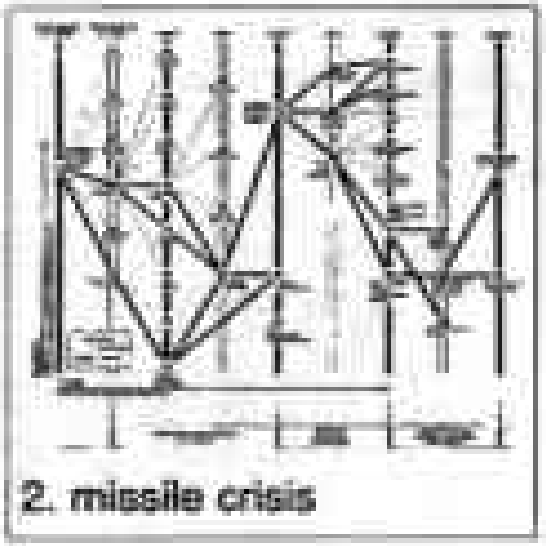
Classifying Visual Representations

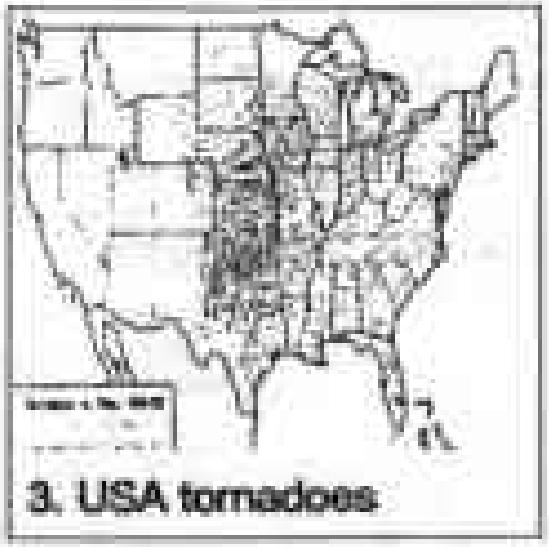
- Lohse et al, 1994: **How do people** categorize visual representations?
- Participants sorted 60 visual representations into categories and assigned labels from Likert scales
- Experimenters clustered the results various ways.

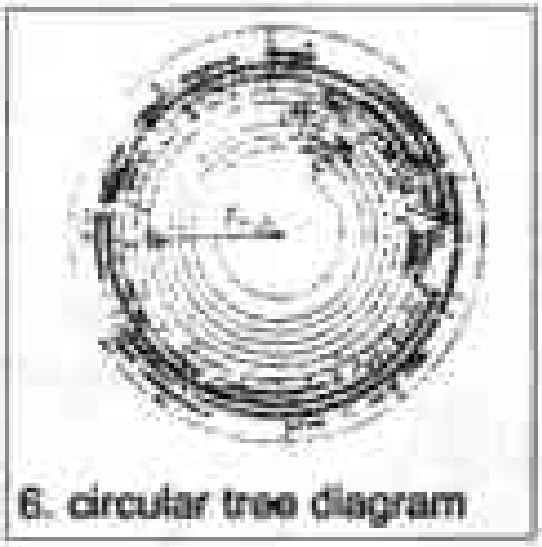
Lohse, G L; Biolsi, K; Walker, N and H H Rueter. "A Classification of Visual Representations." CACM, Vol. 37, No. 12, pp 36-49, 1994.

Subset of Example Visual Representations From Lohse et al. 94









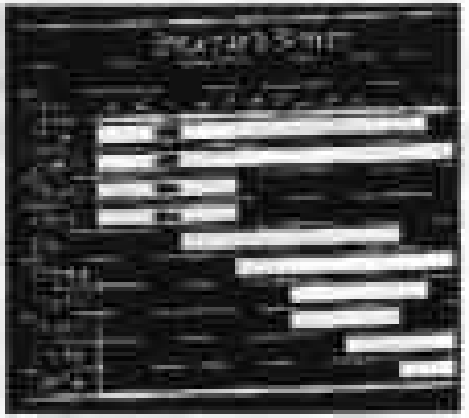
Lake

10. gibberellins

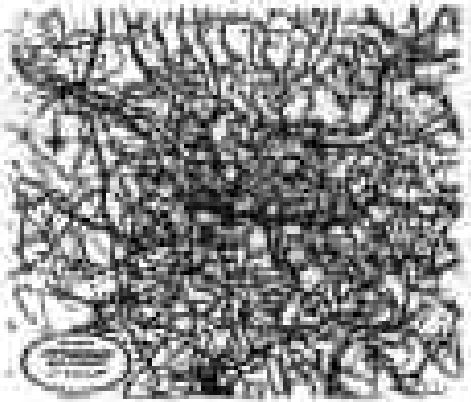
11. heart

12. microbiolo

dsheet budget

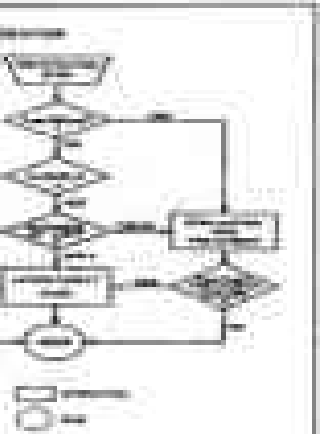


14. Gantt chart

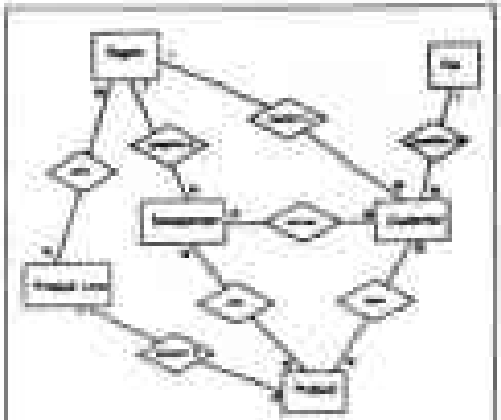


15. Pittsburgh map

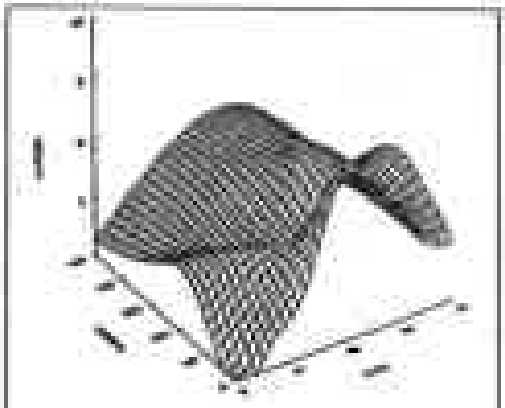
16. list of integ



hart



18. data model



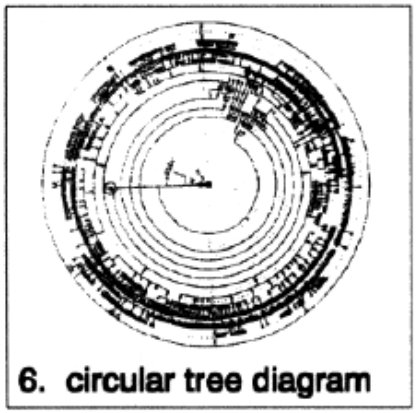
19. response surface

20. wheelbarr

Likert-style Scales Used

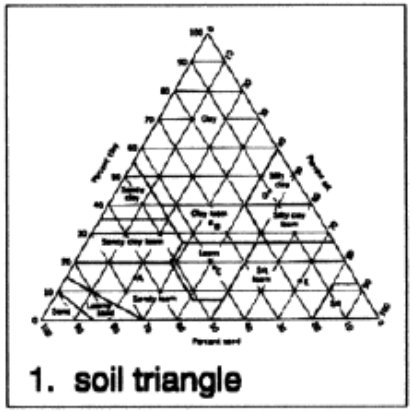
- Spatial -- nonspatial
- Hard to understand – easy to understand
- attractive -- unattractive
- conveys a lot of information – conveys a little information
- emphasizes whole – emphasizes parts
- … (10 used total)

Some results



6. circular tree diagram

hard to understand 1.7

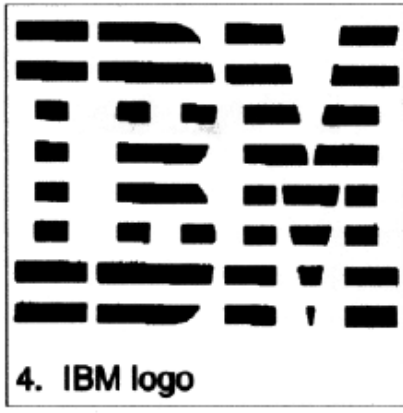


1. soil triangle

hard to understand 3.3

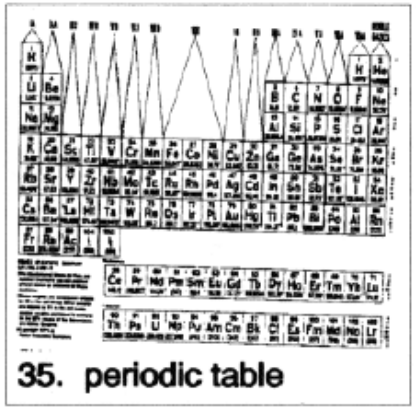
5. microscope

easy to understand 8.2



4. IBM logo

easy to understand 8.4

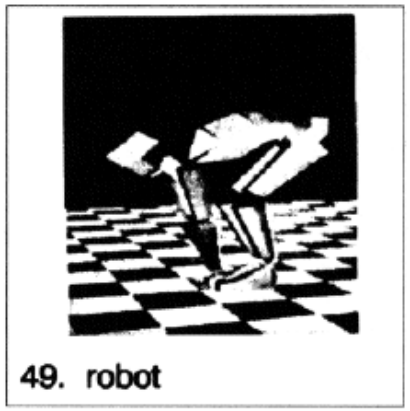


35. periodic table

conveys a lot 1.7

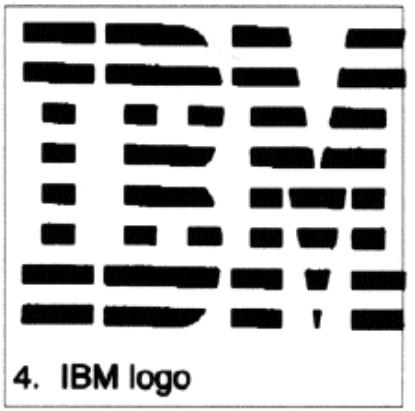
15. Pittsburgh map

conveys a lot 2.1



49. robot

conveys a little 7.3



4. IBM logo

conveys a little 7.7

Interesting Findings

Lohse et al. 94

- Photorealistic images were least informative
  - Echoes results in icon studies – better to use less complex, more schematic images
- Graphs and tables are the most self-similar categories
  - Results in the literature comparing these are inconclusive
- Temporal data more difficult to show than cyclic data

Properties of Visual Perception

Visual Properties

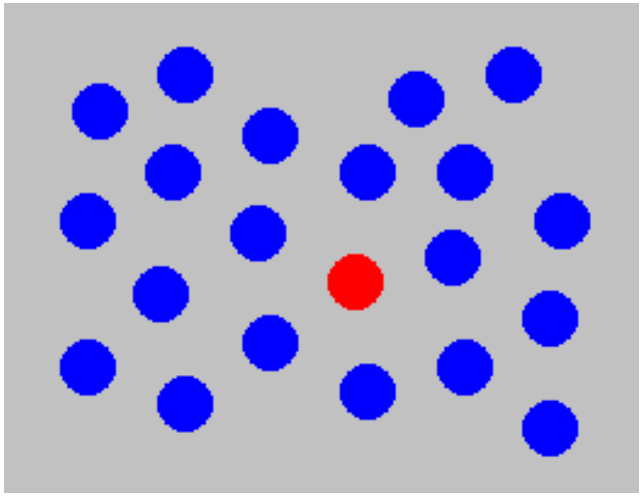
- Preattentive Processing
- Accuracy of Interpretation of Visual Properties
- Illusions and the Relation to Graphical Integrity

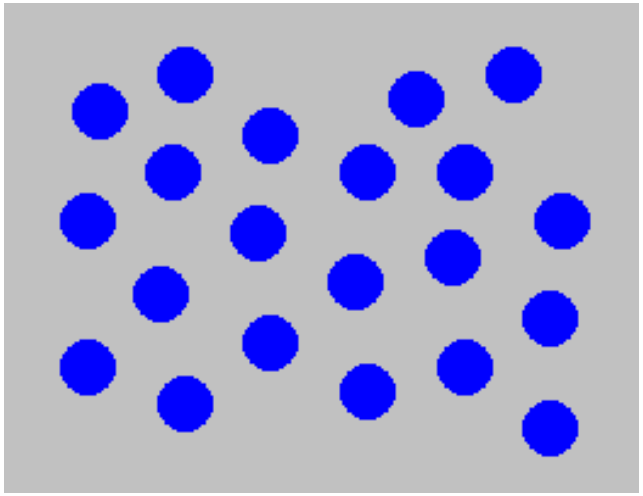
Preattentive processing sildes from Healey
http://www.csc.ncsu.edu/faculty/healey/PP/PP.html

Preattentive Processing

- Some properties are processed preattentively
  (without need for focusing attention).
- Important for design of visualizations
  - what can be perceived immediately
  - what properties are good discriminators
  - what can mislead viewers

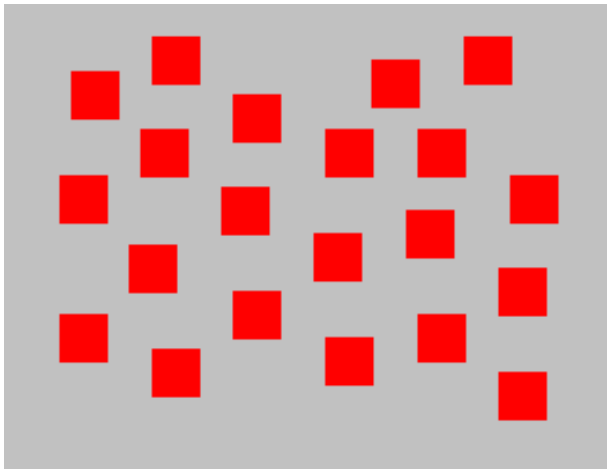
Example: Color Selection

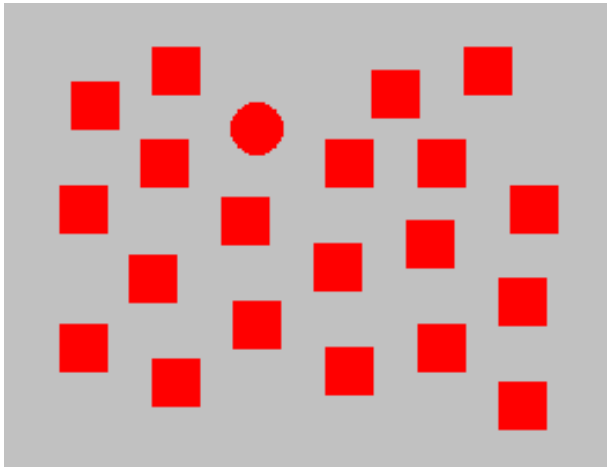




Viewer can rapidly and accurately determine whether the target (red circle) is present or absent. Difference detected in **color**.

Example: Shape Selection



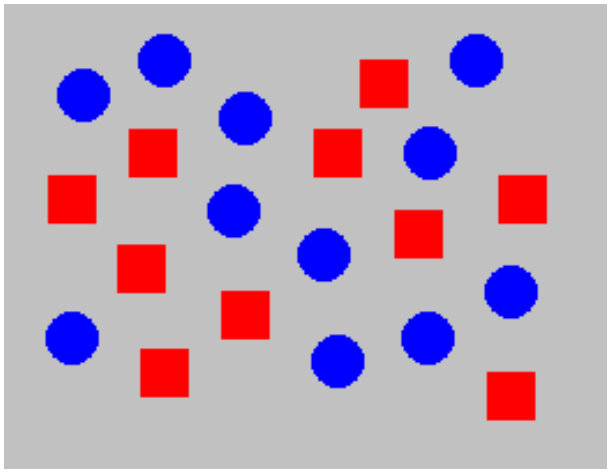


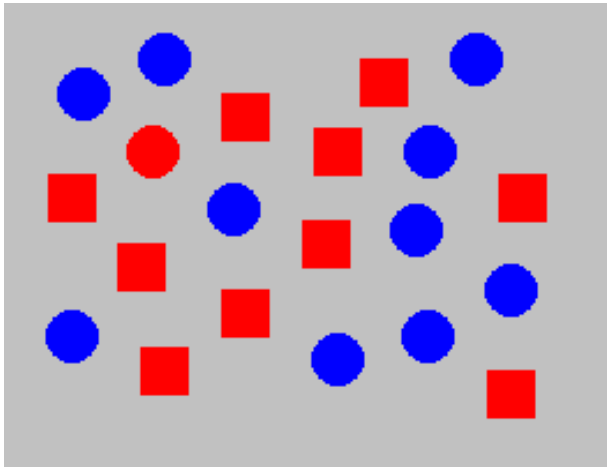
Viewer can rapidly and accurately determine whether the target (red circle) is present or absent. Difference detected in **form** (curvature)

Pre-attentive Processing

- < 200–250 ms qualifies as pre-attentive
  - eye movements take at least 200ms
  - yet certain processing can be done very quickly, implying low-level processing in parallel
- If a decision takes a fixed amount of time regardless of the number of distractors, it is considered to be preattentive

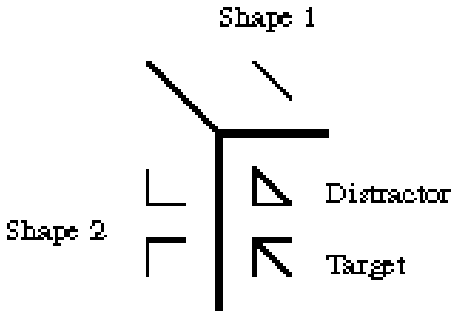
Example: Conjunction of Features

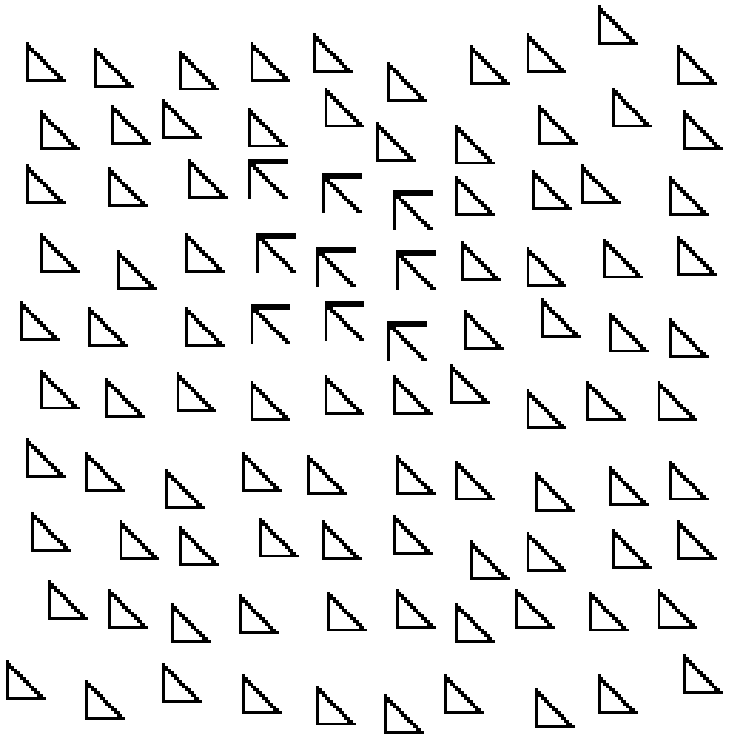




Viewer *cannot* rapidly and accurately determine whether the target (red circle) is present or absent when **target has two or more features, each of which are present in the distractors**. Viewer must search sequentially.

