

Introduction to Information Visualization

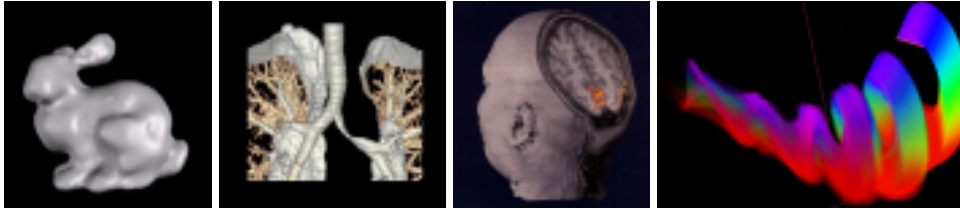
Jinwook Seo, Ph.D.
Professor, Dept. of Computer Science and
Engineering Director, Human-Computer Interaction
Lab
Seoul National University

Introduction What is it?

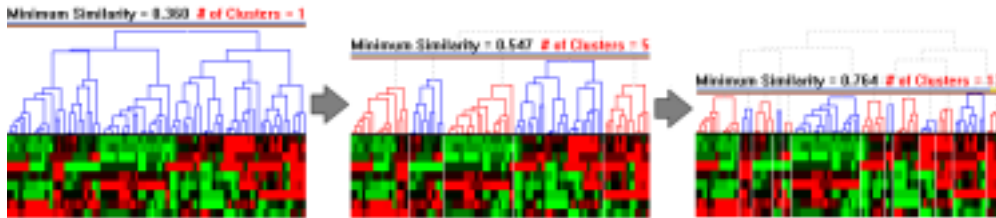
- Information Visualization vs. Scientific Visualization
- Data Visualizations – its power
- Data Visualization – definition

Introduction Visualization

- Scientific Visualization

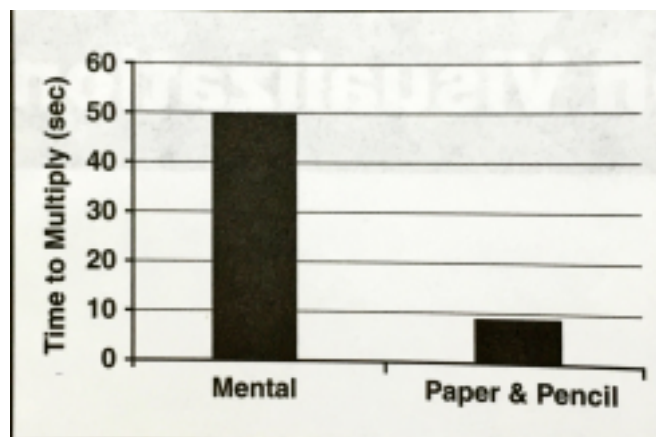


- Information Visualization - Abstract data



Introduction hci lab Why Use an External Representation?

- Finding the *artificial memory* that best supports our natural means of perception
 - Bertin, 1983



Introduction hci lab Anything Interesting?

Microsoft Excel - periodic.com

File Edit View Insert Format Tools Data Window Help Add-Ins

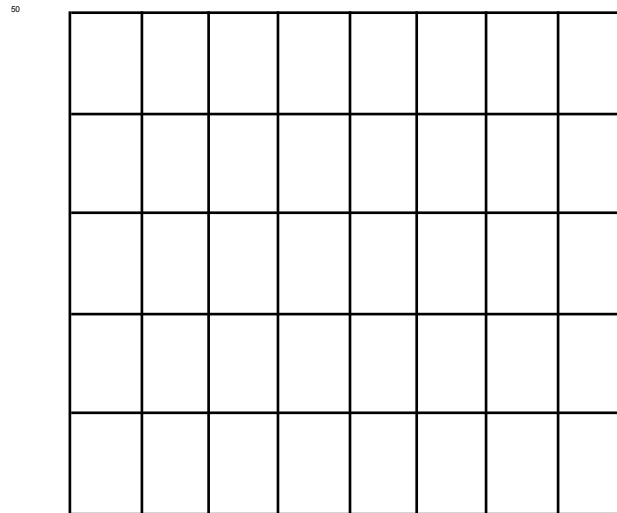
Open a spreadsheet for help

A1	B	C	D	E	F	G	H	I	J	K
1	Element	1P1	2P2	Atomic Mass	Atomic Mass	Atomic Mass	Atomic Mass	Atomic Mass	Atomic Mass	Atomic Mass
2	H	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008	1.008
3	He	4.003	4.003	4.003	4.003	4.003	4.003	4.003	4.003	4.003
4	Li	6.941	6.941	6.941	6.941	6.941	6.941	6.941	6.941	6.941
5	Be	9.012	9.012	9.012	9.012	9.012	9.012	9.012	9.012	9.012
6	B	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81	10.81
7	C	12.01	12.01	12.01	12.01	12.01	12.01	12.01	12.01	12.01
8	N	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01	14.01
9	O	15.99	15.99	15.99	15.99	15.99	15.99	15.99	15.99	15.99
10	F	18.99	18.99	18.99	18.99	18.99	18.99	18.99	18.99	18.99
11	Ne	20.18	20.18	20.18	20.18	20.18	20.18	20.18	20.18	20.18
12	Na	22.99	22.99	22.99	22.99	22.99	22.99	22.99	22.99	22.99
13	Mg	24.30	24.30	24.30	24.30	24.30	24.30	24.30	24.30	24.30
14	Al	26.98	26.98	26.98	26.98	26.98	26.98	26.98	26.98	26.98
15	Si	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08
16	P	30.97	30.97	30.97	30.97	30.97	30.97	30.97	30.97	30.97
17	S	32.06	32.06	32.06	32.06	32.06	32.06	32.06	32.06	32.06
18	Cl	35.45	35.45	35.45	35.45	35.45	35.45	35.45	35.45	35.45
19	K	39.09	39.09	39.09	39.09	39.09	39.09	39.09	39.09	39.09
20	Ca	40.08	40.08	40.08	40.08	40.08	40.08	40.08	40.08	40.08
21	Sc	44.96	44.96	44.96	44.96	44.96	44.96	44.96	44.96	44.96
22	Ti	47.88	47.88	47.88	47.88	47.88	47.88	47.88	47.88	47.88
23	V	50.94	50.94	50.94	50.94	50.94	50.94	50.94	50.94	50.94
24	Cr	51.99	51.99	51.99	51.99	51.99	51.99	51.99	51.99	51.99
25	Mn	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94	54.94
26	Fe	55.85	55.85	55.85	55.85	55.85	55.85	55.85	55.85	55.85
27	Co	58.93	58.93	58.93	58.93	58.93	58.93	58.93	58.93	58.93
28	Ni	58.69	58.69	58.69	58.69	58.69	58.69	58.69	58.69	58.69
29	Cu	63.55	63.55	63.55	63.55	63.55	63.55	63.55	63.55	63.55
30	Zn	65.38	65.38	65.38	65.38	65.38	65.38	65.38	65.38	65.38
31	Ga	69.72	69.72	69.72	69.72	69.72	69.72	69.72	69.72	69.72
32	Ge	72.64	72.64	72.64	72.64	72.64	72.64	72.64	72.64	72.64
33	As	74.92	74.92	74.92	74.92	74.92	74.92	74.92	74.92	74.92
34	Se	78.96	78.96	78.96	78.96	78.96	78.96	78.96	78.96	78.96
35	Br	79.90	79.90	79.90	79.90	79.90	79.90	79.90	79.90	79.90
36	Kr	83.80	83.80	83.80	83.80	83.80	83.80	83.80	83.80	83.80
37	Rb	85.47	85.47	85.47	85.47	85.47	85.47	85.47	85.47	85.47
38	Sr	87.62	87.62	87.62	87.62	87.62	87.62	87.62	87.62	87.62
39	Y	88.91	88.91	88.91	88.91	88.91	88.91	88.91	88.91	88.91
40	Zr	91.22	91.22	91.22	91.22	91.22	91.22	91.22	91.22	91.22
41	Nb	92.91	92.91	92.91	92.91	92.91	92.91	92.91	92.91	92.91
42	Mo	95.94	95.94	95.94	95.94	95.94	95.94	95.94	95.94	95.94
43	Tc	98.91	98.91	98.91	98.91	98.91	98.91	98.91	98.91	98.91
44	Ru	101.07	101.07	101.07	101.07	101.07	101.07	101.07	101.07	101.07
45	Rh	102.91	102.91	102.91	102.91	102.91	102.91	102.91	102.91	102.91
46	Pd	106.42	106.42	106.42	106.42	106.42	106.42	106.42	106.42	106.42
47	Ag	107.87	107.87	107.87	107.87	107.87	107.87	107.87	107.87	107.87
48	Cd	112.41	112.41	112.41	112.41	112.41	112.41	112.41	112.41	112.41
49	In	114.82	114.82	114.82	114.82	114.82	114.82	114.82	114.82	114.82
50	Sn	118.71	118.71	118.71	118.71	118.71	118.71	118.71	118.71	118.71
51	Sb	121.76	121.76	121.76	121.76	121.76	121.76	121.76	121.76	121.76
52	Te	127.60	127.60	127.60	127.60	127.60	127.60	127.60	127.60	127.60
53	I	126.90	126.90	126.90	126.90	126.90	126.90	126.90	126.90	126.90
54	Xe	131.29	131.29	131.29	131.29	131.29	131.29	131.29	131.29	131.29
55	Ba	137.33	137.33	137.33	137.33	137.33	137.33	137.33	137.33	137.33
56	La	138.91	138.91	138.91	138.91	138.91	138.91	138.91	138.91	138.91
57	Ce	140.12	140.12	140.12	140.12	140.12	140.12	140.12	140.12	140.12
58	Pr	140.91	140.91	140.91	140.91	140.91	140.91	140.91	140.91	140.91
59	Nd	144.24	144.24	144.24	144.24	144.24	144.24	144.24	144.24	144.24
60	Pm	144.91	144.91	144.91	144.91	144.91	144.91	144.91	144.91	144.91
61	Sm	150.36	150.36	150.36	150.36	150.36	150.36	150.36	150.36	150.36
62	Eu	151.96	151.96	151.96	151.96	151.96	151.96	151.96	151.96	151.96
63	Gd	157.25	157.25	157.25	157.25	157.25	157.25	157.25	157.25	157.25
64	Tb	158.93	158.93	158.93	158.93	158.93	158.93	158.93	158.93	158.93
65	Dy	162.50	162.50	162.50	162.50	162.50	162.50	162.50	162.50	162.50
66	Ho	164.93	164.93	164.93	164.93	164.93	164.93	164.93	164.93	164.93
67	Er	167.26	167.26	167.26	167.26	167.26	167.26	167.26	167.26	167.26
68	Tm	168.93	168.93	168.93	168.93	168.93	168.93	168.93	168.93	168.93
69	Yb	173.05	173.05	173.05	173.05	173.05	173.05	173.05	173.05	173.05
70	Lu	174.97	174.97	174.97	174.97	174.97	174.97	174.97	174.97	174.97
71	Hf	178.49	178.49	178.49	178.49	178.49	178.49	178.49	178.49	178.49
72	Ta	180.95	180.95	180.95	180.95	180.95	180.95	180.95	180.95	180.95
73	W	183.84	183.84	183.84	183.84	183.84	183.84	183.84	183.84	183.84
74	Re	186.21	186.21	186.21	186.21	186.21	186.21	186.21	186.21	186.21
75	Os	190.23	190.23	190.23	190.23	190.23	190.23	190.23	190.23	190.23
76	Ir	192.22	192.22	192.22	192.22	192.22	192.22	192.22	192.22	192.22
77	Pt	195.08	195.08	195.08	195.08	195.08	195.08	195.08	195.08	195.08
78	Au	196.97	196.97	196.97	196.97	196.97	196.97	196.97	196.97	196.97
79	Hg	200.59	200.59	200.59	200.59	200.59	200.59	200.59	200.59	200.59
80	Tl	204.38	204.38	204.38	204.38	204.38	204.38	204.38	204.38	204.38
81	Pb	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2
82	Bi	208.98	208.98	208.98	208.98	208.98	208.98	208.98	208.98	208.98
83	Po	209	209	209	209	209	209	209	209	209
84	At	210	210	210	210	210	210	210	210	210
85	Fr	223	223	223	223	223	223	223	223	223
86	Ra	226	226	226	226	226	226	226	226	226
87	Ac	227	227	227	227	227	227	227	227	227
88	Th	232.04	232.04	232.04	232.04	232.04	232.04	232.04	232.04	232.04
89	Pa	231.04	231.04	231.04	231.04	231.04	231.04	231.04	231.04	231.04
90	U	238.03	238.03	238.03	238.03	238.03	238.03	238.03	238.03	238.03
91	Np	237.05	237.05	237.05	237.05	237.05	237.05	237.05	237.05	237.05
92	Pu	244.06	244.06	244.06	244.06	244.06	244.06	244.06	244.06	244.06
93	Am	243.06	243.06	243.06	243.06	243.06	243.06	243.06	243.06	243.06
94	Cm	247.07	247.07	247.07	247.07	247.07	247.07	247.07	247.07	247.07
95	Bk	247.07	247.07	247.07	247.07	247.07	247.07	247.07	247.07	247.07
96	Cf	251.08	251.08	251.08	251.08	251.08	251.08	251.08	251.08	251.08
97	Es	252.08	252.08	252.08	252.08	252.08	252.08	252.08	252.08	252.08
98	Fm	257.10	257.10	257.10	257.10	257.10	257.10	257.10	257.10	257.10
99	Md	258.10	258.10	258.10	258.10	258.10	258.10	258.10	258.10	258.10
100	No	259.10	259.10	259.10	259.10	259.10	259.10	259.10	259.10	259.10
101	Lr	262.11	262.11	262.11	262.11	262.11	262.11	262.11	262.11	262.11
102	Rf	261.10	261.10	261.10	261.10	261.10	261.10	261.10	261.10	261.10
103	Db	262.11	262.11	262.11	262.11	262.11	262.11	262.11	262.11	262.11
104	Sg	266.12	266.12	266.12	266.12	266.12	266.12	266.12	266.12	266.12
105	Bh	264.10	264.10	264.10	264.10	264.10	264.10	264.10	264.10	264.10
106	Hs	277.13	277.13	277.13	277.13	277.13	277.13	277.13	277.13	277.13
107	Mt	268.10	268.10	268.10	268.10	268.10	268.10	268.10	268.10	268.10
108	Ds	271.10	271.10	271.10	271.10	271.10	271.10	271.10	271.10	271.10
109	Rg	272.11	272.11	272.11	272.11	272.11	272.11	272.11	272.11	272.11
110	Uu	288.10	288.10	288.10	288.10	288.10	288.10	288.10	288.10	288.10
111	Uub	289.10	289.10	289.10	289.10	289.10	289.10	289.1		

