Data Visualization & Tools

2024/8/27

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LIBRARIES & CULTURAL SERVICES

Slides at https://brosz.ca/slides

Plan

- What is & why do we visualize data?
- Data visualization theory & tips
  - Chart types
  - Visual variables
- Data Vis Exercise
- Data visualization tools

Visualization Studio

TFDL 466B

Display Wall

- 34.5 million pixels
- Compare that to HD (2.07 million) or even 4K (8.3 million)
- 16’ (4.9m) wide and 6’ (1.8m) tall

Space to support research & learning

- Free to book by faculty & grad students

Uses:

Analysis

Presentation

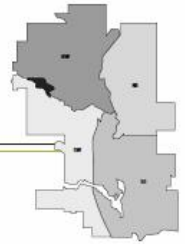
Teaching

Events

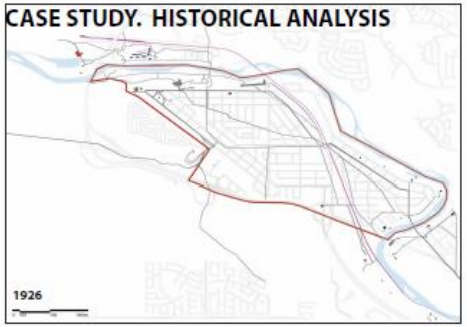
https://library.ucalgary.ca/visualization

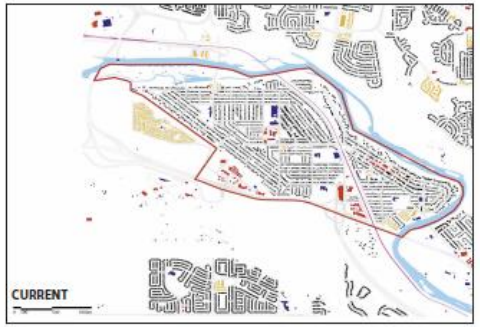
HISTORICAL TIMELINE

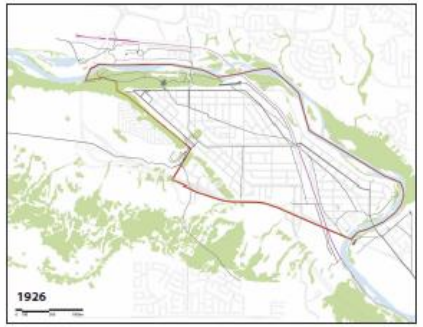
1787: explorer D. Thompson is the first to describe the Douglas Fir Trail
1887: Cattle ranching on Bow Island (now Bowness Park)
1885: construction of CPR twin bridges
1890: T. Stone establishes Bowness Ranche
1890: T.Stone gives Bowness its name and builds the house
1908: John Hextall buys Bowness Ranch
1911: Hextall Bridge built and made public along with two river islands
1912-1913: Lagoon of Bowness Park built; Street car established in Bowness
1916: Bowness Park redevelopment
Hextall brings electric light, water and gas to Bowness;
Bowness Golf and Country Club and Tregillus Clay Products Plant built
1919: Bowness Ranche used as a Baker Memorial Sanatorium
1919: 1750 trees and grass planted at Baker Memorial Sanatorium (today Baker Park)
1942: Anne and Lindsay French establish mink farm operations
1946: Soldiers Settlement area ashtablished
1948: Bowness incorporated as a village
1950: April 12 – last streetcar to Bowness Park
1952: Bowness incorporated as a town
1953: construction of Bearspaw Dam to control flooding
1964: August 15 – Bowness becomes part of Calgary
1975: Hextall mansion demolished
1979: closing of the sanatorium
1988: Winter Olympics
1997: the Golf Clubhouse destroyed by fire
2012-2015: re-development of Bowness Park



CASE STUDY. HISTORICAL ANALYSIS

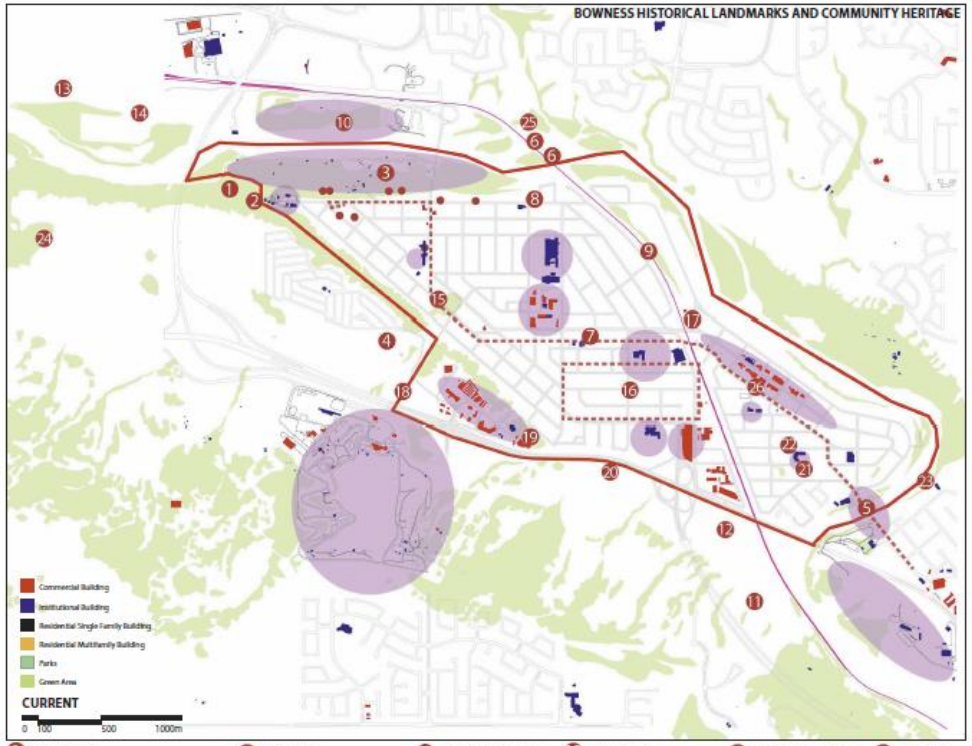






HISTORICAL EVOLUTION OF BOWNESS. FIGURE GROUND AND GREEN/NATURAL COVER

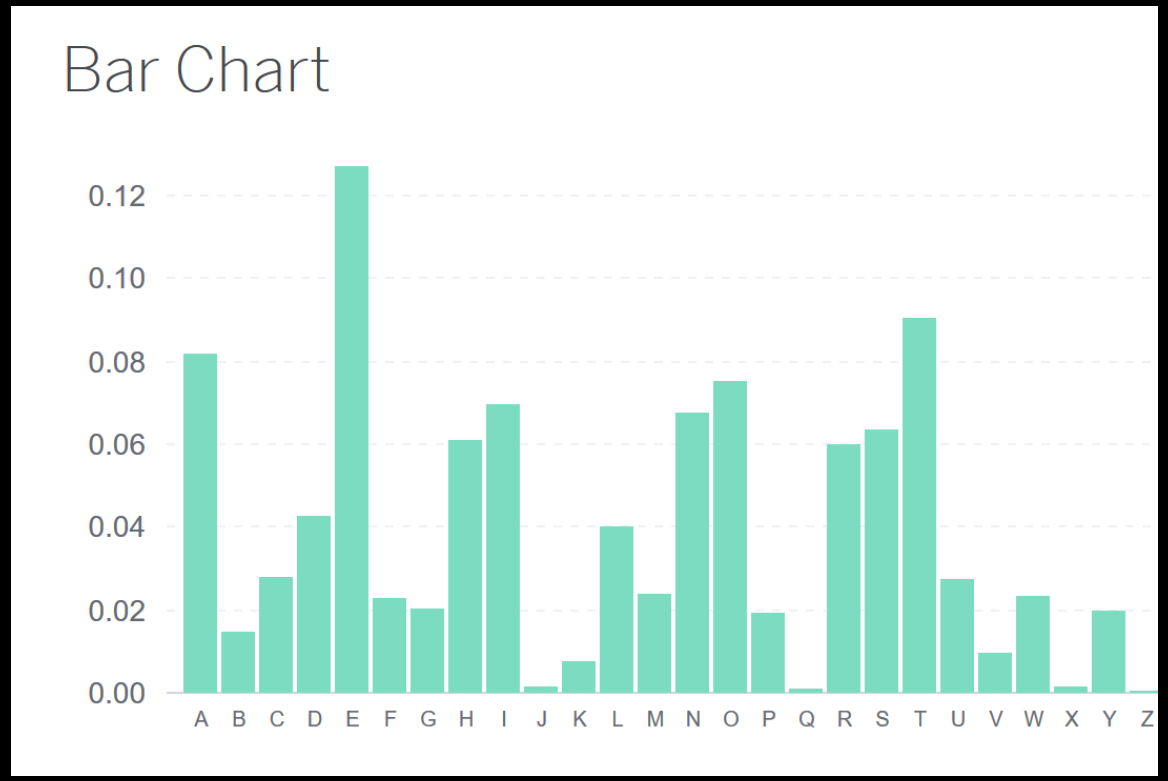
BOWNESS HISTORICAL LANDMARKS AND COMMUNITY HERITAGE

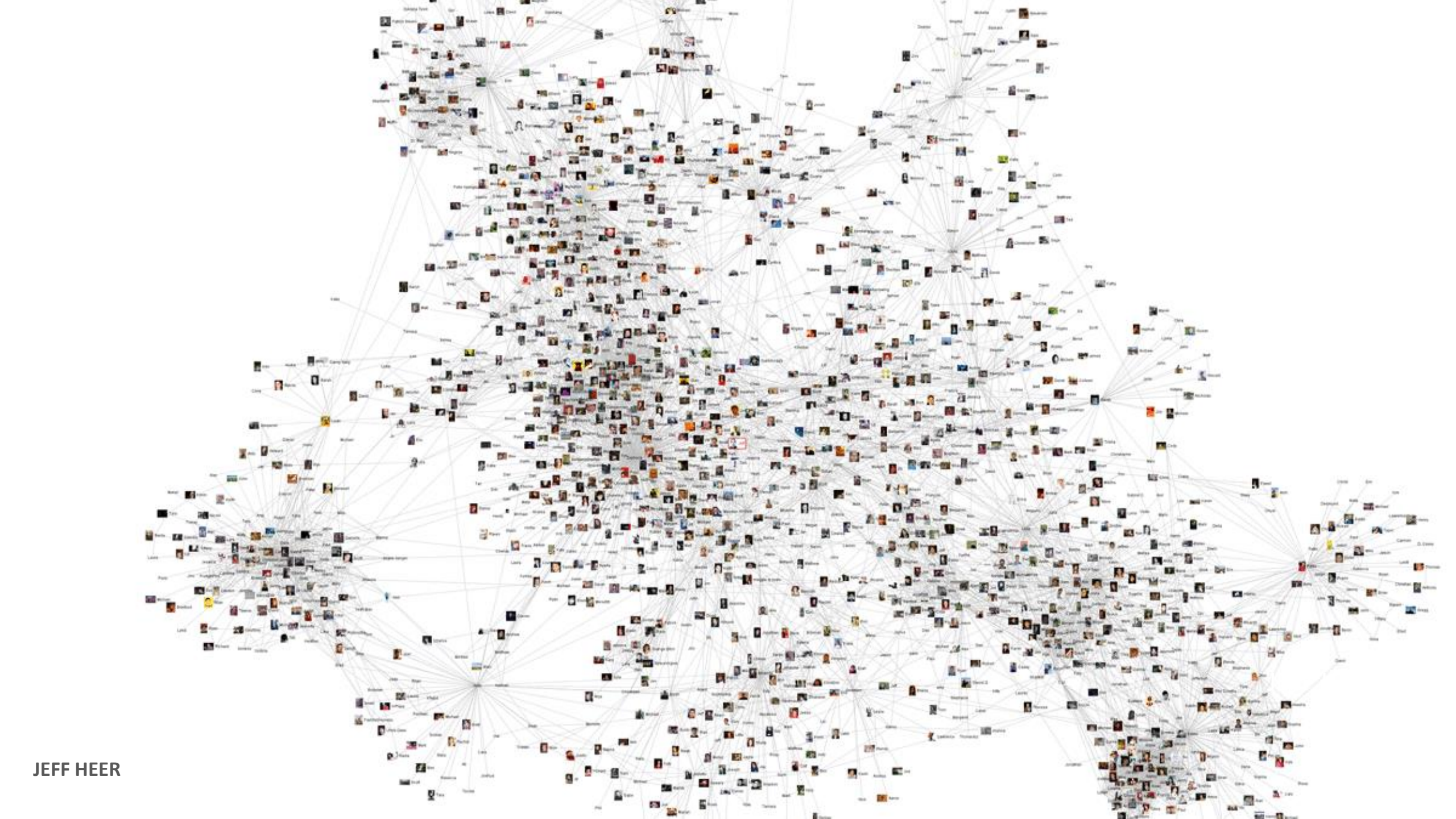


1. Douglas Fir Trail
2. Hextall Mansion/ Woods Christian Home
Woods Home Mental Health and Child Welfare Services
3. site of Bowness Ranch/ Hextall Estates
Bowness Park
4. Bowness Golf and Country Club
Greenwood Village Mobile Home Community
5. **Hextall Bridge**
6. **Twinn Bridges**
7. route of Bowness Street Railway Line
8. site of Bowness Flying Field
9. **Canadian Pacific Railway**
10. Bowness Ranch/ Baker Sanatorium
Baker Park
11. Tregillus Clay Products Plant
12. Wilson Gardens
13. site of the Keith Siding
14. Alberta Ice Company Plant
Al Azhar Shrine Centre
15. Milk Siding
85 Street Nw
16. Veterans Land Act
17. **Canadian Pacific Rail Underpass**
18. site of Zimmer Farm
19. site of Ingewersen Farm
20. site of Ainsworth Farm
21. site of Johnstone Mink Farm
22. Viscount Bennett School
R B Bennett School
23. site of Shouldice House
24. Happy Valley Park
Valley Ridge Golf Course
25. site of Robertson Station (Baker Sanatorium)
26. Rex Theatre
- **Heritage Homes**

What Is Data Visualization?

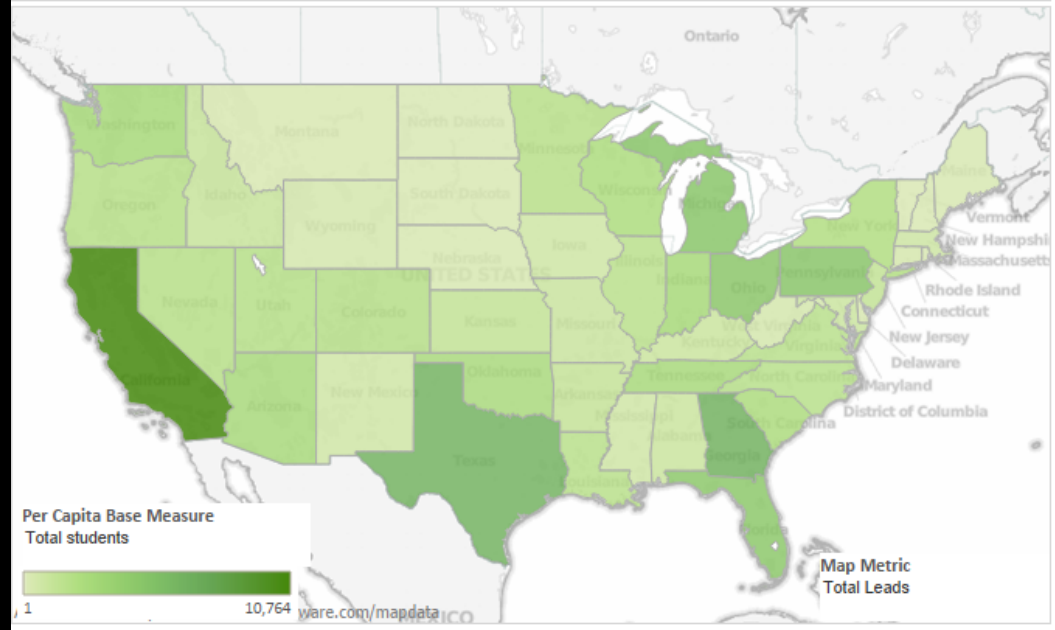
MORE THAN JUST MAKING CHARTS OR PRETTY PICTURES



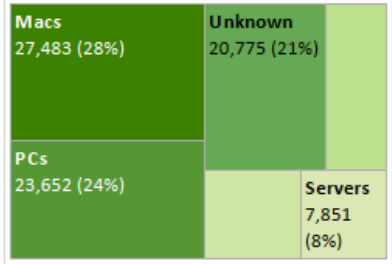


JEFF HEER

Leads by State

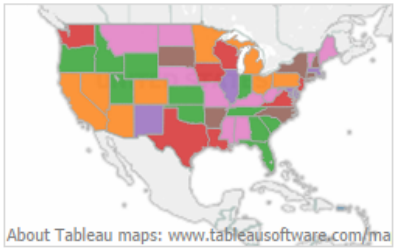


Product Area



Show Classifications Of

State Type



About Tableau maps: www.tableausoftware.com/ma

Response Time

Response Time	Convert %	Leads	Converted
< 2 Hrs	6.46%	5,310	343
< 1 Day	4.67%	9,556	446
Later	3.89%	84,134	3,270

Summary

Lead Gen Budget	$3,226,785
Leads	99,000
Budget per Lead	$32.59
Converted	4,059
Budget per Conversion	$794.97
Convert %	4.10%

Lead Volume Change

	Leads		WoW Change		YoY Change	
	2012	2013	2012	2013	2012	2013
1	4,475	1,933				-57%
2	3,249	1,645	-27%	-15%		-49%
3	1,714	2,035	-47%	24%		19%
4	1,322	4,854	-23%	139%		267%
5	1,476	2,743	12%	-43%		86%
6	5,300	2,643	259%	-4%		-50%
7	3,624	2,420	-32%	-8%		-33%
8	360	1,888	-90%	-22%		424%
9		1,051	-100%	-44%		
10		1,113		6%		
11	1,196	2,639		137%		121%
12	4,418	2,345	269%	-11%		-47%
13	3,990	2,904	-10%	24%		-27%
14	1,155	2,358	-71%	-19%		104%
15		1,809	-100%	-23%		
16		1,086		-40%		
17		1,193		10%		
18		2,941		147%		
19		2,889		-2%		
20		2,616		-9%		
21		3,358		28%		
22		2,554		-24%		
23		1,188		-53%		
24		1,326		12%		
25		2,515		90%		
26		2,411		-4%		
27		2,166		-10%		
28		2,494		15%		
29		1,742		-30%		

Filters

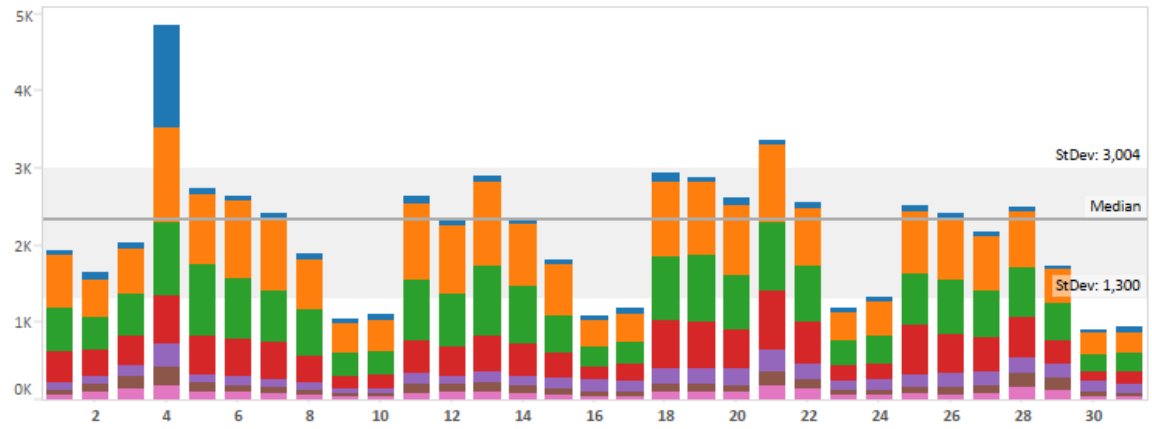
Region

State Type

Lead Source
All

Generated By
All

Breakdown Lead By Day



Measure: Lead

Date Interval: Day

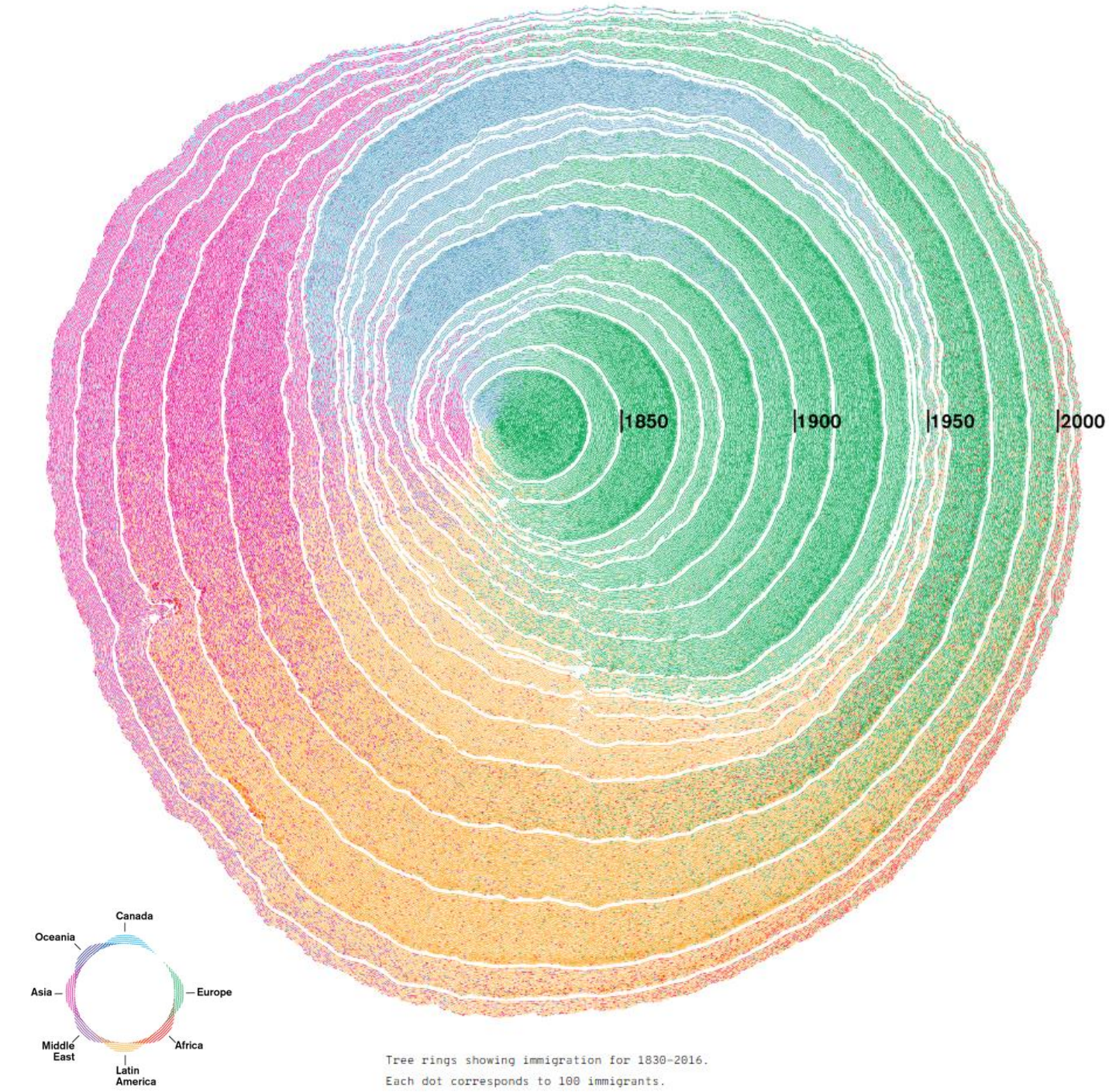
Color By: State Type

- Unspecified
- Type A
- Type B
- Type C
- Type D
- Type E
- Type F

tableau

US Immigration Data

https://web.northeastern.edu/naturalizing-immigration-dataviz/



What is Data Visualization?