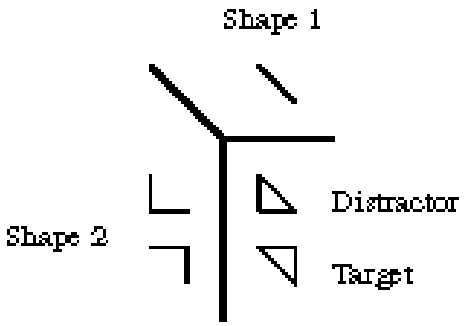
Example: Emergent Features

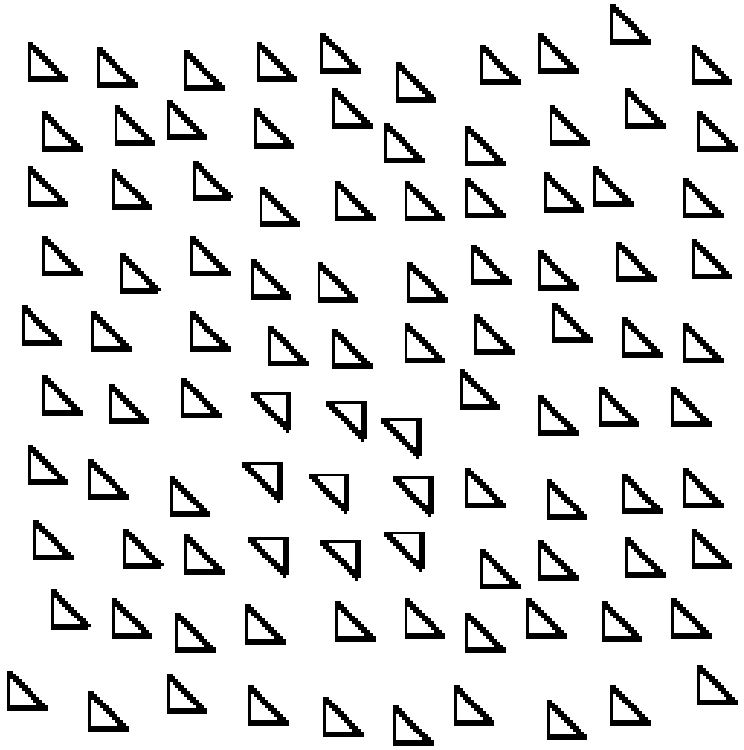




Target has a unique feature with respect to distractors (open sides) and so the group can be detected preattentively.

Example: Emergent Features

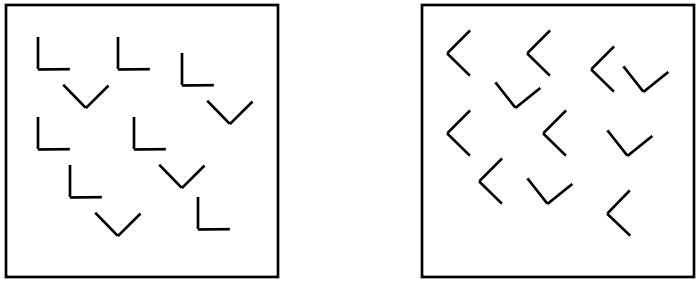




Target does not have a unique feature with respect to distractors and so the group cannot be detected preattentively.

Asymmetric and Graded Preattentive Properties

- Some properties are **asymmetric**
  - a sloped line among vertical lines is preattentive
  - a vertical line among sloped ones is not
- Some properties have a **gradation**
  - some more easily discriminated among than others



SUBJECT PUNCHED QUICKLY OXIDIZED TCEJBUS DEHCNUP YLKCIUQ DEZIDIXO
CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
SCIENCE ENGLISH RECORDS COLUMNS ECNEICS HSILGNE SDROCER SNMULOC
GOVERNS PRECISE EXAMPLE MERCURY SNREVOG ESICERP ELPMAXE YRUCREM
CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
GOVERNS PRECISE EXAMPLE MERCURY SNREVOG ESICERP ELPMAXE YRUCREM
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CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
SCIENCE ENGLISH RECORDS COLUMNS ECNEICS HSILGNE SDROCER SNMULOC

Text NOT Preattentive

SUBJECT PUNCHED QUICKLY OXIDIZED TCEJBUS DEHCNUP YLKCIUQ DEZIDIXO
CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
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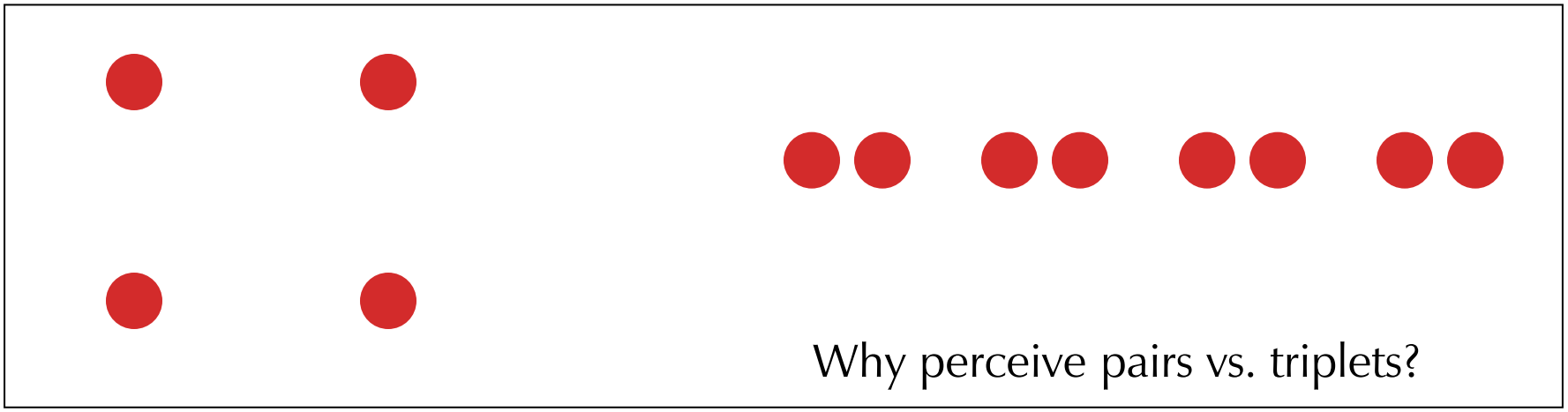
SCIENCE ENGLISH RECORDS COLUMNS ECNEICS HSILGNE SDROCER SNMULOC

Preattentive Visual Properties [Healey 97]

length	Triesman & Gormican [1988]
width	Julesz [1985]
size	Triesman & Gelade [1980]
curvature	Triesman & Gormican [1988]
number	Julesz [1985]; Trick & Pylyshyn [1994]
terminators	Julesz & Bergen [1983]
intersection	Julesz & Bergen [1983]
closure	Enns [1986]; Triesman & Souther [1985]
colour (hue)	Nagy & Sanchez [1990, 1992]; D'Zmura [1991] Kawai et al. [1995]; Bauer et al. [1996]
intensity	Beck et al. [1983]; Triesman & Gormican [1988]
flicker	Julesz [1971]
direction of motion	Nakayama & Silverman [1986]; Driver & McLeod [1992]
binocular lustre	Wolfe & Franzel [1988]
stereoscopic depth	Nakayama & Silverman [1986]
3-D depth cues	Enns [1990]
lighting direction	Enns [1990]

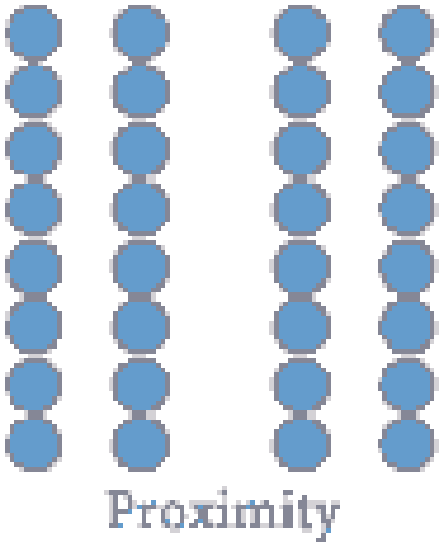
Gestalt Properties

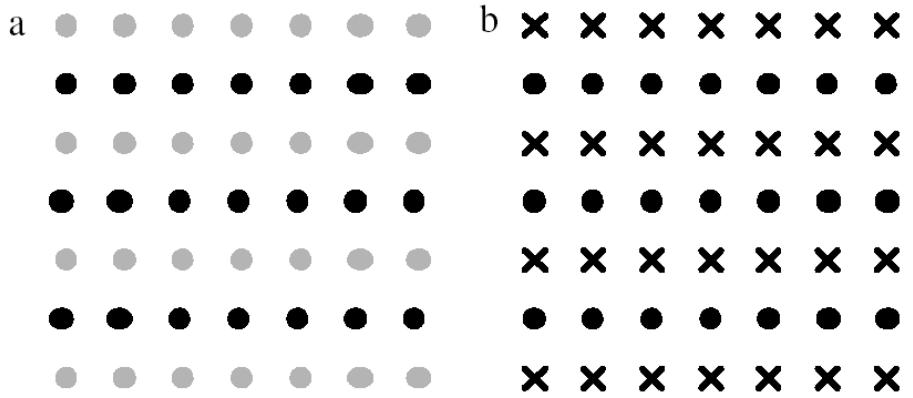
- *Gestalt:* essence or shape of an entity's complete form
- Idea: forms or patterns transcend the stimuli used to create them
  - Why do patterns emerge? Under what circumstances?
- Visual system uses **Proximity, similarity, closure, symmetry, common fate, continuity**



More Gestalt Laws

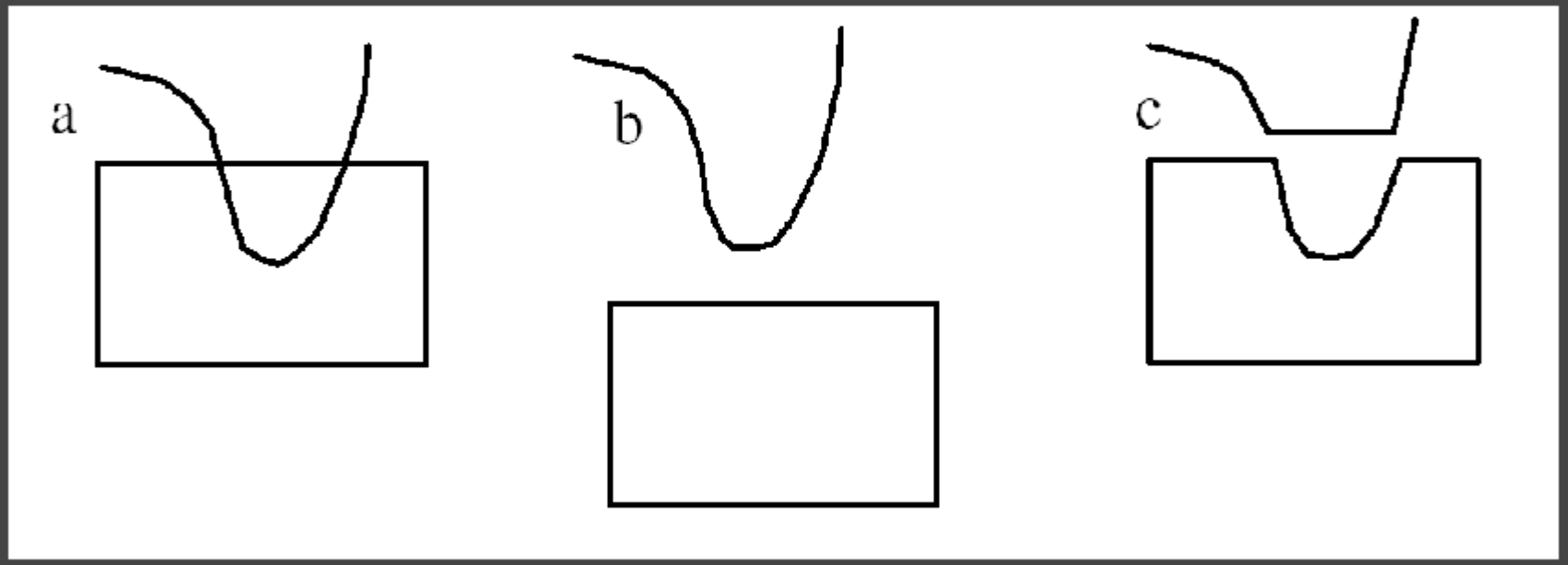
- Law of Proximity
  - Stimulus elements that are close together will be perceived as a group
- Law of Similarity





