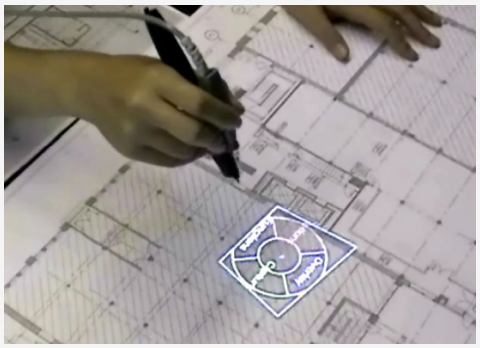
CS160: User Interface Design

Visual Information Design 3/21/2012

Berkeley
UNIVERSITY OF CALIFORNIA

UI of the Day: PenLight

http://www.youtube.com/watch?v=8VHwZHIYtVU

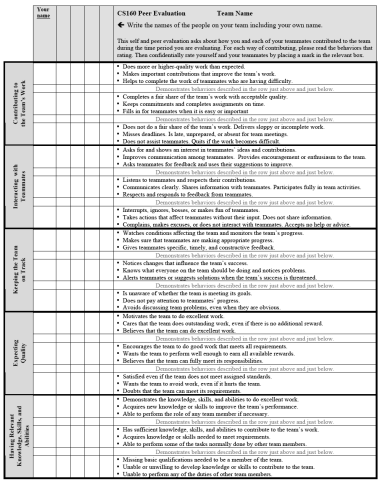


Due Today: Turn in now.

Peer Review Form

Feedback will determine whether you score higher or lower than your group average.

There will be a 2nd round of feedback later.



Your name					CS160 Peer Evaluation Team Name ← Write the names of the people on your team including your own name. This self and peer evaluation asks about how you and each of your teammates contributed to the team during the time period you are evaluating. For each way of contributing, please read the behaviors that rating. Then confidentially rate yourself and your teammates by placing a mark in the relevant box.
Contributing to the Team's Work					• Does more or higher-quality work than expected. • Makes important contributions that improve the team's work. • Helps to complete the work of teammates who are having difficulty.
					Demonstrates behaviors described in the row just above and just below.
					• Completes a fair share of the team's work with acceptable quality. • Keeps commitments and completes assignments on time. • Fills in for teammates when it is easy or important.
					Demonstrates behaviors described in the row just above and just below.
					• Does not do a fair share of the team's work. Delivers sloppy or incomplete work. • Misses deadlines. Is late, unprepared, or absent for team meetings. • Does not assist teammates. Quits if the work becomes difficult.
Interacting with Teammates					• Asks for and shows an interest in teammates' ideas and contributions. • Improves communication among teammates. Provides encouragement or enthusiasm to the team. • Asks teammates for feedback and uses their suggestions to improve.
					Demonstrates behaviors described in the row just above and just below.
					• Listens to teammates and respects their contributions. • Communicates clearly. Shares information with teammates. Participates fully in team activities. • Respects and responds to feedback from teammates.
					Demonstrates behaviors described in the row just above and just below.
					• Interrupts, ignores, bosses, or makes fun of teammates. • Takes actions that affect teammates without their input. Does not share information. • Complains, makes excuses, or does not interact with teammates. Accepts no help or advice.
Keeping the Team on Track					• Watches conditions affecting the team and monitors the team's progress. • Makes sure that teammates are making appropriate progress. • Gives teammates specific, timely, and constructive feedback.
					Demonstrates behaviors described in the row just above and just below.
					• Notices changes that influence the team's success. • Knows what everyone on the team should be doing and notices problems. • Alerts teammates or suggests solutions when the team's success is threatened.
					Demonstrates behaviors described in the row just above and just below.
					• Is unaware of whether the team is meeting its goals. • Does not pay attention to teammates' progress. • Avoids discussing team problems, even when they are obvious.
Expecting Quality					• Motivates the team to do excellent work. • Cares that the team does outstanding work, even if there is no additional reward. • Believes that the team can do excellent work.
					Demonstrates behaviors described in the row just above and just below.
					• Encourages the team to do good work that meets all requirements. • Wants the team to perform well enough to earn all available rewards. • Believes that the team can fully meet its responsibilities.
					Demonstrates behaviors described in the row just above and just below.
					• Satisfied even if the team does not meet assigned standards. • Wants the team to avoid work, even if it hurts the team. • Doubts that the team can meet its requirements.
Having Relevant Knowledge, Skills, and Abilities					• Demonstrates the knowledge, skills, and abilities to do excellent work. • Acquires new knowledge or skills to improve the team's performance. • Able to perform the role of any team member if necessary.
					Demonstrates behaviors described in the row just above and just below.
					• Has sufficient knowledge, skills, and abilities to contribute to the team's work. • Acquires knowledge or skills needed to meet requirements. • Able to perform some of the tasks normally done by other team members.
					Demonstrates behaviors described in the row just above and just below.
					• Missing basic qualifications needed to be a member of the team. • Unable or unwilling to develop knowledge or skills to contribute to the team. • Unable to perform any of the duties of other team members.