Visual representation of data

"Transformation of the symbolic into the geometric" [McCormick et al, 1987]

"… artificial memory that best supports our natural means of perception" [Bertin, 1967]

"Use of computer-generated, interactive, visual representations of data to amplify cognition" [Card, Mackinlay, & Shneidermann, 1999]

Why Data Visualization?

"The ability to take data –

to be able to **understand** it,
to **visualize** it,
to **communicate** it –

that's going to be a hugely important skill in the next decades,

… because now we really do have essentially free and ubiquitous data.

So the complimentary **scarce factor is the ability to understand** the data and extract value from it."

Hal Varian, Google's Chief Economist
The McKinsey Quarterly, Jan 2009

Information transmission rates of the senses vs processing rates by concious mind

~Bits per second

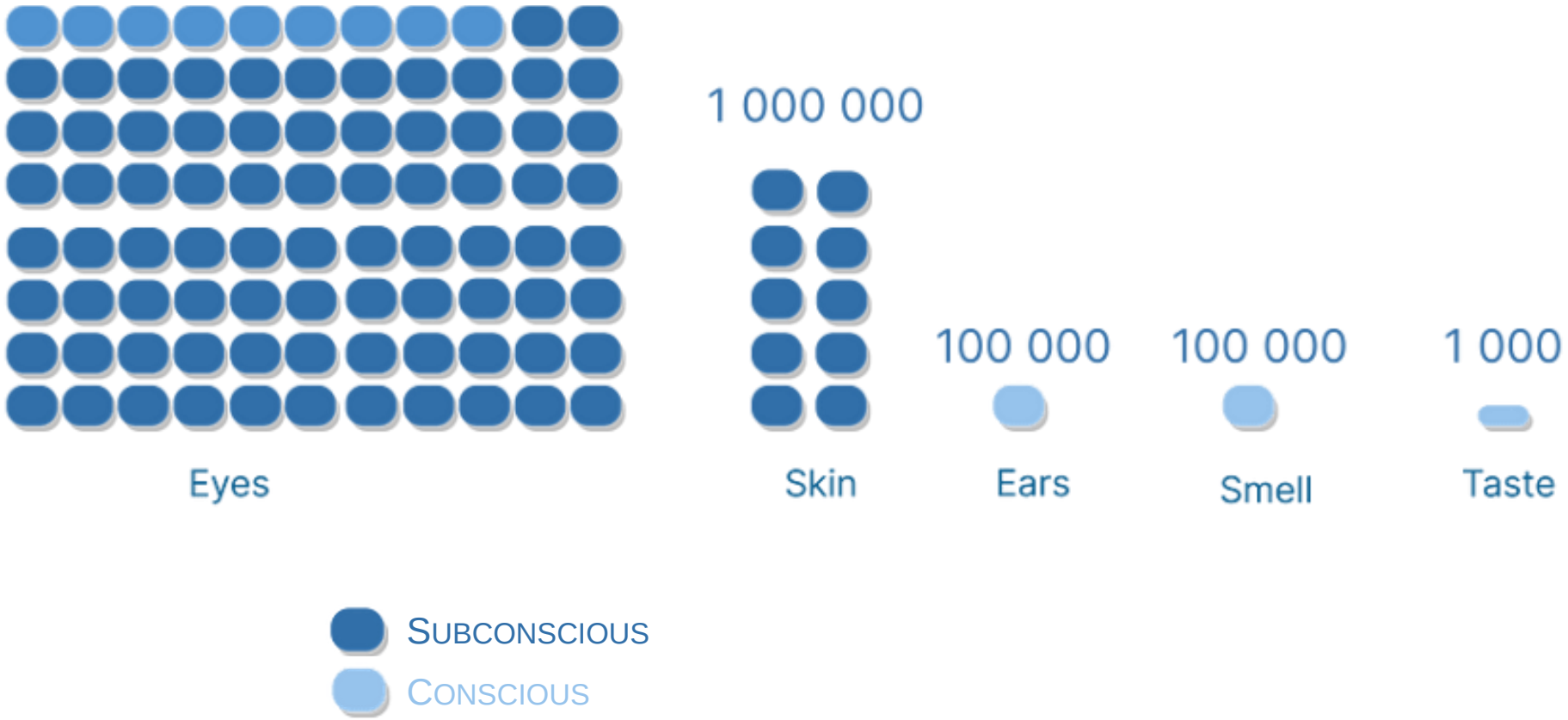


Diagram from https://nightingaledvs.com/dashboards-human-brain-processing/
Based on data from https://www.britannica.com/science/information-theory/Physiology

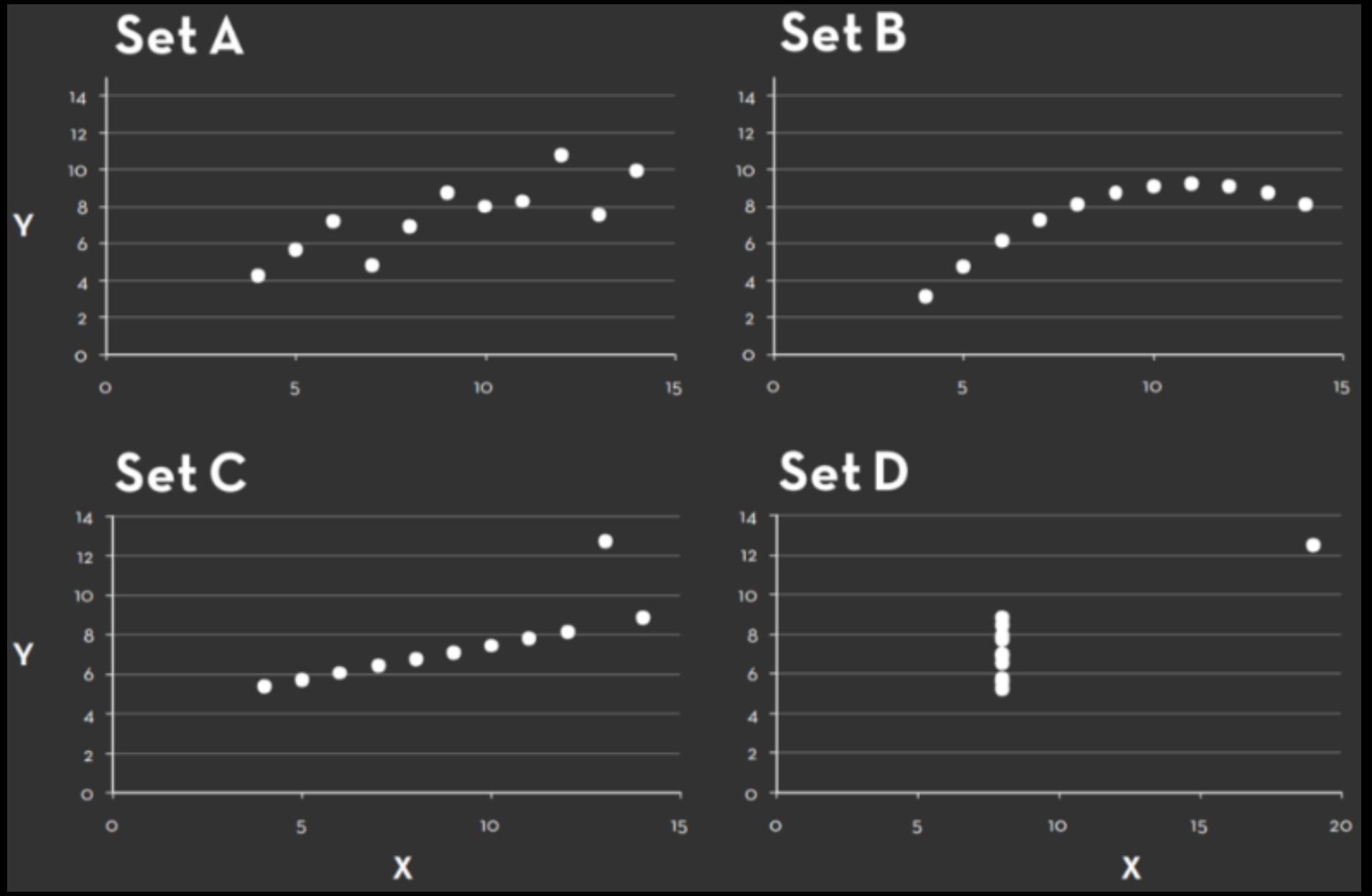
Set A		Set B		Set C		Set D	
X	Y	X	Y	X	Y	X	Y
10	8.08	10	9.14	10	7.47	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.1	4	5.39	19	12.5
12	10.84	12	9.11	12	8.15	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

Summary Statistics

$u_X = 9.0$ $\sigma_X = 3.317$

$u_Y = 7.5$ $\sigma_Y = 2.03$

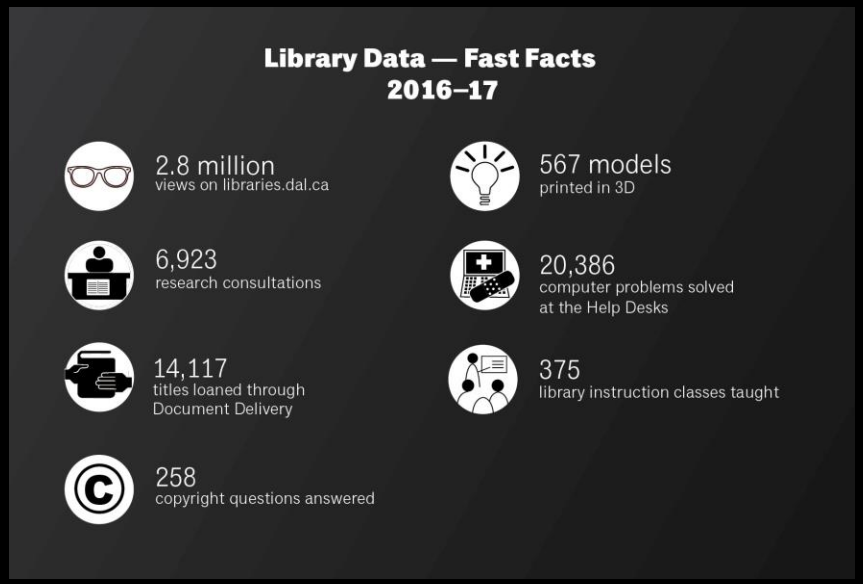
Anscombe's Quartet (Anscombe, Francis J., 1973)


Set A
Y
14
12
10
8
6
4
2
0
0
5
10
15
Set B
14
12
10
8
6
4
2
0
0
5
10
15
Set C
Y
14
12
10
8
6
4
2
0
0
5
10
15
X
Set D
14
12
10
8
6
4
2
0
0
5
10
15
20
X

InfoGraphics vs DataGraphics

DataGraphic

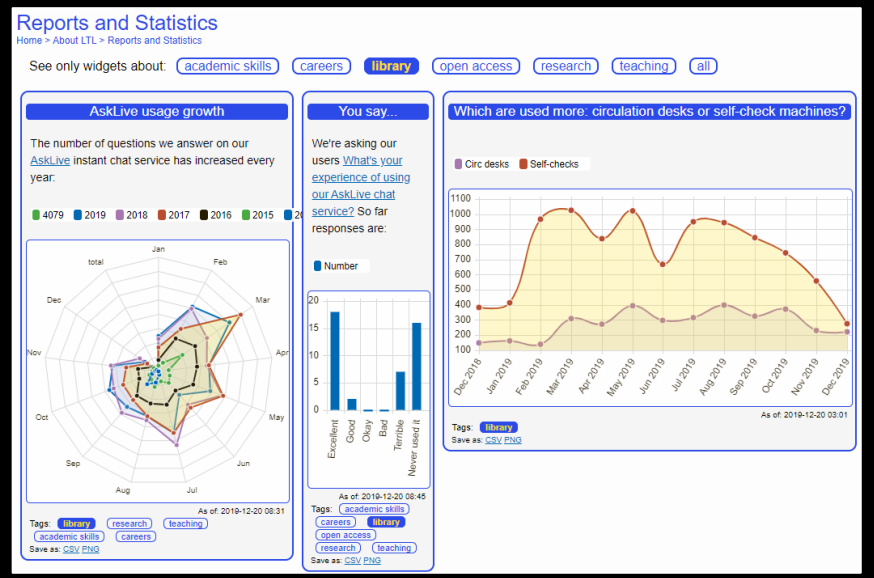
Uses words and numbers to represent quantitative data. Icon-like graphical elements for visual appeal



https://libraries.dal.ca/about/library-assessment/library-data.html

InfoGraphic

Visually encodes quantitative and/or qualitative data into marks, shapes, sizes, colours, etc.



https://library2.lincoln.ac.nz/dashboard/#library

http://understandinggraphics.com/visualizations/infoposters-are-not-infographics/

InfoGraphic vs Data Visualizations

Infographics tell a premeditated story to guide the audience (subjective).

Data Visualizations leave the audience their own conclusions (objective).

InfoGraphic

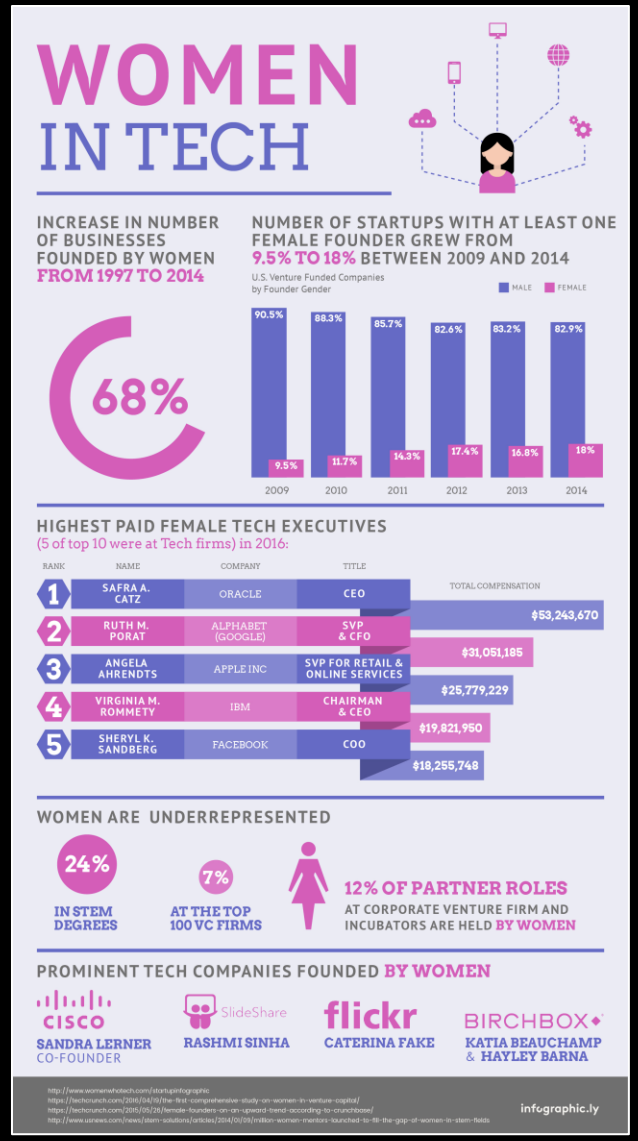
- Best for telling a **premeditated story** and offer **subjectivity**
- Best for **guiding the audience** to conclusions and **point out relationships**
- Created **manually** for one **specific dataset**

Data Visualization

- Best for allowing the audience to **draw their own conclusions**, and offer **objectivity**
- Ideal for understanding **data at a glance**
- **May not** be designed for a **specific data**

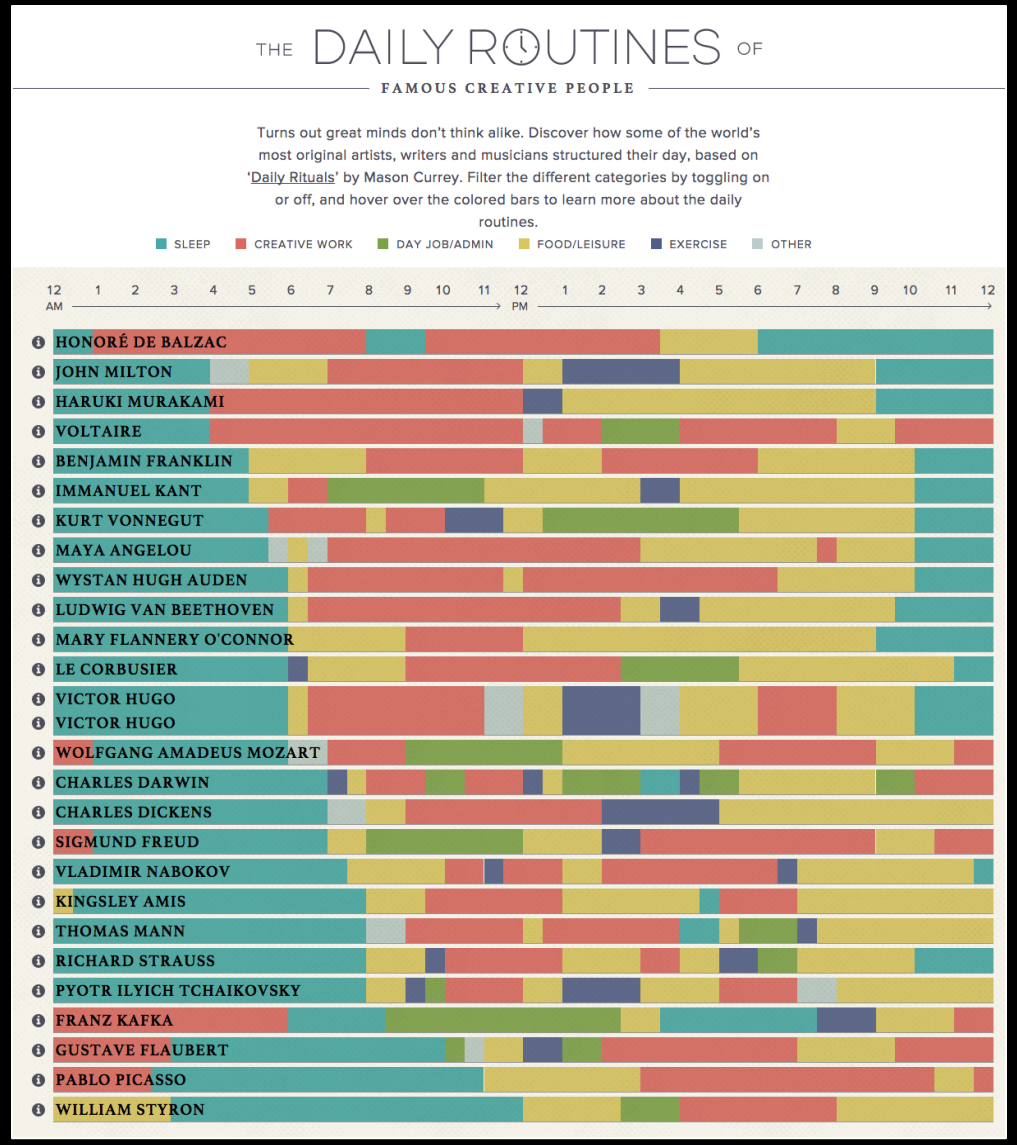
https://blog.prototypr.io/getting-it-right-why-infographics-are-not-the-same-as-data-visualizations-a23da7de745e

InfoGraphic



From https://www.entrepreneur.com/article/289932

Data Visualization



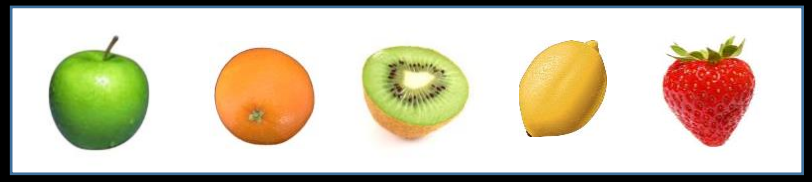
From https://podio.com/site/creative-routines

How Do We Make a Good Data Visualization?