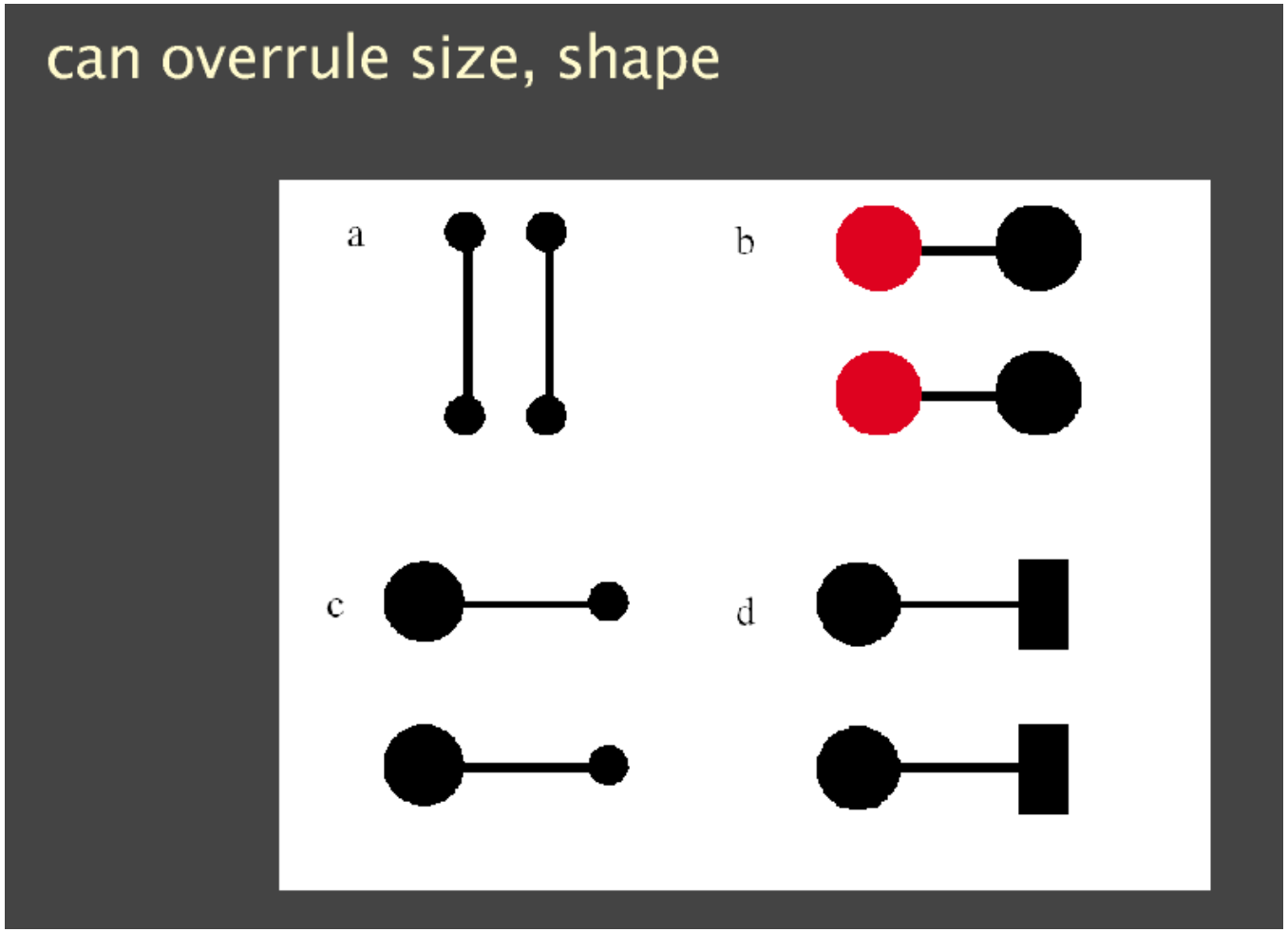
Continuity

smooth not abrupt change
overrules proximity

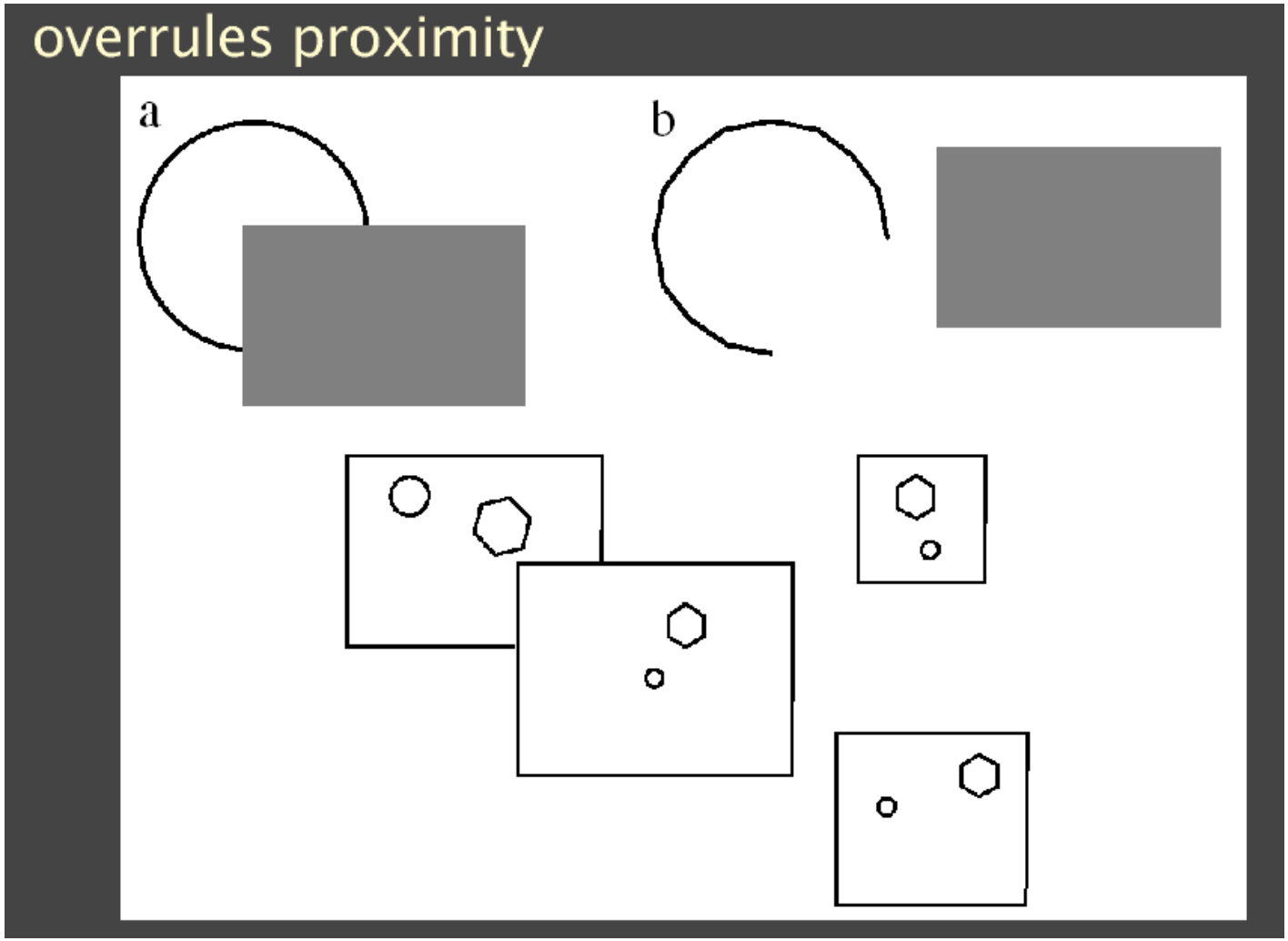


Slide adapted from Tamara Munzner

Connectedness



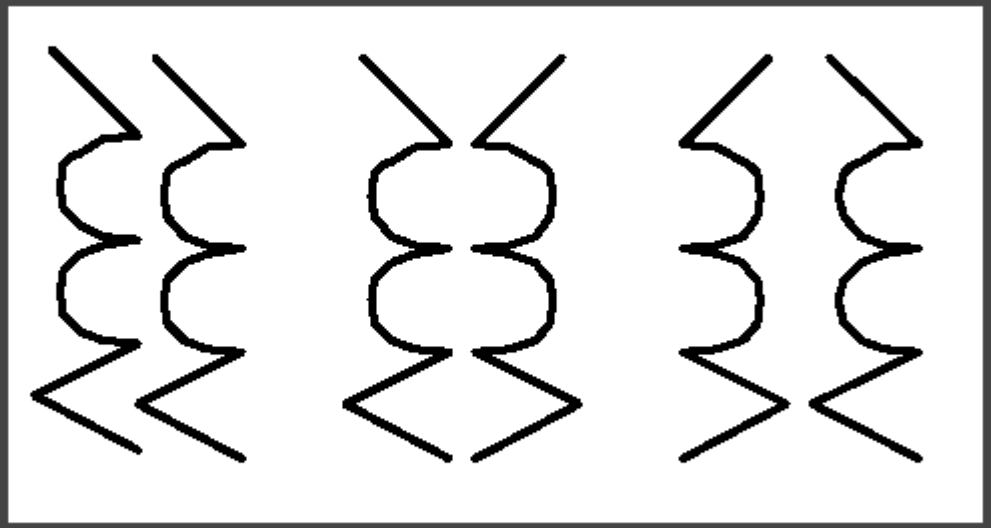
Closure



Slide adapted from Tamara Munzner

Symmetry

emphasizes relationships



Slide adapted from Tamara Munzner

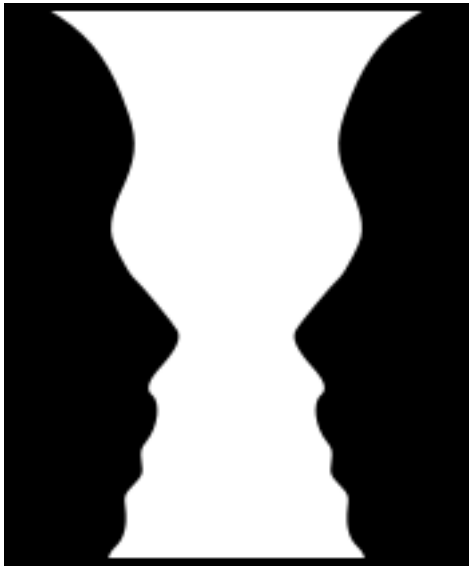
More Gestalt Laws

- Law of Common Fate
  - move a subset of objects among similar ones and they will be perceived as a group
  - example: http://www.andyrutledge.com/common-fate.php

- More info: http://en.wikipedia.org/wiki/Principles_of_grouping

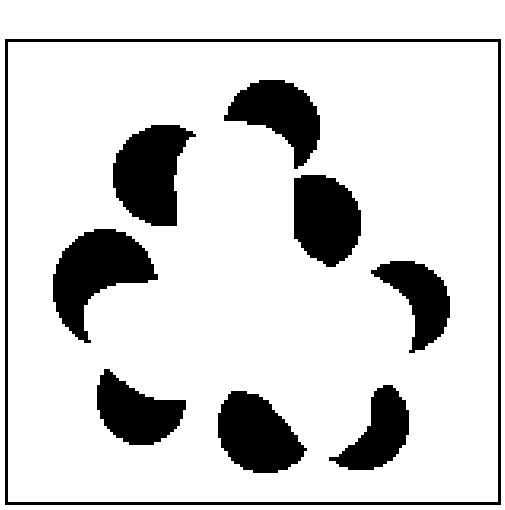
Gestalt Laws of Perceptual Organization [Kaufman 74]

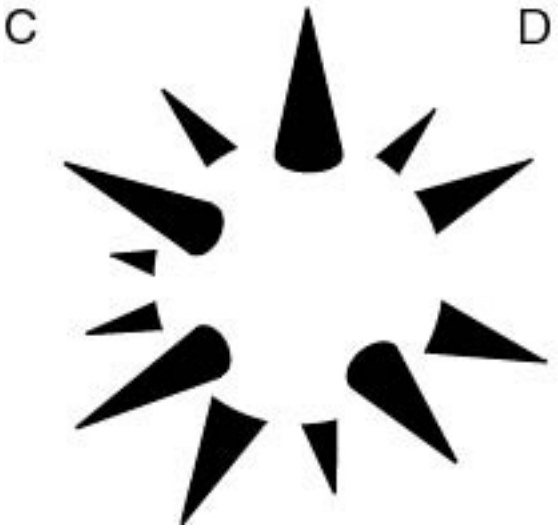
- Figure and Ground
  - We take elements that are similar in appearance/shape and group them together as a whole
  - Contrast is a natural means to perceive difference/similarity
  - Illusions exploit ambiguity in figure/ground relationships: **multistability**

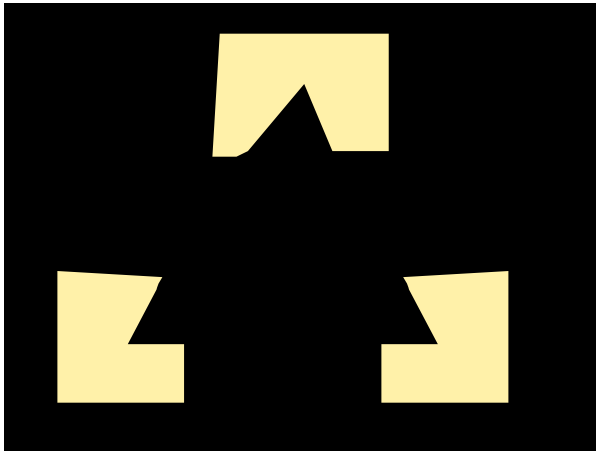


Gestalt Laws of Perceptual Organization [Kaufman 74]

- Reification: Experienced percept contains more explicit spatial information than the sensory stimulus itself:





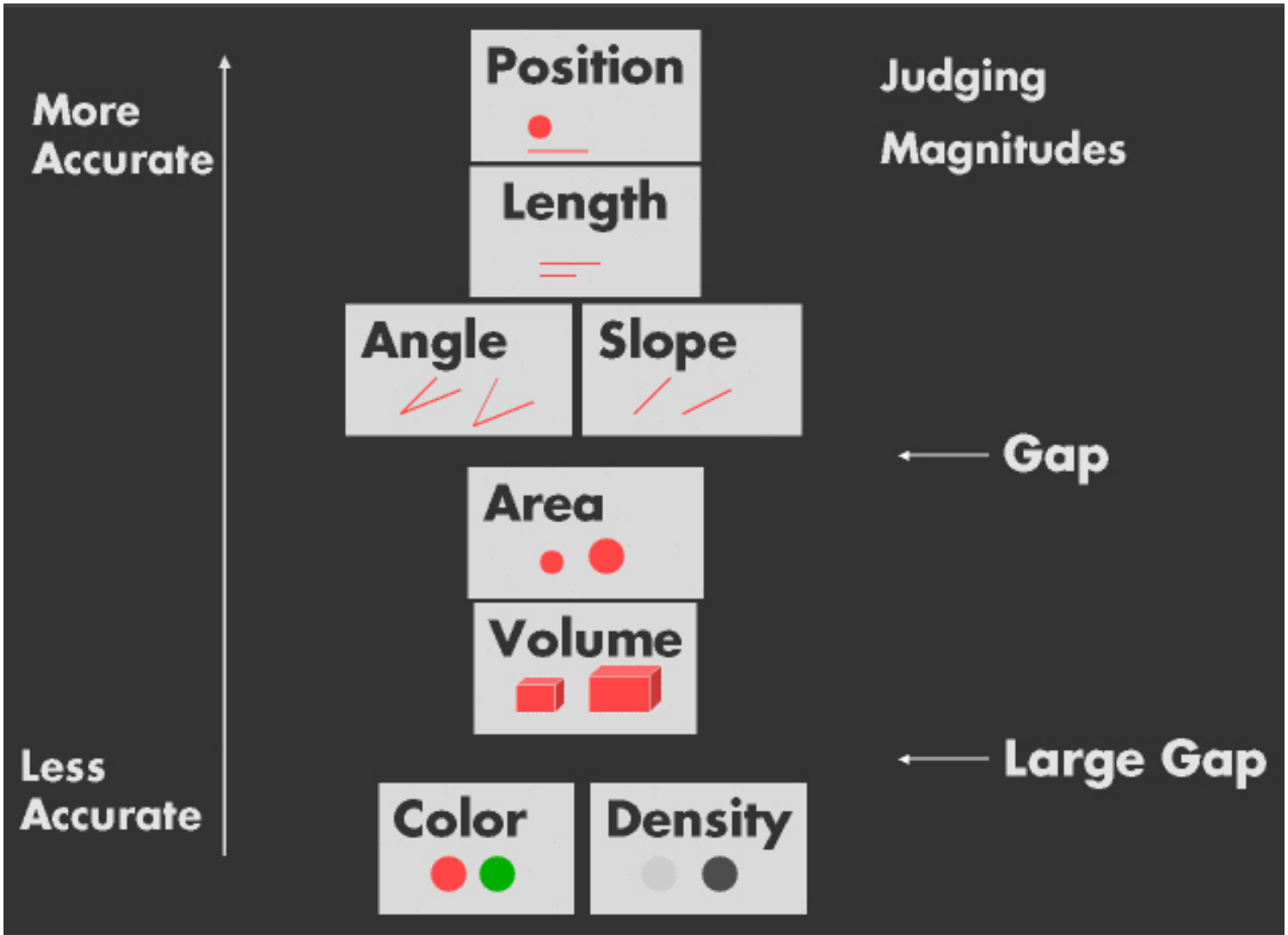


Which Visual Properties are Appropriate for Which Information Types?

Accuracy Ranking of Quantitative Perceptual Tasks

Estimated; only pairwise comparisons have been validated

[Mackinlay 88 from Cleveland & McGill]



Interpretations of Visual Properties

Some properties discriminated more accurately but have no intrinsic meaning [Senay & Ingatious 97, Kosslyn, others]

- Density (Greyscale)
  - Darker → More
- Size / Length / Area
  - Larger → More
- Position
  - Leftmost → first, Topmost → first
- Hue
  - ??? no intrinsic meaning
- Slope
  - ??? no intrinsic meaning

Ranking of Applicability of Properties for Different Data Types

[Mackinlay 88, Not Empirically Verified]

Quantitative	Ordinal	Nominal
Position	Position	Position
Length	Density	Color Hue
Angle	Color Saturation	Texture
Slope	Color Hue	Connection
Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Color Saturation
Color Saturation	Length	Shape
Color Hue	Angle	Length

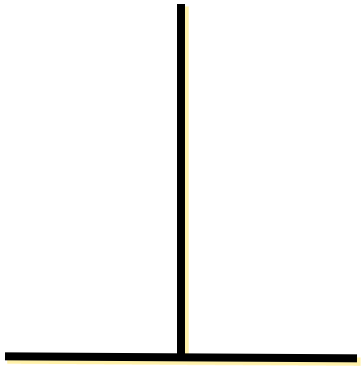
Visual Illusions

- People don't perceive length, area, angle, brightness they way they "should"
- Some illusions have been reclassified as systematic **perceptual errors**
  - e.g., brightness contrasts (grey square on white background vs. on black background)
  - partly due to increase in our understanding of the relevant parts of the visual system
- Nevertheless, the visual system does some really unexpected things

Illusions of Linear Extent

- Mueller-Lyon (off by 25-30%)

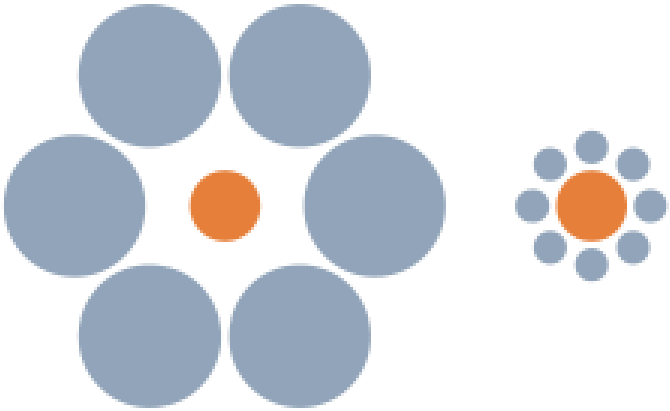
- Horizontal-Vertical



Illusions of Area

- Delboeuf Illusion

- Ebbinghaus illusion



- Height of 4-story building overestimated by approximately 25%
  - Worse for real objects!

Tufte's Principles

Tufte's Principles of Graphical Excellence

"Graphical excellence is the well-designed presentation of interesting data – a matter of *substance*, of *statistics*, and of *design*."

- consists of complex ideas communicated with clarity, precision and efficiency
- is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space
- requires telling the truth about the data

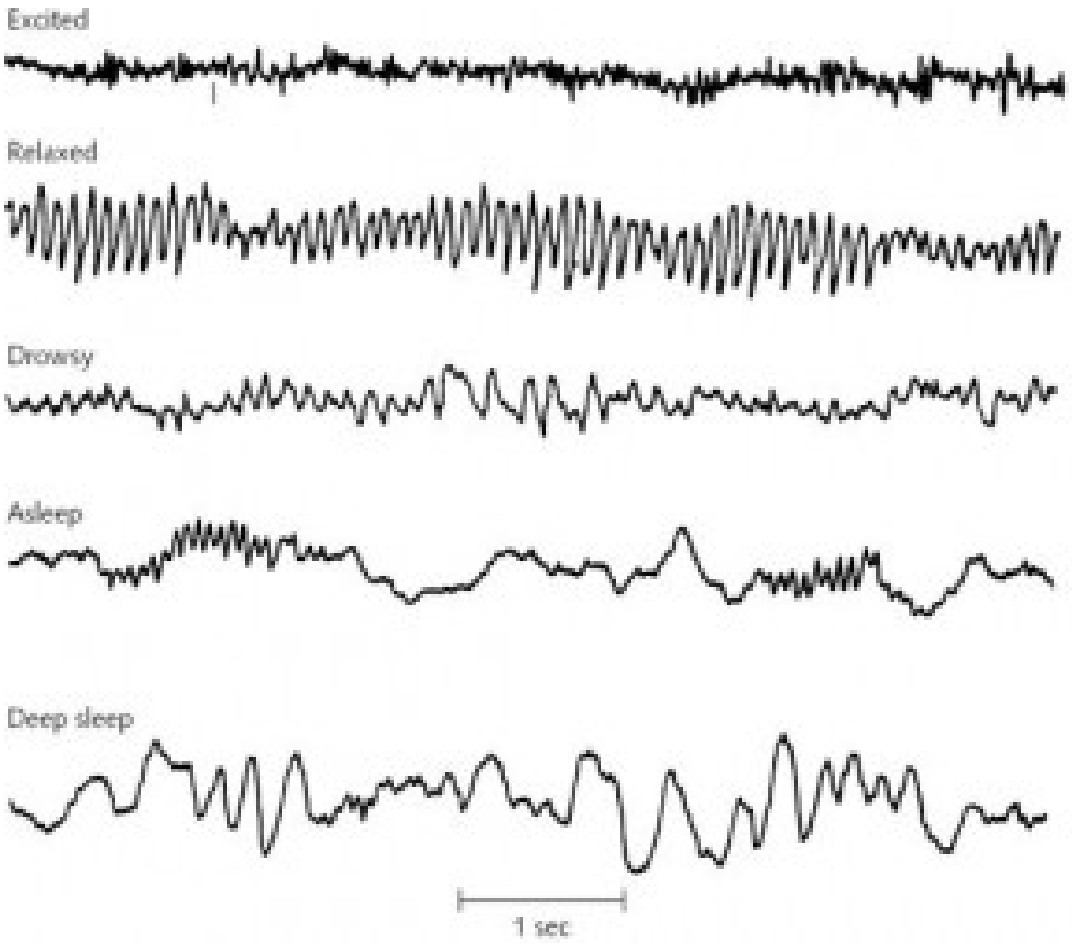
Tufte's Principles of Graphical Excellence

- Data Ink, multifunctioning graphical elements, high data density and small multiples, aesthetics

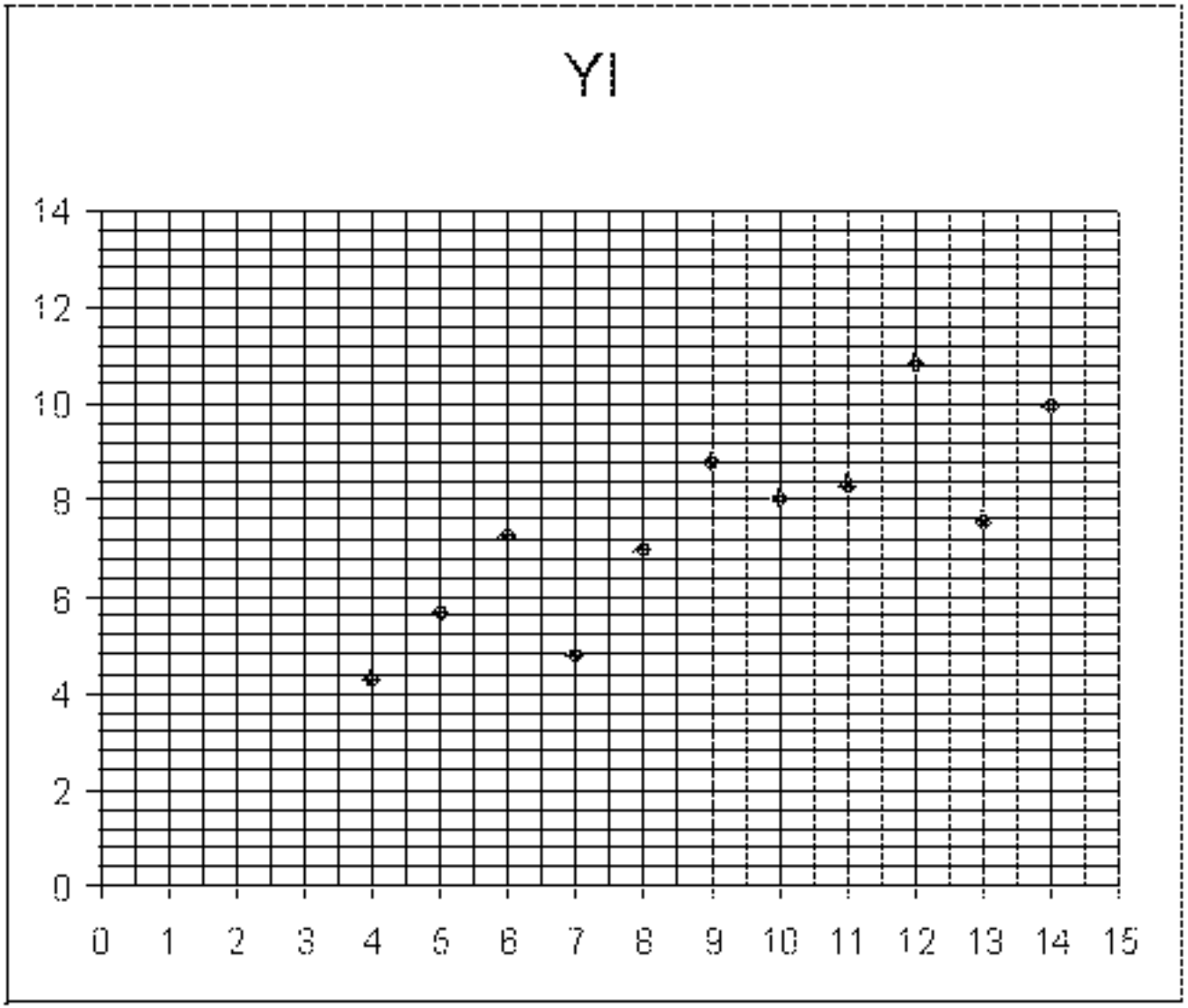
Data Ink

- **Above all else, show the data.**
- "A large share of ink on a graphic should represent data-information, the ink changing as the data change. Data-ink is the non-erasable core of a graphic, the non-redundant ink arranged in response to variation in the numbers represented."