Due Today: Mid-Semester Feedback

Google form online

Help us improve the course. Tell us what is good and not so good about the course.

CS 160 Spring 2012 Midsemester Feedback

Please take a few minutes to review your experience of the course thus far. Your answers to the questions below will help us plan for the second half of the semester (and future offerings of CS160). Your answers are anonymous.

How worthwhile is this class so far?

- 1 Not worthwhile at all
- 2
- 3
- 4
- 5
- 6
- 7 Very worthwhile

How effective is your professor?

- 1 Not effective at all
- 2
- 3
- 4
- 5
- 6
- 7 Very effective

What aspects of the class do you like? What would you like to see more of between now and the end of the semester?

What do you think we could cut down on? What is not working well?

Assignment: Interactive Prototype

Interactive Prototype (due Apr 9)

Redesign interface based on low-fidelity feedback
Create first working implementation on device
Can include Wizard of Oz parts where justified
Can include pre-built functionality but only if heavily justified

In class Presentations (Apr 9 & 11)

5 min presentation (short! be careful about timing)
Focus on two items:
- tell the high-level story
- show the prototype (live may not be best idea)

Feedback from class
(you will provide feedback on each presentation)

Topics

Visualization

- Why do we create visualizations?
- Data and image
- Estimating magnitude
- Deconstructions

Why Do We Create Visualizations?

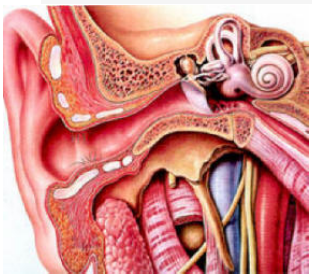
What is Visualization?

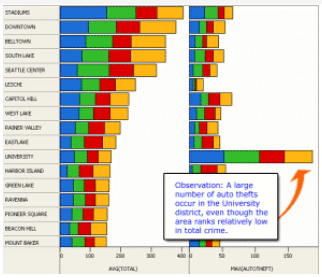
Definition [www.oed.com]

1. The action or fact of visualizing; the power or process of forming a mental picture or vision of something not actually present to the sight; a picture thus formed.

2. The action or process of rendering visible.

Examples





Why Do We Create Visualizations?

Three Primary Functions

Record information

- Photographs, blueprints, …

Support reasoning about information (analyze)

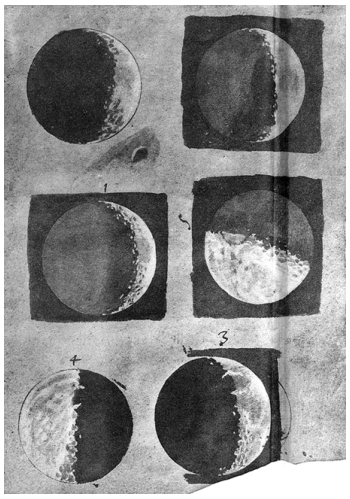
- Process and calculate
- Reason about data
- Feedback and interaction

Convey information to others (present)

- Share and persuade
- Collaborate and revise
- Emphasize important aspects of data