• Periodic Table Data

Introduction **hci lab** Anything Interesting?

Scatter Plot



40

30

20

10

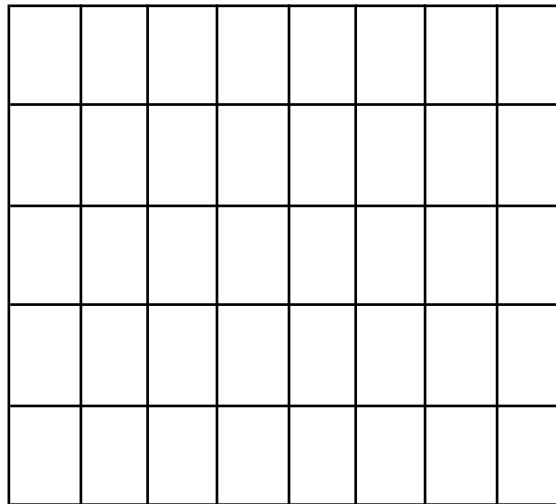
0

50 75 100 125 150 175 200 225 250 Ionization Energy

Anything Interesting?

Scatter Plot

50



40

30

20

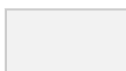
10

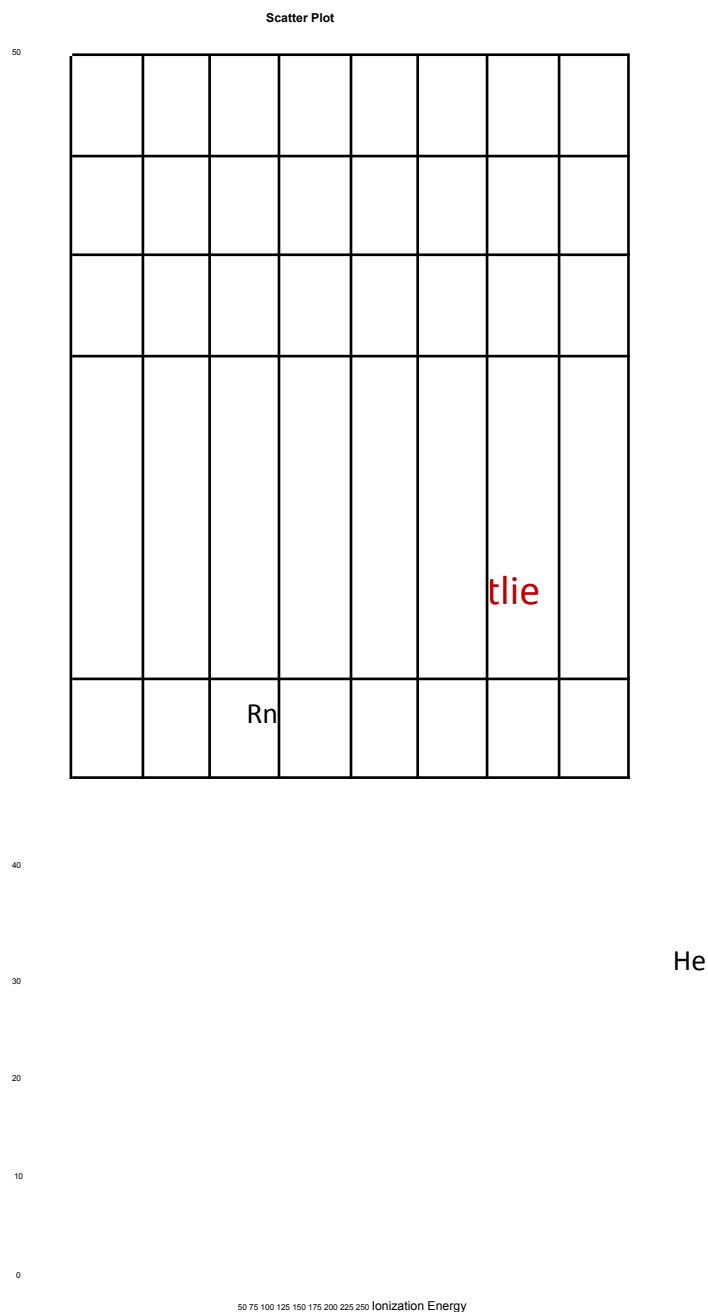
0

50 75 100 125 150 175 200 225 250

Ionization Energy

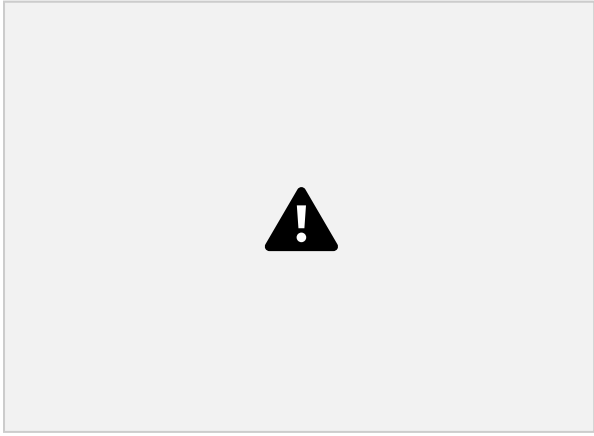
Correlation...What else??



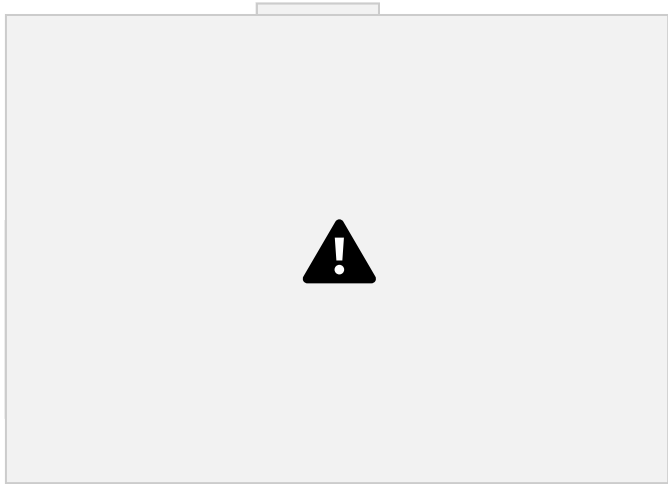


Introduction Visualizations Reveal Structures

- Statistical characterization of datasets is a very powerful approach
 - losing information through summarization hide the true structure of the dataset



Descriptive statistics => Over-simplification



in Details?

ifferent structures

nd/or more complex datasets?