- **Know the Data**
  - Number of attributes
  - Data types: ordinal vs ordered (ordinal or quantitative)
  - Trustworthiness: bad fields, inaccuracies, missing values
- **Know your purpose (& audience)**
  - What do you/they want to see?
  - What might you/they want to focus on?
- **Decide how encode the data**
  - Requires awareness of:
    - Human perceptual system
    - Display capacity
    - Characteristics of data (size, type)
    - Task

Data

Categorical

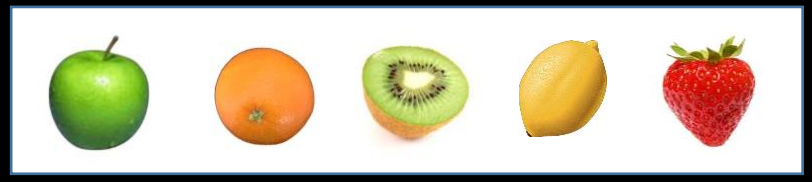


Ordered Small Medium Large

Quantitative 1 2 5.29 42 101

Data

Categorical



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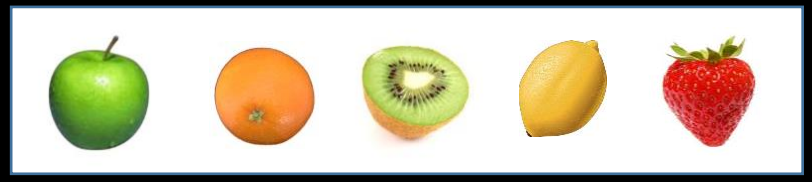
Quantitative 1 2 5.29 42 101

Can you differentiate the types?

Operate on Data

Categorical



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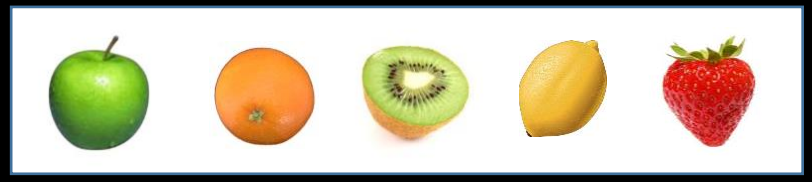
Quantitative 1 2 5.29 42 101

After encoding can these still be put in order?

Data

Categorical



Ordered Small Medium Large

Quantitative 1 2 5.29 42 101

Can amounts be accurately estimated? Are ratios maintained?

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- **Know your purpose (& audience)**
  - What do you/they want to see?
  - What might you/they want to focus on?

- **Decide how encode the data**
  - Requires awareness of:
    - Human perceptual system
    - Display capacity
    - Characteristics of data (size, type)
    - Task

Exercise:

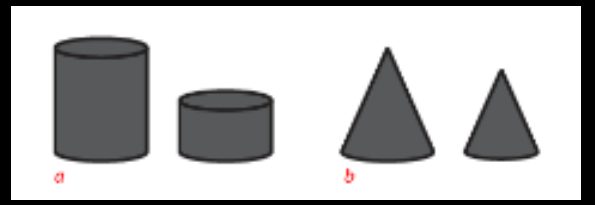
How many ways can you communicate two quantities?

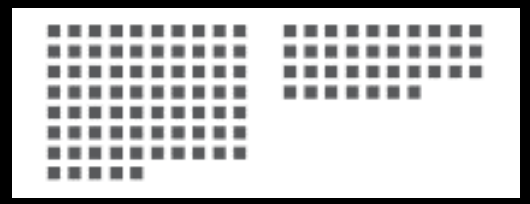
75 and 51

http://blog.visual.ly/45-ways-to-communicate-two-quantities/

75, 37
a
b
c

a
b


a
b



75
37
a
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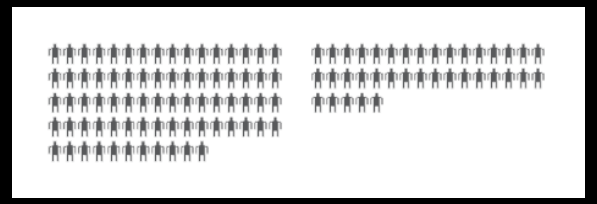

75
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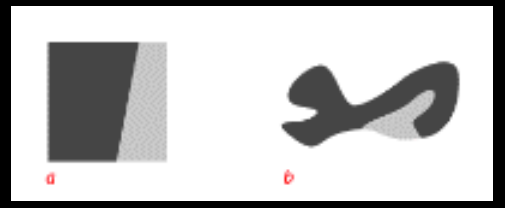
a
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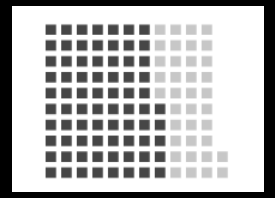
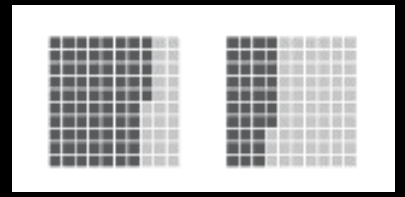
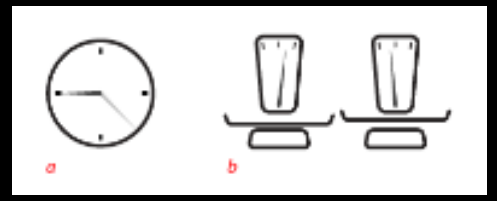


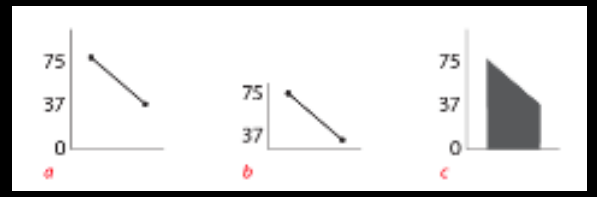



a
b

a
b
c

a
b
c

a
b


75
37
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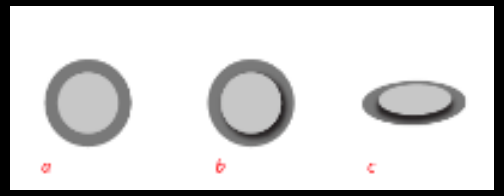
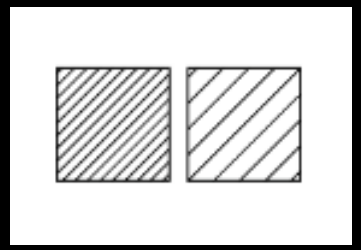
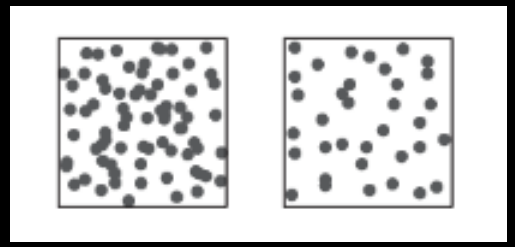
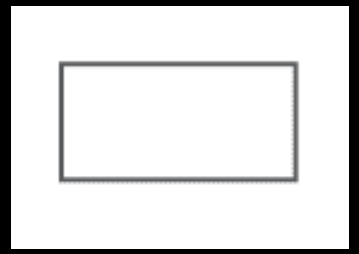
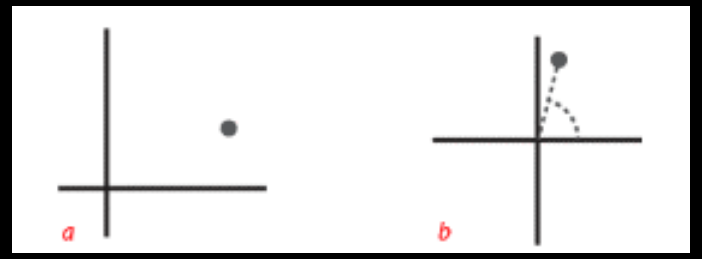
a
75
37
b
75
37
0
c

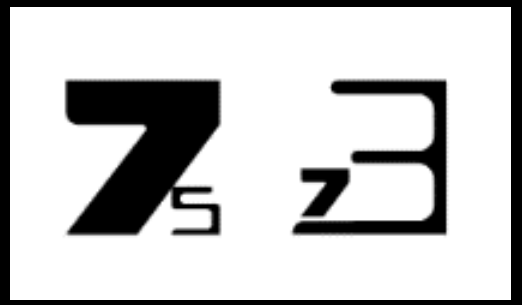

a
b
c











http://blog.visual.ly/45-ways-to-communicate-two-quantities/

Visual Encoding works with a Sign System

Images are perceived as a set of signs

A **designer** encodes information in signs

A **receiver** decodes information from signs

Jacques Bertin, *The Semiology of Graphics*, 1967

Perception

Brain

Visual Cortex: fast & efficient – pre-attentive processing

Cerebral Cortex: slower, less efficient

Goal: do as much as possible with Visual Cortex as possible

Perception

How many 3s?

1 8 4 7 9 5 3 2 1 2 4 6 7 8 9 5 6 4 3

4 8 0 6 4 8 0 3 2 8 8 7 9 6 2 3 1 0 6

9 9 6 3 4 4 2 6 8 1 5 6 8 7 9 0 3 2 1

1 5 6 8 7 9 6 5 1 2 3 5 9 9 7 8 9 6 5

4 3 2 1 3 2 1 5 4 9 8 3 4 2 5 8 4 8 9

2 2 1 5 6 7 8 6 5 6 3 1 4 5 1 3 4 5 1

Perception

How many 3s?

1 8 4 7 9 5 3 2 1 2 4 6 7 8 9 5 6 4 3

4 8 0 6 4 8 0 3 2 8 8 7 9 6 2 3 1 0 6

9 9 6 3 4 4 2 6 8 1 5 6 8 7 9 0 3 2 1

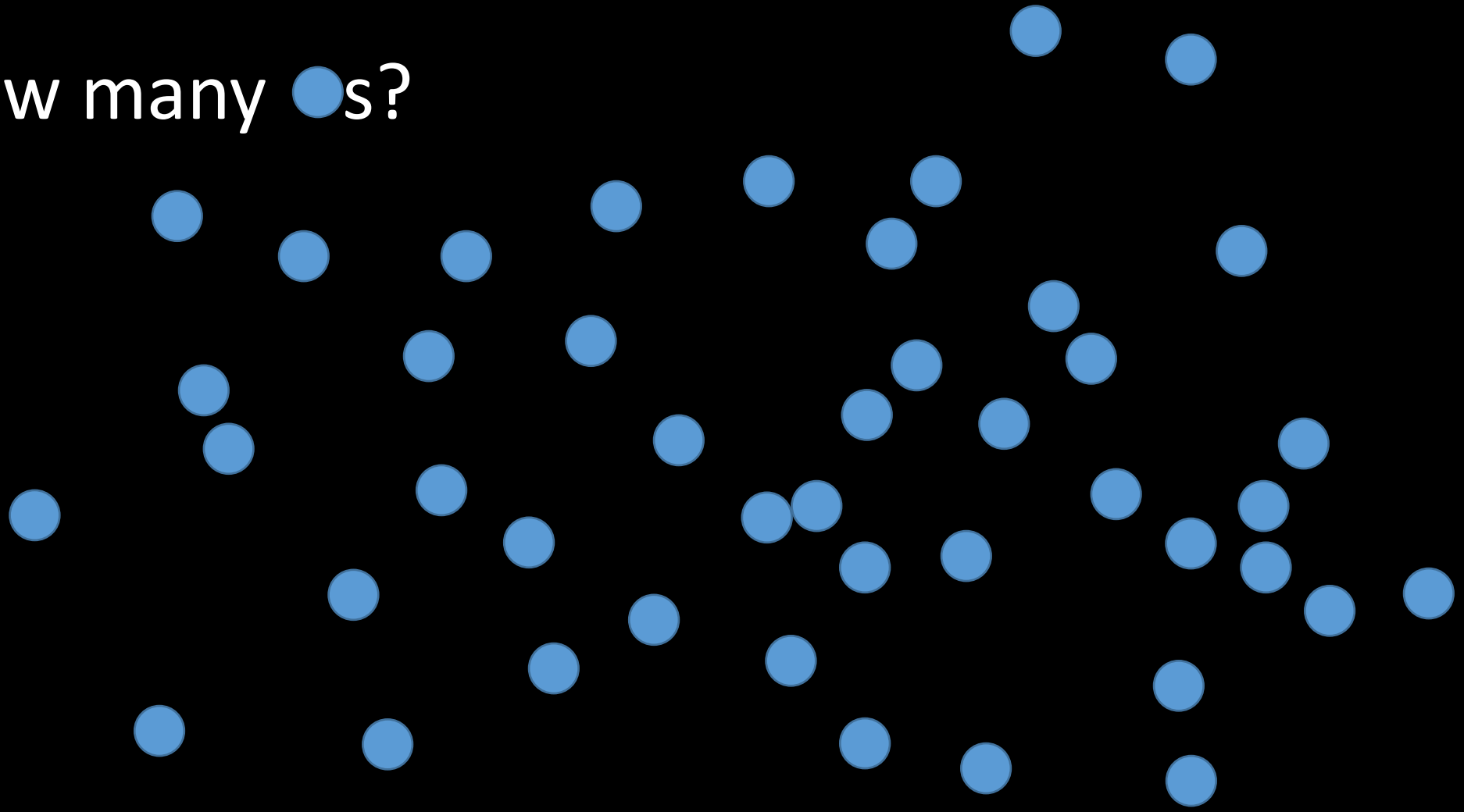
1 5 6 8 7 9 6 5 1 2 3 5 9 9 7 8 9 6 5

4 3 2 1 3 2 1 5 4 9 8 3 4 2 5 8 4 8 9

2 2 1 5 6 7 8 6 5 6 3 1 4 5 1 3 4 5 1

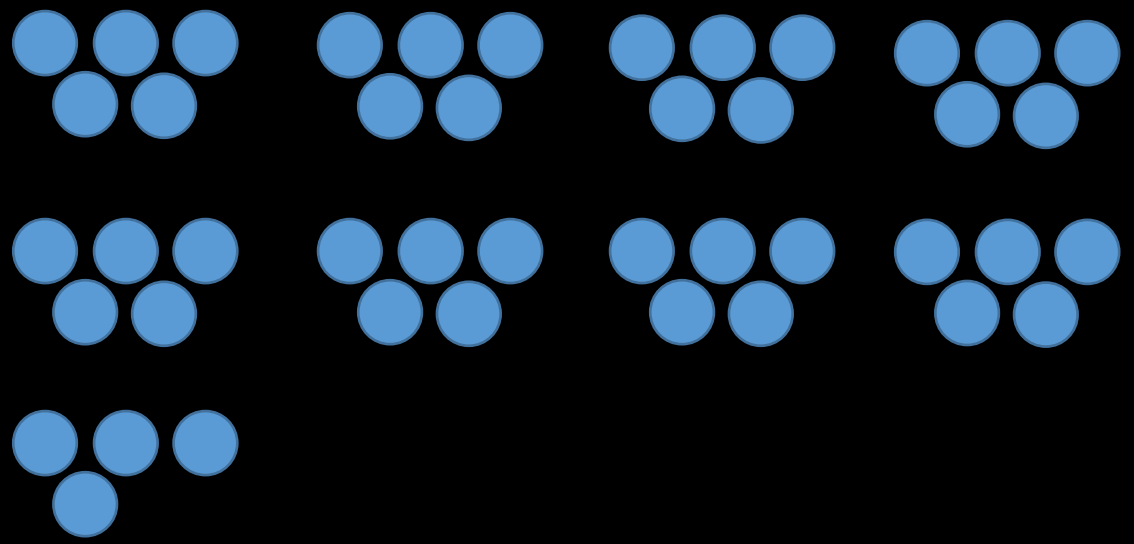
Perception

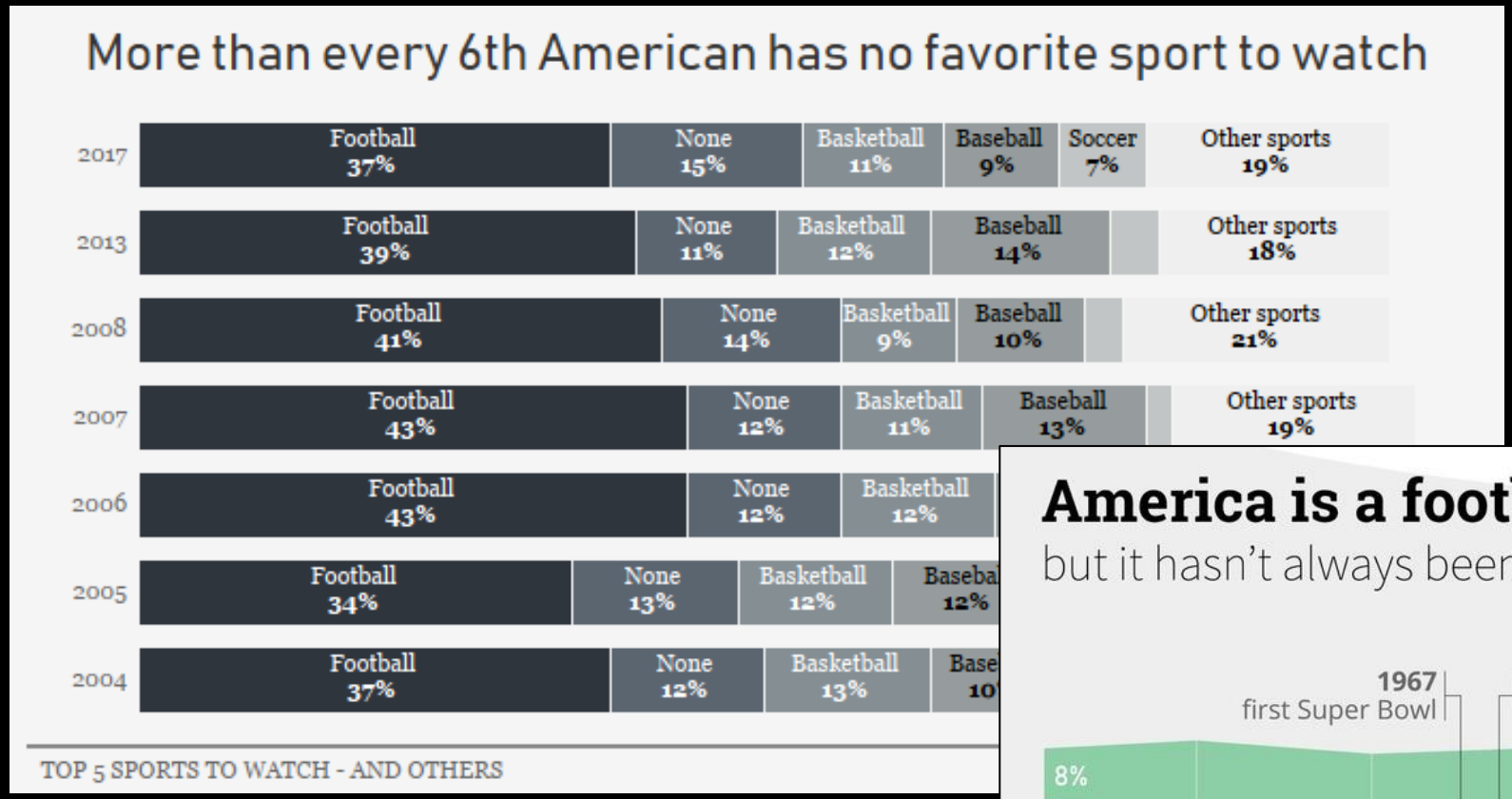
How many s?

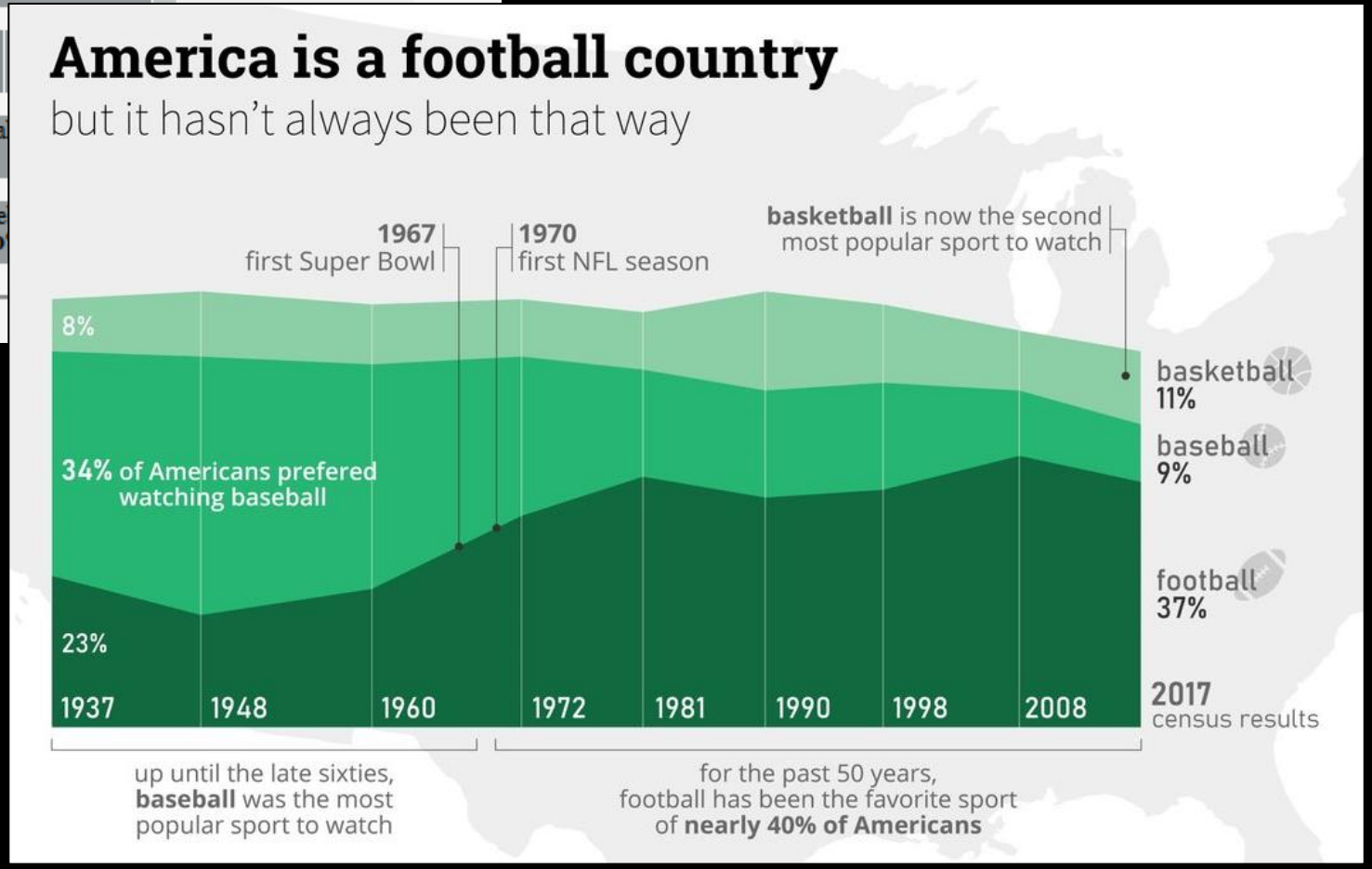


Perception

How many ●s?