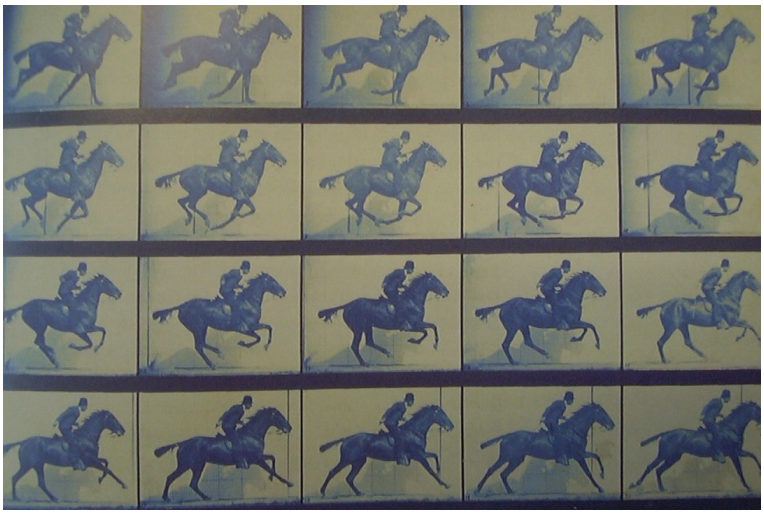
Record Information

Drawing: Phases of the Moon



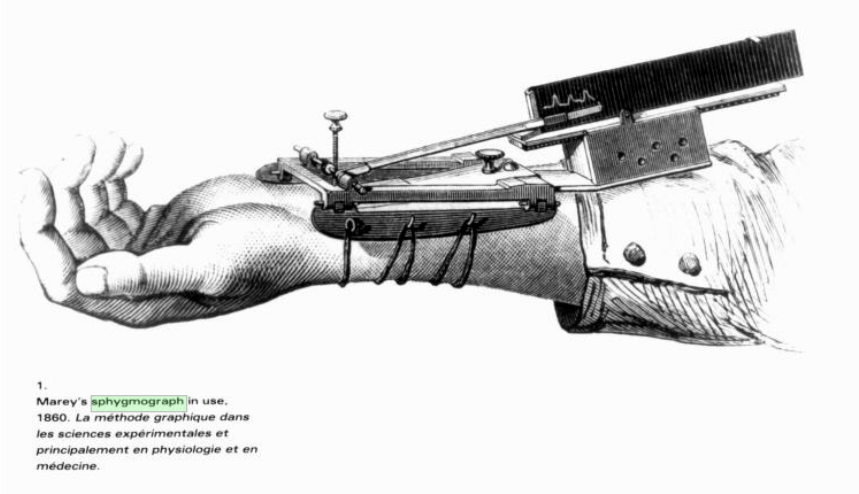
Galileo's drawings of the phases of the moon from 1616
http://galileo.rice.edu/sci/observations/moon.html

Answer Question



Gallop, Bay Horse "Daisy" [Muybridge 1884-86]

Other Recording Instruments



Marey's sphygmograph [from Braun 83]

Support Reasoning

Data in Context: Cholera Outbreak

In 1864 John Snow plotted the position of each cholera case on a map. [from Tufte 83]

Data in Context: Cholera Outbreak

Used map to hypothesize that pump on Broad St. was the cause. [from Tufte 83]

Make a Decision: Challenger

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
61A LH Center Field**	22A	None	None	0.280	None	None	36°-66°
61A LH ~~CENTER~~ FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

BLOW BY HISTORY

SRM-15 WORST BLOW-BY
- 2 CASE JOINTS (30°), (110°) ARC
- MUCH WORSE VISUALLY THAN SRM-22

SRM 22 BLOW-BY
- 2 CASE JOINTS (30-40°)

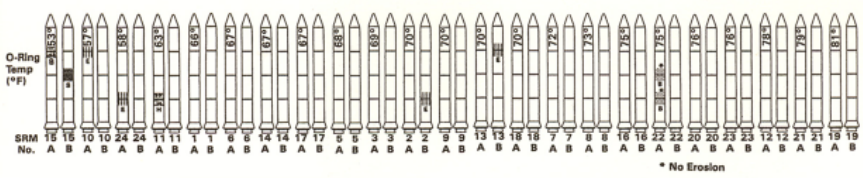
SRM-13B, 15, 16A, 18, 23A 24A
- NOZZLE BLOW-BY

HISTORY OF O-RING TEMPERATURES (DEGREES - F)

MOTOR	MOT	AMB	O-RING	WIND
DM-4	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29	10 MPH
			27	25 MPH

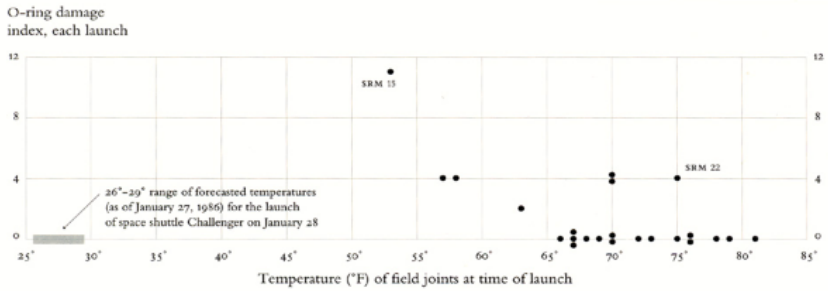
2 of 13 pages of material faxed to NASA by Morton Thiokol [from Tufte 1997]

Make a Decision: Challenger



Visualizations by booster rocket manufacturer of damage to O-rings [Tufte 97]