*...make **both** calculations **and** graphs.
Both sorts of output should be studied;
each will contribute to understanding.*

F. J. Anscombe, 1973

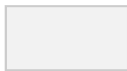
Introduction  Same Stats, Different Graphs

- Generating Datasets with Varied Appearance and Identical Statistics



<https://www.autodeskresearch.com/publications/samestats>

Introduction

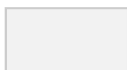


Definition of Visualization

- The use of computer-supported, interactive, visual representations of **abstract** data to amplify **cognition**
 - Stuart Card, Jock Mackinlay, Ben Shneiderman, 1999



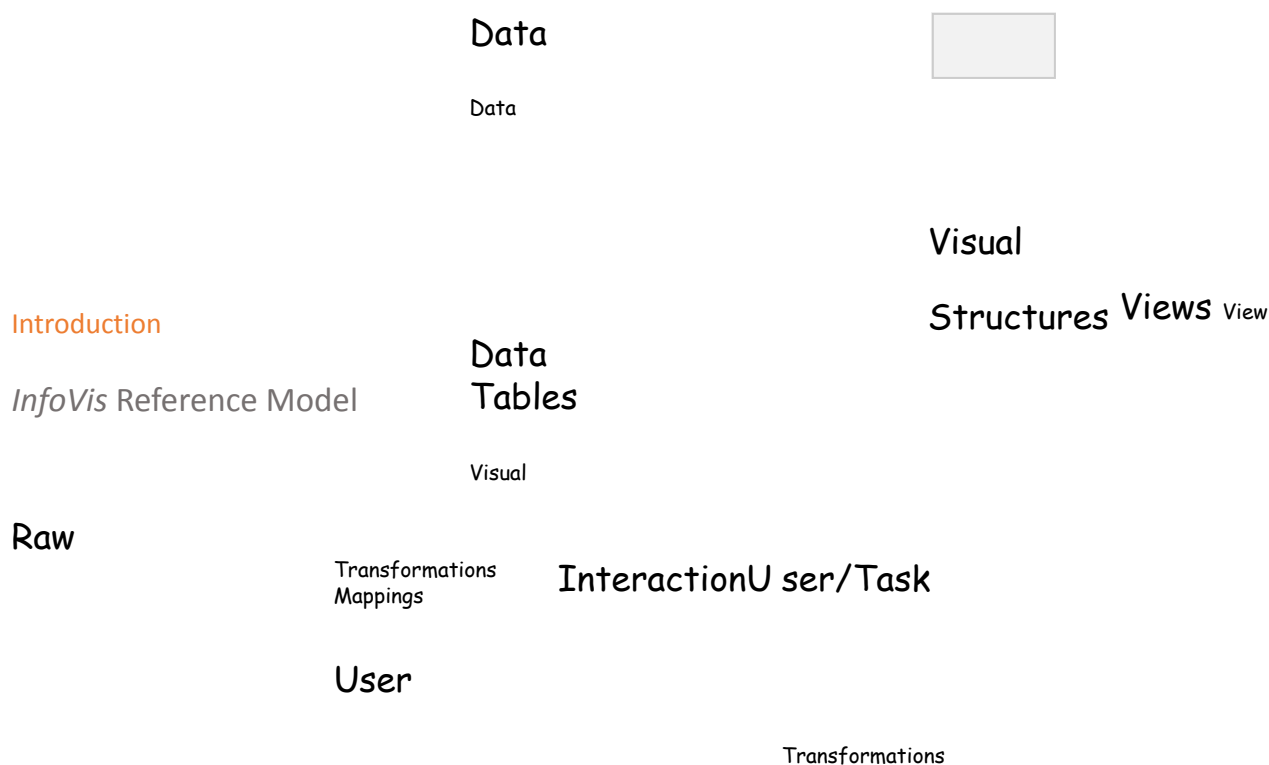
Introduction



Definitions

- The use of computer-supported, interactive, visual representations of **abstract** data to amplify **cognition**
 - Stuart Card, Jock Mackinlay, Ben Shneiderman, 1999

- Finding the *artificial memory* that best supports our natural means of perception
 - Bertin, 1983
- Provide tools that present data in a way to help people understand and gain insight from it



Introduction

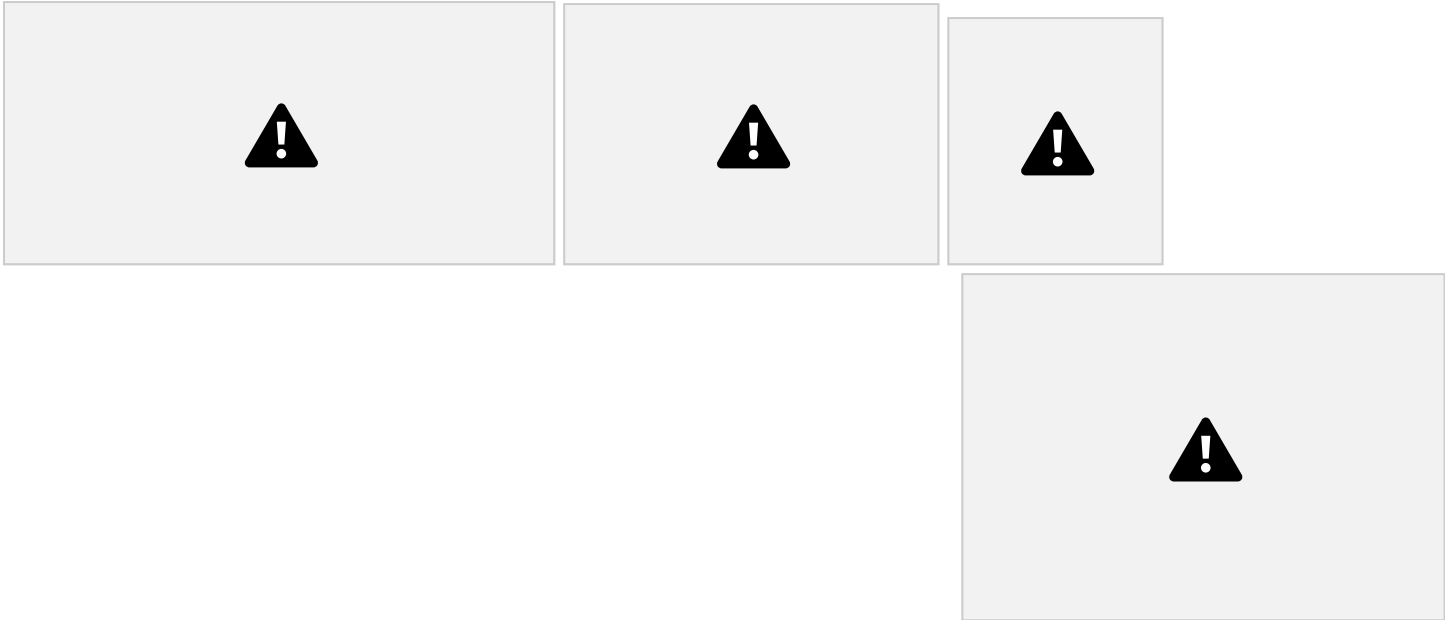
InfoVis is Interdisciplinary

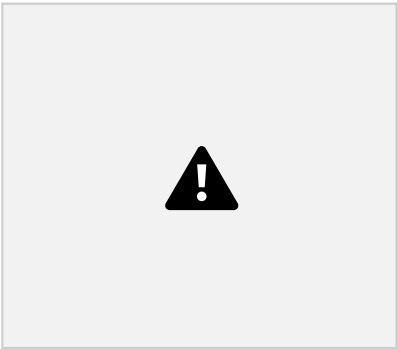
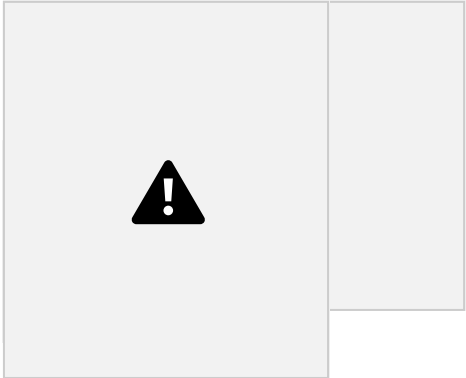
- Graphics: drawing in real time (<100 ms)

- Cognitive psychology: appropriate representation
- HCI: using users and tasks to

Historical Aspect

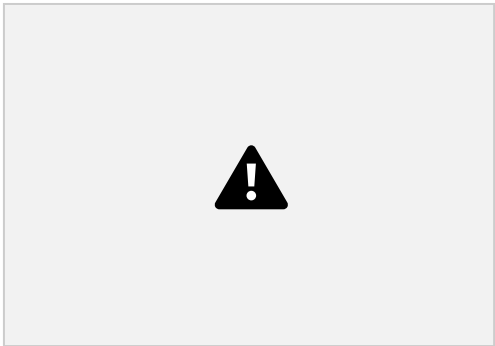
Data Visualizations – Historical Examples





Data Visualizations – Historical Examples

“charts communicated better
than tables of data”

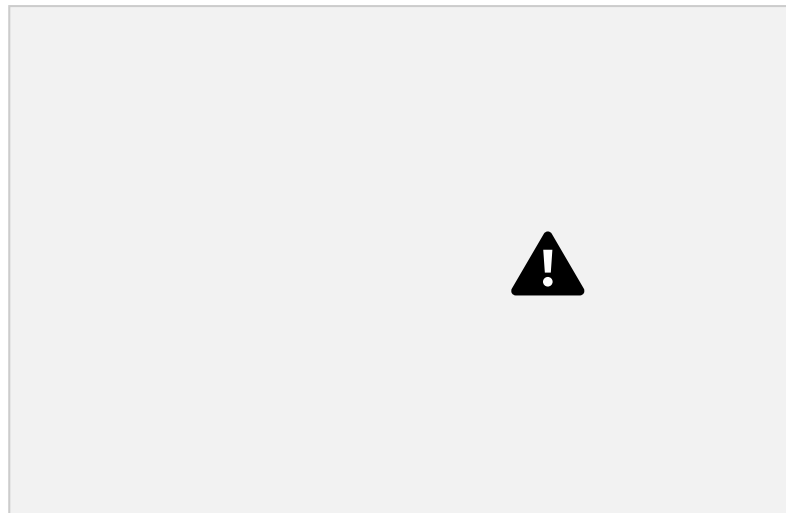


William Playfair (1759~1823)
Scottish civil engineer
Playfair has been credited with inventing
the **line**, **bar**, **area**, and **pie** charts.