A high data-ink ratio



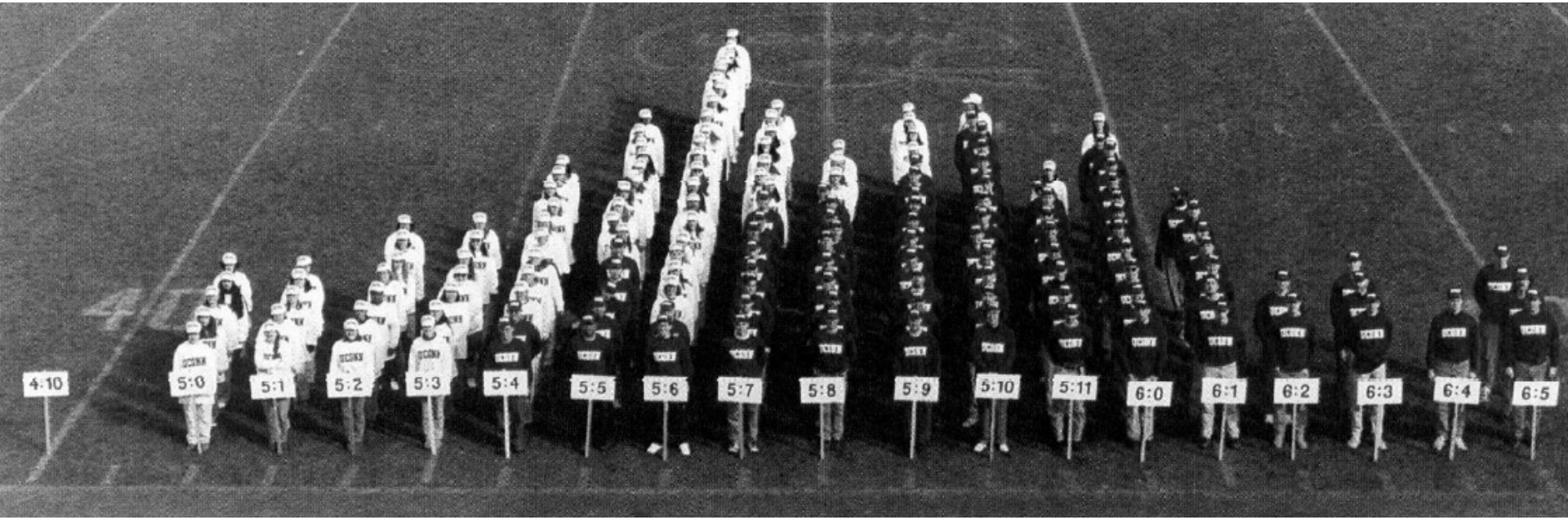
A low data-ink ratio



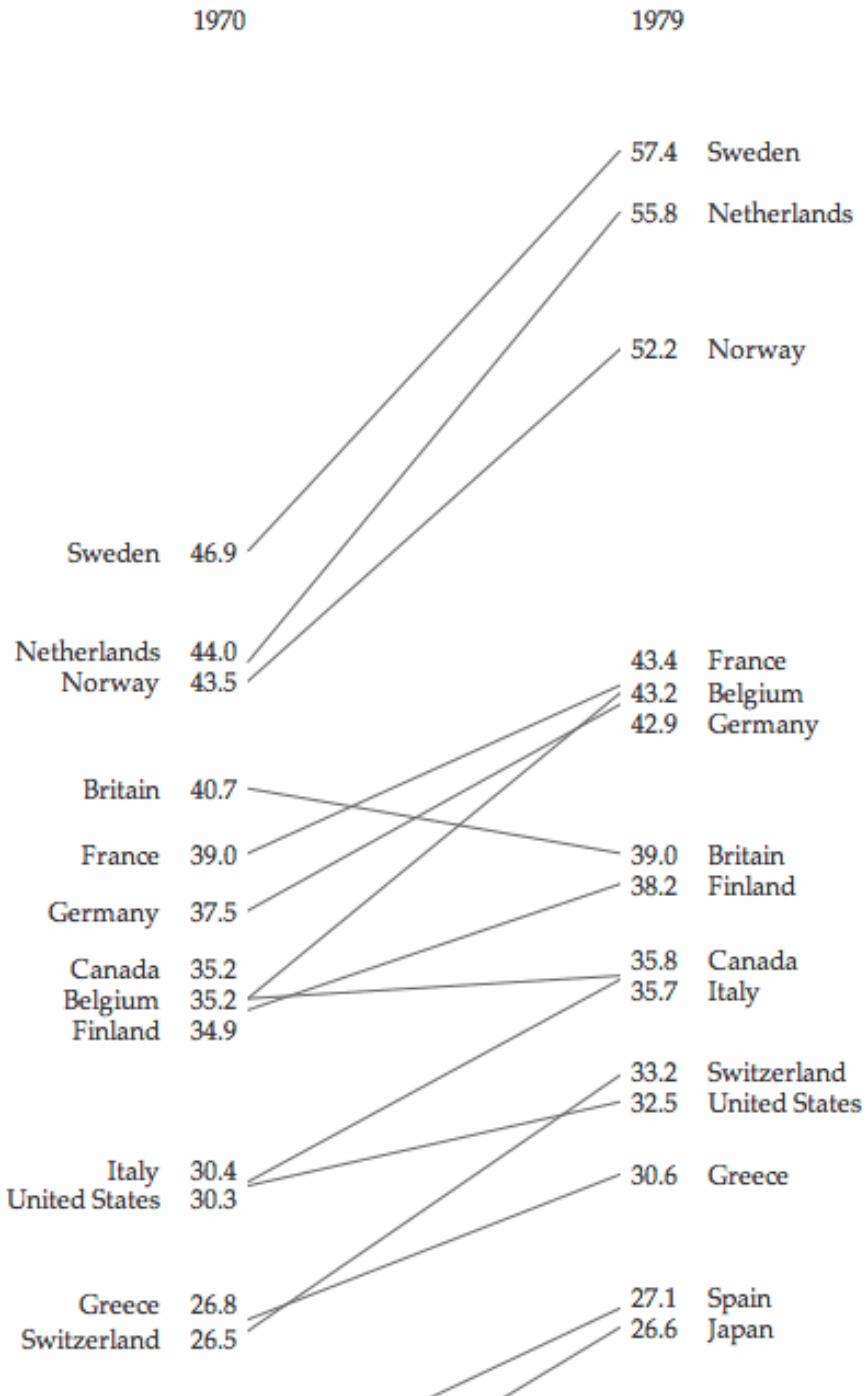
Multifunctioning Graphical Elements

- **Mobilize every graphical element, perhaps several times over, to show the data.**
- "The same ink should often serve more than one graphical purpose. A graphical element may carry data information and also perform a design function usually left to non-data ink. Or it might show several different pieces of data."

Data-built Data Measures



Government tax collections

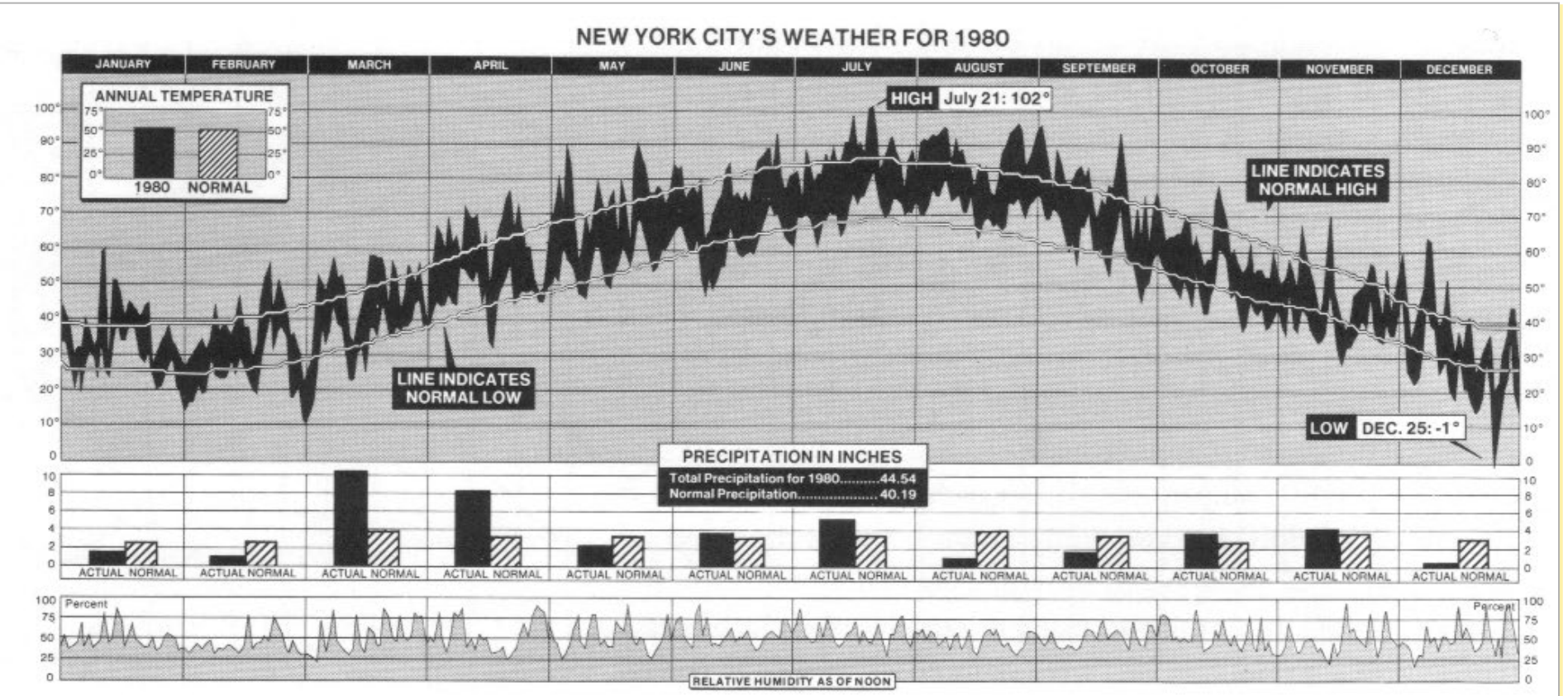


High Data Density and Small Multiples

- Take advantage of eye's ability to detect large amounts of information in small spaces
- Data density = (# entries in data matrix) / area of data graphic

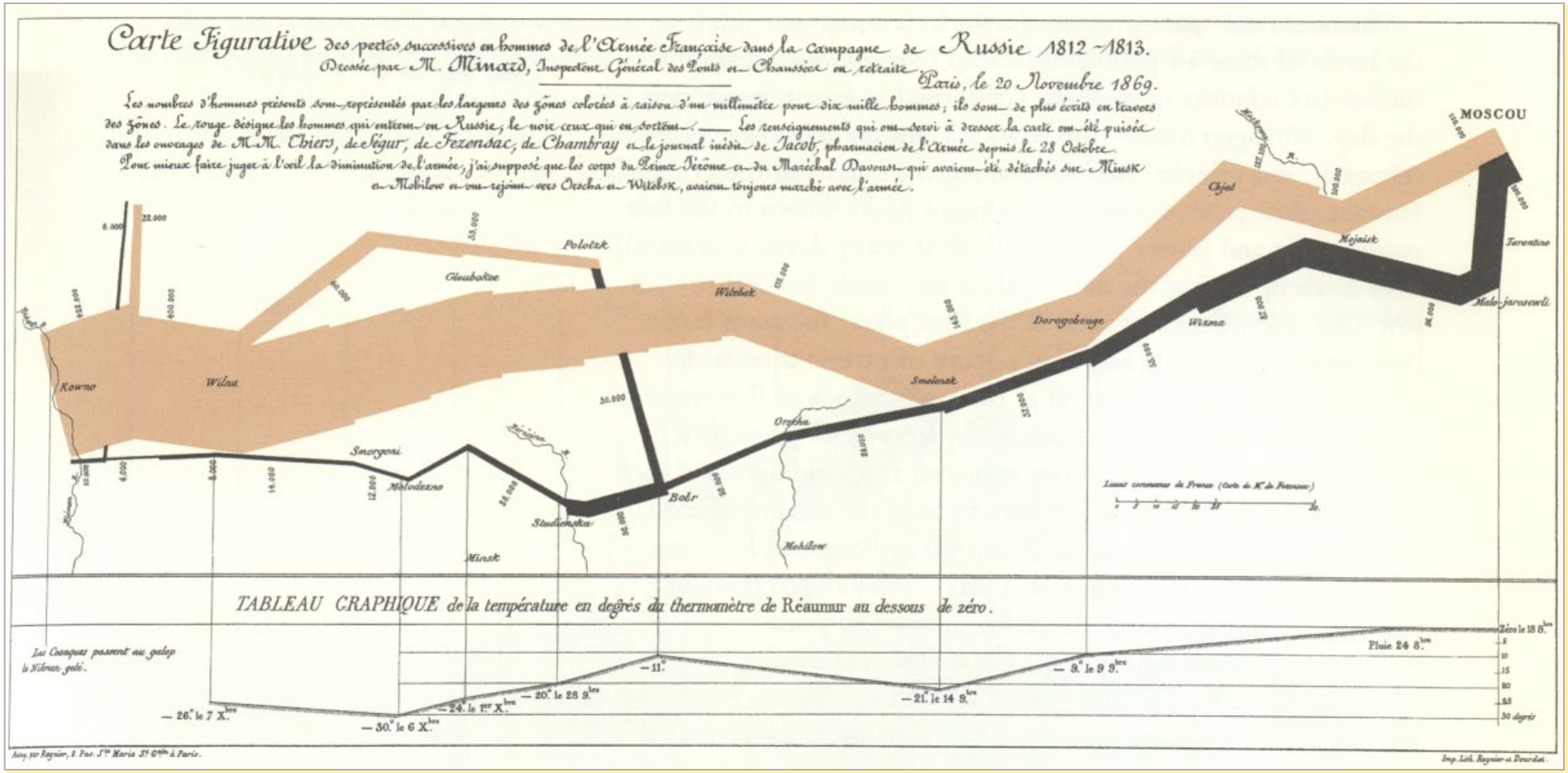
Data-dense

- 181 numbers per square inch:



New York Times, January 11, 1981, p. 32.

Napoleon's 1812 March by Charles Joseph Minard

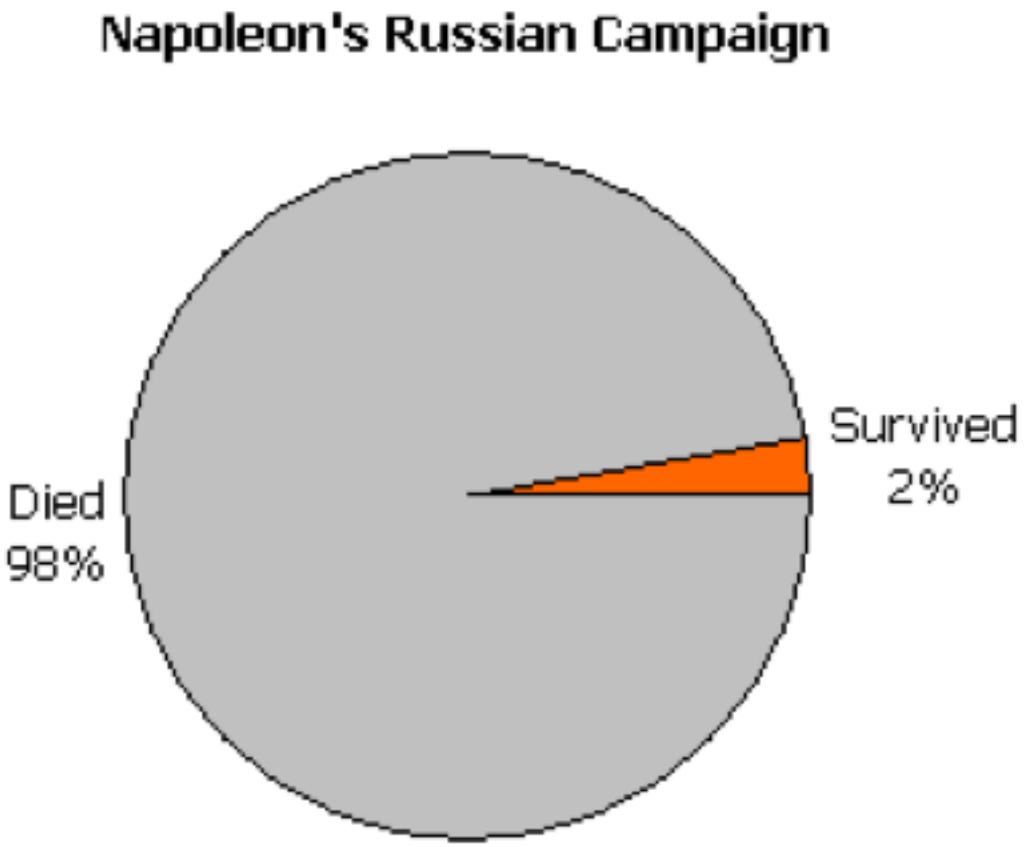


Variables shown:

- size of army
- direction
- latitude
- longitude
- temperature
- date

[Tufte]