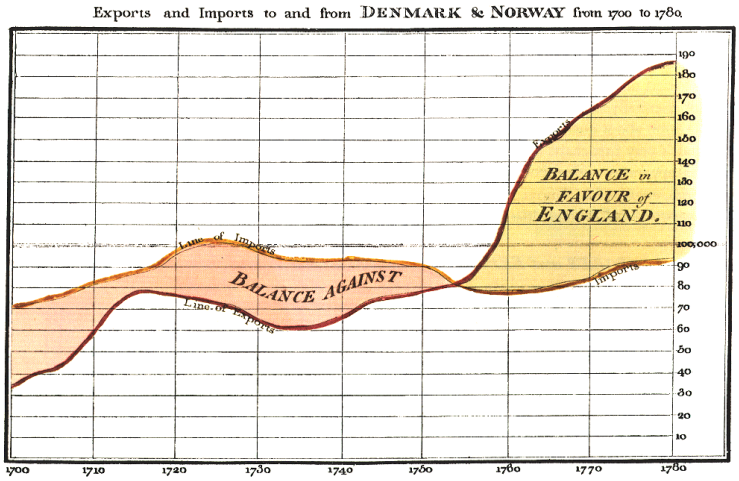
Make a Decision: Challenger



Visualizations drawn by Tufte show how low temperatures damage O-rings [Tufte 97]

Convey Information to Others

Present Argument: Exports & Imports

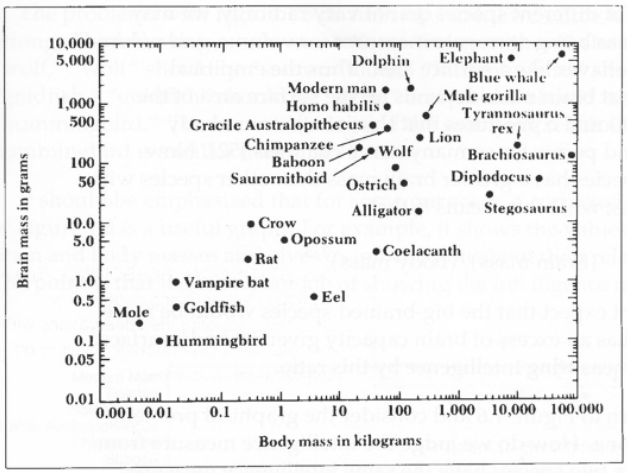


[Playfair 1786]

Tell Story: Most Powerful Brain?

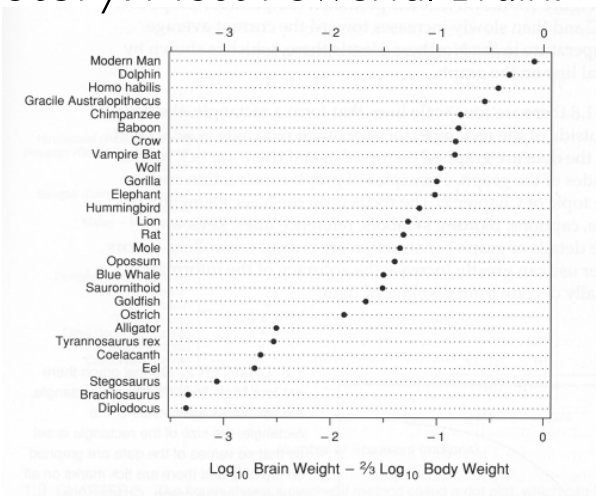
ID	Name	Body Weight	Brain Weight
1	Lesser Short-tailed Shrew	5	0.14
2	Little Brown Bat	10	0.25
3	Mouse	23	0.3
4	Big Brown Bat	23	0.4
5	Musk Shrew	48	0.33
6	Star Nosed Mole	60	1
7	Eastern American Mole	75	1.2
8	Ground Squirrel	101	4
9	Tree Shrew	104	2.5
10	Golden Hamster	120	1
11	Mole Rate	122	3
12	Galago	200	5
13	Rat	280	1.9
14	Chinchilla	425	6.4
15	Desert Hedgehog	550	2.4
16	Rock Hyrax (a)	750	12.3
17	European Hedgehog	785	3.5
18	Tenrec	900	2.6
19	Arctic Ground Squirrel	920	5.7
20	African Giant Pouched Rat	1000	6.6
21	Guinea Pig	1040	5.5
22	Mountain Beaver	1350	8.1
23	Slow Loris	1400	12.5
24	Genet	1410	17.5
25	Phalanger	1620	11.4

Tell Story: Most Powerful Brain?



The Dragons of Eden [Carl Sagan]

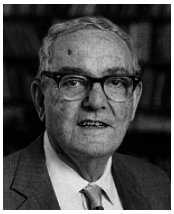
Tell Story: Most Powerful Brain?



The Elements of Graping Data [Cleveland]

Attention

"What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it."