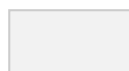
source: https://en.wikipedia.org/wiki/William_Playfair

Historical Aspect

Data Visualizations – Historical Examples



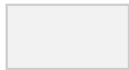
Advance of Napoleon's Grande Armée into Russia in 1812
Charles Joseph Minard, 1861



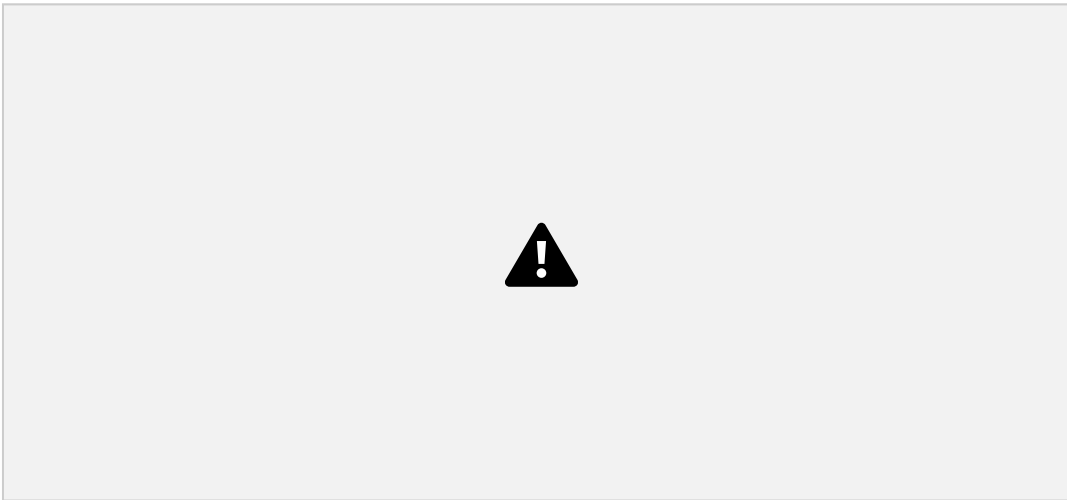
Size of army
Position
Direction of movement
Temperature
Time



Historical Aspect

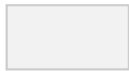


Data Visualizations – Historical Examples



Modern redrawing of Charles Joseph Minard's figurative map of the 1812 French invasion of Russia, including a table of temperatures converting [degrees Réaumur](#) to degrees [Fahrenheit](#) and [Celsius](#).
https://en.wikipedia.org/wiki/Charles_Joseph_Minard

Historical Aspect



1864 Exports of French Wine

Charles Minard
(economic cartographer)

Historical Aspect

1854 London Cholera Epidemic

John Snow

Historical Aspect

Rose-petal diagram



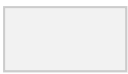
Mortality of British Army



Florence Nightingale's diagram showing the dramatic reduction in death rates in the hospitals of Scutari following the changes she introduced

Source: Nightingale (1858)

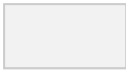
Perception



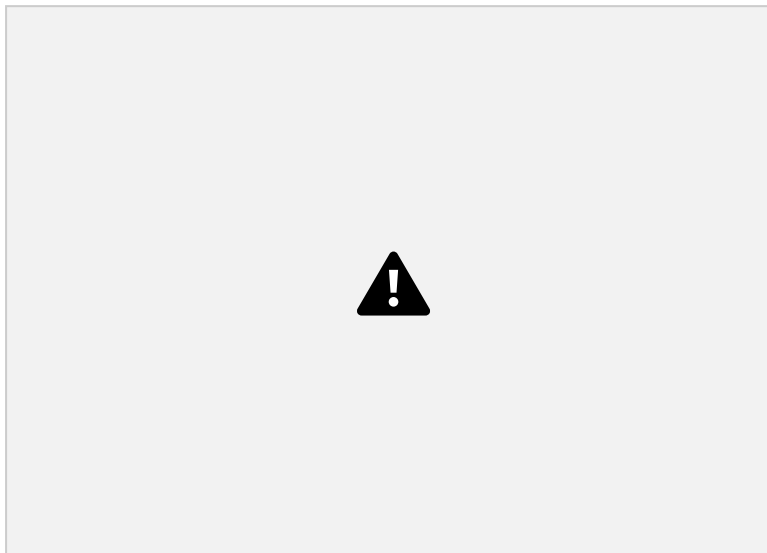
Perception for InfoVis

- Visual Perception
- Visual Encodings of Quantitative Data
- Data Types and Tasks for InfoVis

Perception

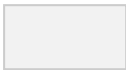


Relative Perception

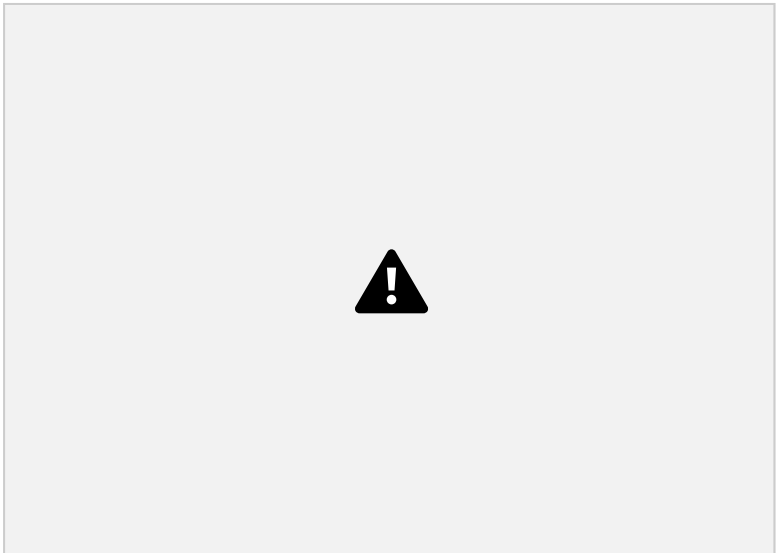


courtesy of John McCann, from Stone 2001 SIGGRAPH course graphics.stanford.edu/courses/cs448b-02-spring/04cdrom.pdf

Perception

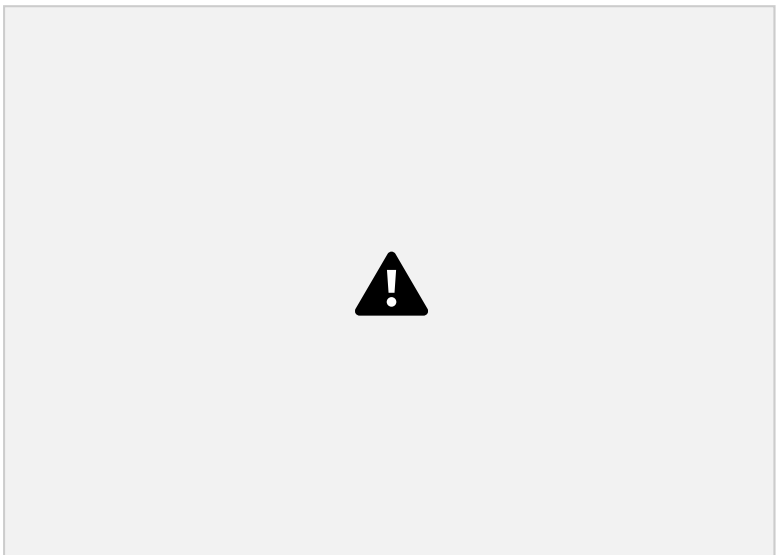


Relative Perception



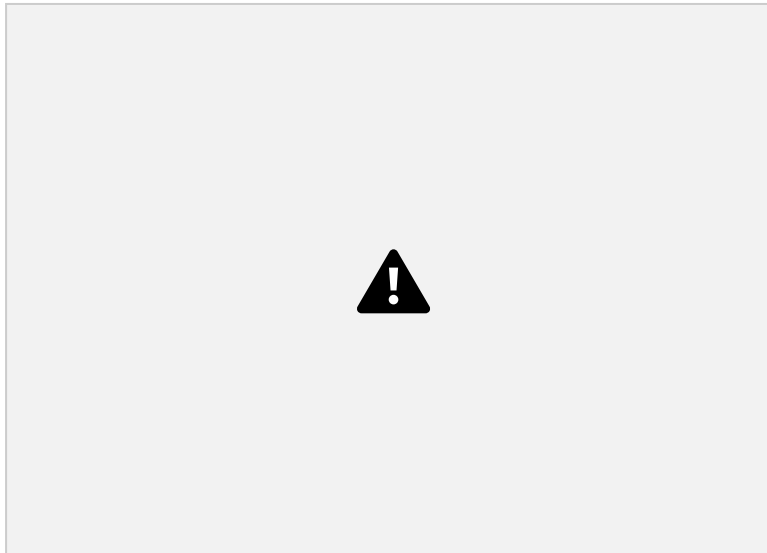
courtesy of John McCann, from Stone 2001 SIGGRAPH course graphics.stanford.edu/courses/cs448b-02-spring/04cdrom.pdf

Perception  Relative Perception



courtesy of John McCann, from Stone 2001 SIGGRAPH course graphics.stanford.edu/courses/cs448b-02-spring/04cdrom.pdf