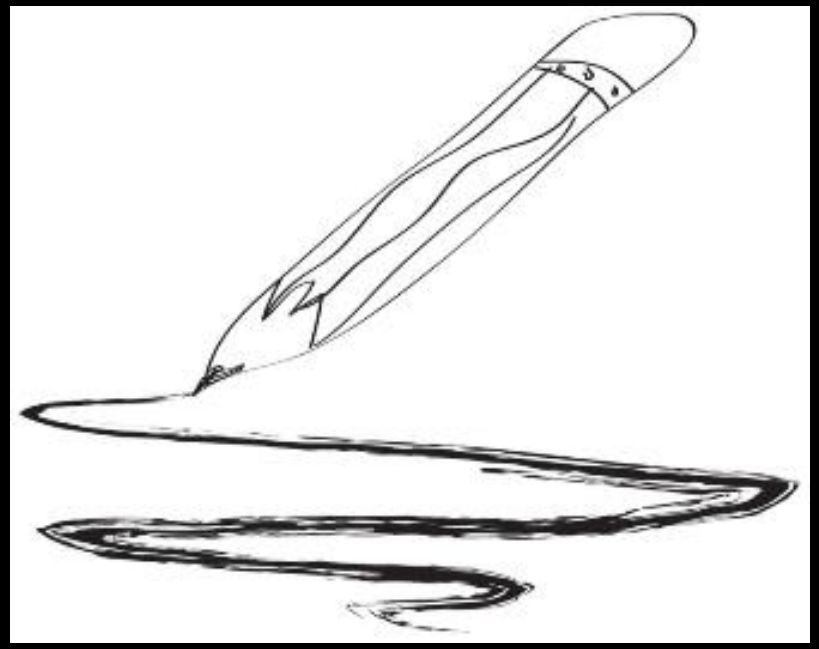




Example from https://www.makeovermonday.co.uk/gallery/

Visual Encoding

- Marks



- What can we change about a mark?

Visual Variables VARY MARKS

POSITION

changes in the x, y, (z) location

SIZE

change in length, area, repetition

SHAPE

infinite number of shapes

VALUE

changes from light to dark

ORIENTATION

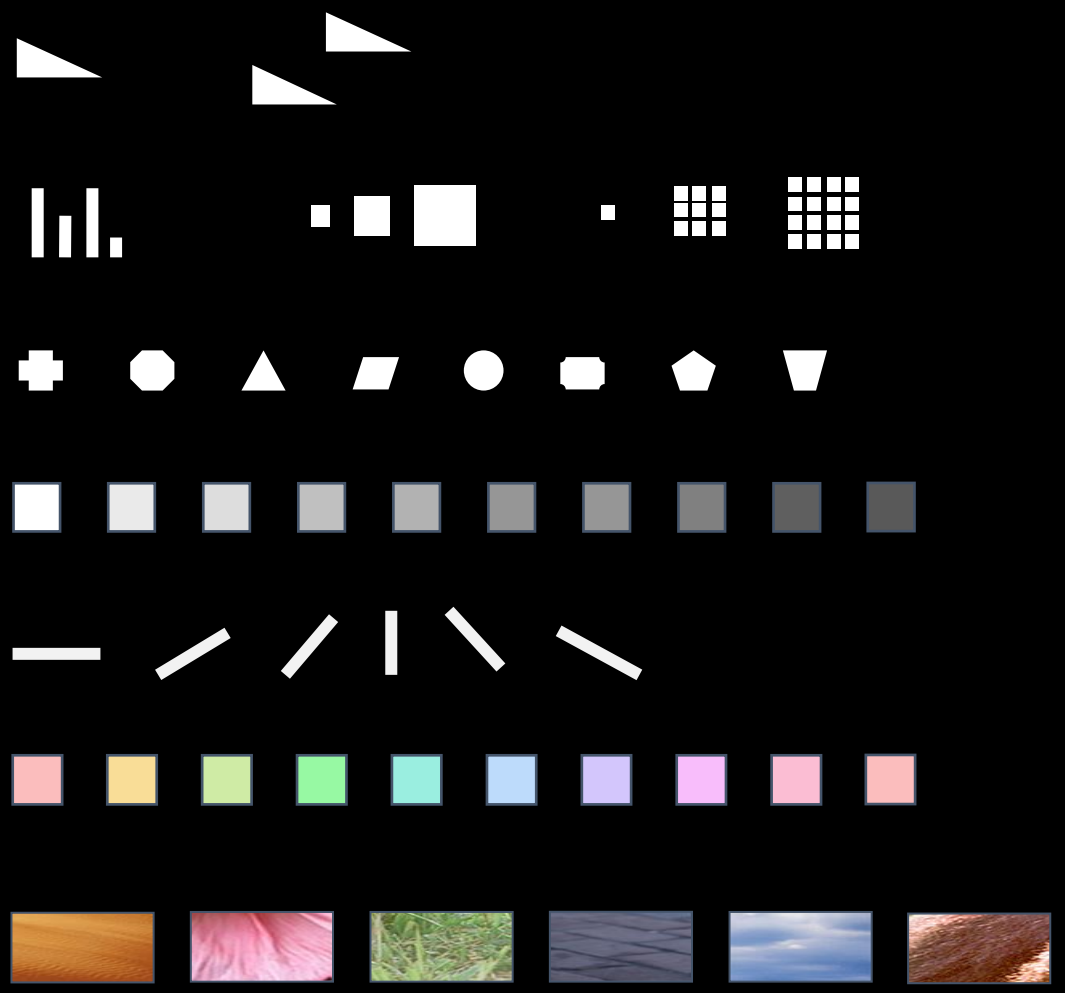
changes in alignment

COLOR

changes in hue at a given value

TEXTURE

variation in pattern



+ Opacity, Sketchiness, Connection, and Containment

Visualization ~~Rules~~ Advice

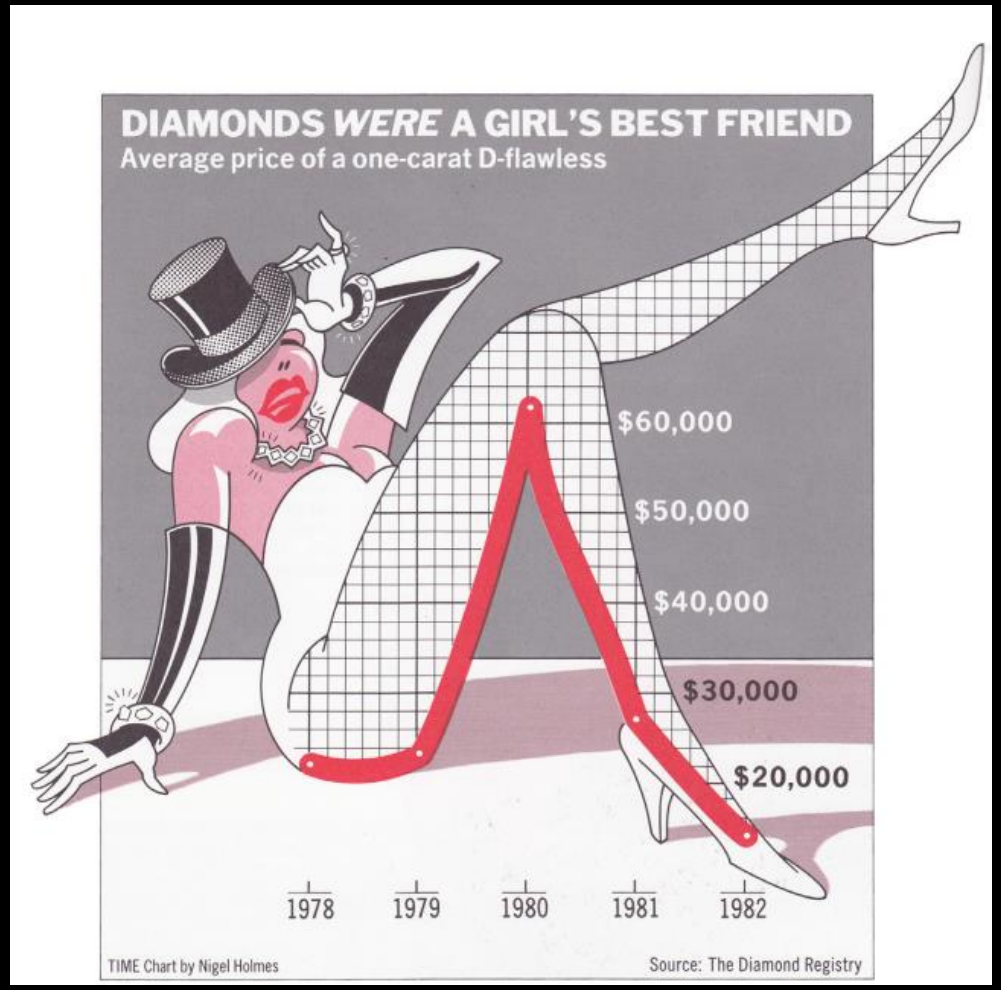
"Avoid chart junk at all costs"

"Never use pie charts"

"Bright colors don't work"

"No rainbow color-maps"

- These are all very situationally dependent
- Make sure you have reasons for breaking them



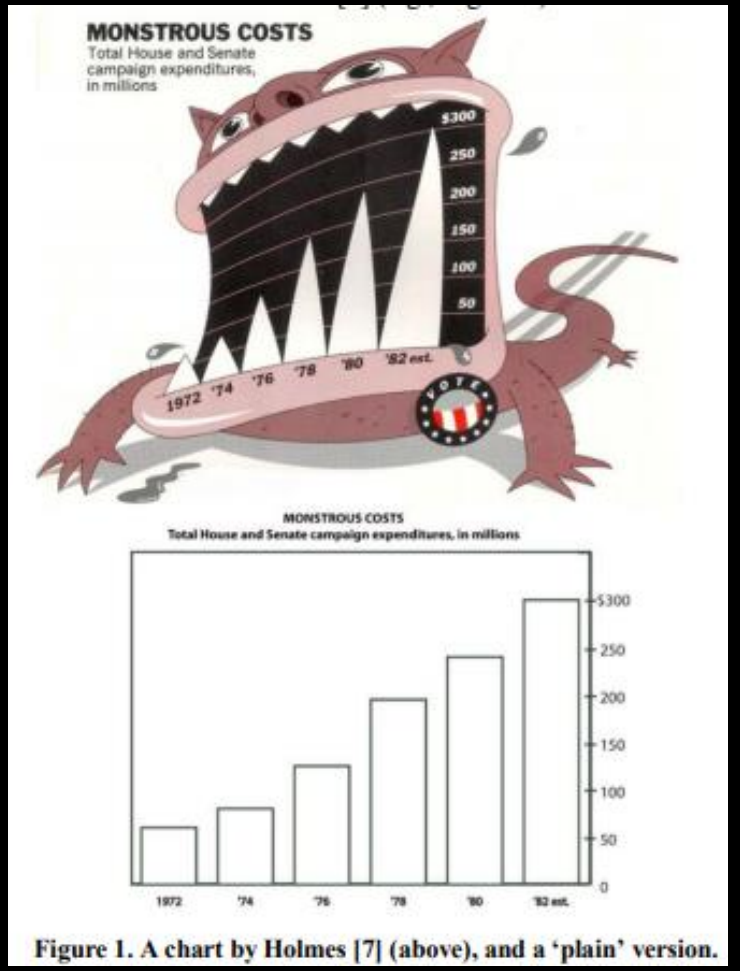


Figure 1. A chart by Holmes [7] (above), and a 'plain' version.

Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts

Scott Bateman, Regan L. Mandryk, Carl Gutwin,
Aaron Genest, David McDine, Christopher Brooks
Department of Computer Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
scott.bateman@usask.ca, regan@cs.usask.ca, gutwin@cs.usask.ca,
aaron.genest@usask.ca, dam085@mail.usask.ca, cab938@mail.usask.ca

Visual Variable Properties

1. **Selective**
   - Is a change of a mark in this variable alone enough to allow us to select it from other marks?
2. **Associative**
3. **Quantitative**
4. **Order**
5. **Length**

Is Size Selective?

Can you find the big & small Muppets?

Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

Is Size Selective?

Can you find the big & small Muppets?

Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

Visual Variable Properties

1. **Selective**
   - Is a change of a mark in this variable alone enough to allow us to select it from other marks?
2. **Associative**
   - Can we identify a group of marks by this variable?
3. **Quantitative**
4. **Order**
5. **Length**

Is Size Associative?

Can you find the small Muppets?

Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

Is Size Associative?

Can you find the small Muppets?

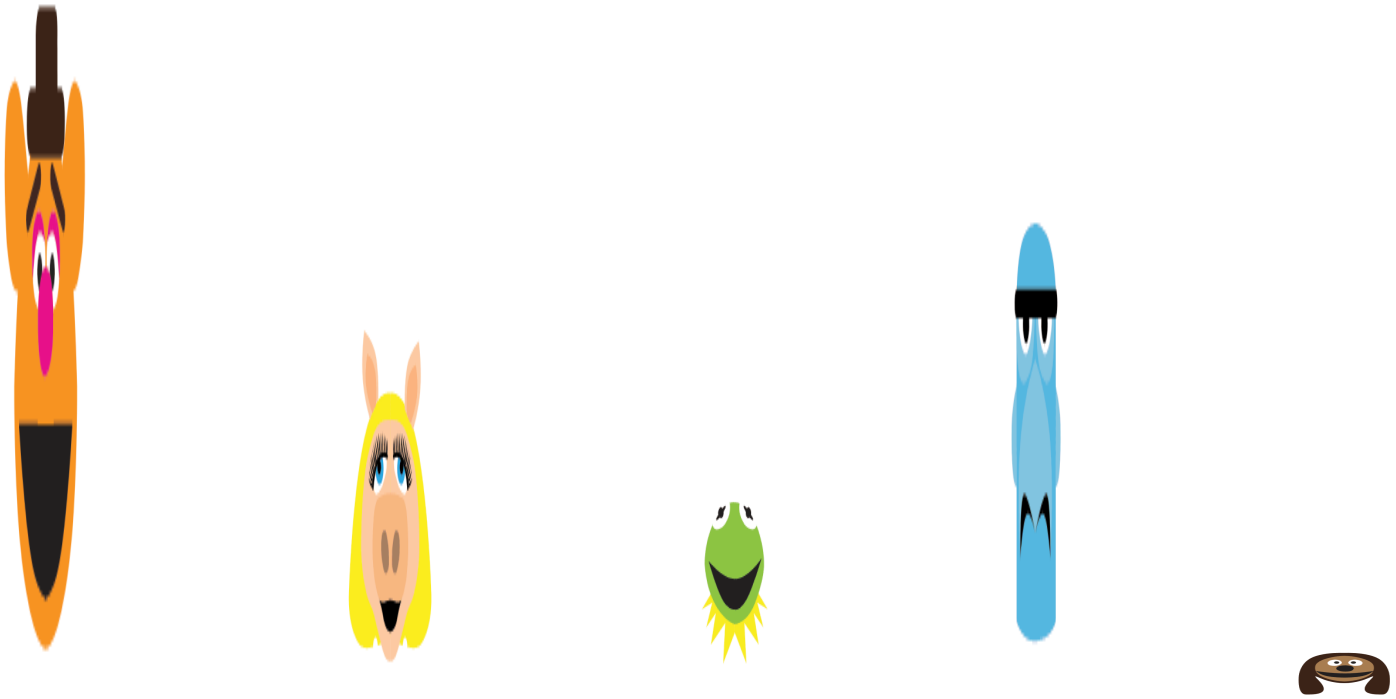
Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

Visual Variable Properties

1. **Selective**
   - Is a change of a mark in this variable alone enough to allow us to select it from other marks?
2. **Associative**
   - Can we identify a group of marks in this variable?
3. **Quantitative**
   - Can the relation between two of these marks be seen as numeric? Can we tell if one is 3X another?
4. **Order**
5. **Length**

Is Size Quantitative?

What value is Kermit compared to Fozzie?



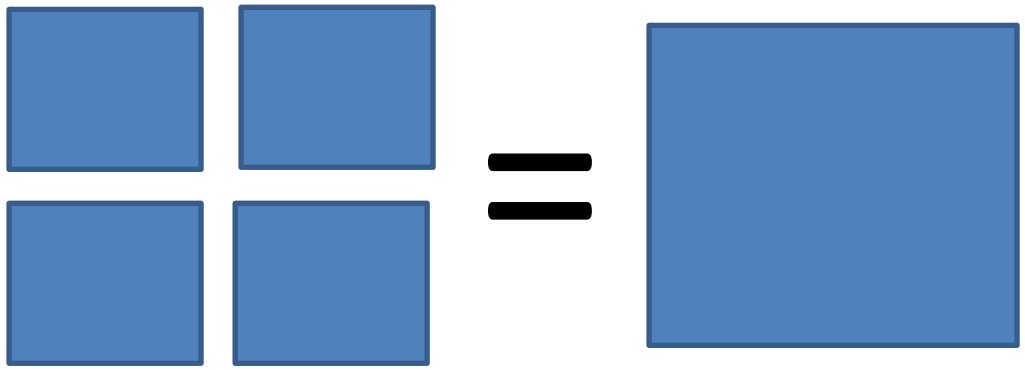
Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

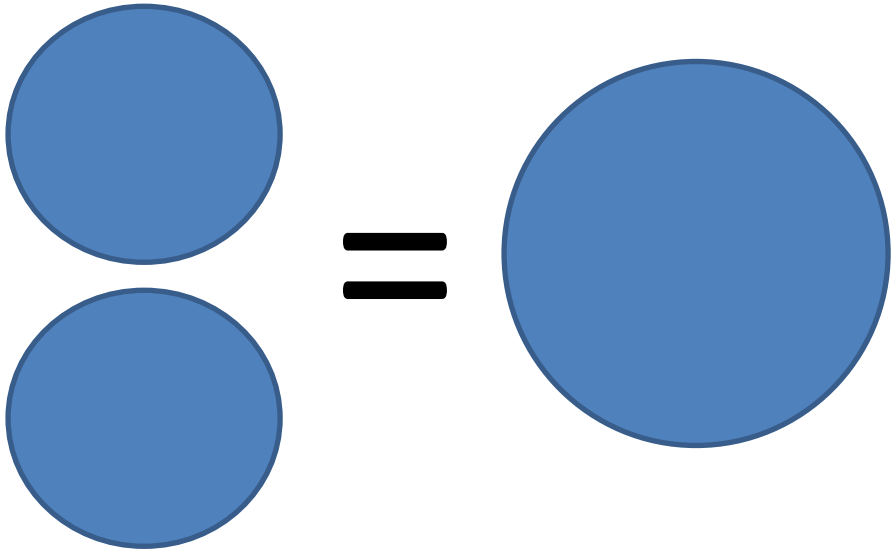
Is Size Quantitative?

What value is Kermit compared to Fozzy?

Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

Is Size Quantitative?





Visual Variable Properties

1. **Selective**
   - Is a change of a mark in this variable alone enough to allow us to select it from other marks?
2. **Associative**
   - Can we identify a group of marks in this variable?
3. **Quantitative**
   - Can the relation between two of these marks be seen as numeric? Can we tell if one is 3X another?
4. **Order**
   - Does this variable support ordered reading (more/less)?
5. **Length**

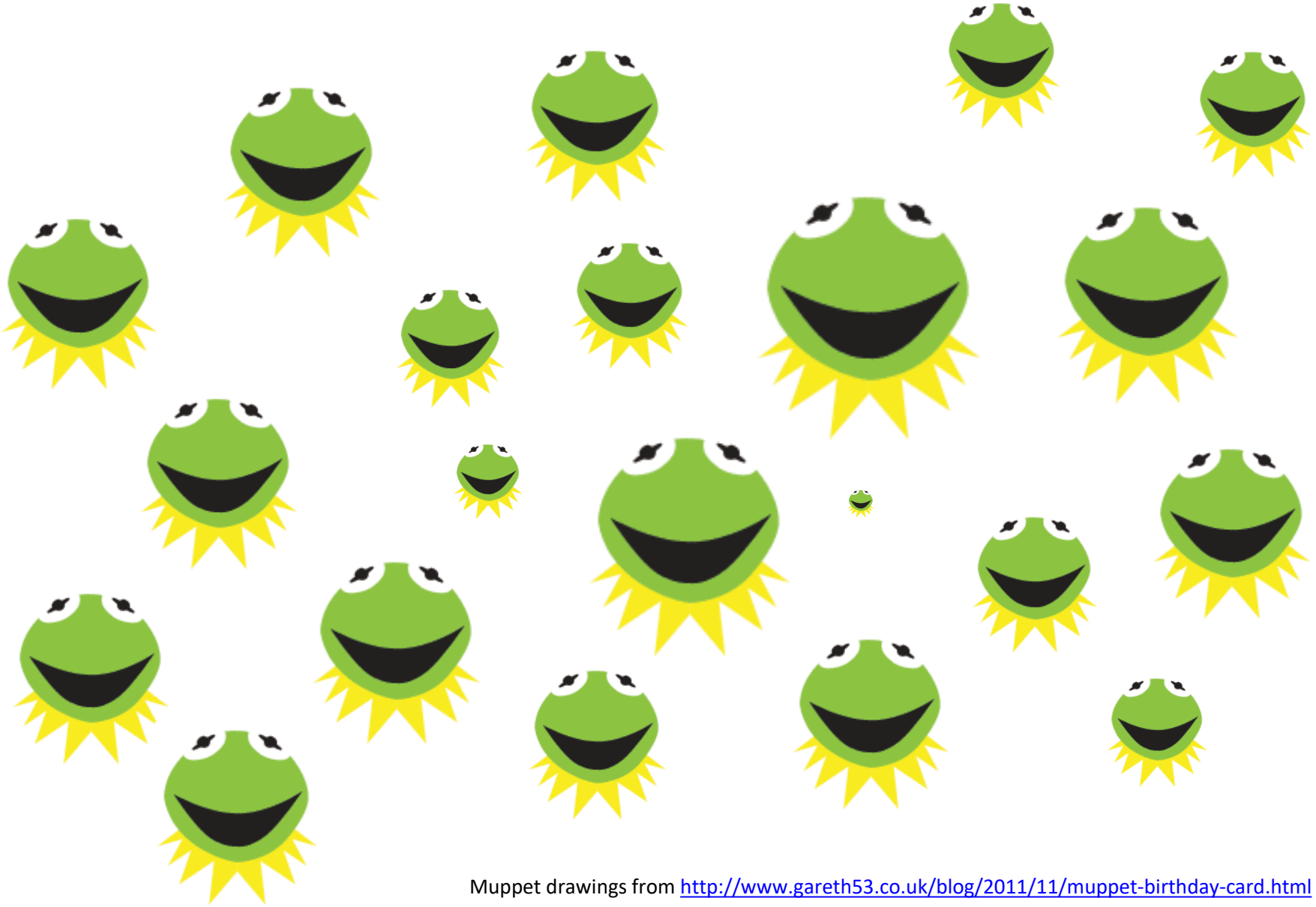
Is Size Ordered?

Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

Visual Variable Properties

1. **Selective**
   - Is a change of a mark in this variable alone enough to allow us to select it from other marks?
2. **Associative**
   - Can we identify a group of marks in this variable?
3. **Quantitative**
   - Can the relation between two of these marks be seen as numeric? Can we tell if one is 3X another?
4. **Order**
   - Does this variable support ordered reading (more/less)?
5. **Length**
   - How many differences in this variable can be discerned?

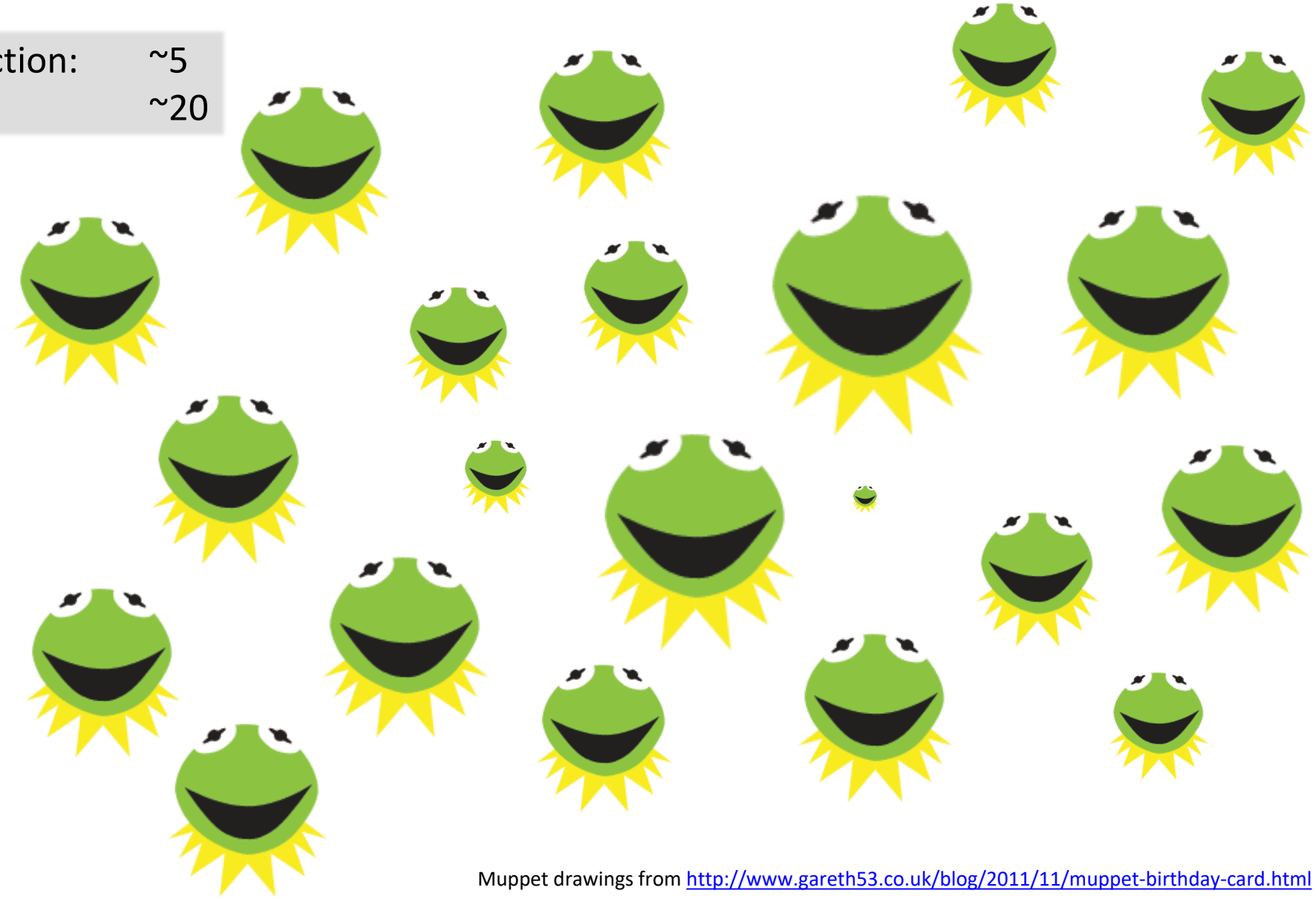
What Length Does Size Have?



Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

What Length Does Size Have?

Association/Selection:	~5
Distinction:	~20



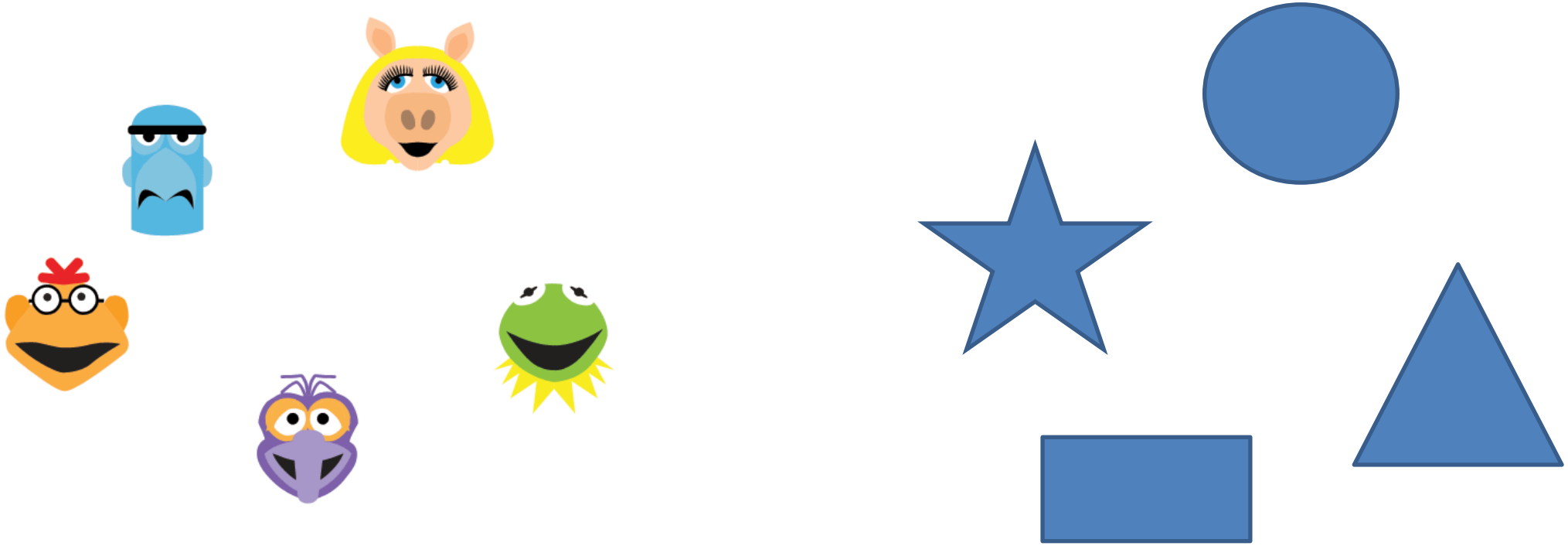
Muppet drawings from http://www.gareth53.co.uk/blog/2011/11/muppet-birthday-card.html

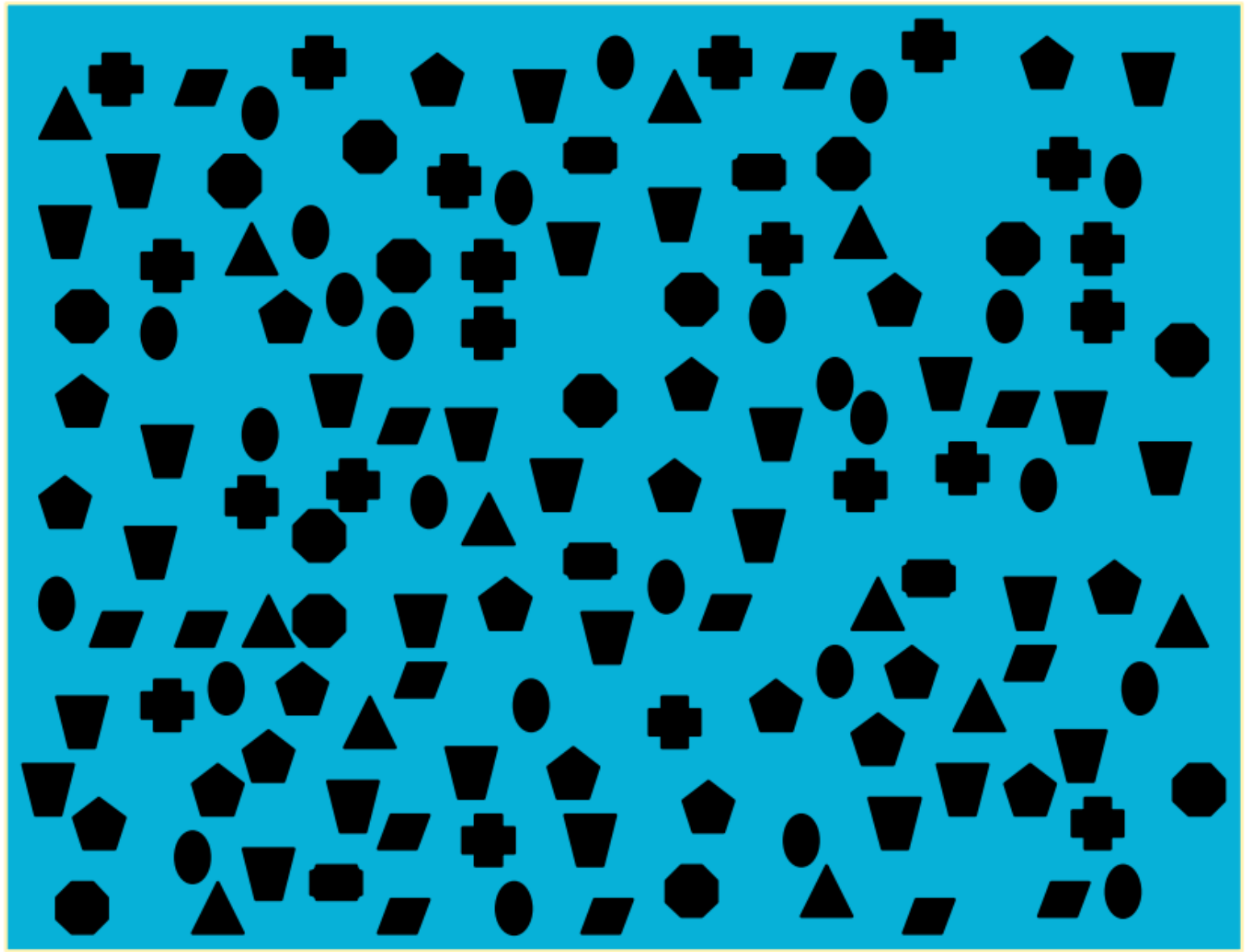
Visual Encoding
Channel Properties

- **Selective**
  - Is a change in this variable alone enough to allow us to select it from a group?
- **Associative**
  - Can we identify a group of these marks?
- **Quantitative**
  - Can the relation between two of these marks be seen as numeric? Can we tell if one is 3X as much as another?
- **Order**
  - Does this variable support ordered reading (more/less)?
- **Length**
  - How many differences in this variable can be discerned?

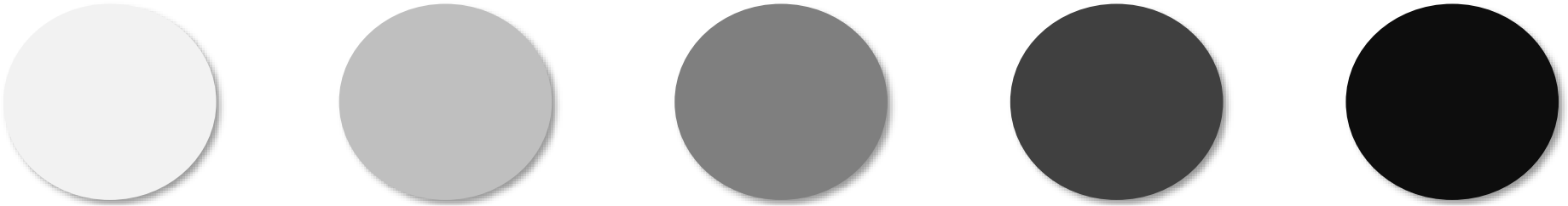
Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape					
Lightness					
Saturation					
Hue					
Angle					
Texture					

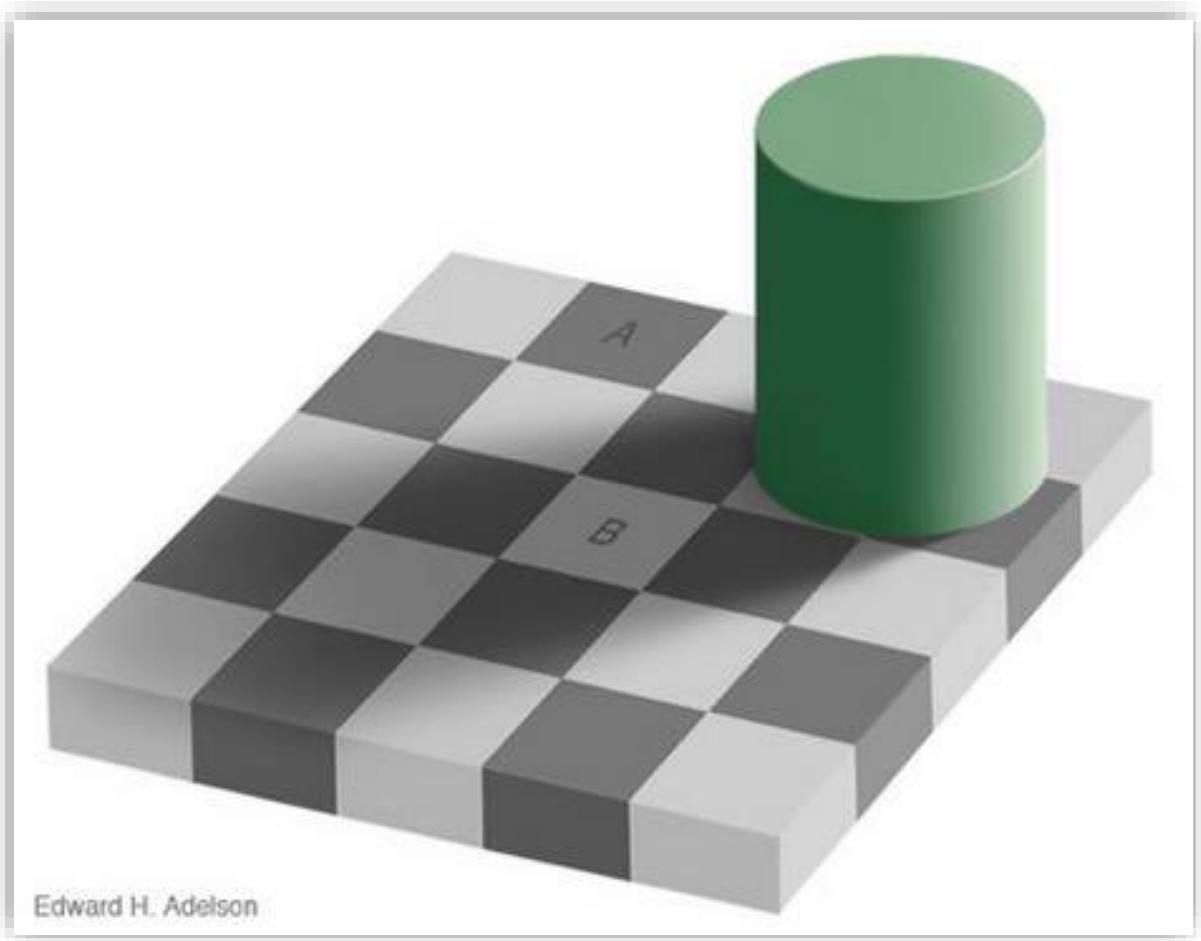
Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness					
Saturation					
Hue					
Angle					
Texture					

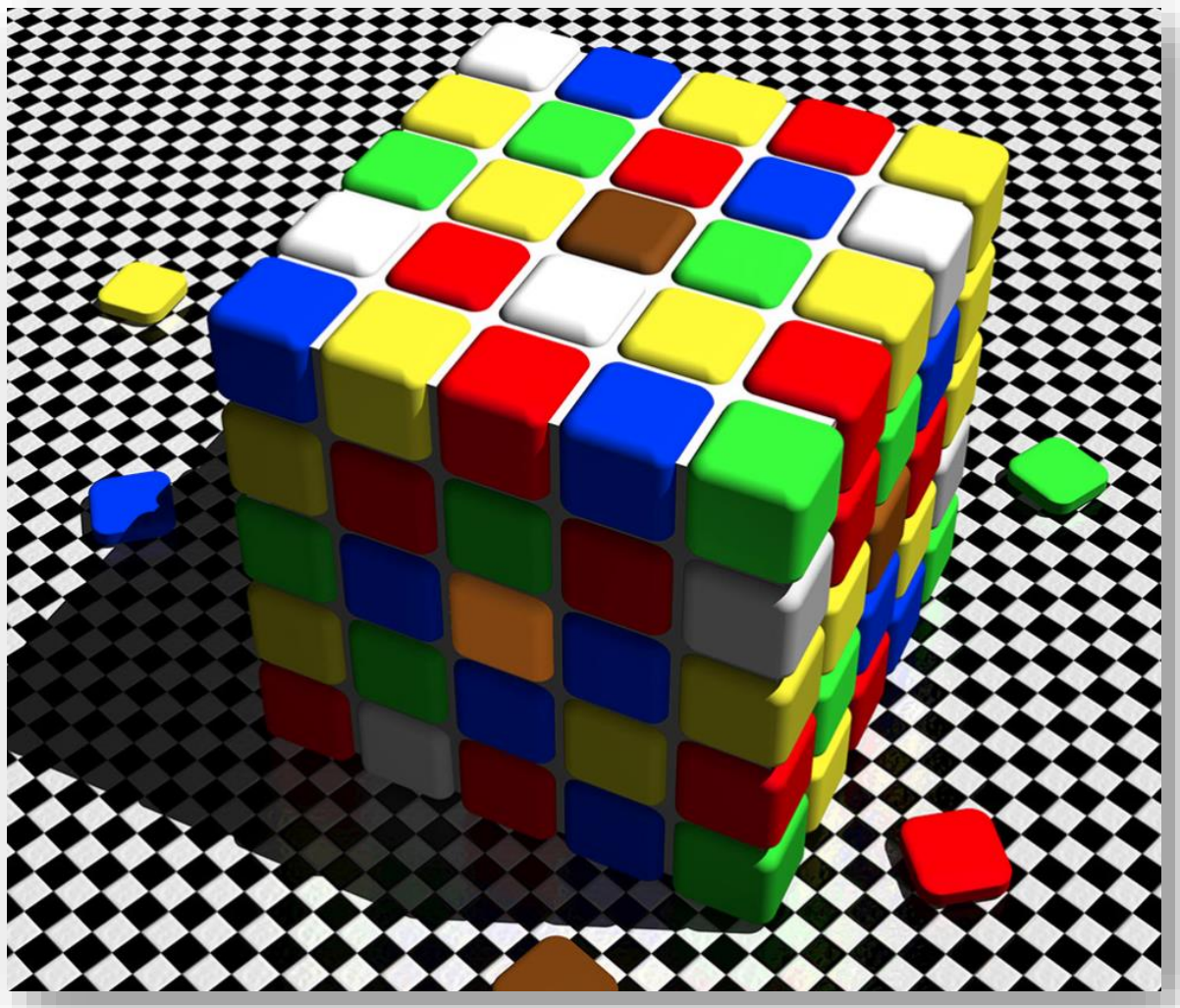




Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness	Yes	Yes	No	Yes	7 / 10
Saturation	Yes	Yes	No	Yes	7 / 10
Hue					
Angle					
Texture					

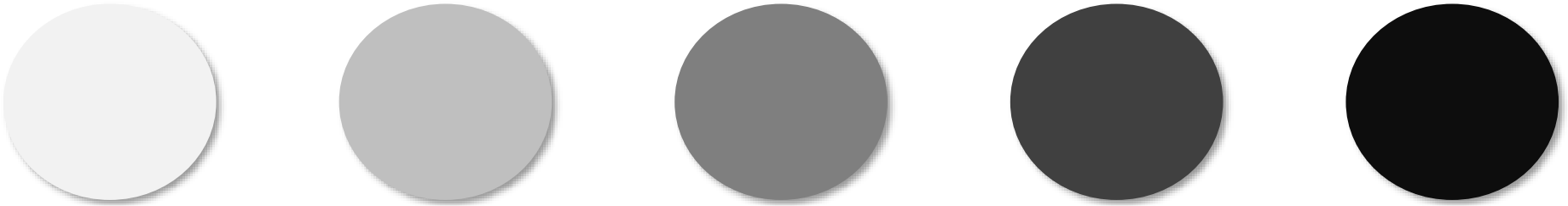






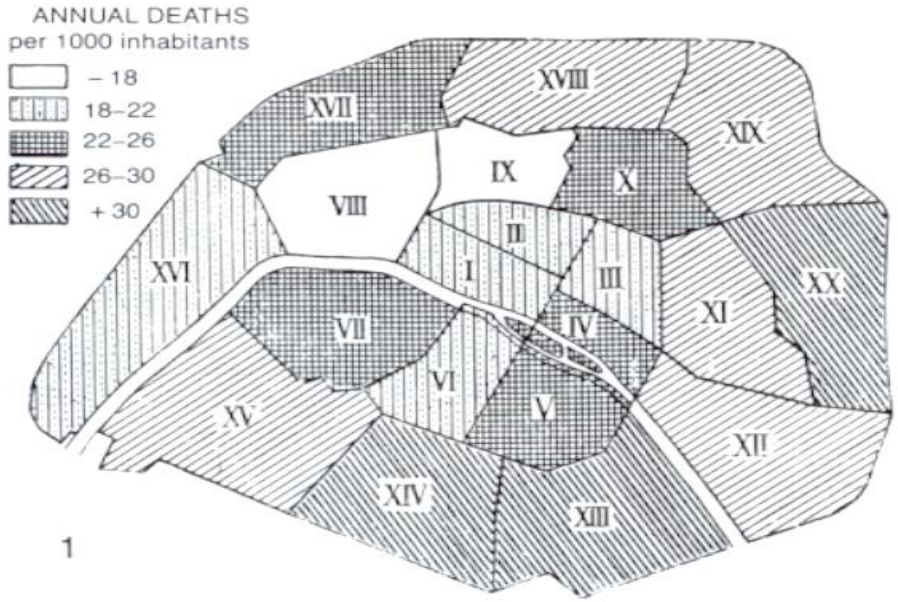
Weber's Law: human perception is fundamentally based on relative judgments, not absolute values.