~Herb Simon
as quoted by Hal Varian
Scientific American
September 1995

[slide from PARC UIR group]

Data

Data Types

Physical type (model)

Characterized by storage format
Characterized by machine operations

Example:

bool, short, int32, float, double, string, …

Abstract type

Provide (conceptual) descriptions of the data
May be characterized by methods/attributes
May be organized into a hierarchy

Example:

nominal, ordinal, quantitative, …,
plants, animals, metazoans, …

Nominal, Ordinal & Quantitative

N - Nominal (labels)

Fruits: Apples, oranges, …

O - Ordered

Quality of meat: Grade A, AA, AAA

Q - Quantitative

Real numbers

Ordered, with measurable distances, or amounts

Dates: Jan, 19, 2006; Location: (LAT 33.98, LONG -118.45)

Physical measurement: Length, Mass, Temp, …

S. S. Stevens, On the theory of scales of measurements, 1946

From Data Model to Data Type

Data model

32.5, 54.0, -17.3, …

floats

Conceptual model

Temperature

Data type

Burned vs. Not burned (N)

Hot, warm, cold (O)

Continuous range of values (Q)

[based on slide from Munzner]

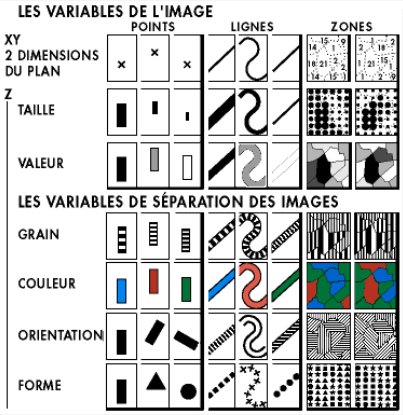
Image

Jacques Bertin

Visual Variables

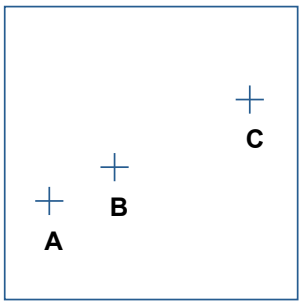
Position
Size
Value

Texture
Color
Orientation
Shape



Note: Bertin does not consider 3D or time
Note: Card and Mackinlay extend the number of vars.

Information in Position



1. A, B, C are distinguishable
2. B is between A and C.
3. BC is twice as long as AB.

4. ∴ Encode quantitative variables (Q)

Information in Color and Value

Value is perceived as ordered

∴ Encode ordinal variables (O)

∴ Encode continuous variables (Q) [not as well]

Hue is normally perceived as unordered

∴ Encode nominal variables (N) using color

Bertins' "Levels of Organization"

Position	**N**	**O**	**Q**
Size	**N**	**O**	**Q**
Value	**N**	**O**	**Q**
Texture	**N**	**O**	
Color	**N**		
Orientation	**N**		
Shape	**N**		

N Nominal
O Ordinal
Q Quantitative

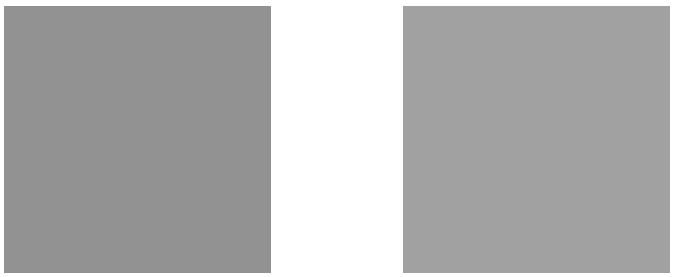
Estimating Magnitude

Detecting Brightness

Which is brighter?

Detecting Brightness

(128, 128, 128) **(144, 144, 144)**



Which is brighter?

Just Noticeable Differences

JND (Weber's Law)