Perception  Relative Perception

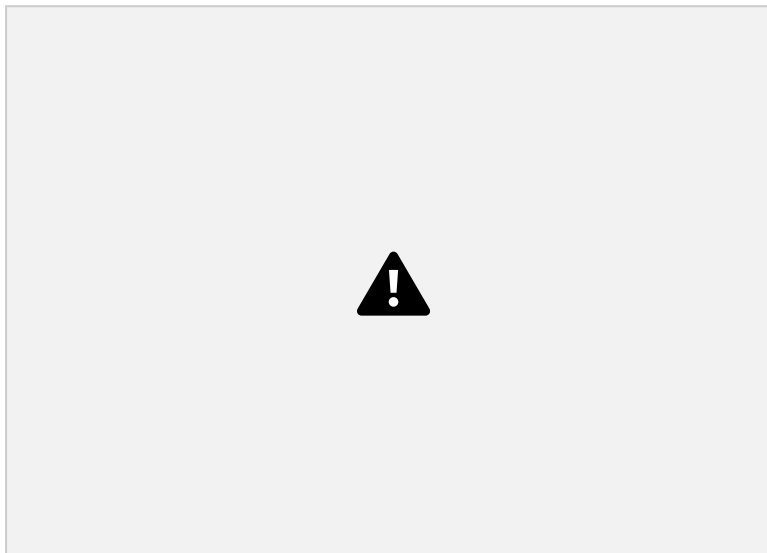


courtesy of John McCann, from Stone 2001 SIGGRAPH course graphics.stanford.edu/courses/cs448b-02-spring/04cdrom.pdf

Perception



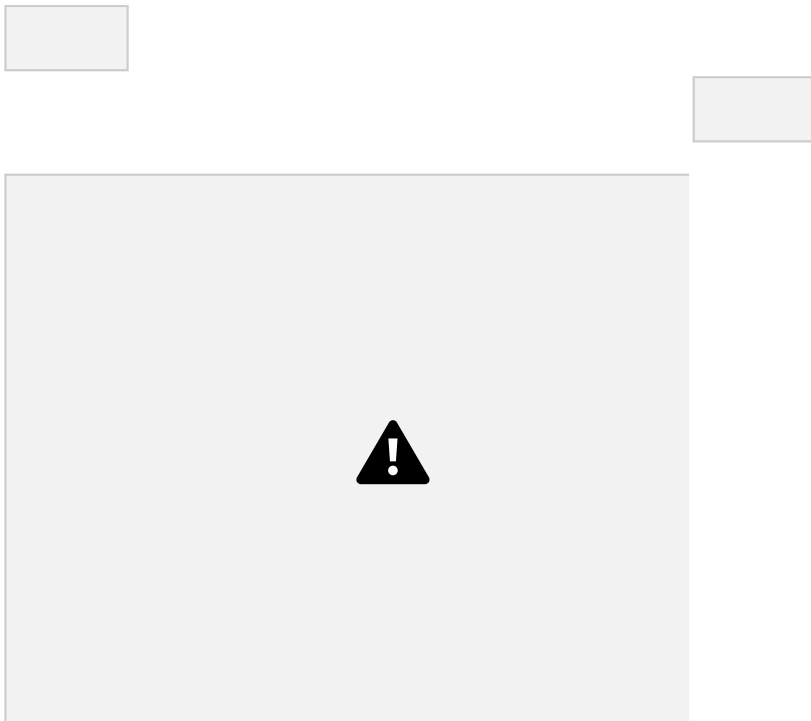
Relative Perception



courtesy of John McCann, from Stone 2001 SIGGRAPH course graphics.stanford.edu/courses/cs448b-02-spring/04cdrom.pdf

Perception

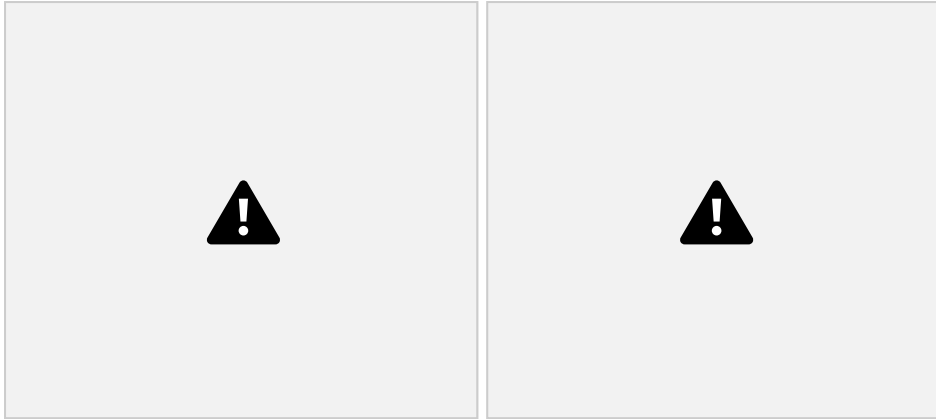
Relative Perception **Perception**



Relative versus Absolute Judgements

- Luminance contrast – Simultaneous Brightness Contrast

- Luminance perception is based on relative judgements

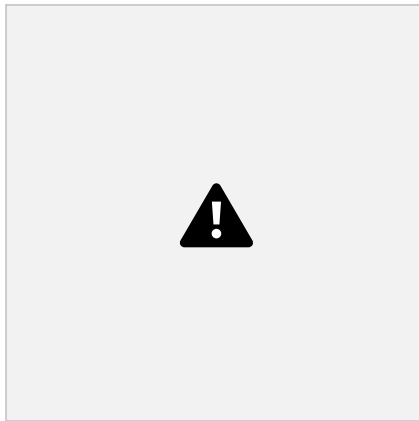


Perception

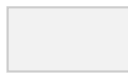


Relative versus Absolute Judgements

- Luminance contrast – Simultaneous Brightness Contrast
- Luminance perception is based on relative judgements



Expressiveness and Effectiveness Principles



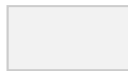
Two criteria for evaluating graphical designs

- **Expressiveness**

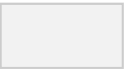
- Vis idiom should express all of, and only, the information in the dataset attributes

- Effectiveness

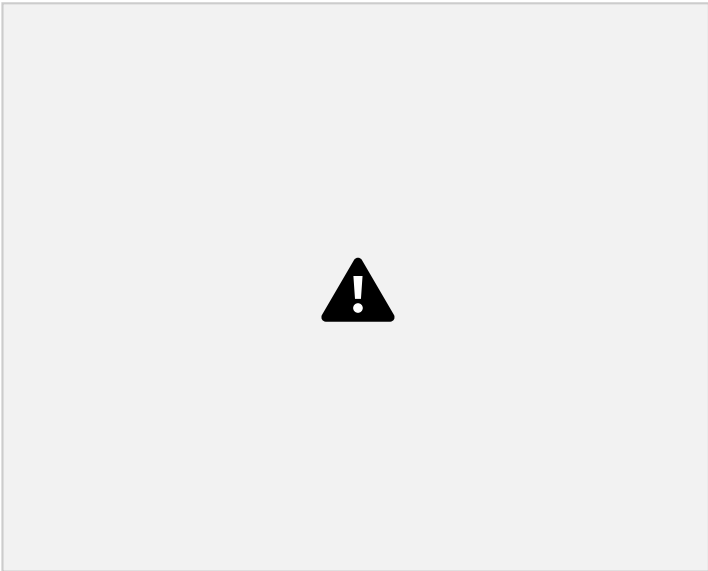
- Most important attributes should be encoded with the most effective channels
ranking of channels



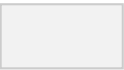
Expressiveness and Effectiveness Principles



Better Expressiveness! More Effective?



Expressiveness and Effectiveness Principles



Two criteria for evaluating graphical designs

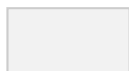
- Expressiveness

- Vis idiom should express all of, and only, the information in the dataset attributes

- Effectiveness

- Most important attributes should be encoded with the most effective channels
ranking of channels

Expressiveness and Effectiveness

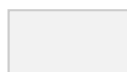


1D, 2D, 3D

- size ratio for each pair 1:4

INTERACTIVE DATA VISUALIZATION: FOUNDATIONS, TECHNIQUES, AND APPLICATIONS, Matthew O. Ward; Georges Grinstein; Daniel Keim, A K Peters Ltd (July 1, 2010)

Expressiveness and Effectiveness



Steven's Power Law

- p : perceived magnitude
- a : actual magnitude



- $p = ka^\alpha$

- $p_1/p_2 = (a_1/a_2)^\alpha$

- length judgment: $\alpha \approx 1$

- area judgment: $\alpha < 1$

- volume judgment: $\alpha \ll 1$

http://en.wikipedia.org/wiki/Stevens'_power_law



Accuracy of
Quantitative
Perceptual
Tasks

Cleveland & McGill 1984

Visual Encoding

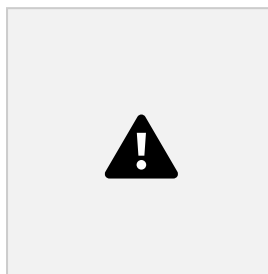
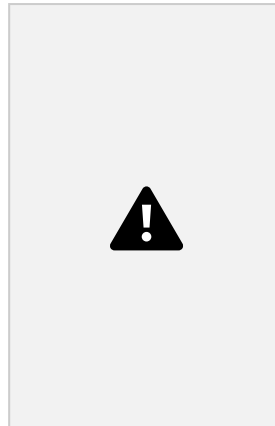
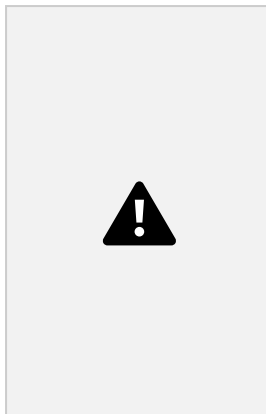
Visual
Encoding
(Effectiveness)
Principles

- Channel Ranking
Varies by Data Type



Introduction  Which representation is best?

- Depends heavily on task

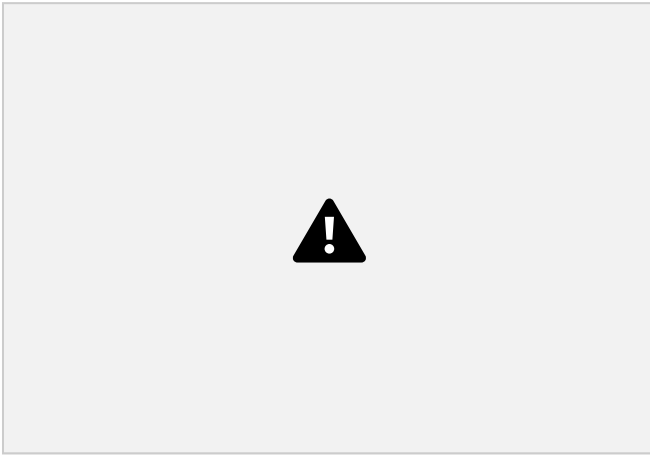


What is precise value?