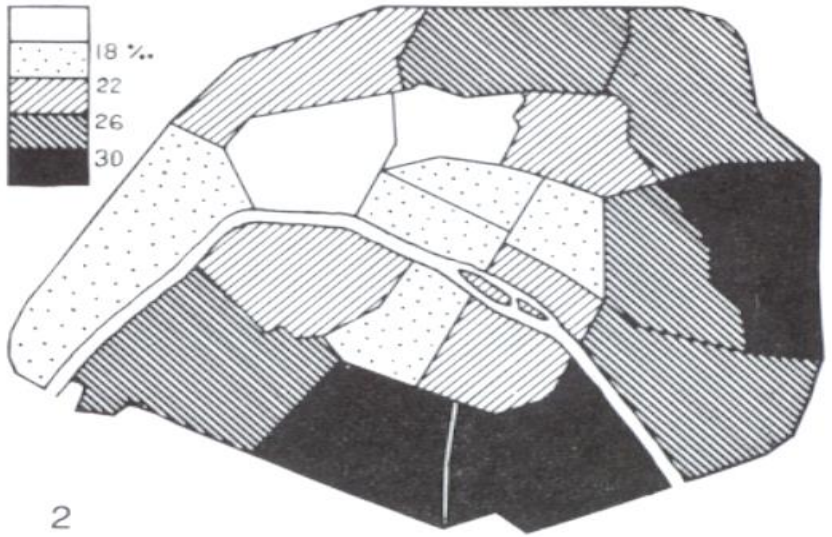
Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness	Yes	Yes	No	Yes	7 / 10
Saturation	Yes	Yes	No	Yes	7 / 10
Hue					
Angle					
Texture					



Lightness & Saturation Are ORDERED, cannot be REORDERED

ANNUAL DEATHS PER 1000 INHABITANTS, PARIS

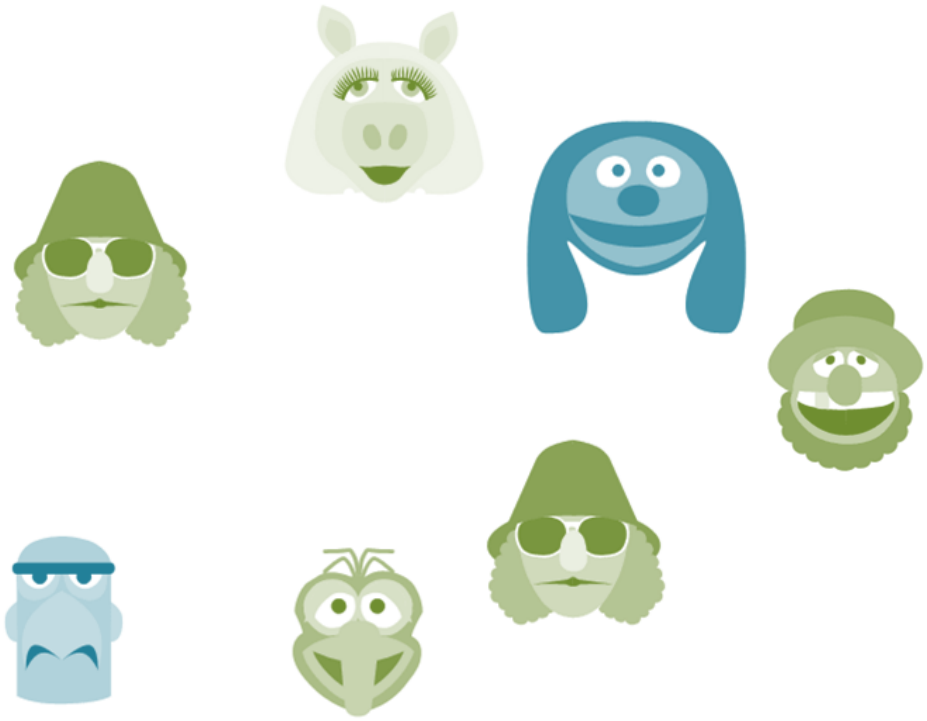


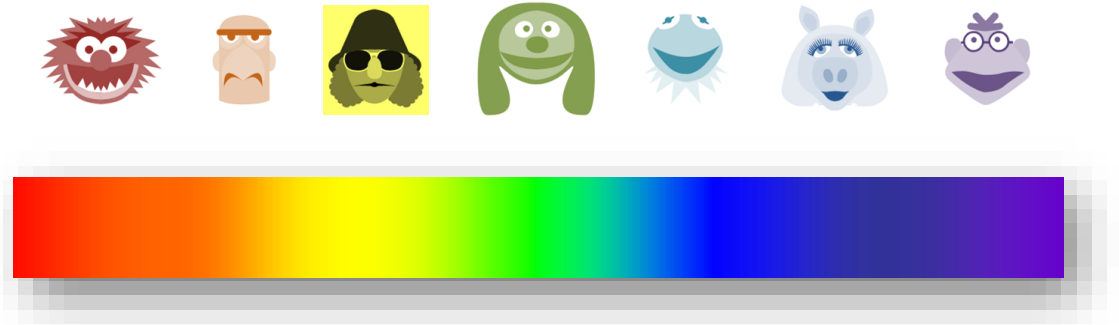


VALUES NOT ORDERED CORRECTLY ACCORDING TO SCALE
INFORMATION HAS TO BE READ POINT BY POINT

VALUES ORDERED CORRECTLY MAKE
THE IMAGE MUCH MORE USEFUL

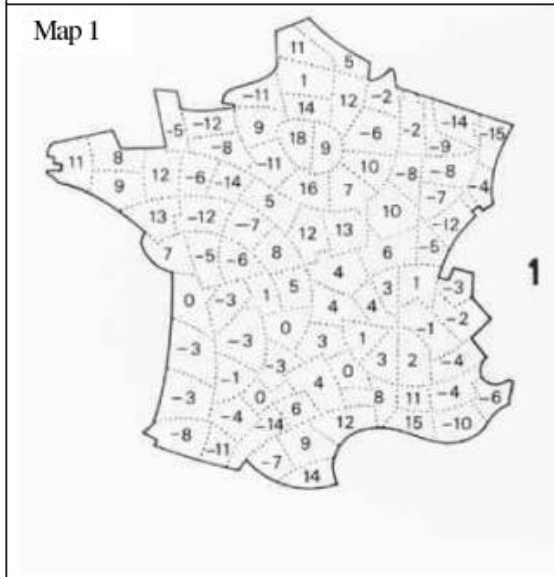
Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness	Yes	Yes	No	Yes	7 / 10
Saturation	Yes	Yes	No	Yes	7 / 10
Hue	Yes	Yes	Not advisable	Not advisable	7 / 10
Angle					
Texture					



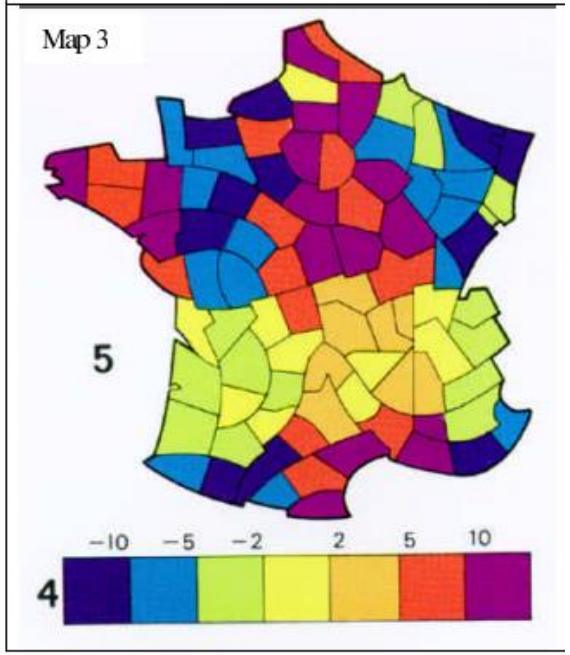


Rainbow Scale Considerations

Map 1



Map 3

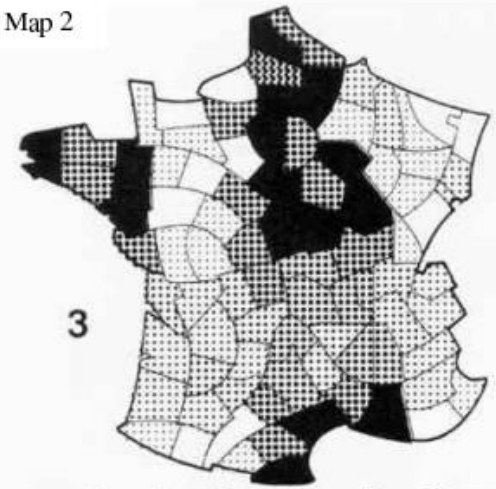


Rainbow Scale Considerations

Map 1

1

Map 2



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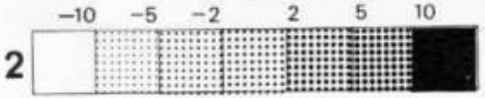
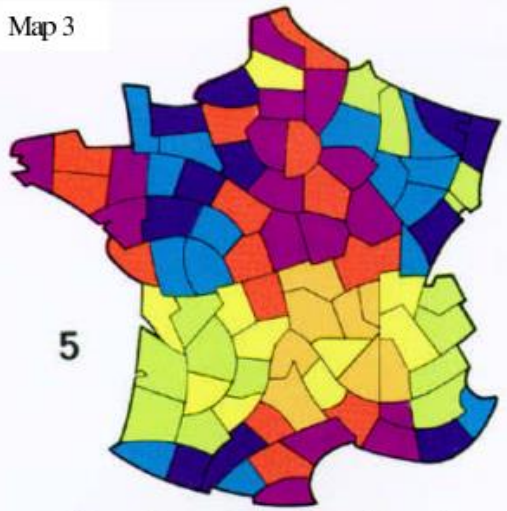
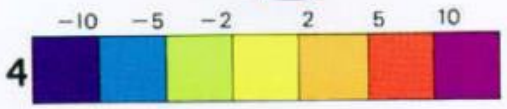


2

Map 3



5

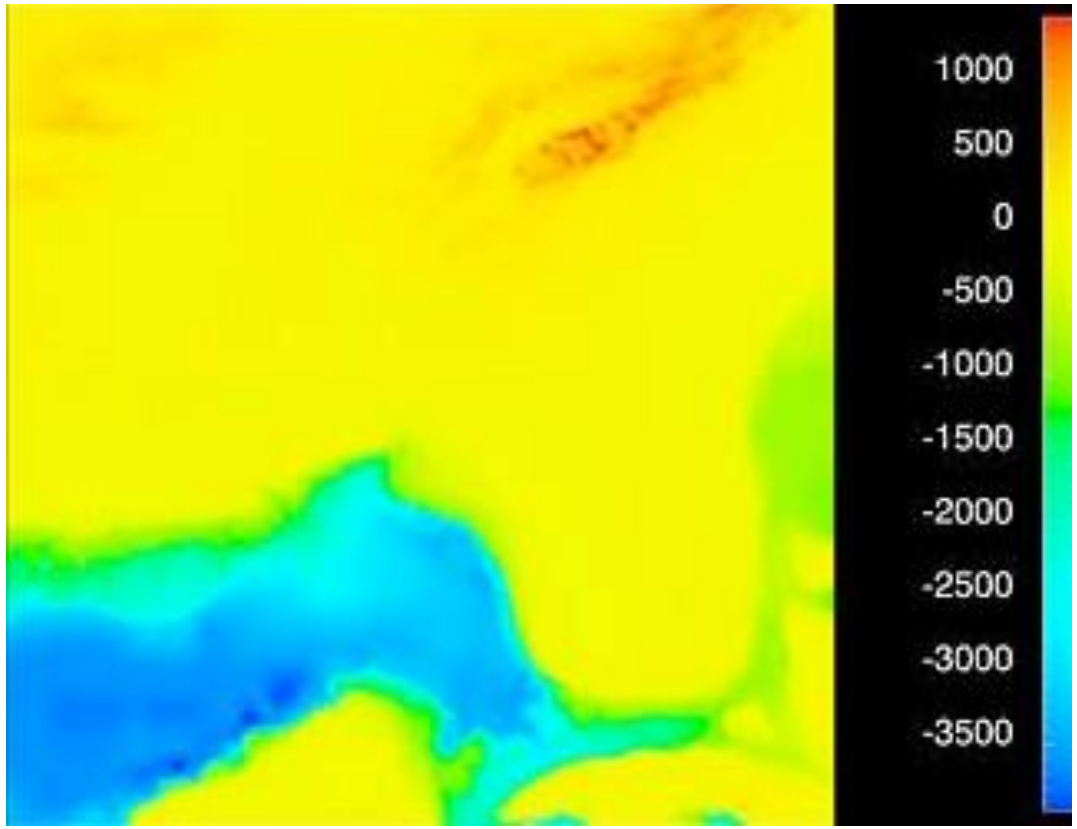


4

Map 4

11

10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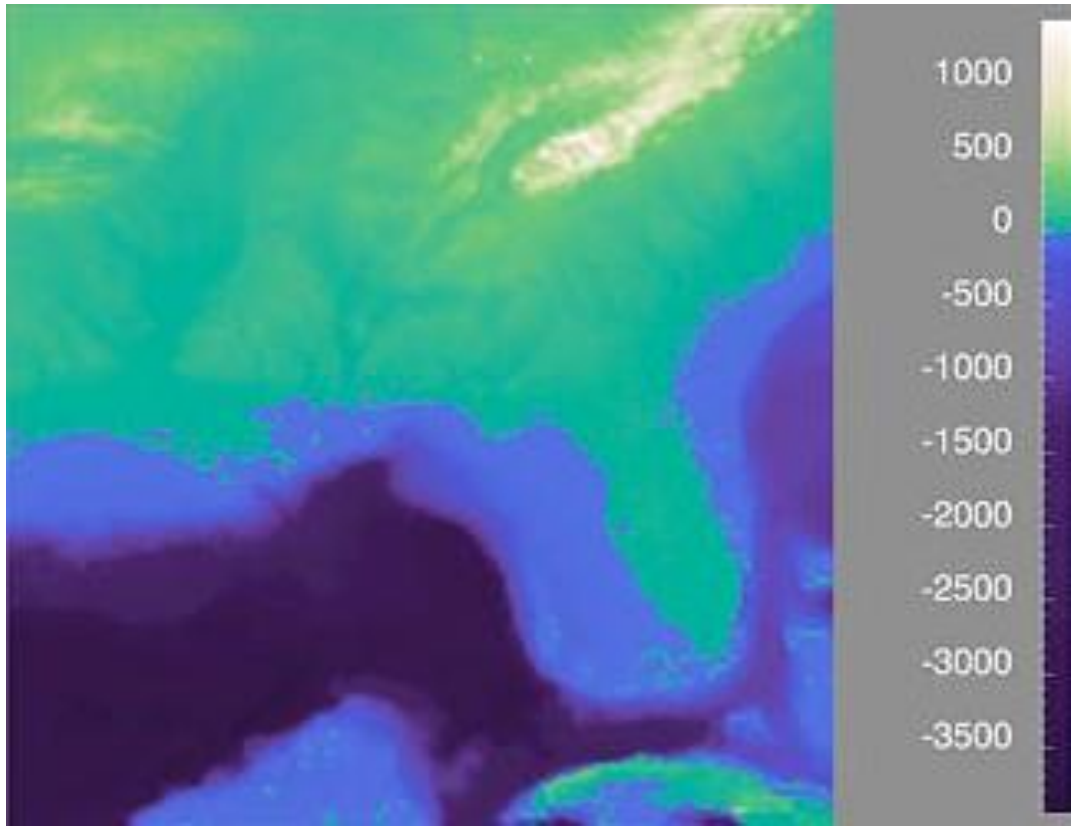
1000
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0
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-1000
-1500
-2000
-2500
-3000
-3500