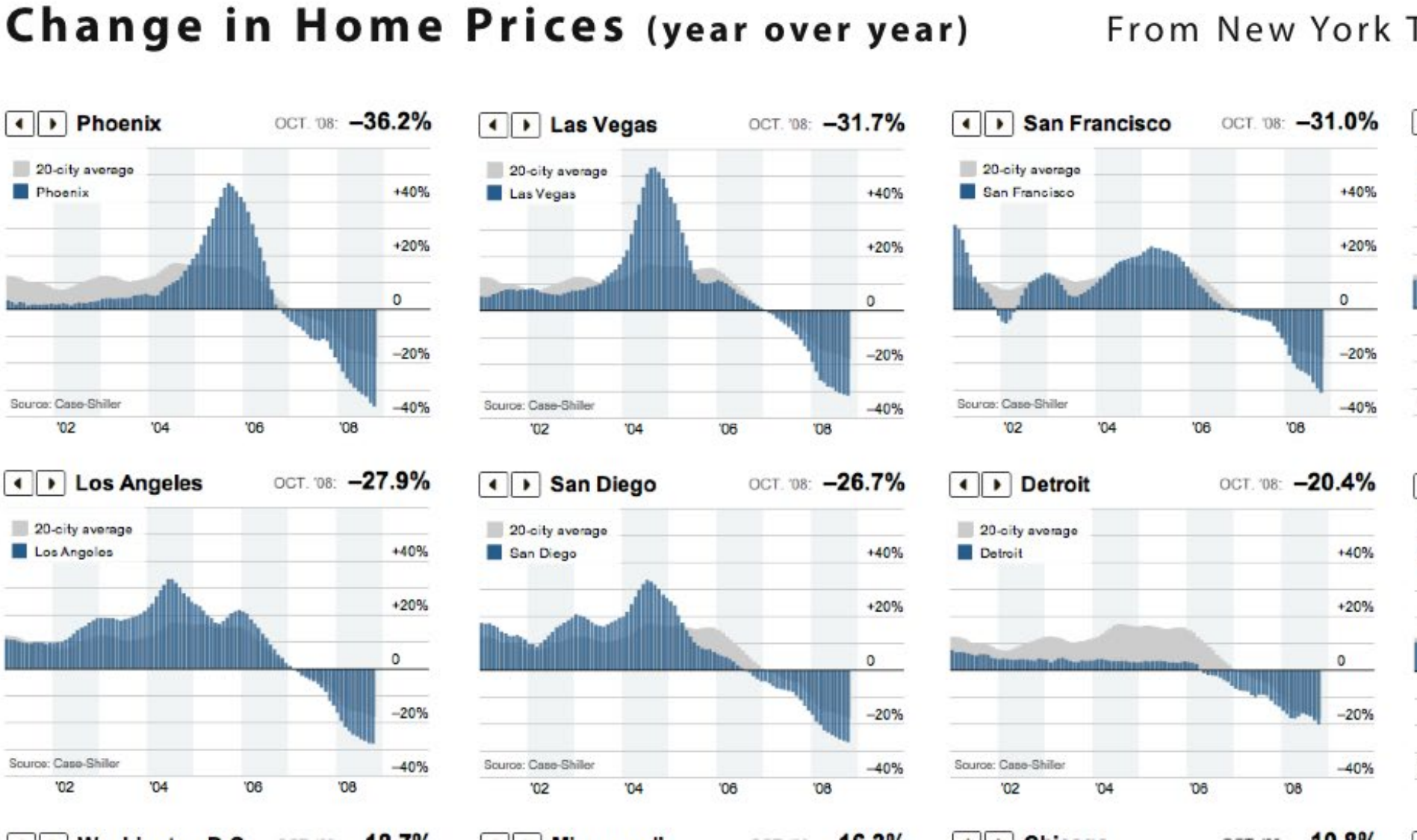
Executive Summary



Small Multiples

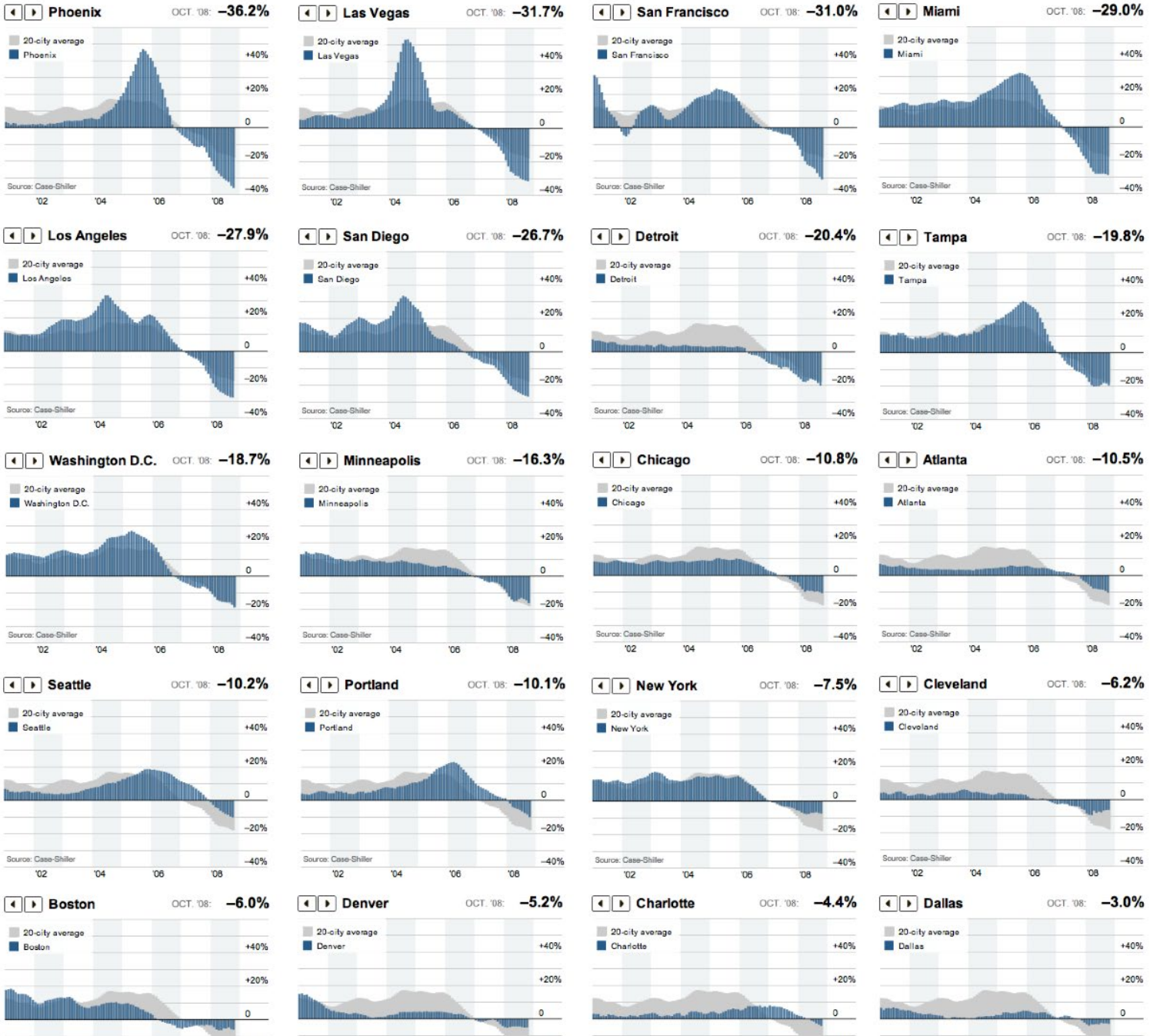
- "At the heart of quantitative reasoning is a single question: **Compared to what?** Small multiple designs, multivariate and data bountiful, answer directly by visually enforcing comparisons of changes, of the differences among objects, of the scope of alternatives. For a wide range of problems in data presentation, small multiples are the best design solution."

Small Multiples



Change in Home Prices (year over year)

From New York Times Economix blog



Aesthetics

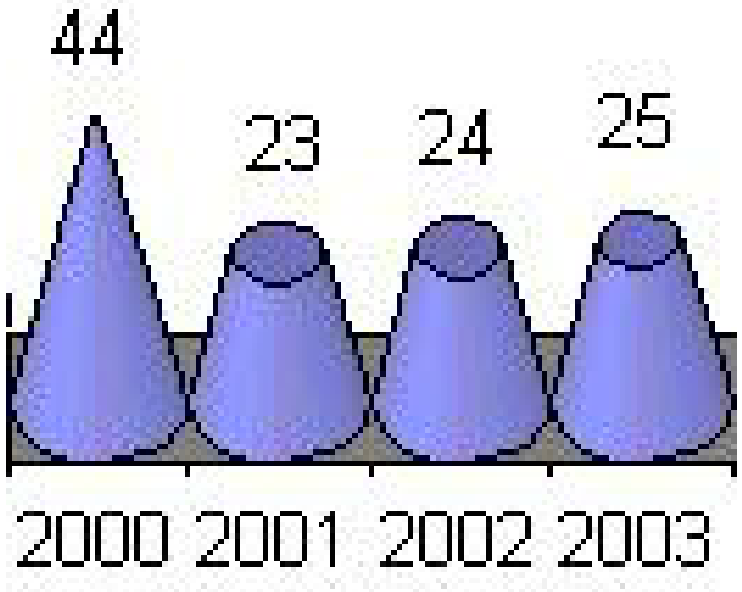
- "Graphical elegance is often found in simplicity of design and complexity of data."
  - Sometimes tables are simplest and most appropriate representation
- Graphics should be wider than they are tall
  - Eye is good at detecting deviations from the horizon

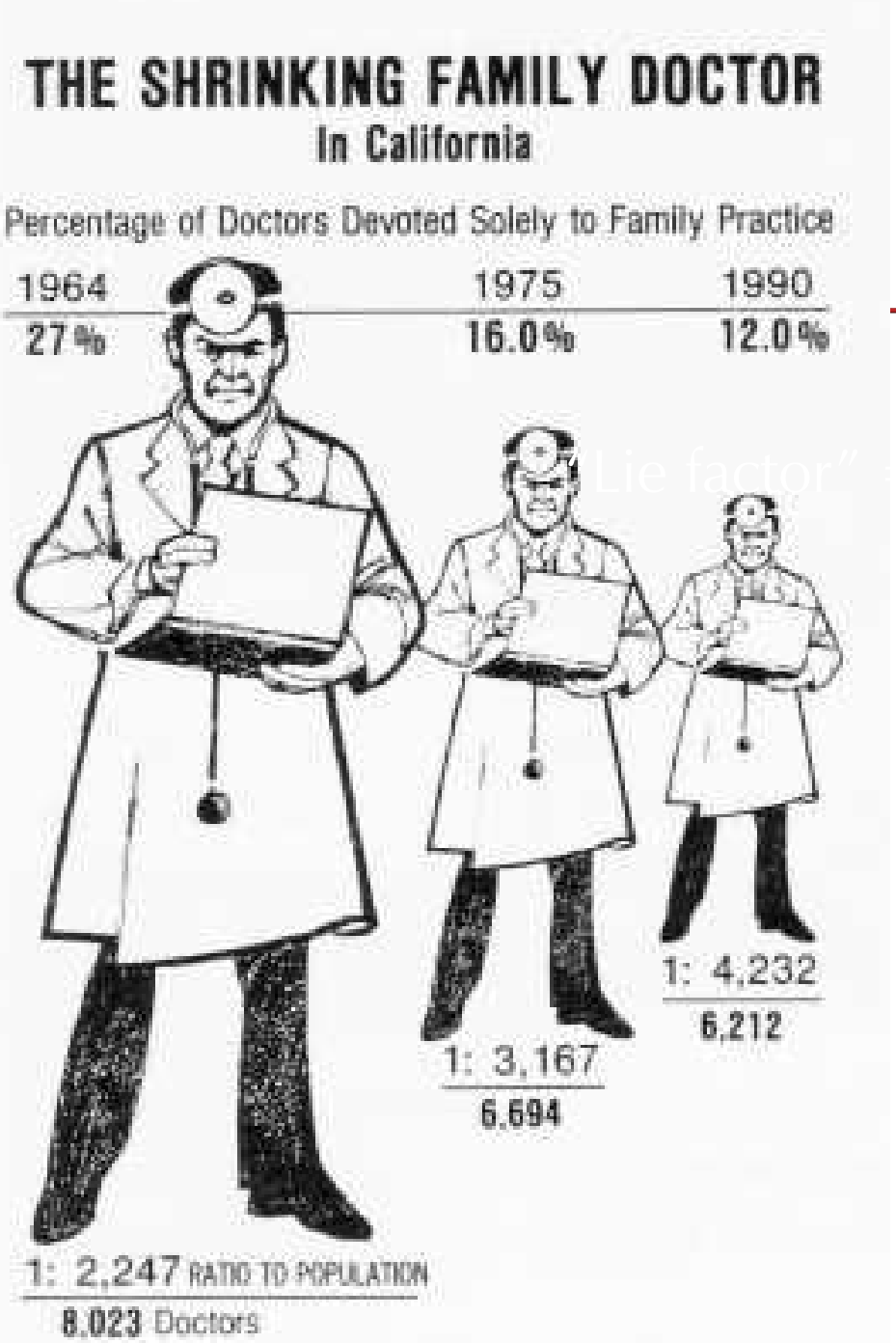
Tufte's Take on Graphical Integrity

- Some lapses intentional, some not
- Lie Factor = $\frac{\text{size of effect in graph}}{\text{size of effect in data}}$
- Visualizations mislead using area
- Visualizations mislead using perspective
- Visualizations mislead by leaving out important context
- Lack of taste and aesthetics

How to Lie With Visualizations

Year	Books circulated
2001	100
2002	141
2003	200




THE SHRINKING FAMILY DOCTOR
In California
Percentage of Doctors Devoted Solely to Family Practice
1964
27%
1975
16.0%
1990
12.0%
1: 2,247 RATIO TO POPULATION
8,023 Doctors
1: 3,167
6,694
1: 4,232
6,212

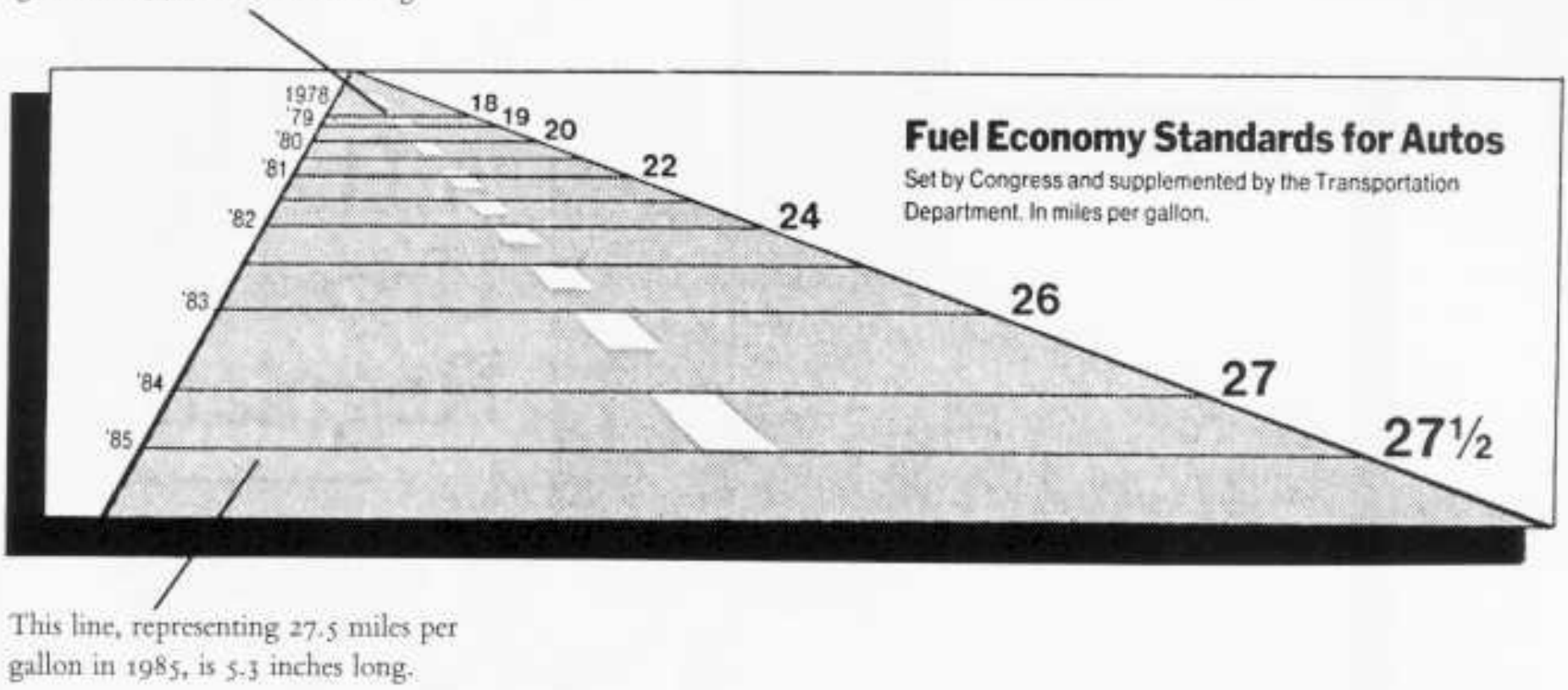
[Tufte]

Washington Post, October 25, 1978, p. 1.