How does the performance

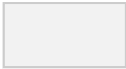
now compared to its peak? How does performance change over time?

Introduction How many buffalo?

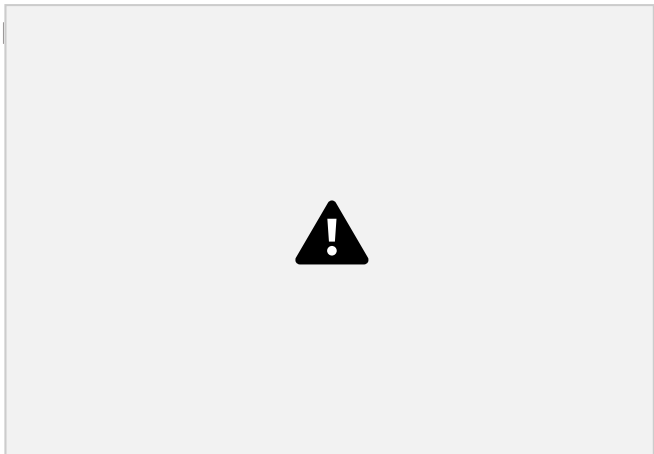


Buffalo

Buffalo



Introduction



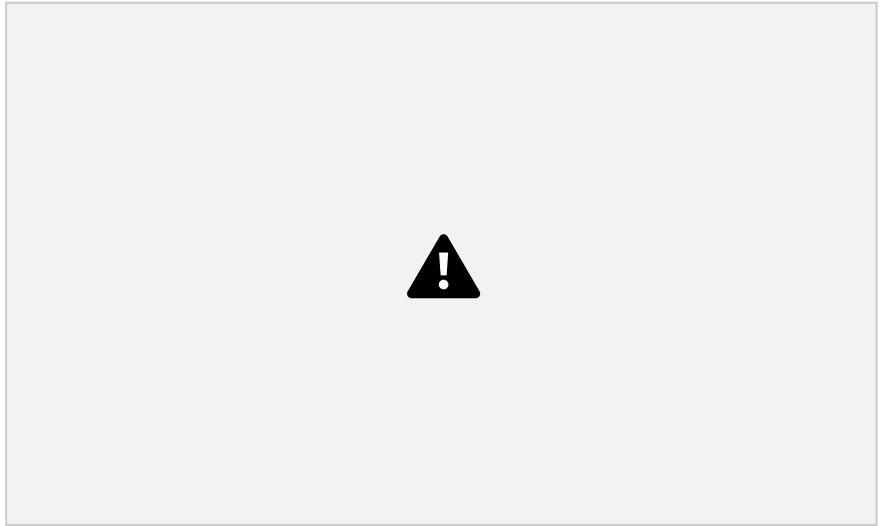
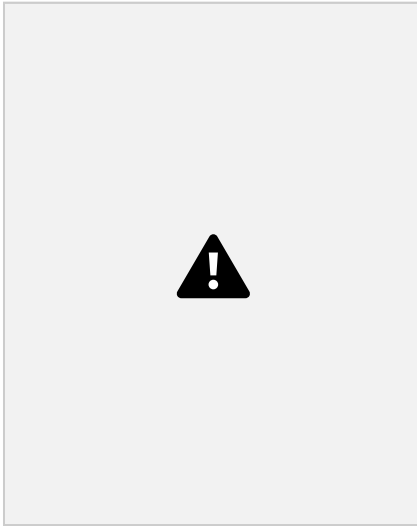
#



Adults # calfs

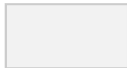
8 4
Adults # calfs

Introduction Am I wasting my HDD space??

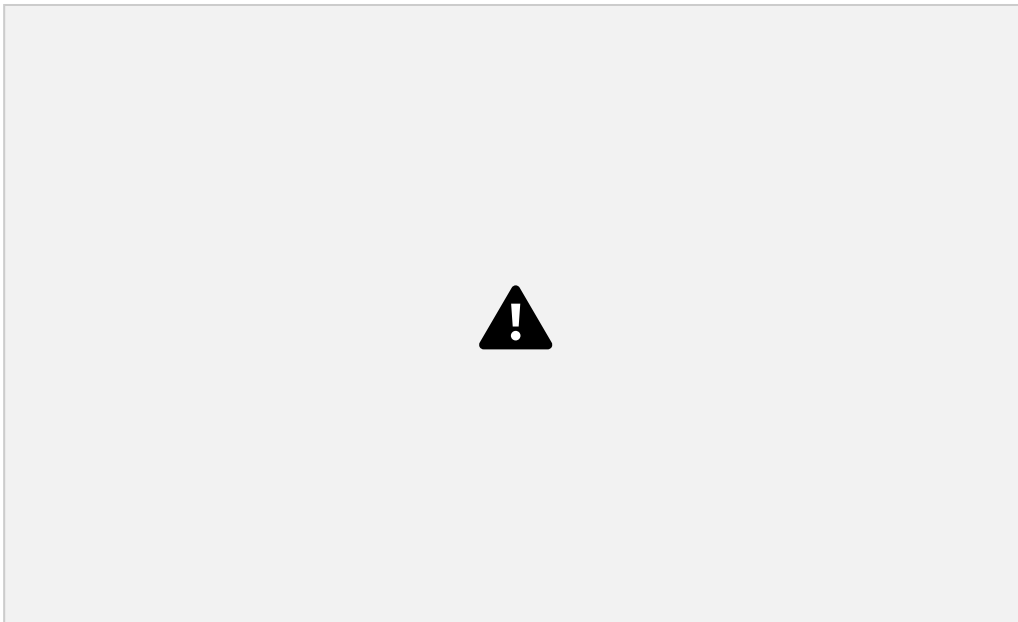


http://w3.win.tue.nl/onderzoek/onderzoek_informatica/visualization/sequoiaview/

Introduction

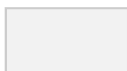


Treemap for Hierarchical Data

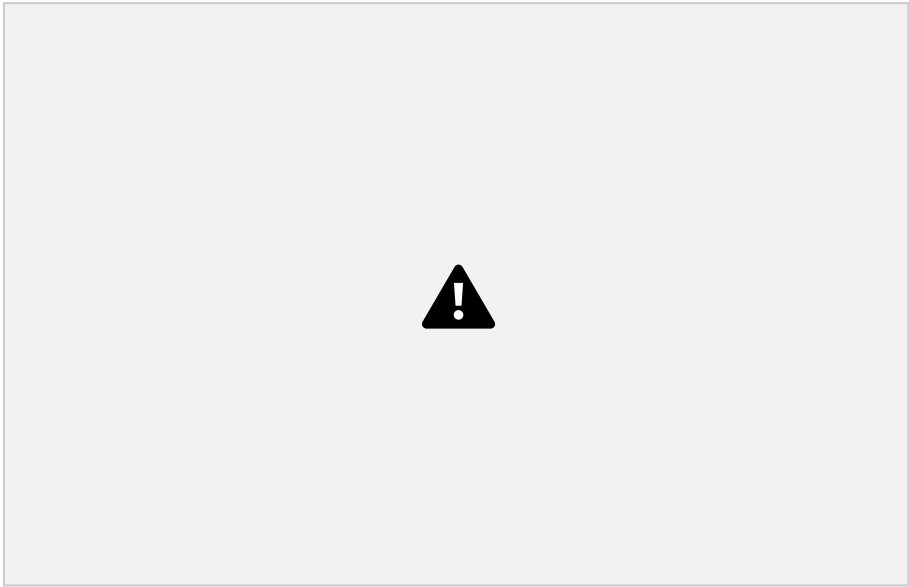


<https://finviz.com/map.ashx>

Introduction

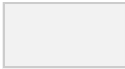


Difference??

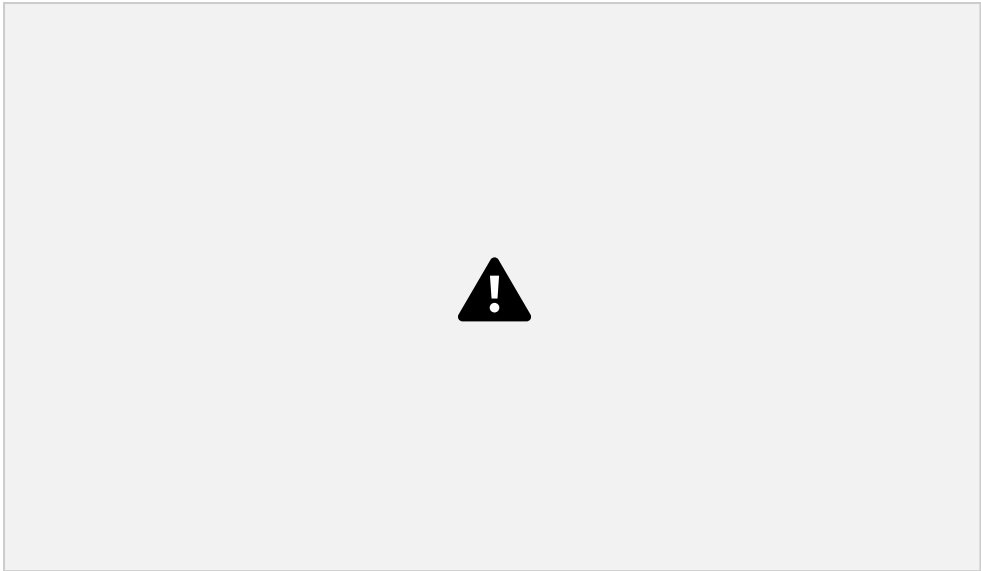


Graphical Perception: Theory, Experimentation and the Application to the Development of Graphical Models. William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531-554, 1984.

Introduction

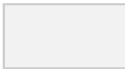


Difference??