$$\Delta S = k \frac{\Delta I}{I}$$

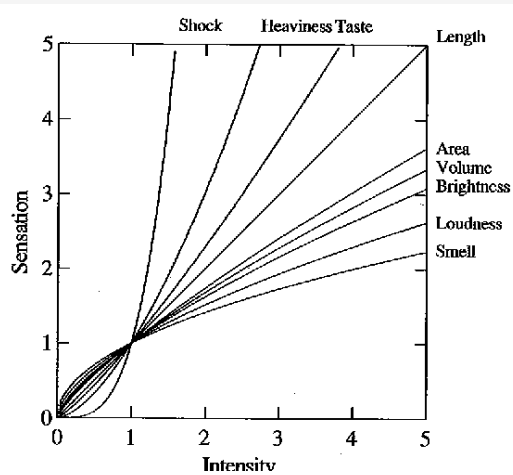
Ratios more important than magnitude

Most continuous variations perceived in discrete steps

Steven's Power law

$$S = I^p$$

p < 1 : underestimate
p > 1 : overestimate

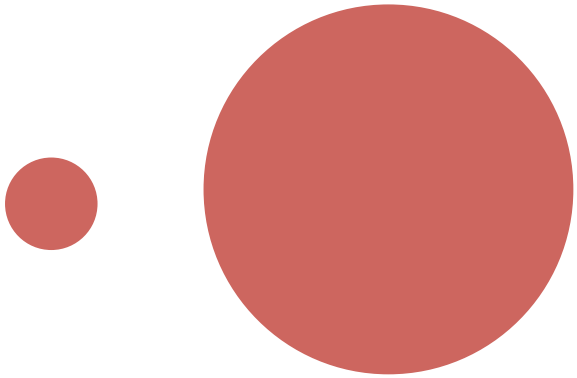


[graph from Wilkinson 99, based on Stevens 61]

Exponents of Power Law

Sensation	Exponent
Loudness	0.6
Brightness	0.33
Smell	0.55 (Coffee) - 0.6 (Heptane)
Taste	0.6 (Saccharine) -1.3 (Salt)
Temperature	1.0 (Cold) – 1.6 (Warm)
Vibration	0.6 (250 Hz) – 0.95 (60 Hz)
Duration	1.1
Pressure	1.1
Heaviness	1.45
Electic Shock	3.5

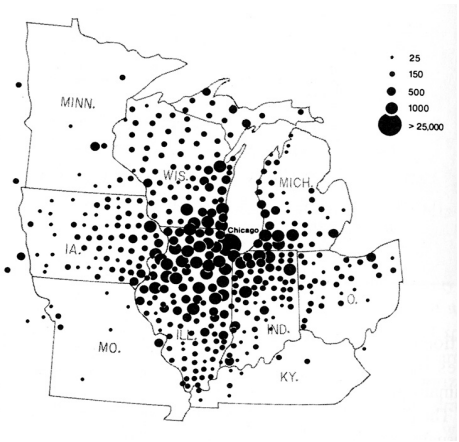
[Psychophysics of Sensory Function, Stevens 61]



Compare area of circles

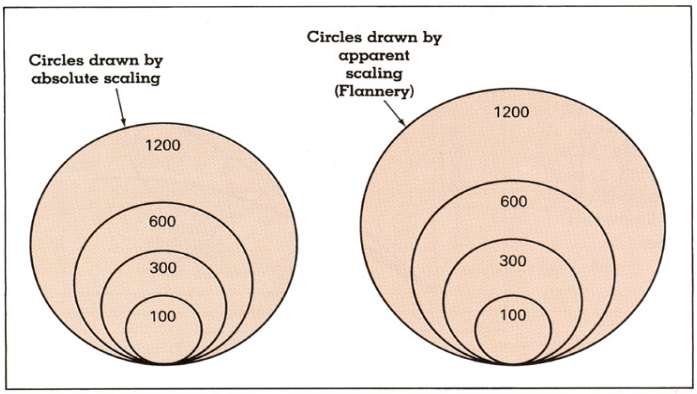
Proportional Symbol Map

Newspaper Circulation



[Cartography: Thematic Map Design, Figure 8.8, p. 172, Dent, 96]

Apparent Magnitude Scaling



[Cartography: Thematic Map Design, Figure 8.6, p. 170, Dent, 96]

$S = 0.98A^{0.87}$ [from Flannery 71]

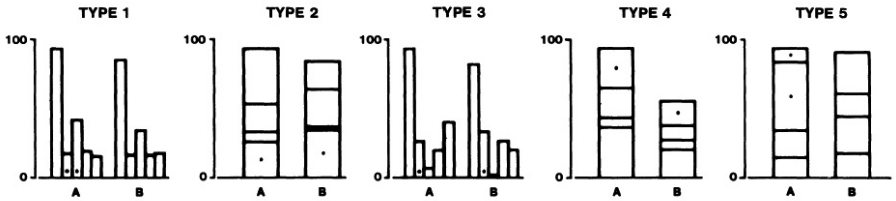


Figure 4. Graphs from position–length experiment.

[Cleveland and McGill 84]

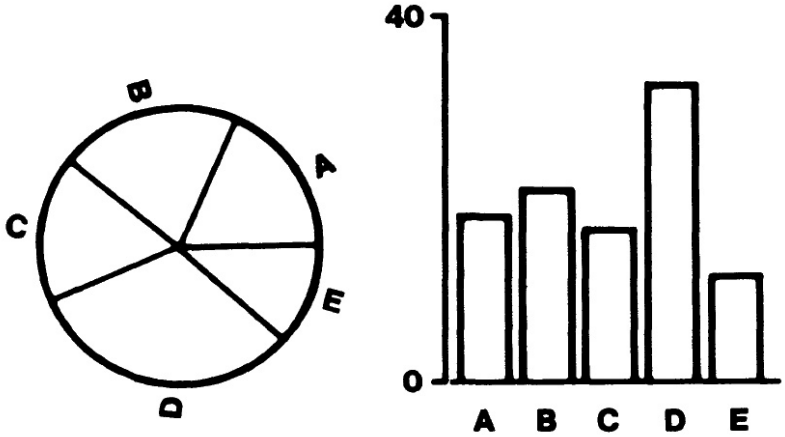


Figure 3. Graphs from position–angle experiment.