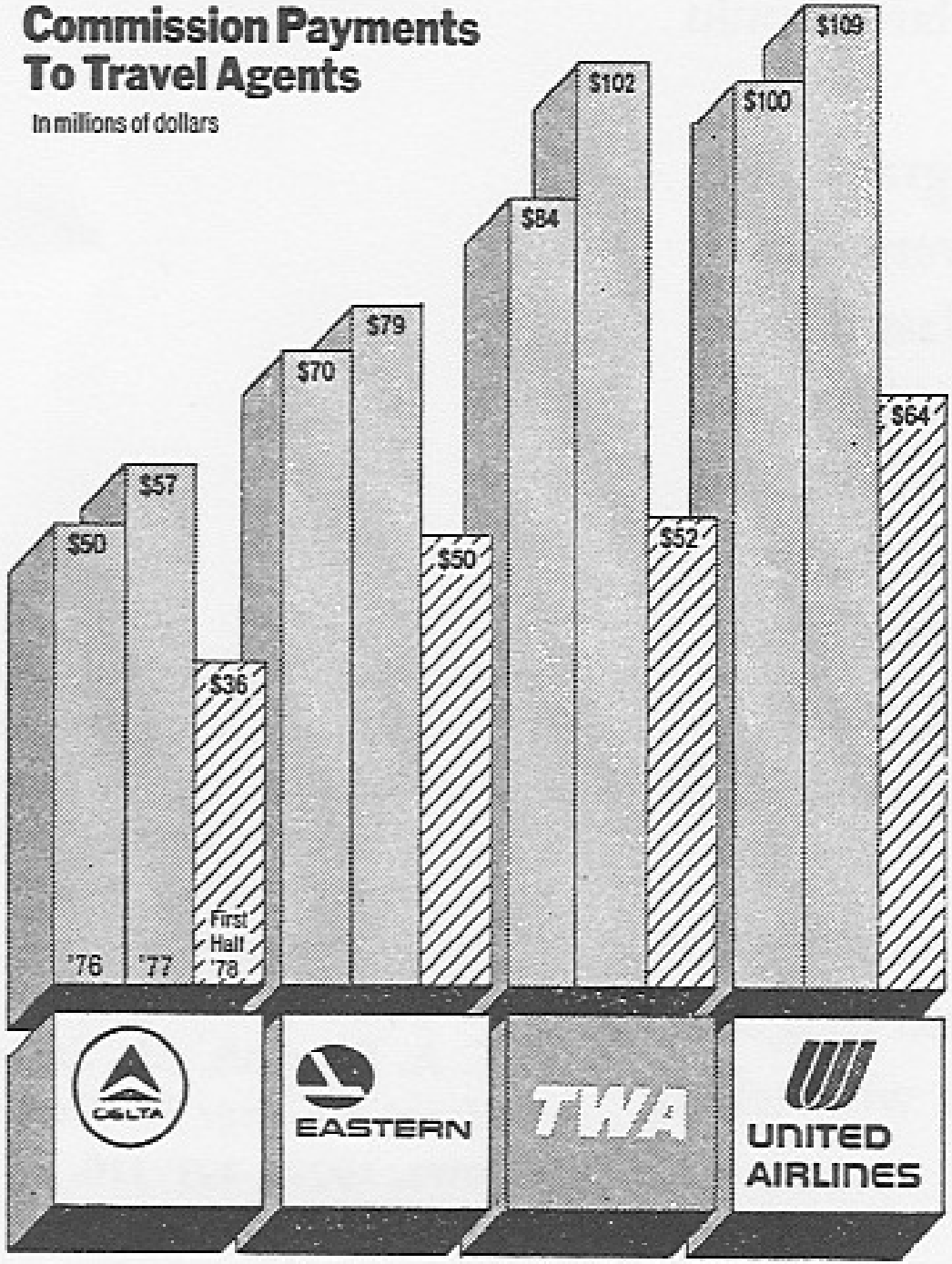
dimens

[Tufte]

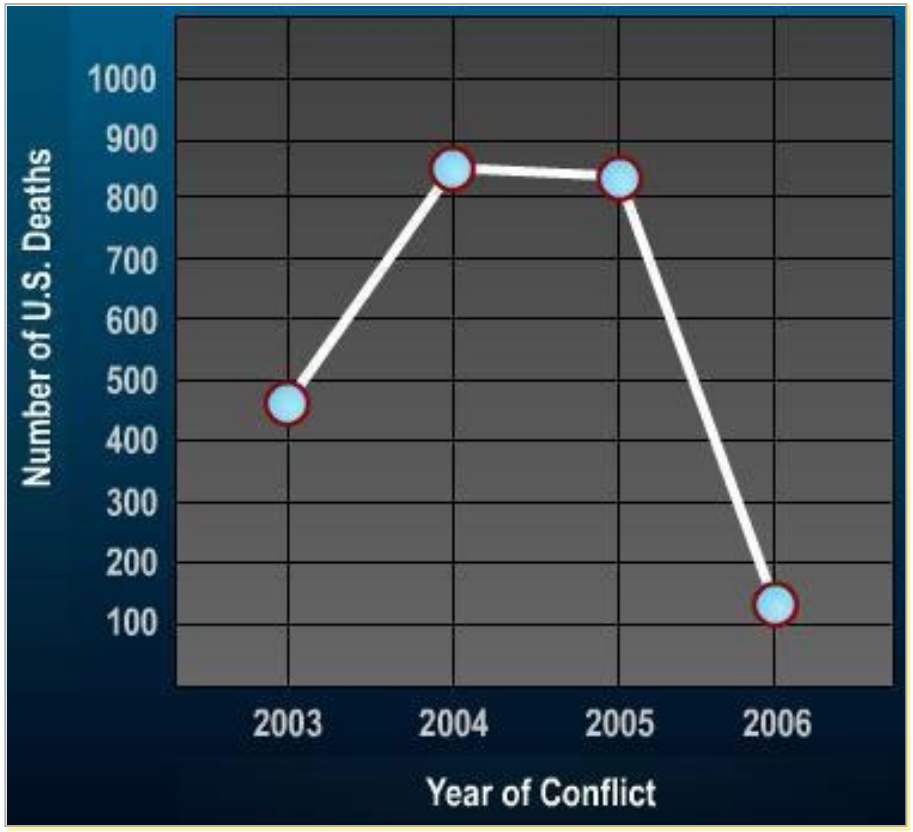
How to Lie With Visualizations



New York Times, August 9, 1978, p. [illegible] [Tufte]


Commission Payments
To Travel Agents
In millions of dollars
$50
$57
$36
$70
$79
$50
$84
$102
$52
$100
$109
$64
'76
'77
First Half '78
DELTA
EASTERN
TWA
UNITED AIRLINES

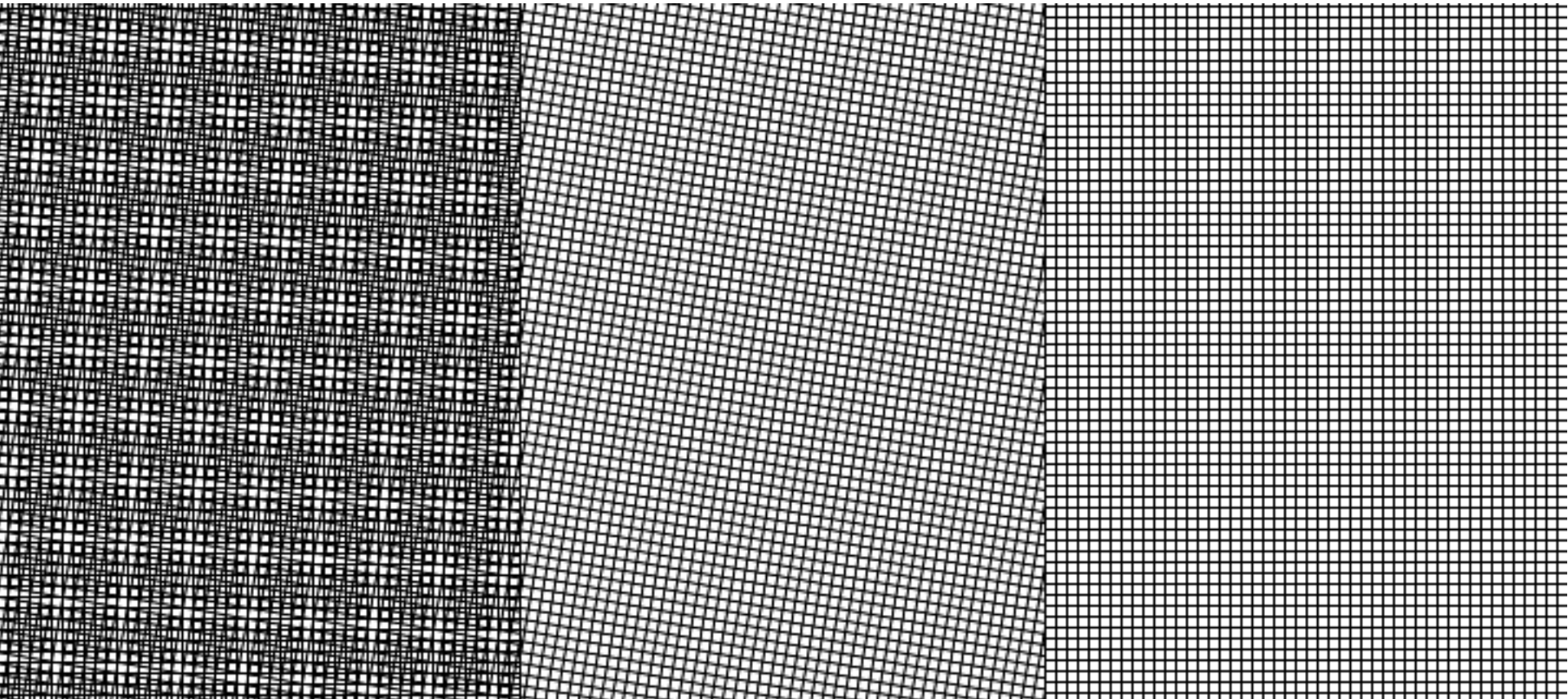
Recent Example

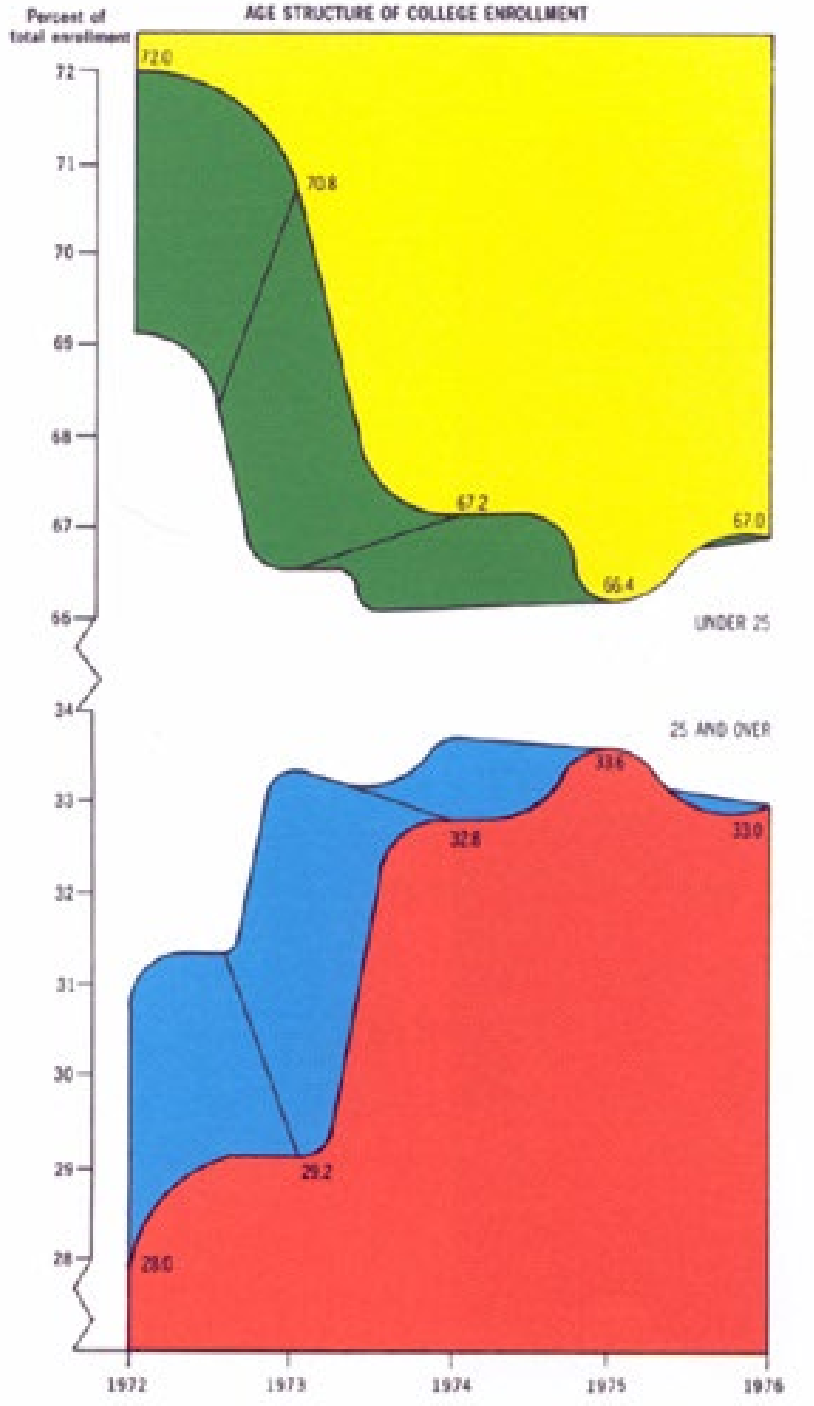


AOL News, March 15, 2006

Data Ink and "Chart Junk"

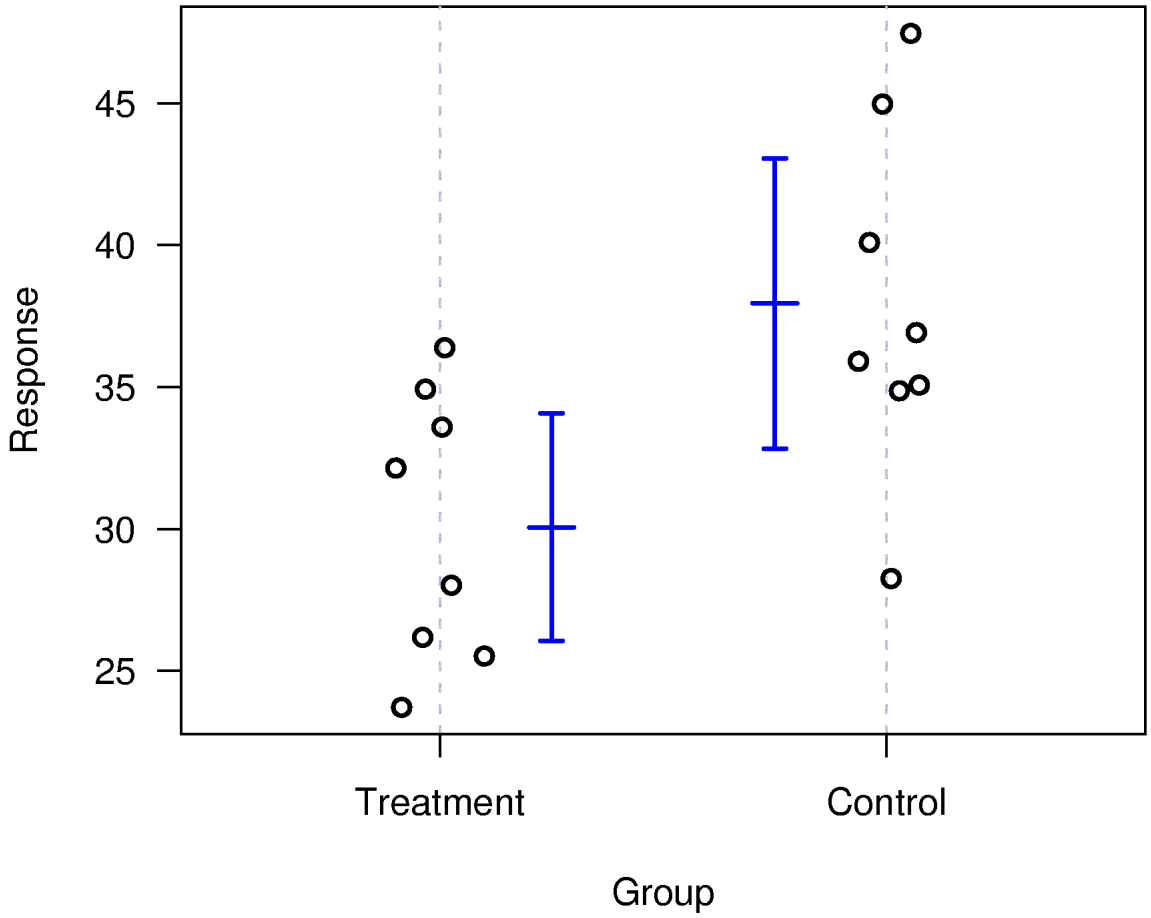
- Junk can mislead, confuse, obscure




AGE STRUCTURE OF COLLEGE ENROLLMENT
Percent of total enrollment
72
71
70
69
68
67
66
34
33
32
31
30
29
28
72.0
70.8
67.2
66.4
67.0
UNDER 25
25 AND OVER
28.0
29.2
32.8
33.6
33.0
1972
1973
1974
1975
1976

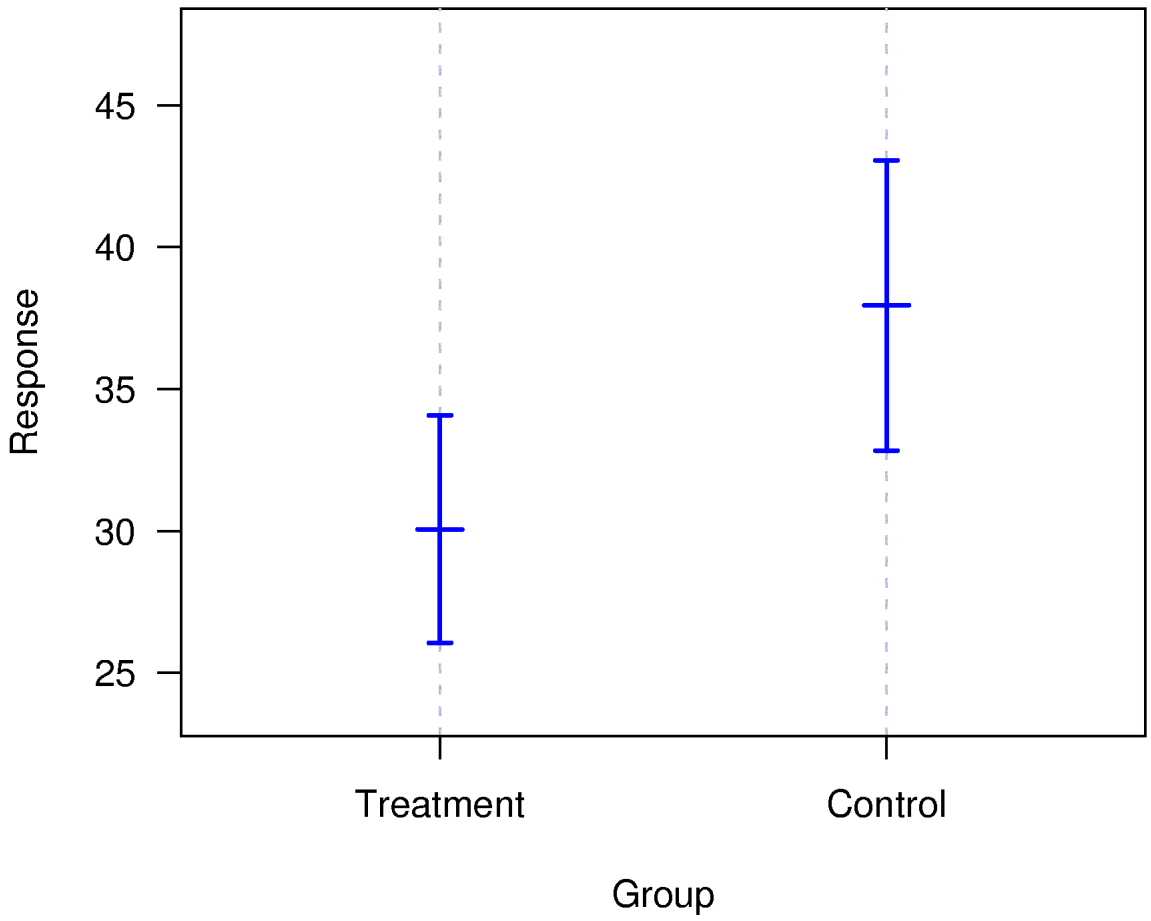
Wrap-up: Excel Charts and You

Example 1



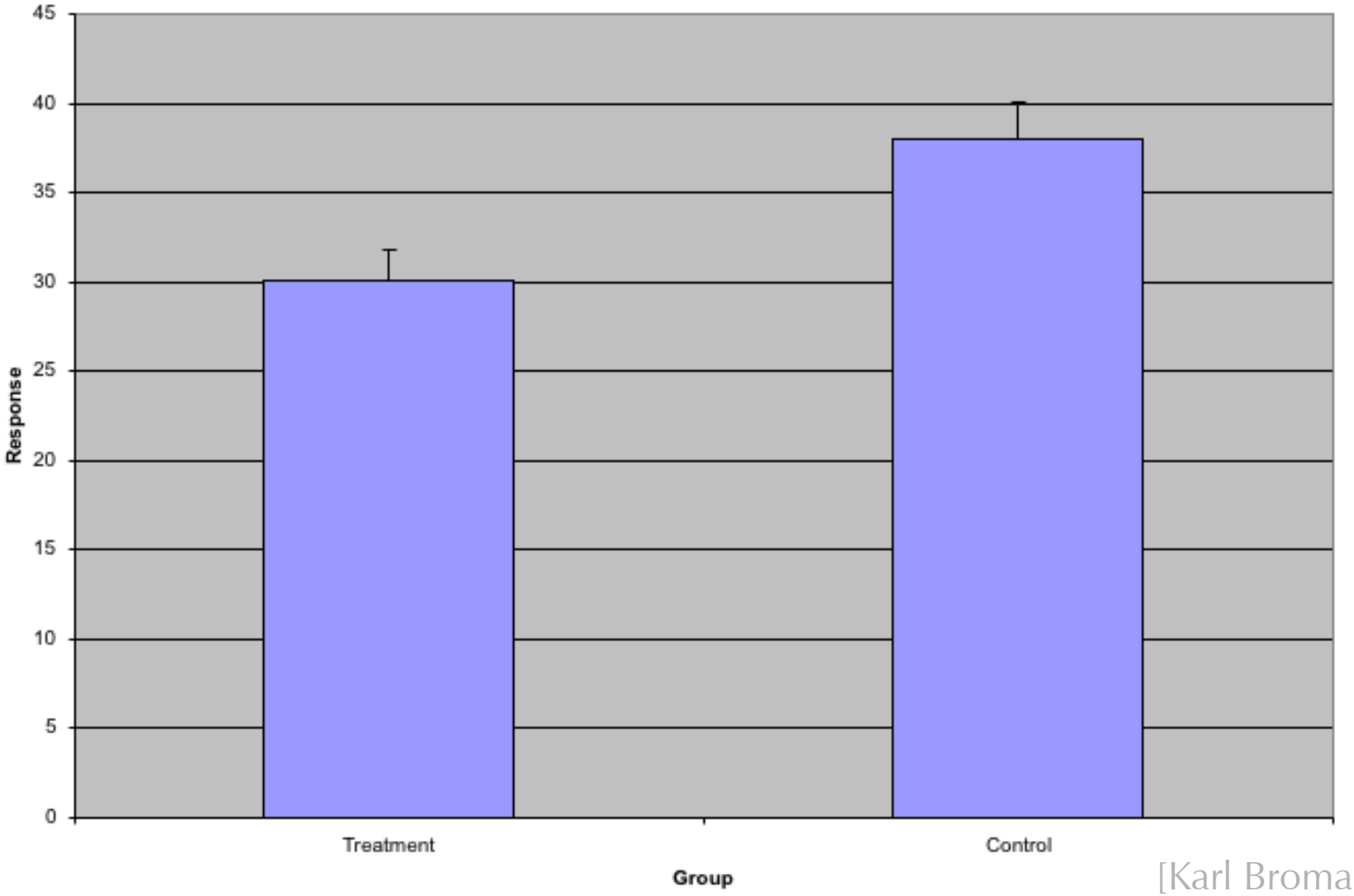
[Karl Broman]