Destroys Detail

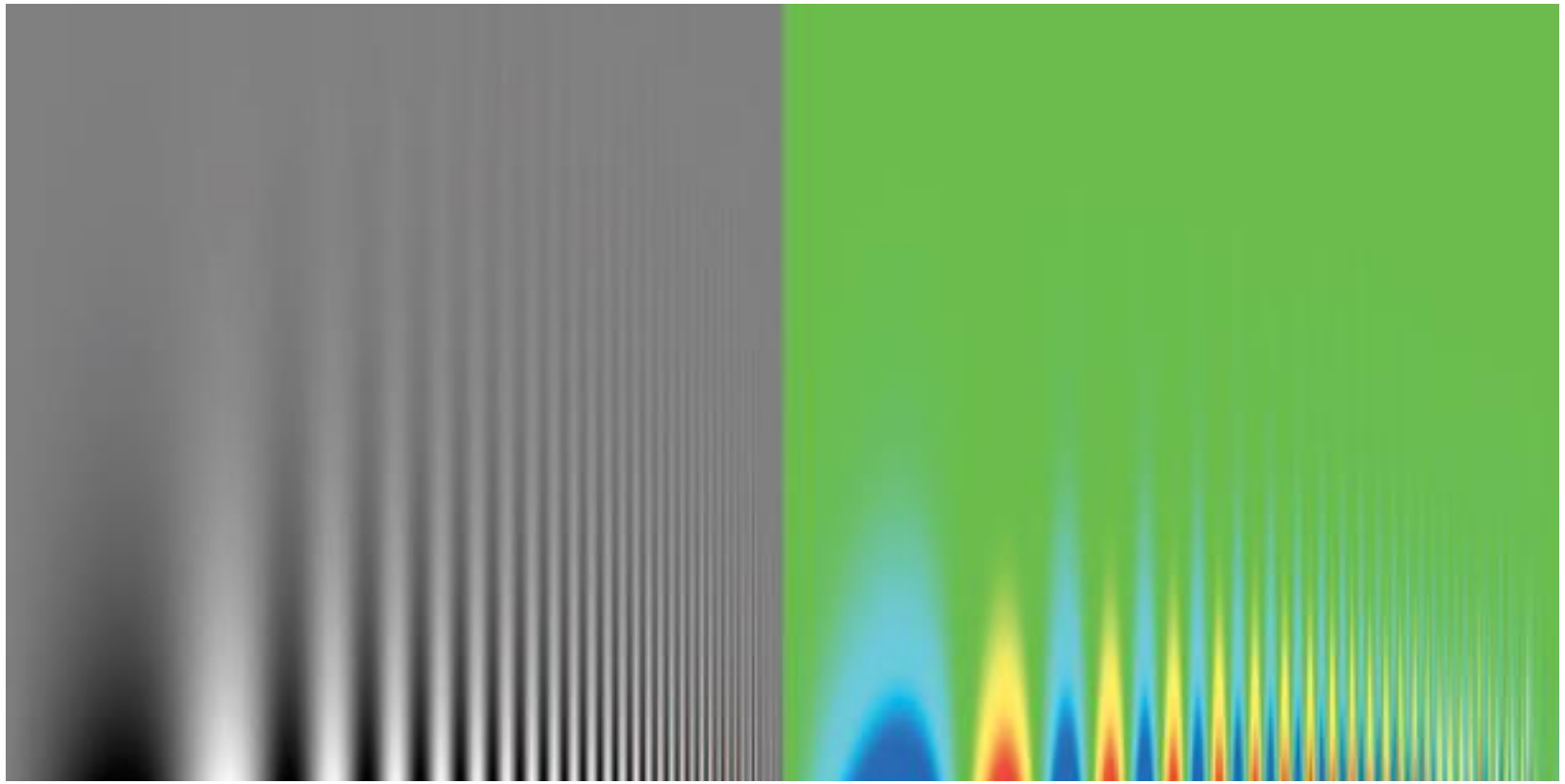
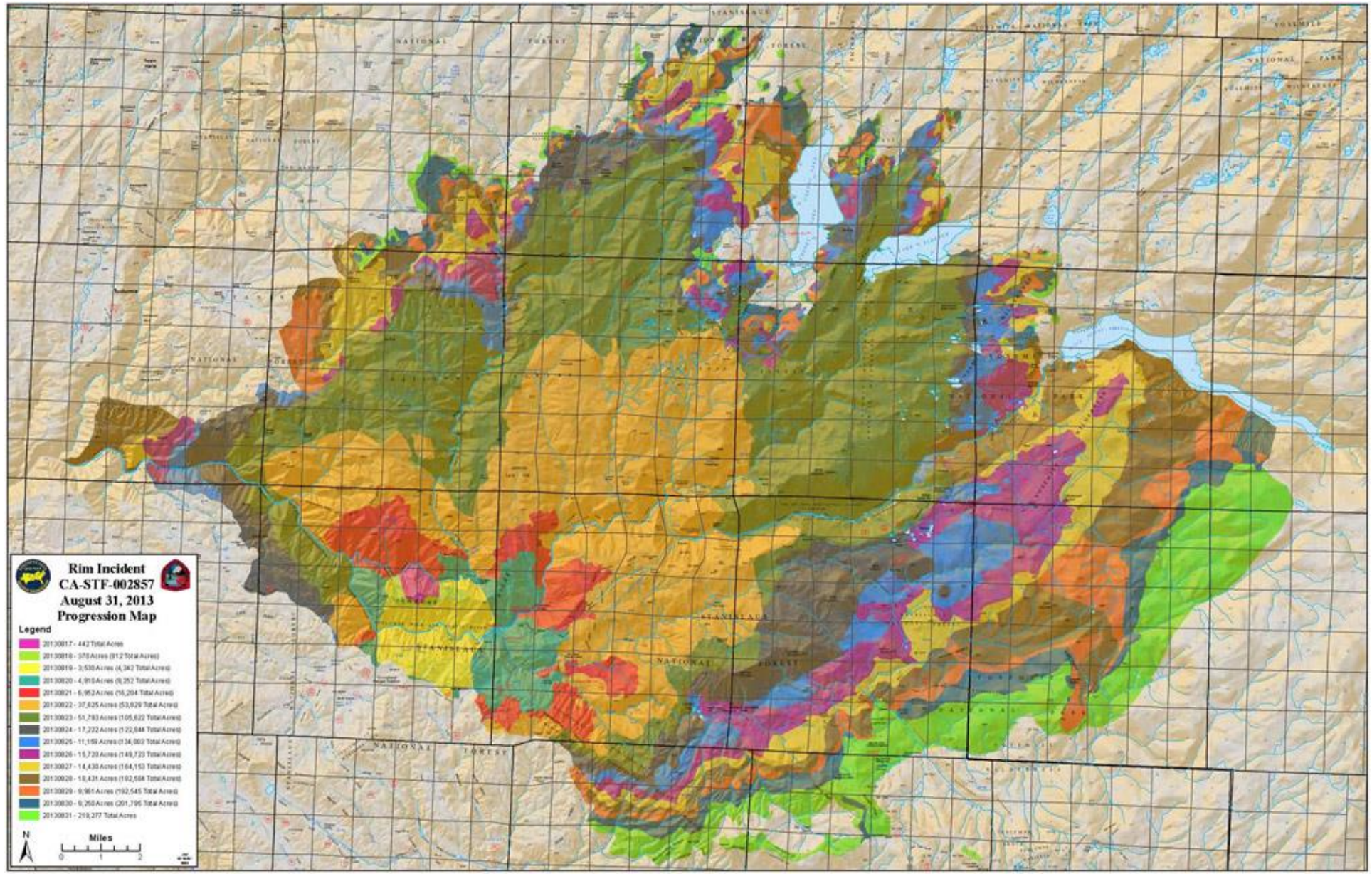
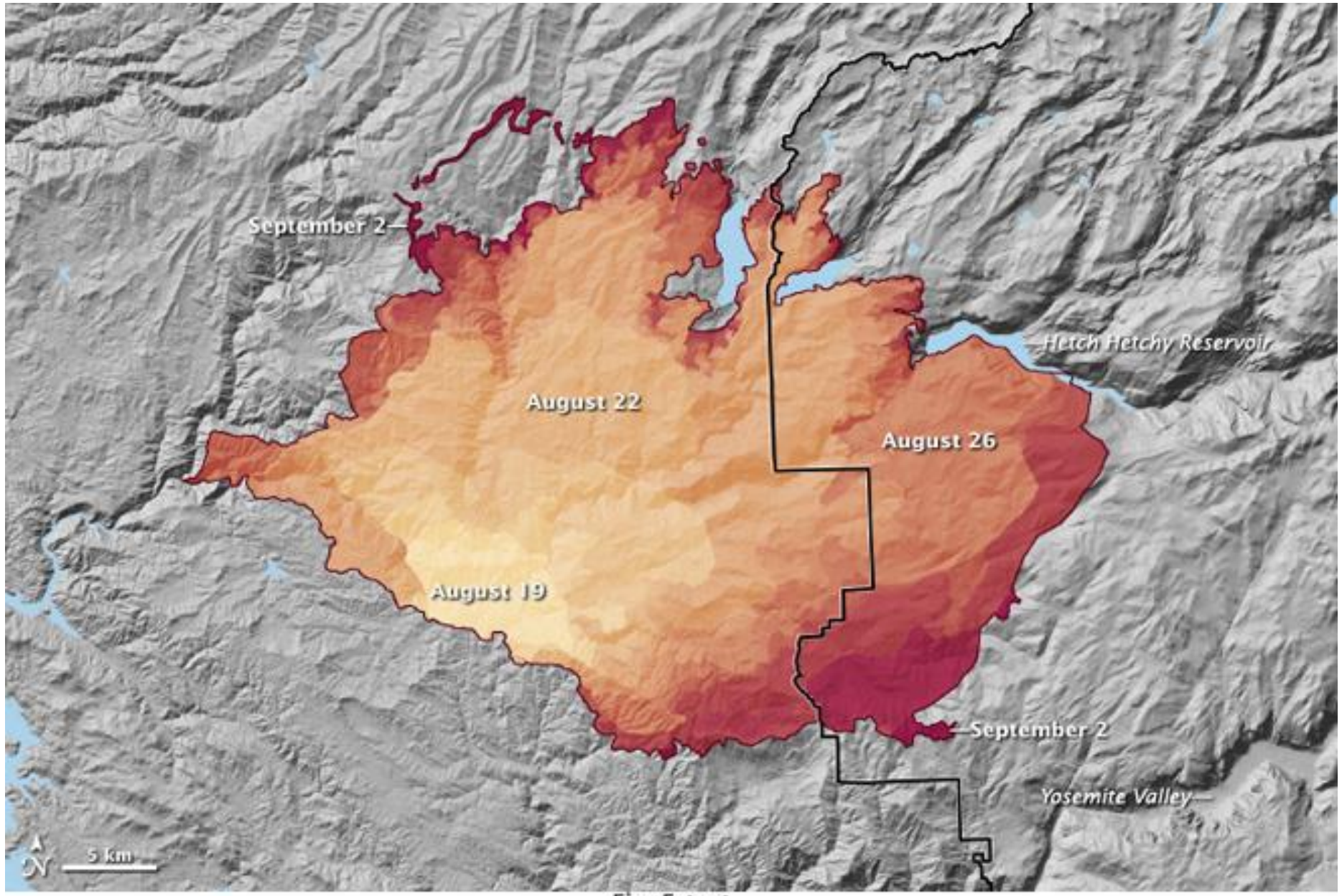


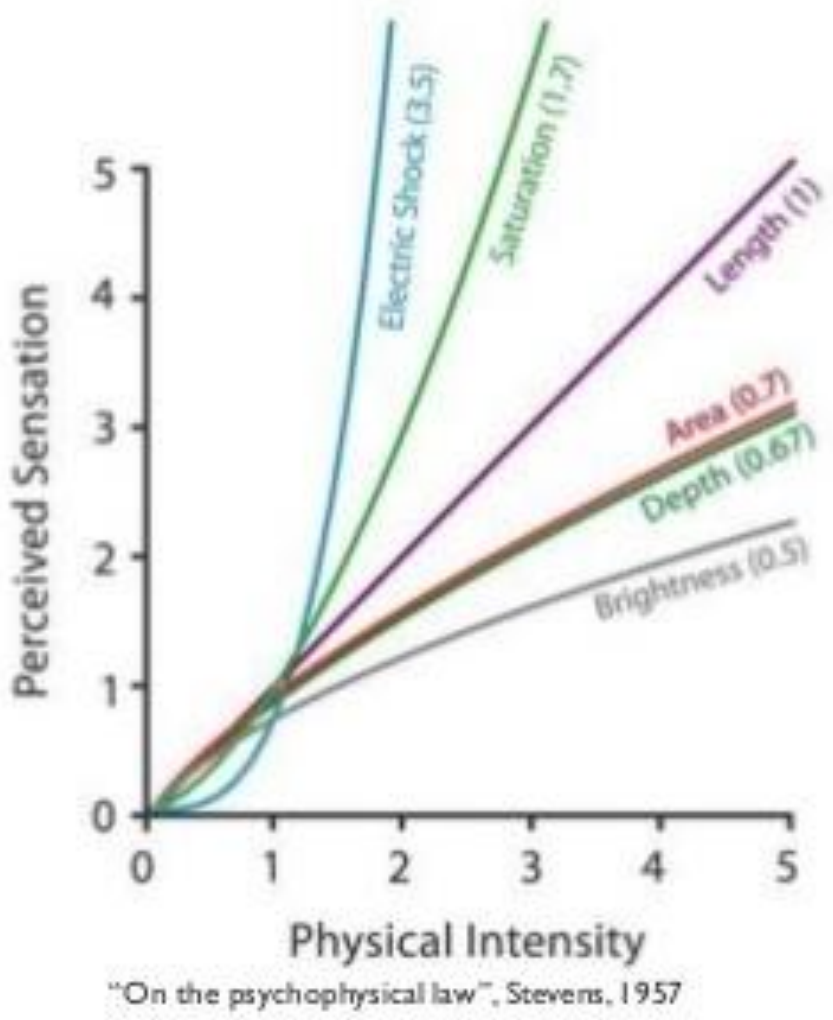
Image from *Borland & Taylor II (2007), Rainbow Color Map (Still) Considered Harmful. IEEE Visualization Viewpoints, pp 14-17.*


Rim Incident
CA-STF-002857
August 31, 2013
Progression Map
Legend
20130817 - 442 Total Acres
20130818 - 370 Acres (812 Total Acres)
20130819 - 3,530 Acres (4,342 Total Acres)
20130820 - 4,910 Acres (9,252 Total Acres)
20130821 - 6,952 Acres (16,204 Total Acres)
20130822 - 37,625 Acres (53,829 Total Acres)
20130823 - 51,793 Acres (105,622 Total Acres)
20130824 - 17,222 Acres (122,844 Total Acres)
20130825 - 11,159 Acres (134,003 Total Acres)
20130826 - 15,720 Acres (149,723 Total Acres)
20130827 - 14,430 Acres (164,153 Total Acres)
20130828 - 18,431 Acres (182,584 Total Acres)
20130829 - 9,961 Acres (192,545 Total Acres)
20130830 - 9,250 Acres (201,795 Total Acres)
20130831 - 219,277 Total Acres
N
Miles
0
1
2

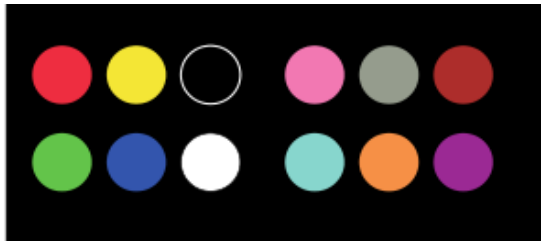

September 2
August 22
August 19
August 26
Hetch Hetchy Reservoir
September 2
Yosemite Valley
N
5 km
Fire Extent
August 19
August 26
September 2

Colour

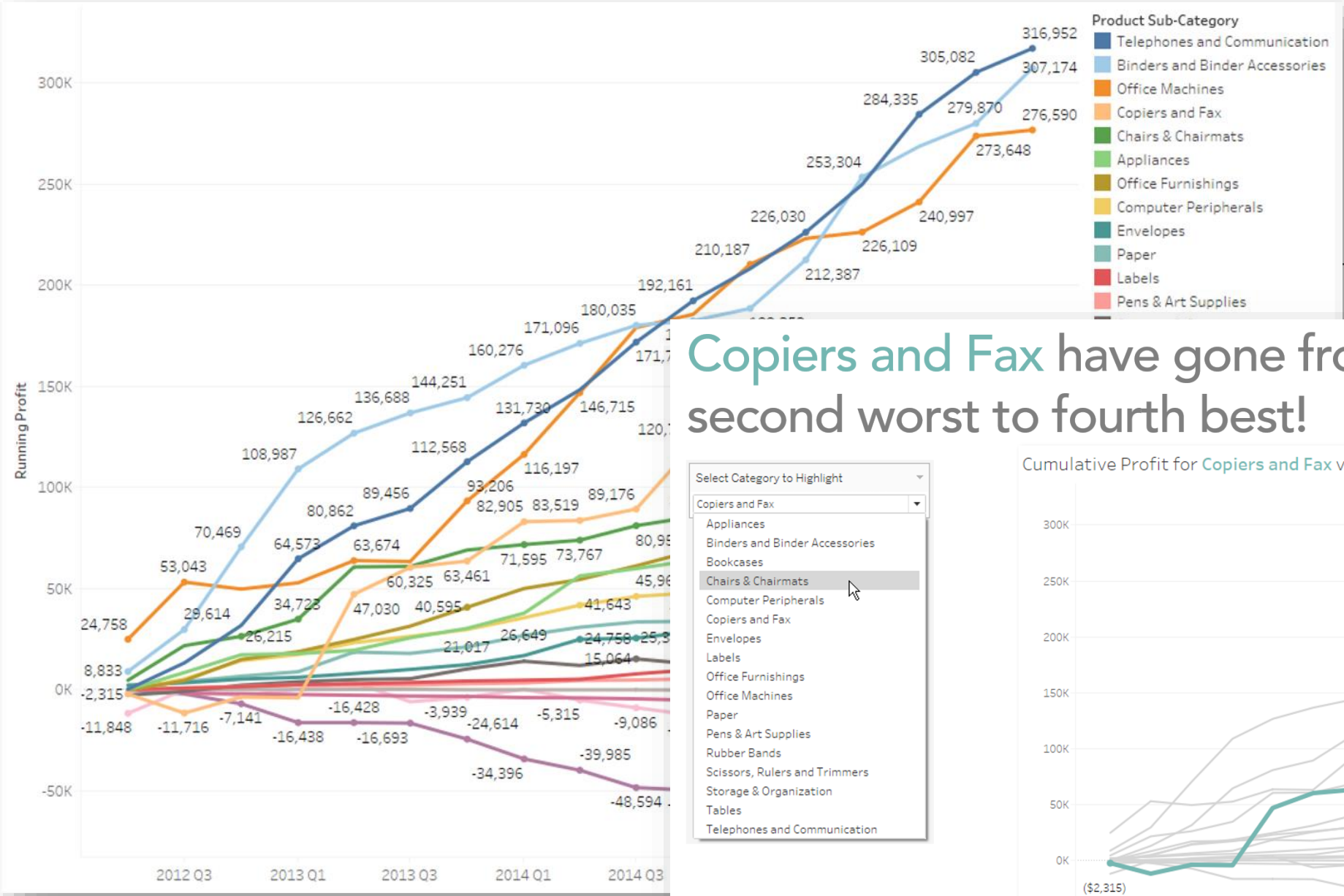
- Use Carefully! Less is more
- Stick to 5-8 colours (less is more)
  - Good contrast
  - Don’t clash
  - Works in grayscale and for colour vision deficiencies (no red & green)



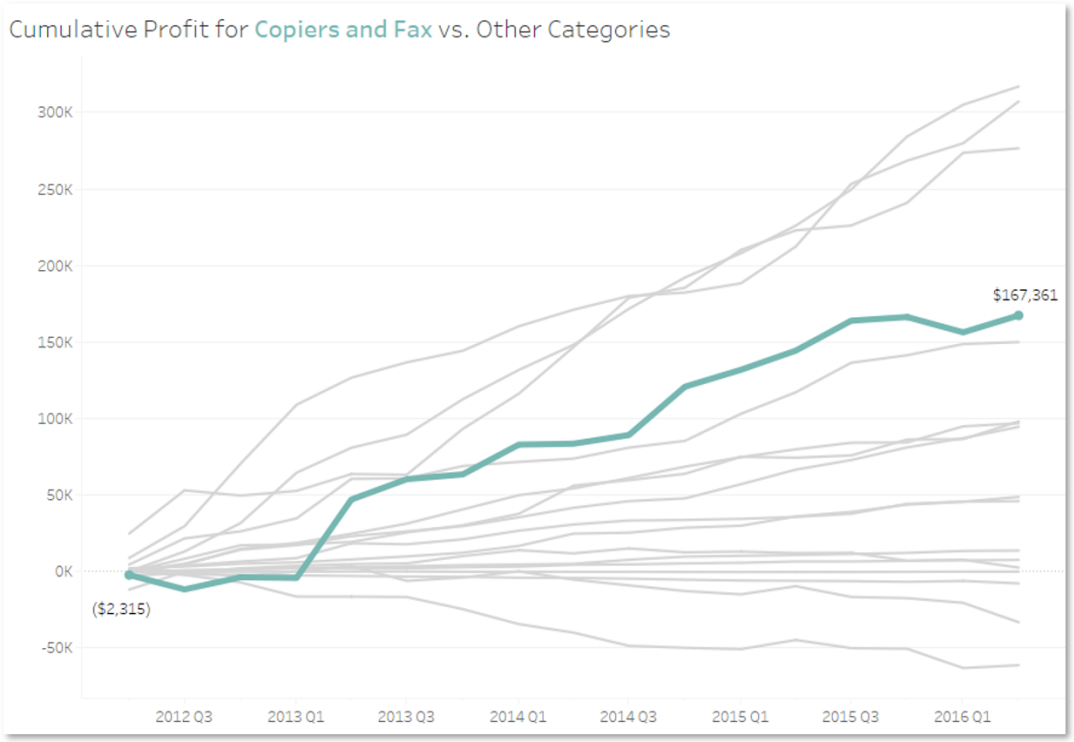
"On the psychophysical law", Stevens, 1957



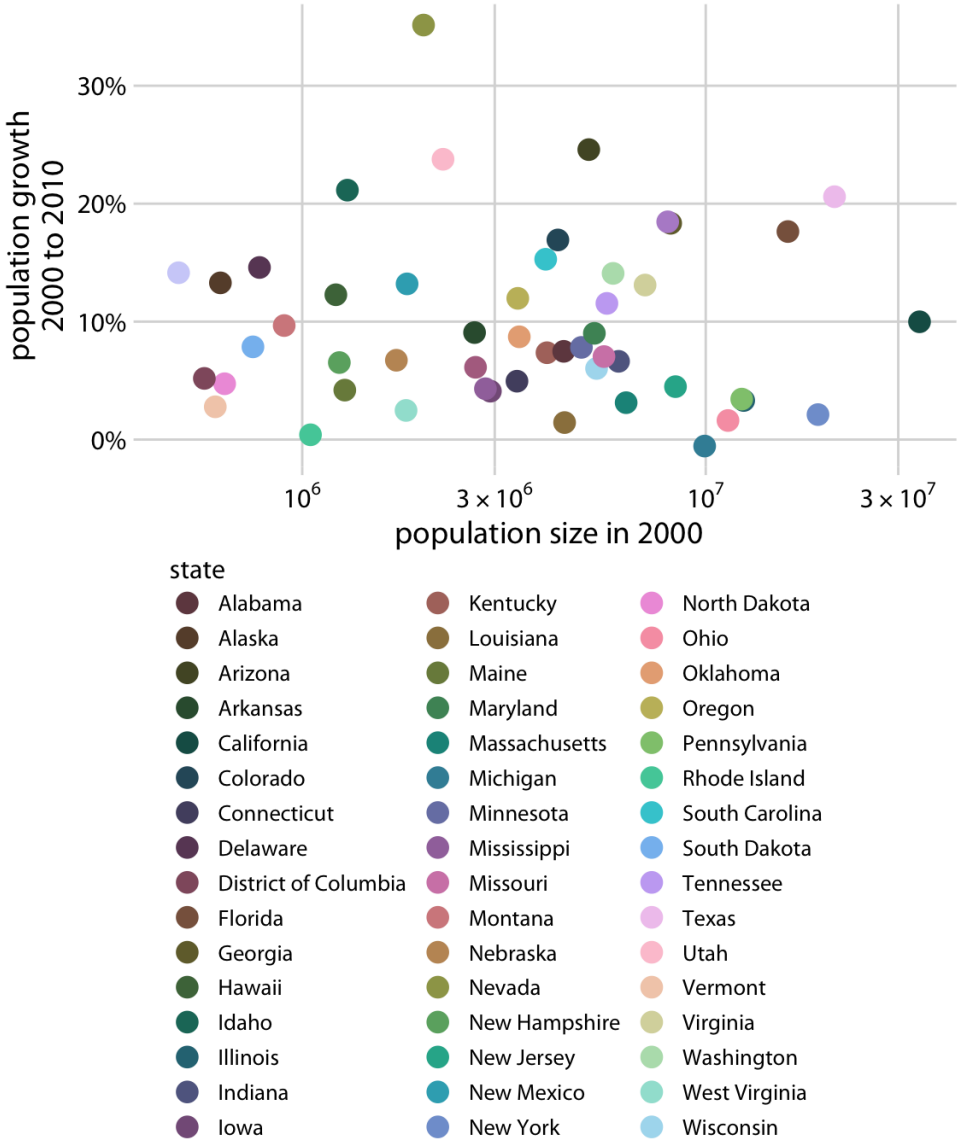
Too much colour



Copiers and Fax have gone from second worst to fourth best!