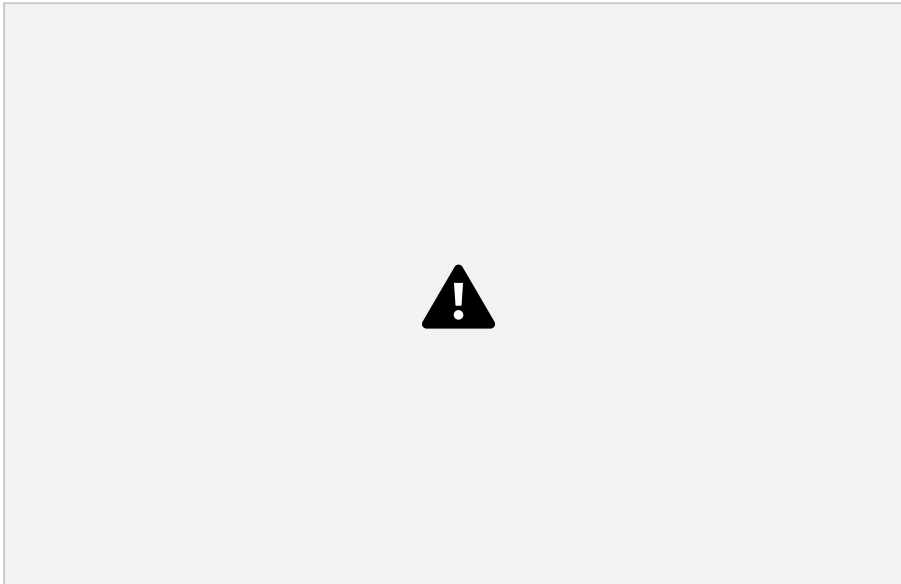


Graphical Perception: Theory, Experimentation and the Application to the Development of Graphical Models. William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531-554, 1984.

Introduction

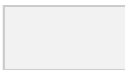


Difference??

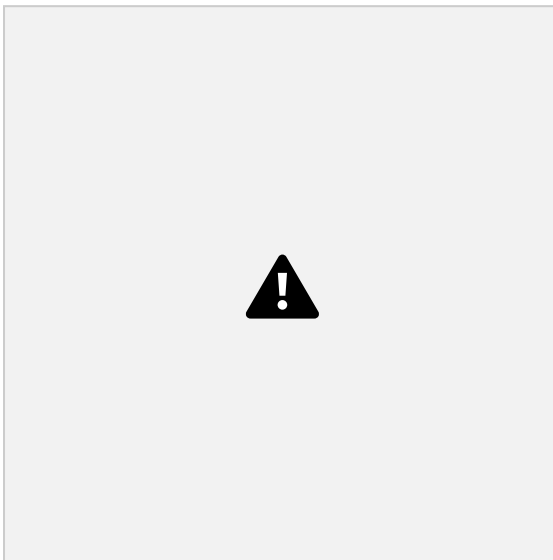


Graphical Perception: Theory, Experimentation and the Application to the Development of Graphical Models. William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531-554, 1984.

Introduction

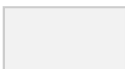


Which is Longer?



Graphical Perception: Theory, Experimentation and the Application to the Development of Graphical Models. William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531-554, 1984.

Introduction



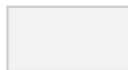
Weber's Law



Graphical Perception:

Theory, Experimentation and the Application to the Development of Graphical Models. William S. Cleveland, Robert McGill, J. Am. Stat. Assoc. 79:387, pp. 531-554, 1984.

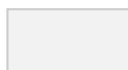
Preattentive Processing



Preattentive Processing

- Cognitive operations done preattentively, without the need for focused attention
 - less than 200-250 ms
 - eye movements take 200 ms
 - minimum time to initiate eye movement
 - involves only information available in a single glance
- Popout effects
- Segmentation effects

Preattentive Processing



Preattentive tasks

- visual features that are detected very rapidly by low-level, fast-acting visual processes
- seems to precede focused attention

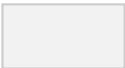
- occurring within a single fixation
- attention plays a critical role in what we see in this early stage

- “pop out” of a display

- easily detected *regardless of the number of distractors*
- vs. time-consuming visual search

Christopher G. Healey, James T. Enns: Attention and Visual Memory in Visualization and Computer Graphics. IEEE Trans. Vis. Comput. Graph. 18(7): 1170-1188

(2012)

Preattentive Processing  How many sevens?

2398419309213985874506209348952034809502
 3984210293841909238740129384610329849238
 4265293845013945594858601239480234958728
 4596394058640598239485802394895029348658
 4561024596234851604569828309458673049561
 3045916459086130495298646658956405196809
 5866304598683049561835601830459680345907
 6283486510465183560241620945613045618304
 5968230459630459860395620349568204385362

Slide Idea from Colin Ware

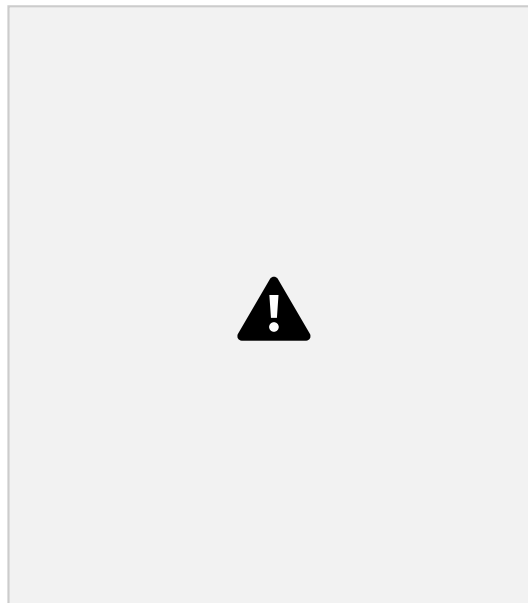
Preattentive Processing  Color Makes Them Pop Out

23984193092139858**7**4506209348952034809502
 3984210293841909238**7**40129384610329849238
 4265293845013945594858601239480234958**7**28

4596394058640598239485802394895029348658
4561024596234851604569828309458673049561
3045916459086130495298646658956405196809
5866304598683049561835601830459680345907
6283486510465183560241620945613045618304
5968230459630459860395620349568204385362

Slide Idea from Colin Ware

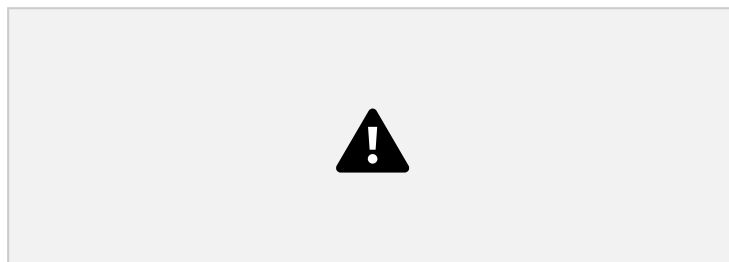
Preattentive Processing Example



<https://www.csc2.ncsu.edu/faculty/healey/PP/>

Preattentive Processing What Kinds of Tasks?

- Target detection
 - Is something there?
- Segmentation (Boundary detection)
 - Can the elements be grouped?
- Region tracking



- Can a distinctive moving group be traced?

- Counting

- How many elements of a certain type are present?

Jinwook Seo / John Stasko

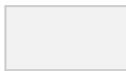
Preattentive Processing



Surrounded colors do not pop out

Colin Ware

Preattentive Processing



Laws of Preattentive display

- Must stand out on some simple dimension
 - color,
 - simple shape = orientation, size
 - motion,
 - depth
- Lessons for highlighting – one of each

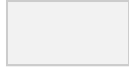
Design Principles  • Shneiderman's Guidelines • Tufte's Design Principles • The

Feynman-Tufte Principle

Design Principles  Design Guidelines / Principles

- Visual presentation of query components
- Visual presentation of results
- Rapid, incremental and reversible actions
- Immediate and continuous feedback
- Selection by pointing (not typing)
- Reduces errors
- Encourages exploration
- Visual Information Seeking Mantra
 - Overview first, zoom and filter, details on demand

Design Principles



Tufte's Design Principles

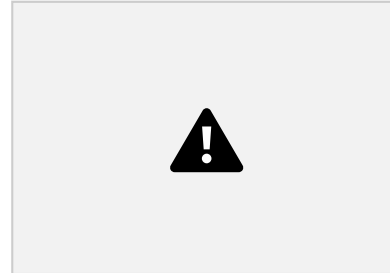
- Tell the truth
 - Graphical integrity
- Do it effectively with clarity, precision...
 - Design principles/aesthetics
- “simple design, intense content”
 - The Feynman-Tufte Principle, April 2005 *Scientific American*

E. Tufte, *The Visual Display of Quantitative Information* (1983)

E. Tufte, *Envisioning Information* (1990)

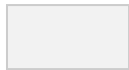
E. Tufte, *Visual Explanations* (1997)

E. Tufte, *Beautiful Evidence* (2006)



Jinwook Seo / John Stasko

Design Principles



Measuring Misrepresentation

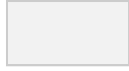
- Visual attribute value should be directly proportional to data attribute value
- Height/width vs. area vs. volume



Lie factor =
$$\frac{\text{Size of effect shown in graphic}}{\text{Size of effect in data}}$$

“Lie factor” = 2.8

John Stasko



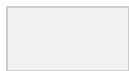
- Maximize data-ink ratio

Data ink

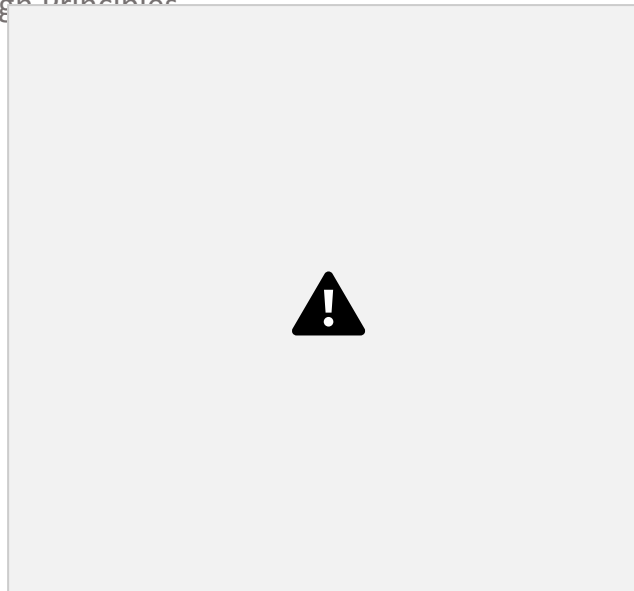
Total ink used in graphic Data-ink ratio =