Example 1



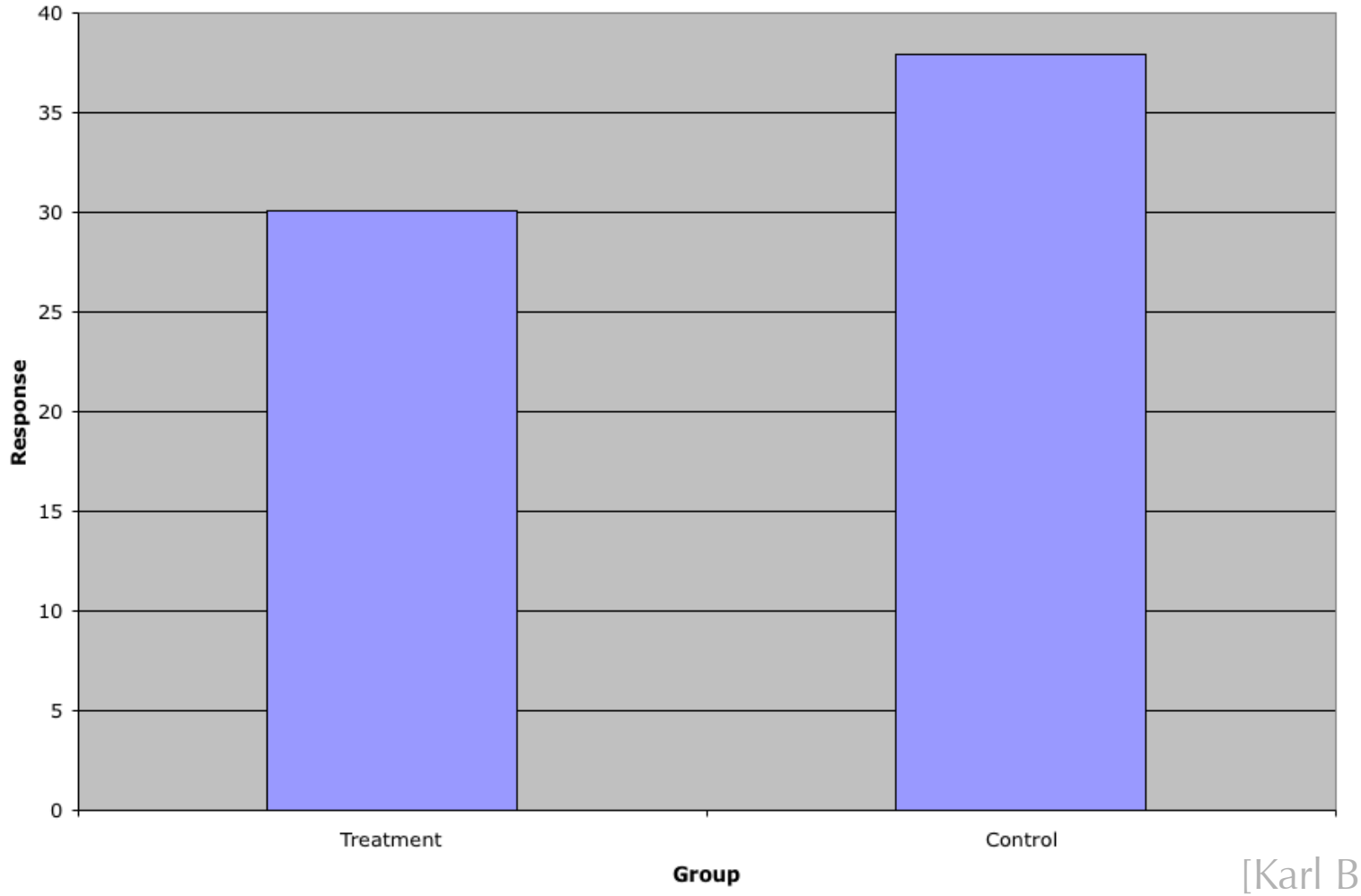
[Karl Broman]

Example 1



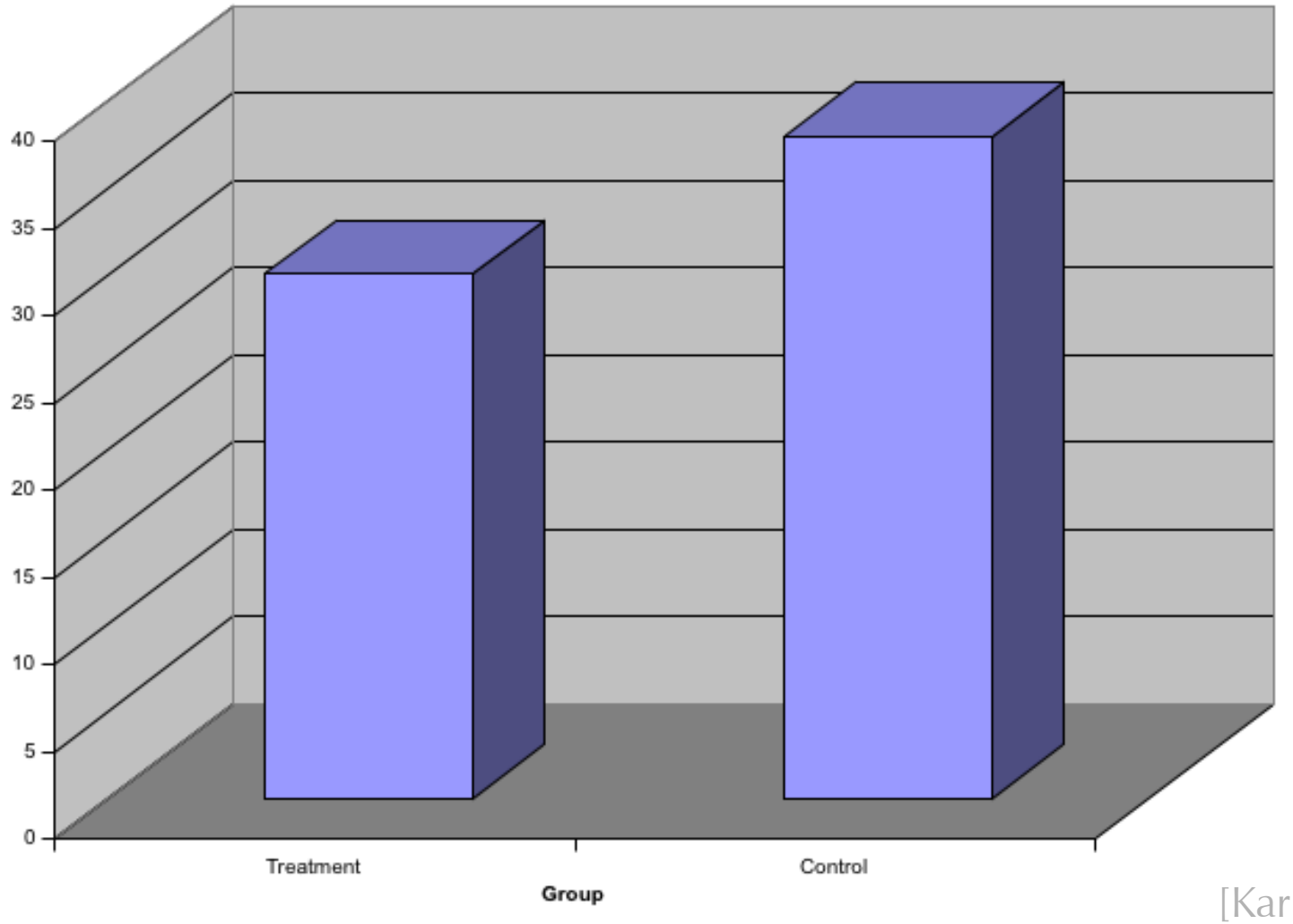
[Karl Broman]

Example 1



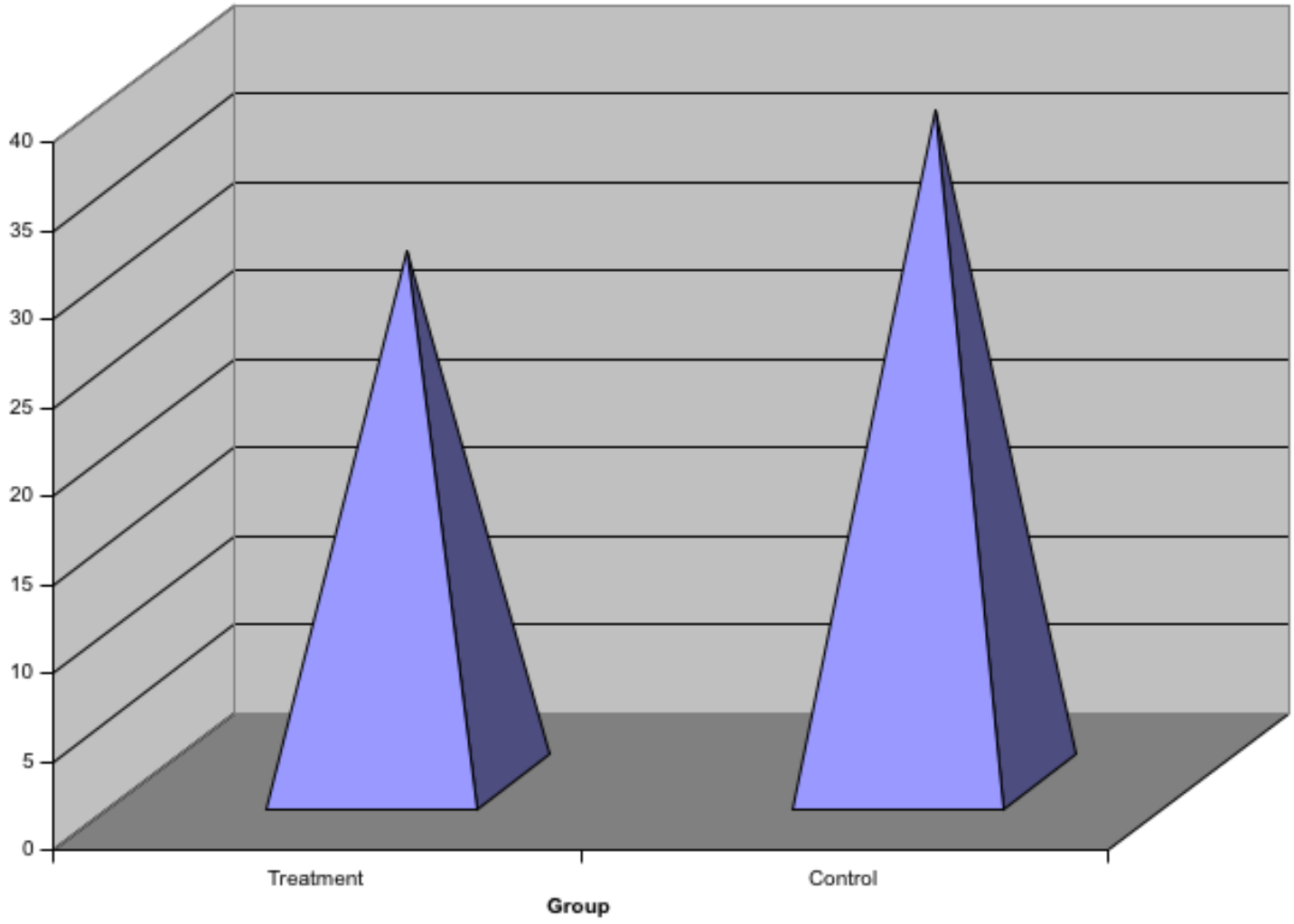
[Karl Broman]

Example 1



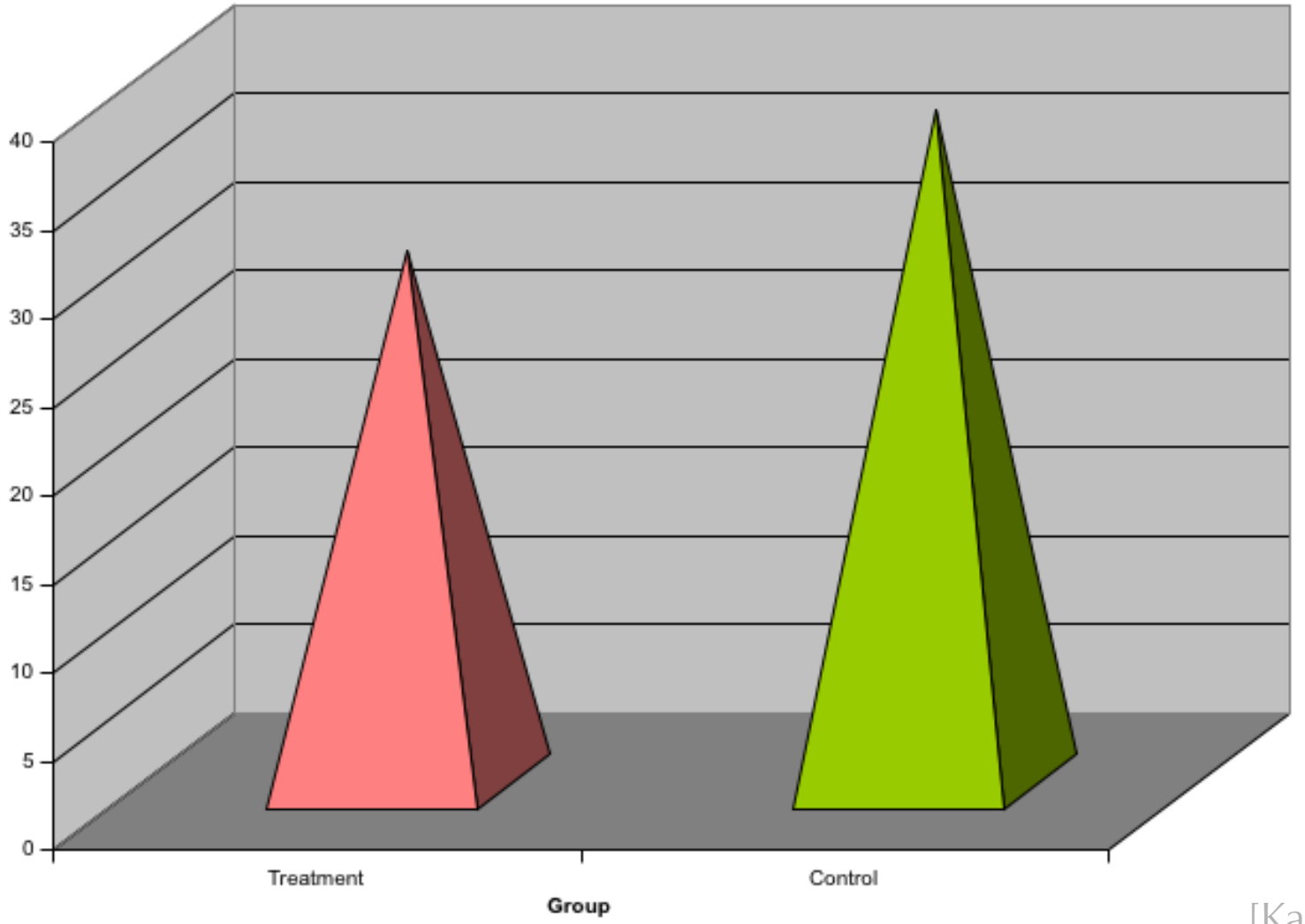
[Karl Broman]