[Cleveland and McGill 84]

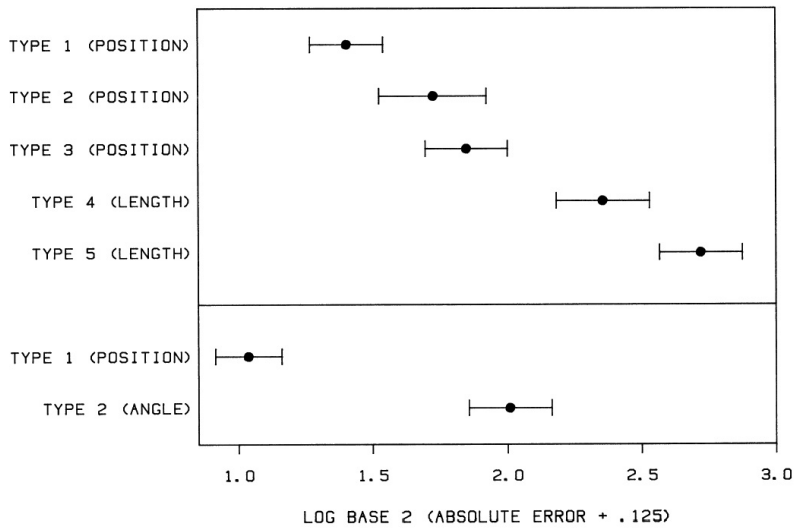
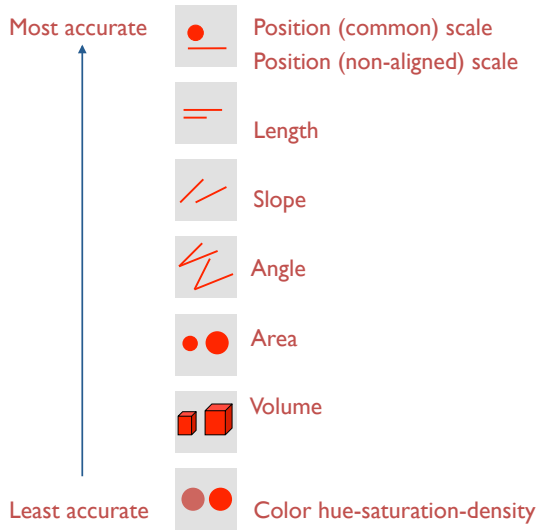


Figure 16. Log absolute error means and 95% confidence intervals for judgment types in position–length experiment (top) and position–angle experiment (bottom).

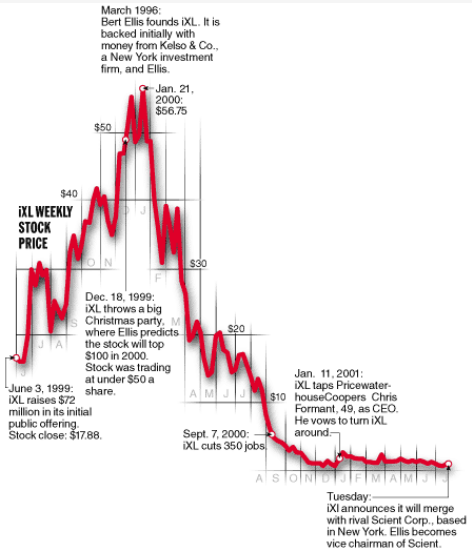
[Cleveland and McGill 84]