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

John Stasko



- Avoid chartjunk
 - Extraneous visual
that detract from



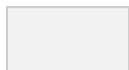
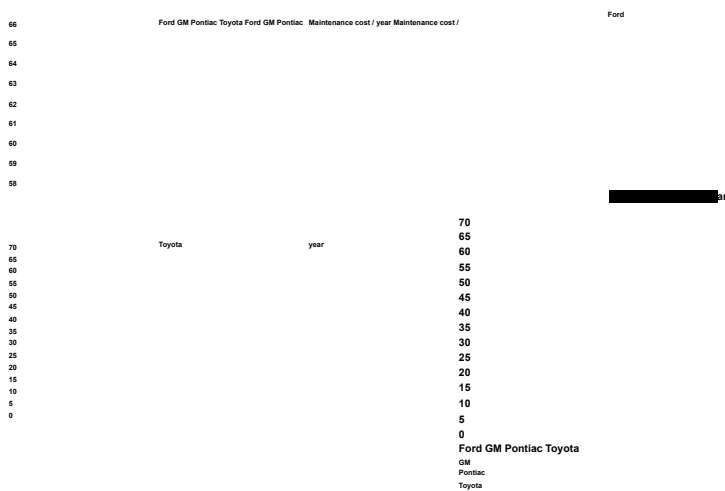
elements
information

<http://nigelholmes.com/>

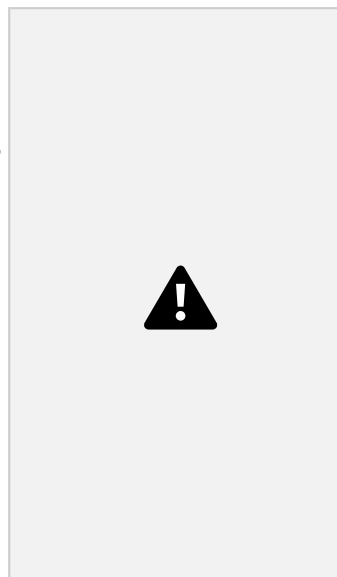
John Stasko



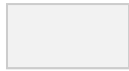
- All visual elements in charts and graphs that are not necessary to comprehend the information represented on the graph, or that distract the viewer from this information



- **Use Small multiples**
 - Repeat visually similar graphical elements nearby rather than spreading far apart
 - The same graphical design structure is repeated
 - Learn once and compare
 - invite comparisons
 - Reveal, all at once, a scope of alternatives, a range of options
 - overview



Design Principles



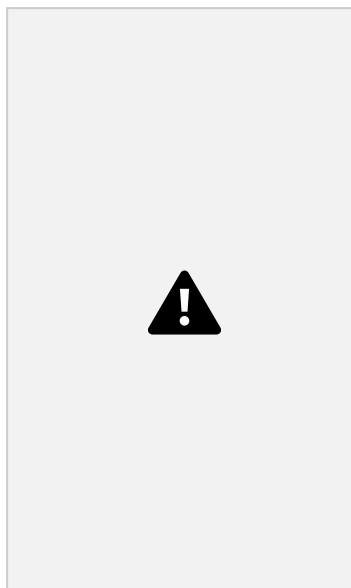
Design Principles

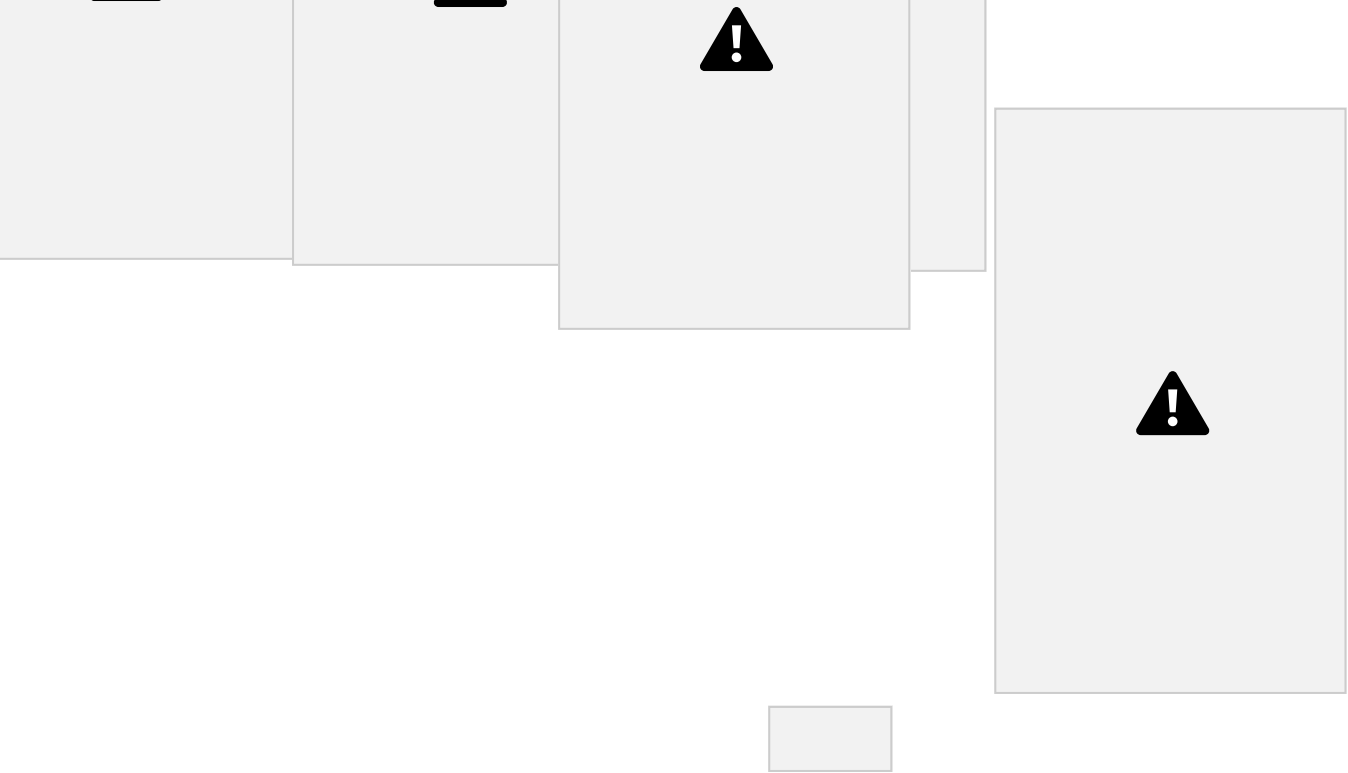
- Utilize narratives of space and time
 - Tell a story of position and chronology through visual elements

Design Principles

Design Principles

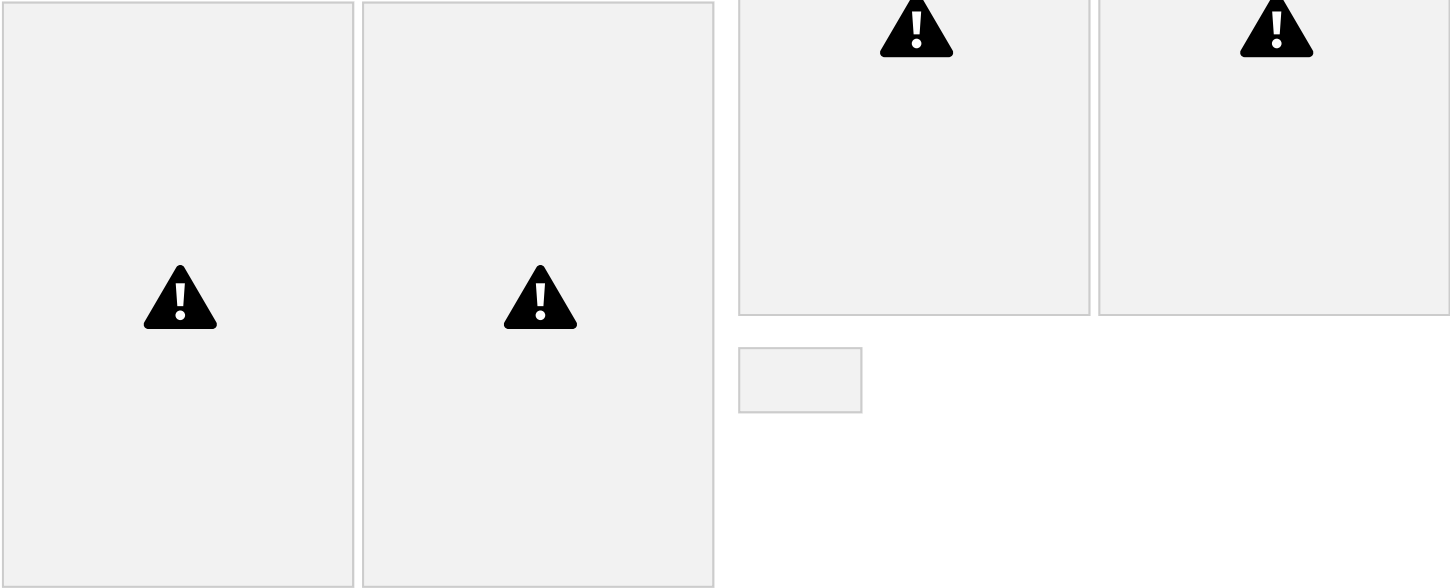
- Utilize narratives of space and time
- Tell a story of position and chronology through visual elements





Design Principles

Design Principles - Utilize narratives of space and time



Design Principles  Power of Negative space



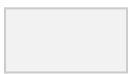
Design Principles  Power of Negative space

Design Principles

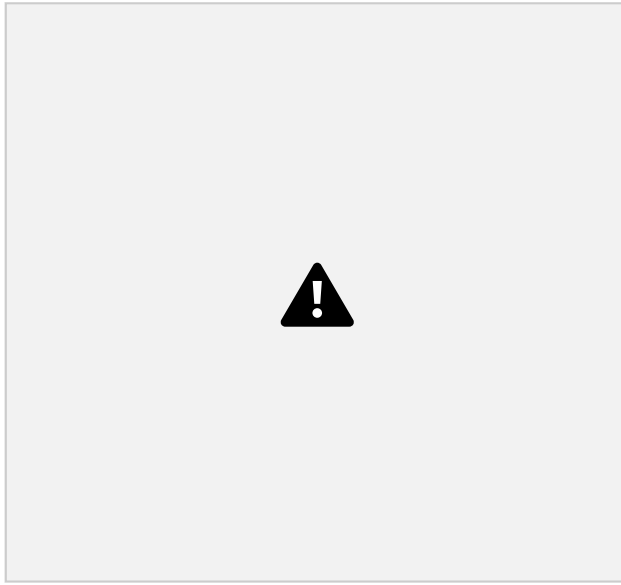


Power of Negative space

Note



Questions?



- <http://hcil.snu.ac.kr/>