Example 1



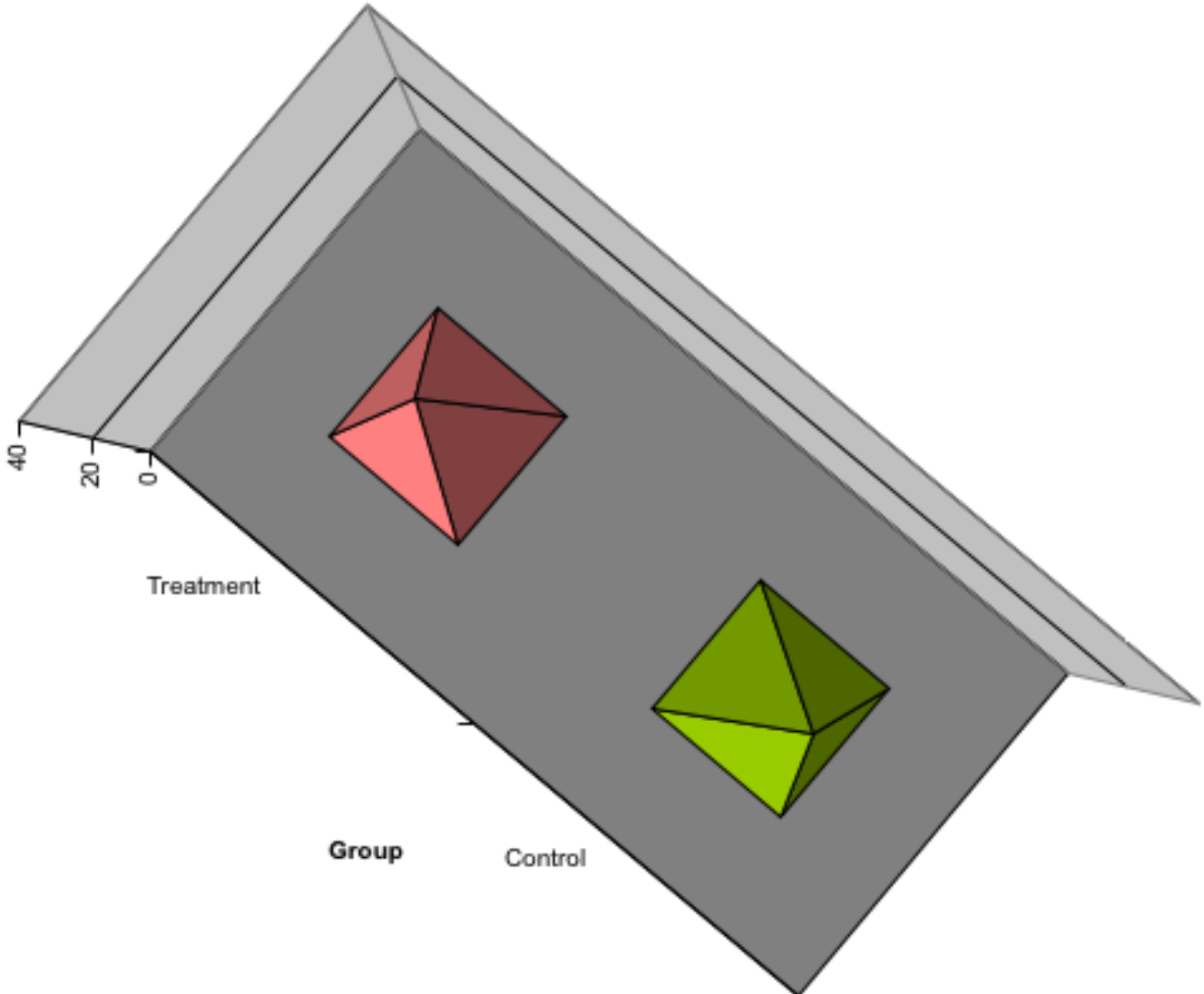
[Karl Broman]

Example 1



[Karl Broman]

Example 1



[Karl Broman]

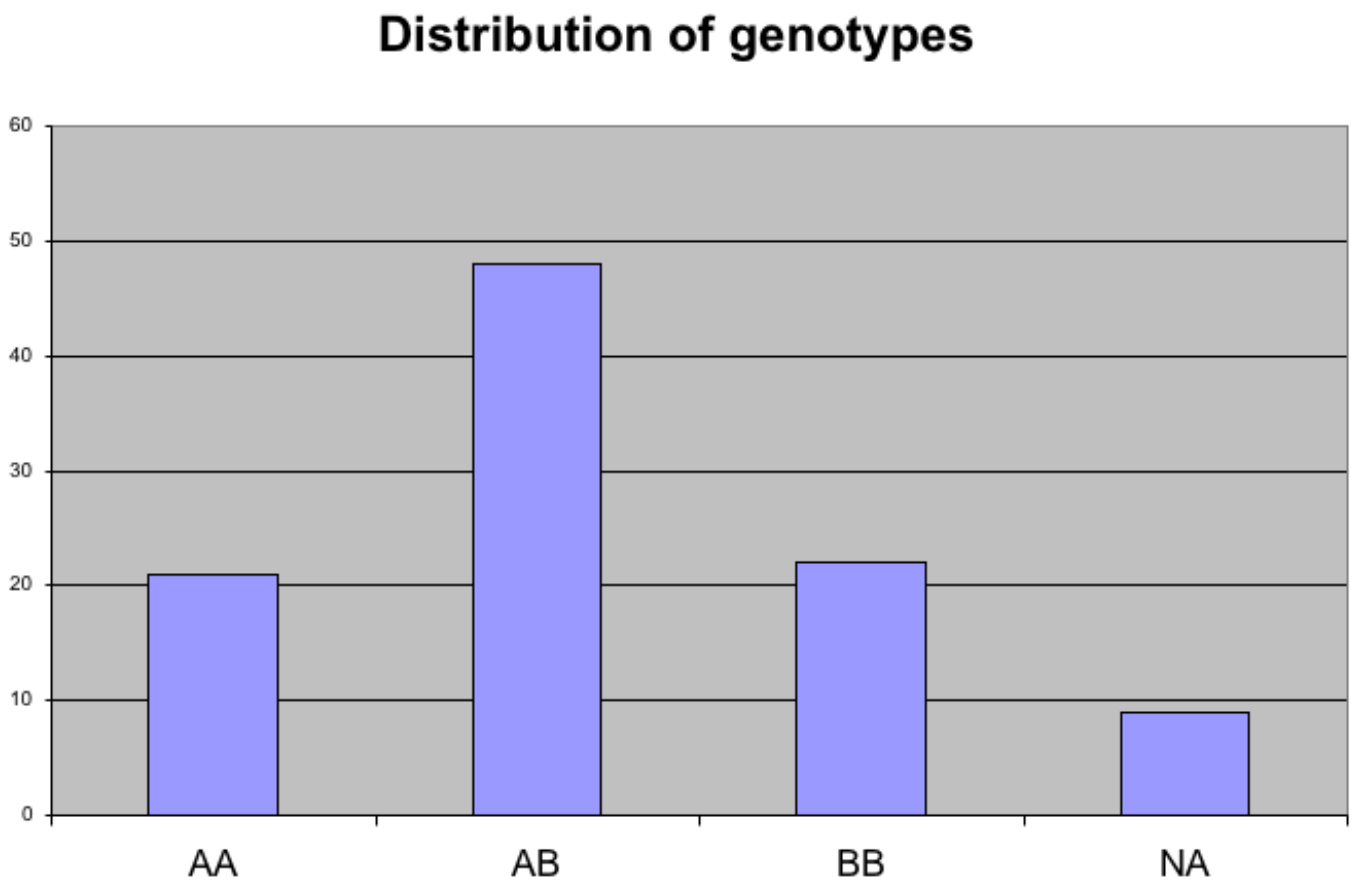
Example 2

Distribution of genotypes

AA	21%
AB	48%
BB	22%
missing	9%

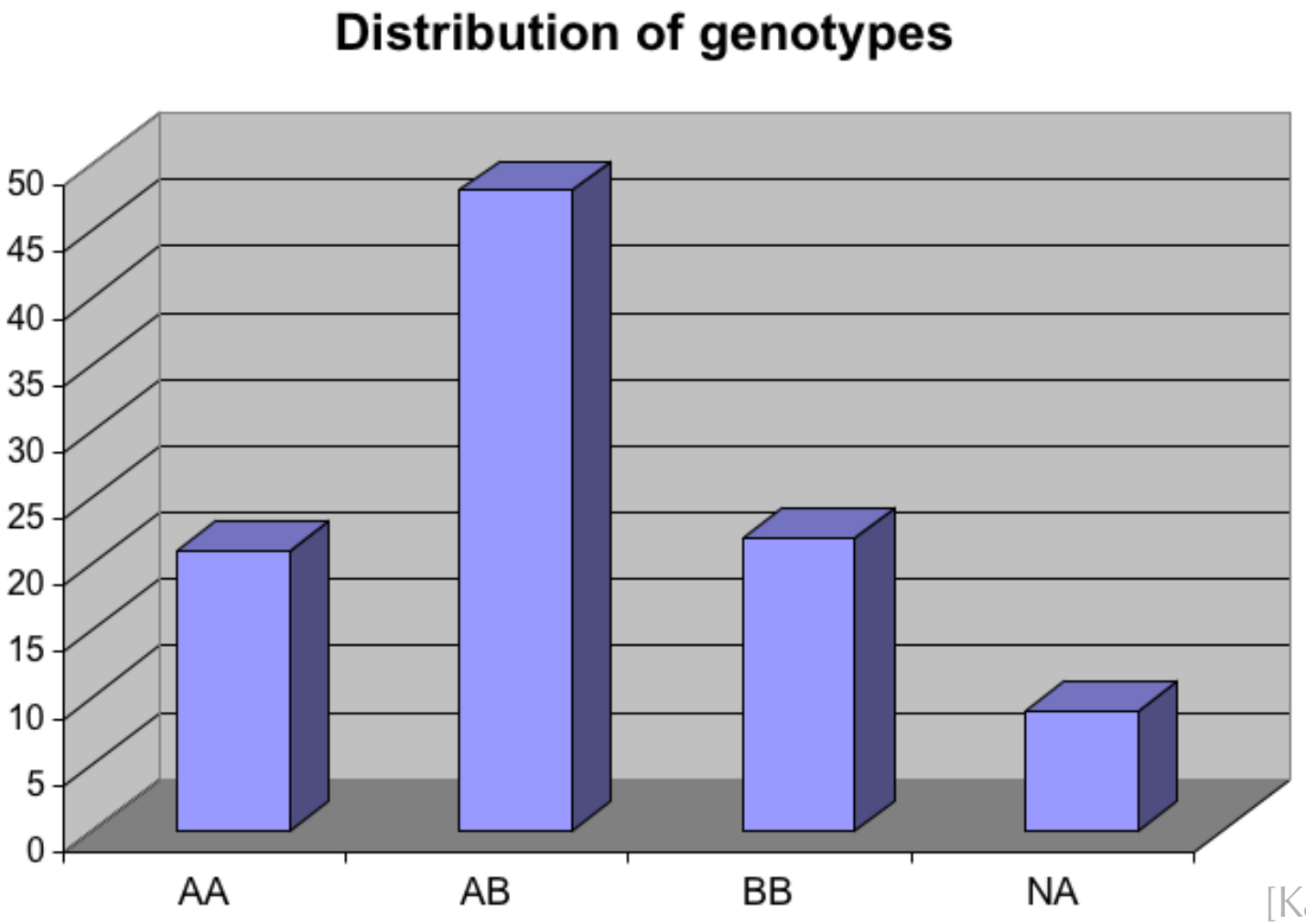
[Karl Broman]

Example 2



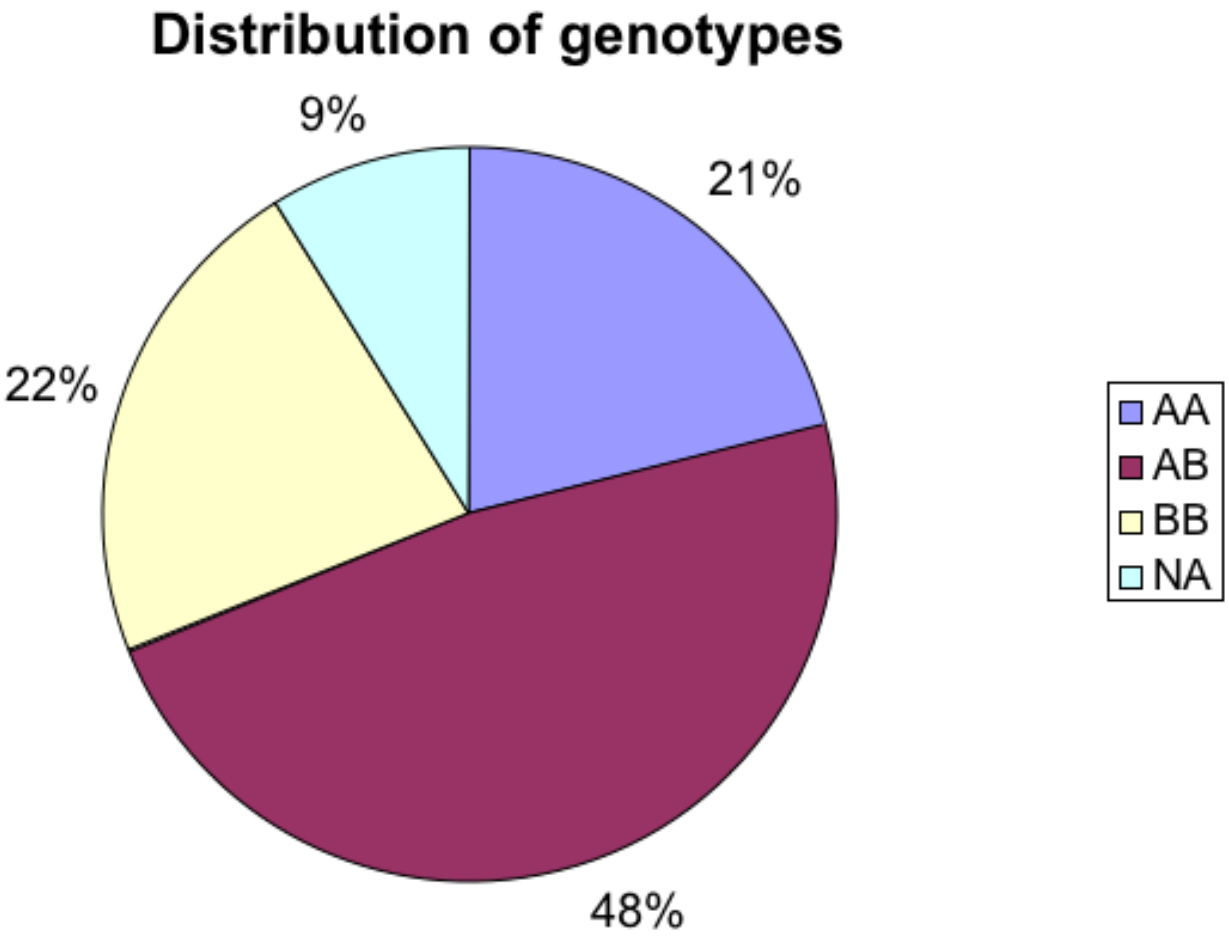
[Karl Broman]

Example 2



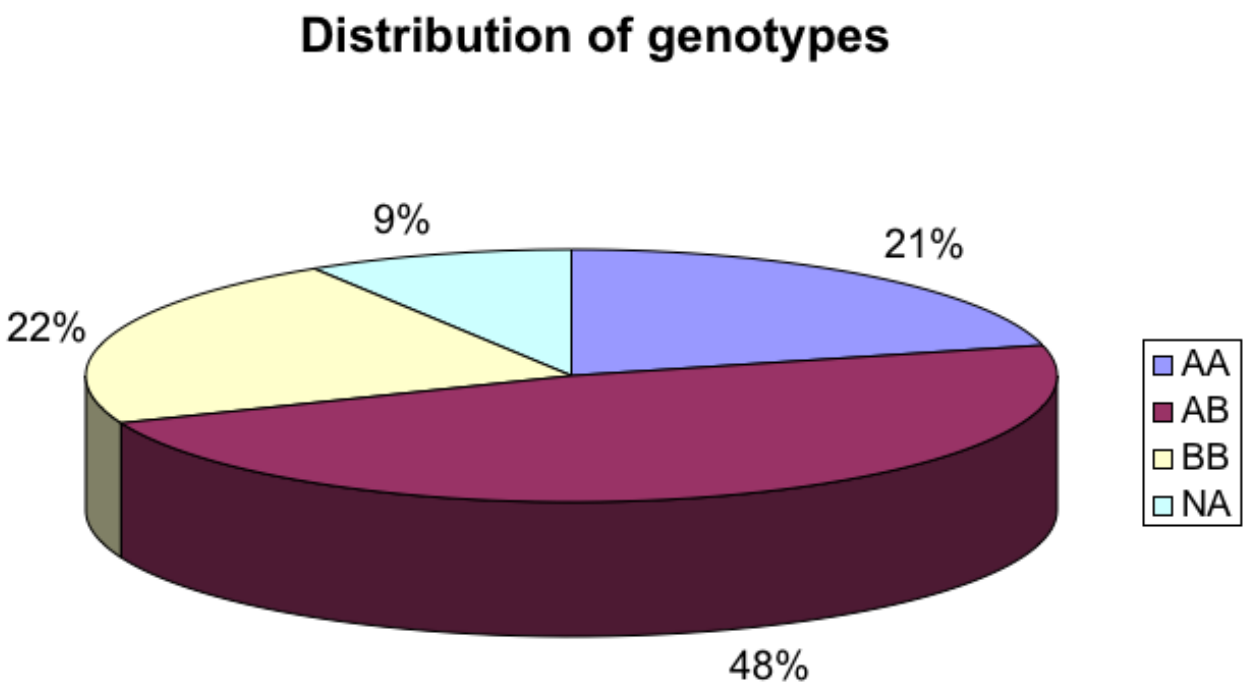
[Karl Broman]

Example 2



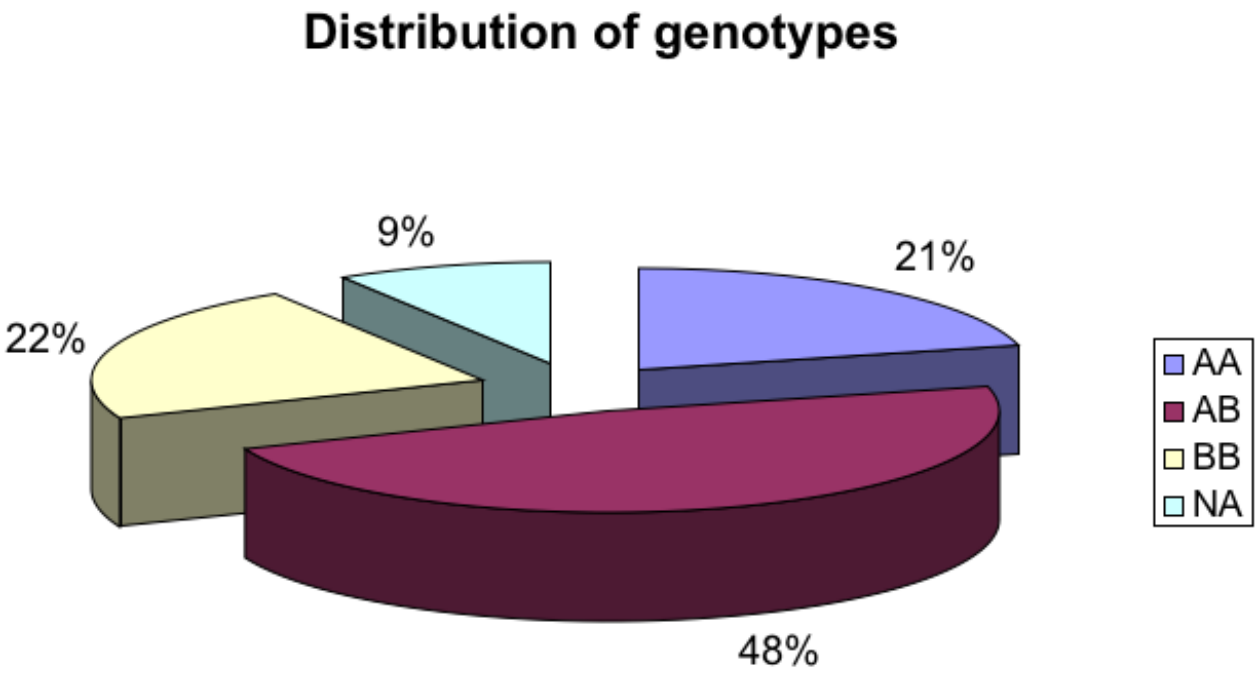
[Karl Broman]

Example 2



[Karl Broman]

Example 2



[Karl Broman]

Resources

- http://flowingdata.com/2010/12/14/10-best-data-visualization-projects-of-the-year-%E2%80%93-2010/
- http://www.tableausoftware.com/products/digital#tour
- http://www-958.ibm.com/software/data/cognos/manyeyes/