Relative Magnitude Estimation

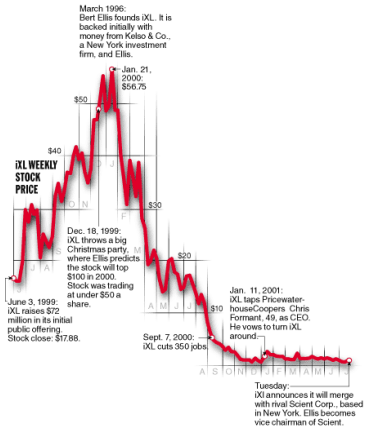


Deconstructions

Stock Chart



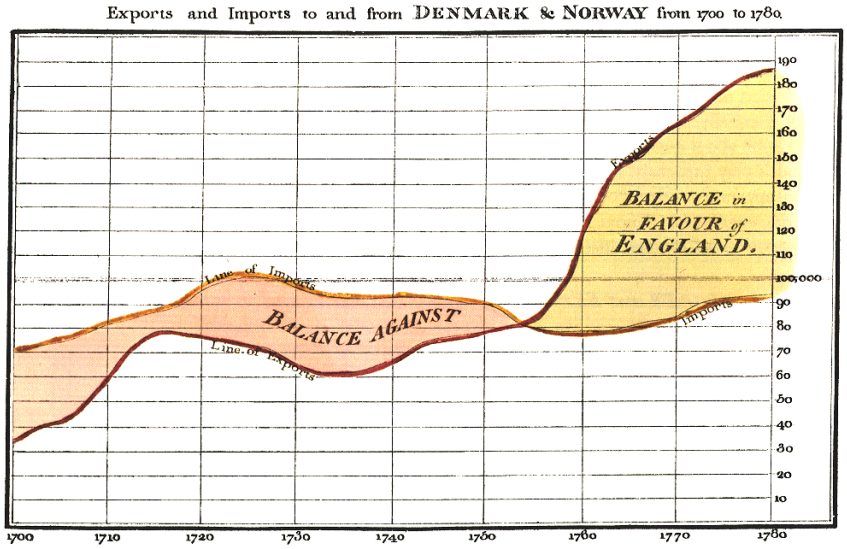
Stock Chart



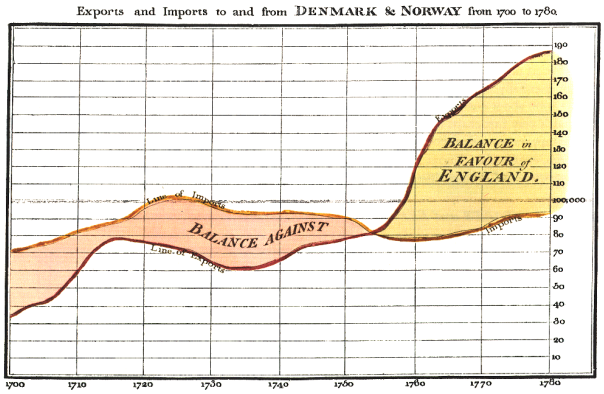
x-axis: time (Q)

y-axis: price (Q)

Exports and Imports [Playfair 1786]

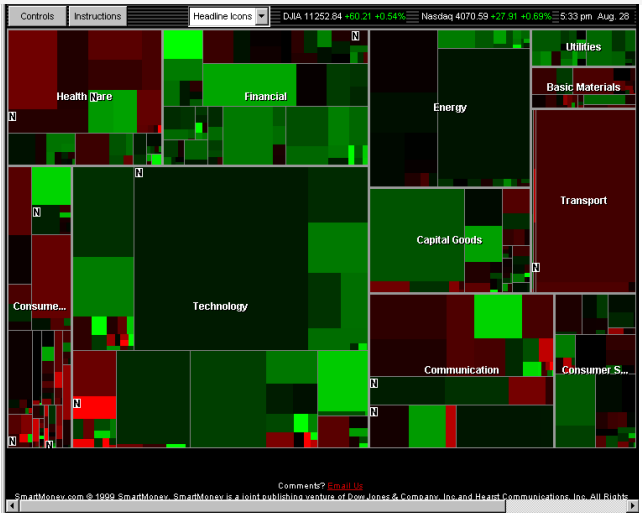


Exports and Imports [Playfair 1786]



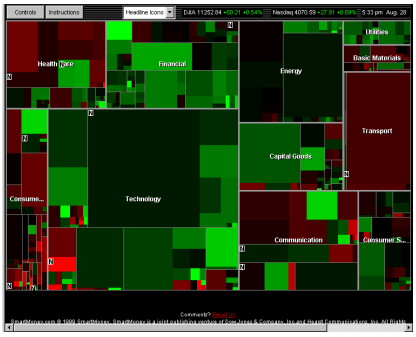
x-axis: year (Q)
y-axis: currency (Q)
color: imports/exports (N)
color: positive/negative (O)

Map of the Market [Wattenberg 1998]



http://www.smartmoney.com/marketmap/

Map of the Market [Wattenberg 1998]



rectangle size: market cap (Q)
rectangle position: market sector (N), market cap (Q)
color hue: loss vs. gain (N, O)
color value: magnitude of loss or gain (Q)

Summary

We create visualizations to

Record information
Support reasoning about the information
Convey information to others

Choose the right mark for your data

Position good for N, O, Q, but Hue best only for N

With careful design it is possible to display many dimensions at once