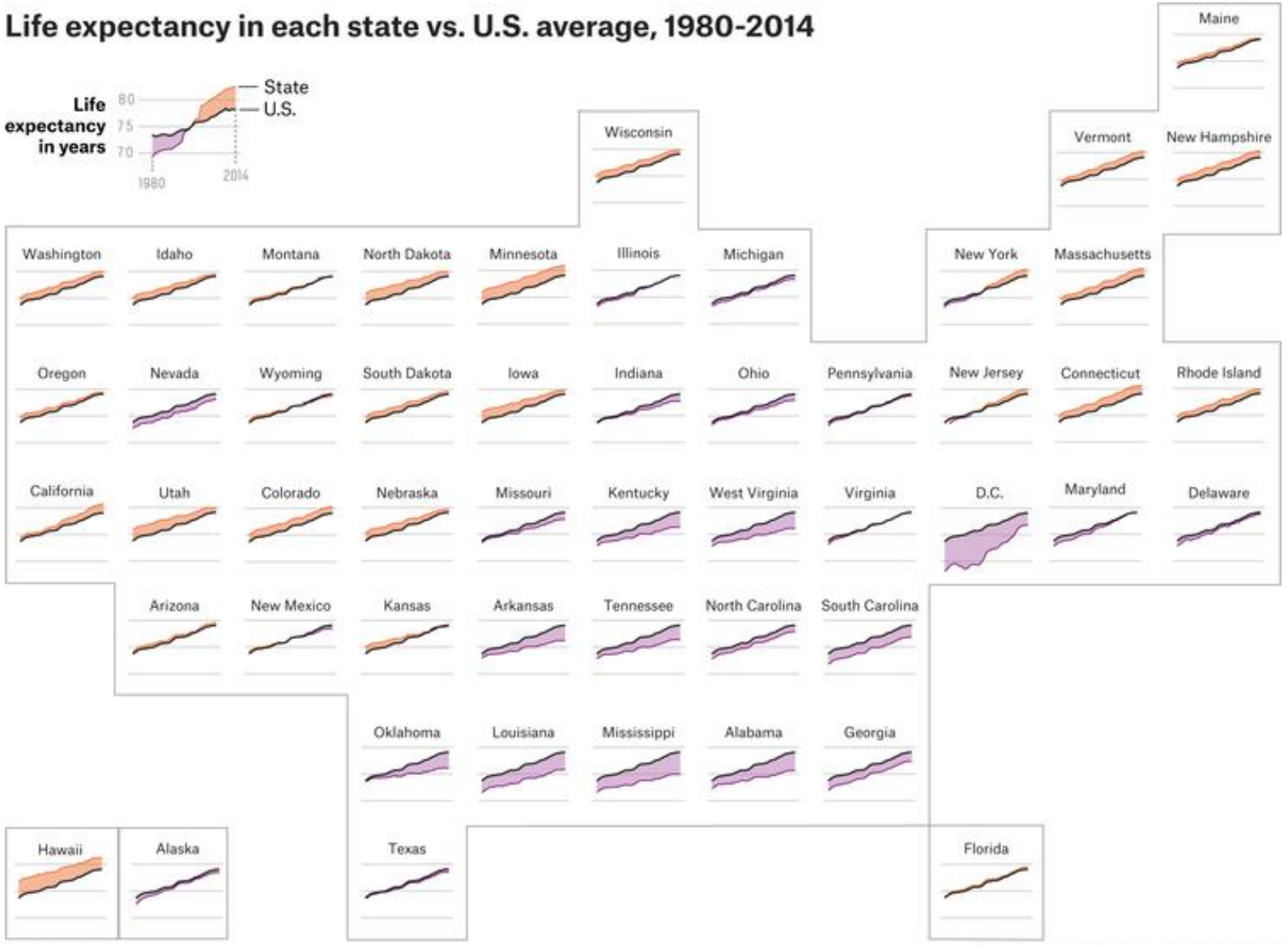


Too many colours



from https://clauswilke.com/dataviz/color-pitfalls.html

Life expectancy in each state vs. U.S. average, 1980-2014



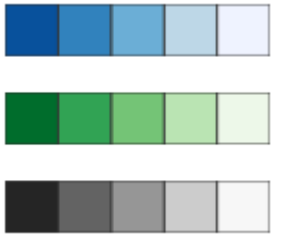
FiveThirtyEight

SOURCE: INSTITUTE FOR HEALTH METRICS AND EVALUATION

Colour Scales

Sequential (dark to light or light to dark)

- Quantitative data or ordered qualitative data
- Single or multiple hues

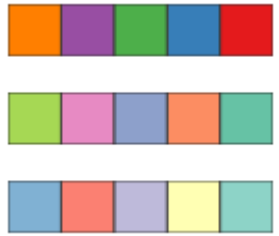


Diverging (dark in 1 hue to light to dark in a different hue)

- Quantitative data or ordered qualitative data
- Use if there is a meaningful middle point

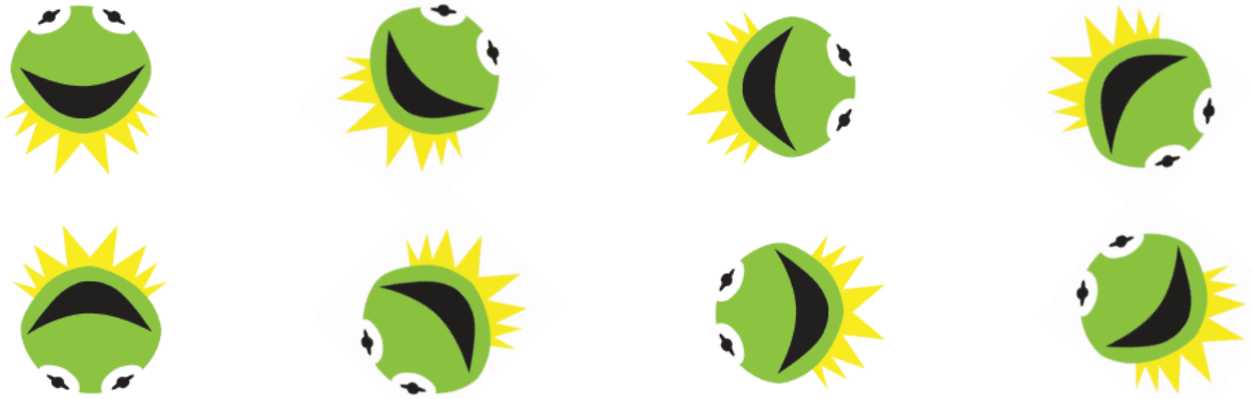
Categorical

- Qualitative data
- Give hues different brightness so that they appear distinct in grayscale
- Be careful with red & green



Color scales from ColorBrewer 2.0

Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness	Yes	Yes	No	Yes	7 / 10
Saturation	Yes	Yes	No	Yes	7 / 10
Hue	Yes	Yes	Not advisable	Not advisable	7 / 10
Angle	Yes	Yes	No	No	4 / 8
Texture					



Variable	Selective	Associative	Quantitative	Order	Length
Size	Yes	Yes	Yes (1D), Mostly (2D), Not likely (3D)	Yes	5/20
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness	Yes	Yes	No	Yes	7 / 10
Saturation	Yes	Yes	No	Yes	7 / 10
Hue	Yes	Yes	Not advisable	Not advisable	7 / 10
Angle	Yes	Yes	No	No	4 / 8
Texture	Yes	Yes	No	No	Infinite

Variable	Selective	Associative	Quantitative	Order	Length
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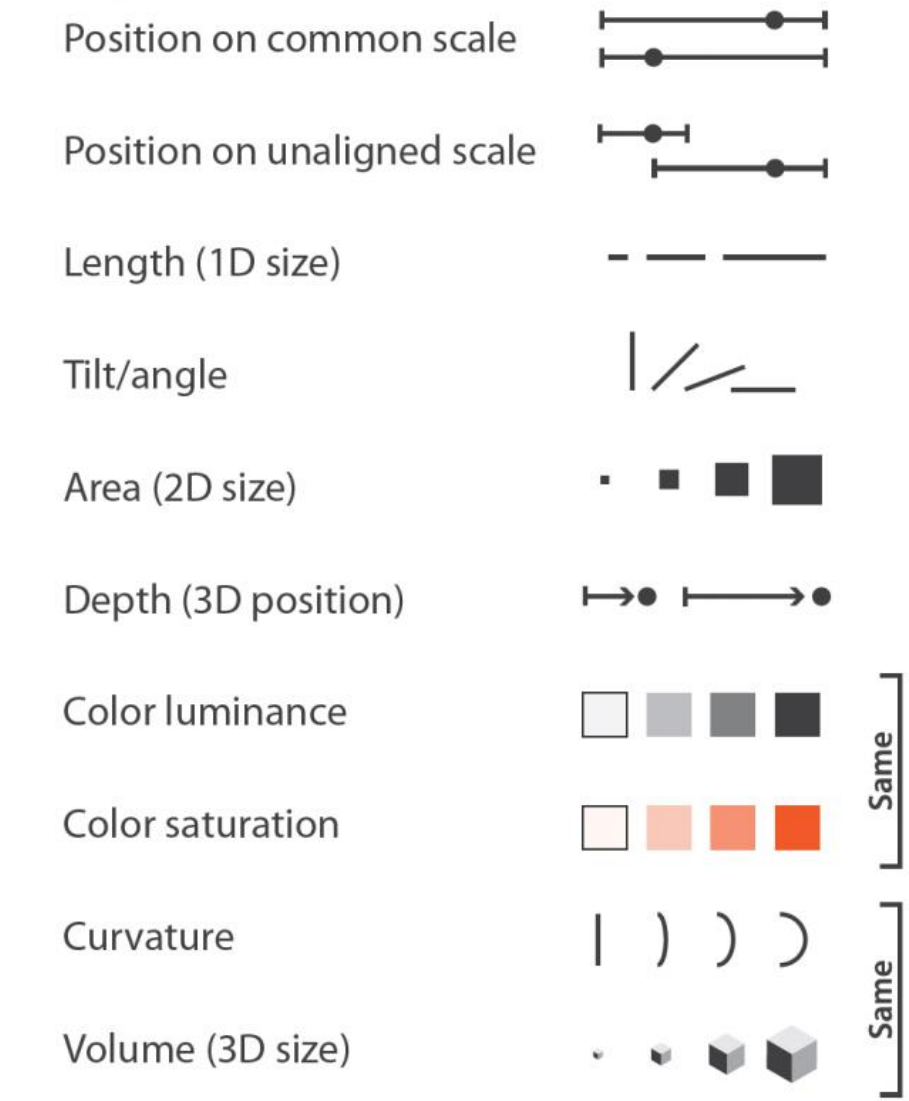
Position	Yes	Yes	Yes	Yes	Infinite
Shape	< 5	< 5	No	No	5 / Infinite
Lightness	Yes	Yes	No	Yes	7 / 10
Saturation	Yes	Yes	No	Yes	7 / 10
Hue	Yes	Yes	Not advisable	Not advisable	7 / 10
Angle	Yes	Yes	No	No	4 / 8
Texture	Yes	Yes	No	No	Infinite

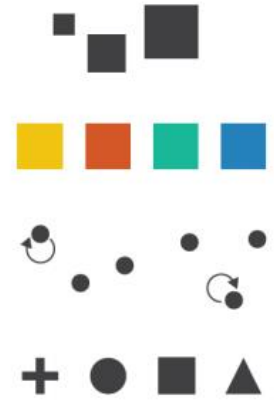
Semiology of Graphics by Jacques Bertin. 1967.

M.S.T. Carpendale. **Considering Visual Variables as a Basis for Information Visualisation**. Research report 2001-693-16, Department of Computer science, University of Calgary, 2003.

Magnitude Channels: Ordered Attributes

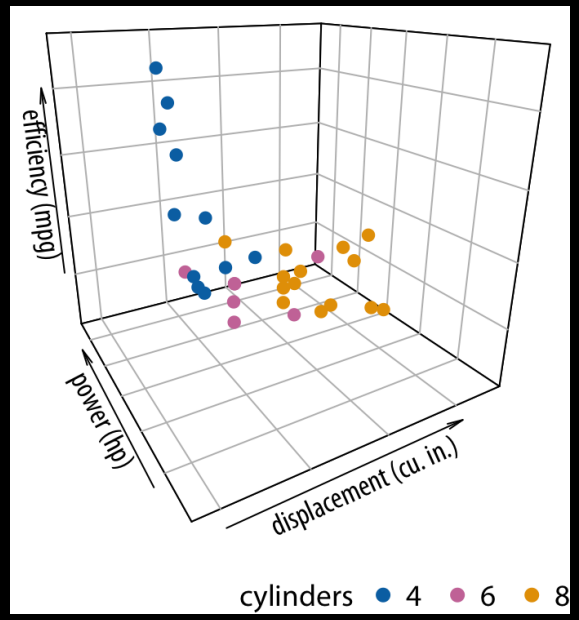


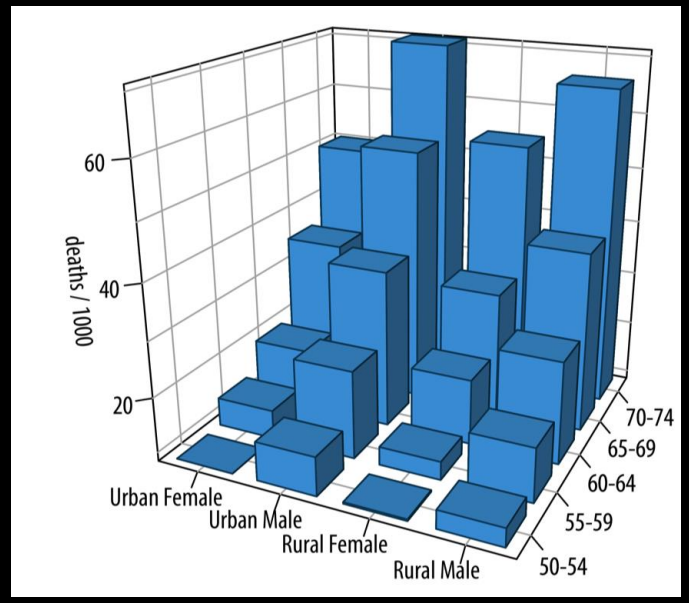
Identity Channels: Categorical Attributes

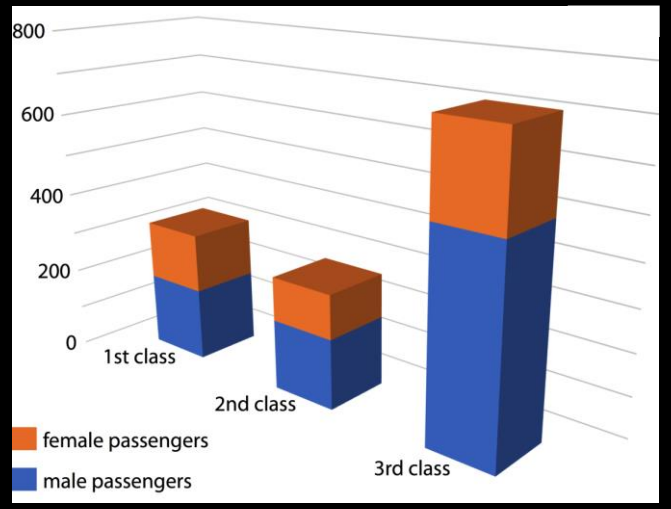


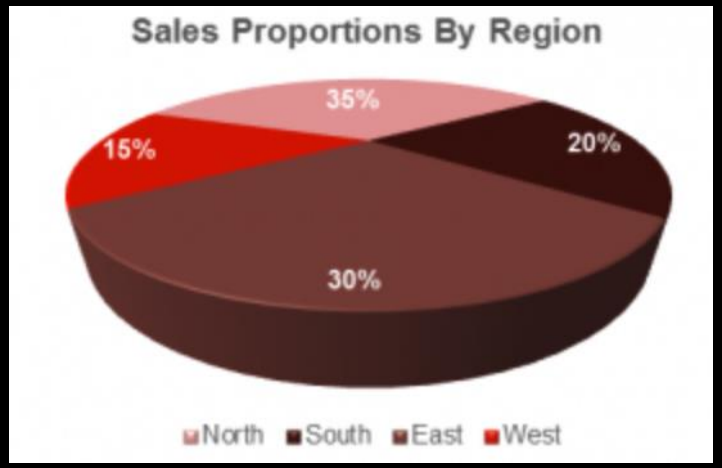
From ***Visual Analysis & Design*** by Tamara Munzner

Avoid 3D



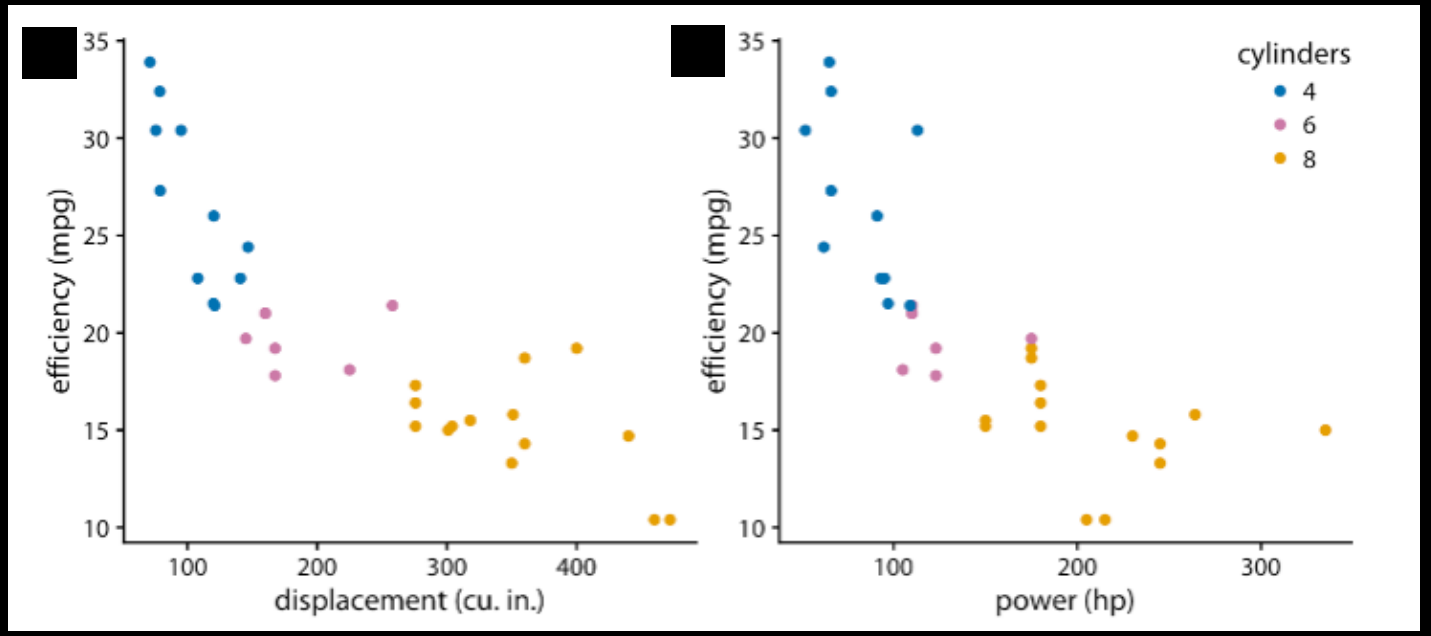


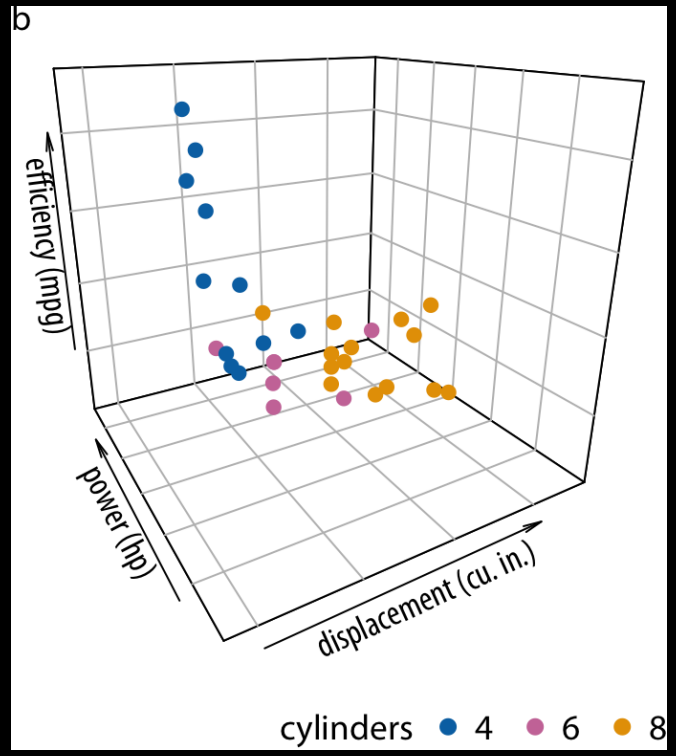


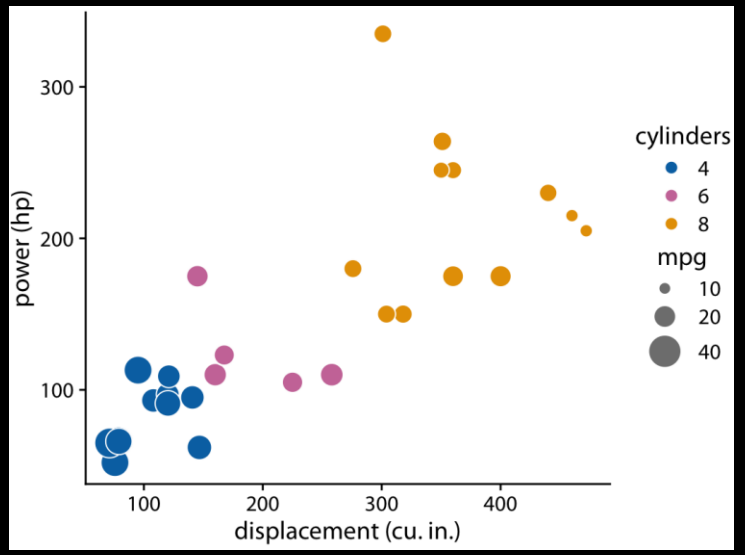


Examples from https://clauswilke.com/dataviz/no-3d.html and https://www.data-to-viz.com/caveat/3d.html

Avoid 3D
Better solution



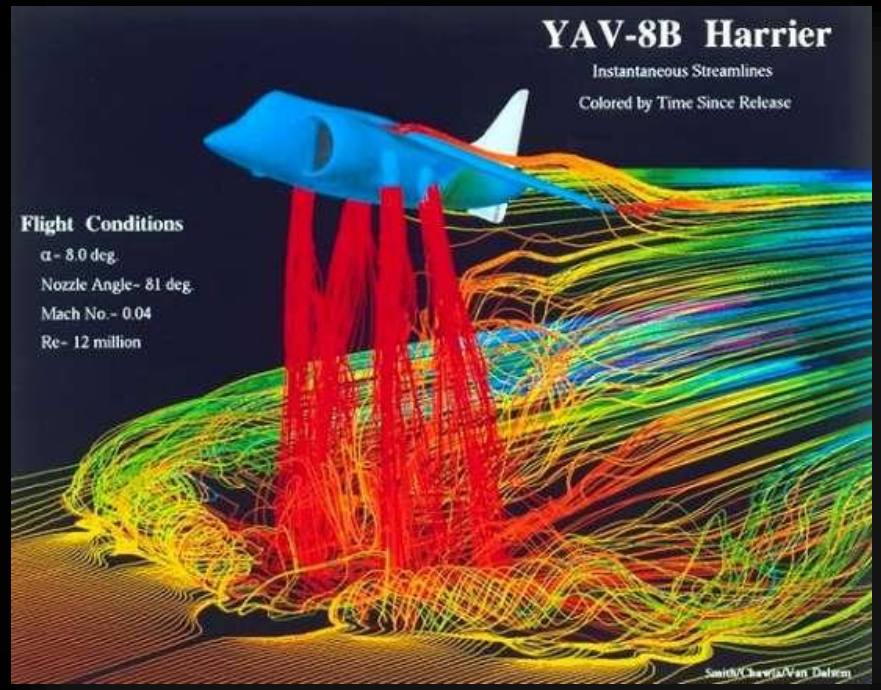


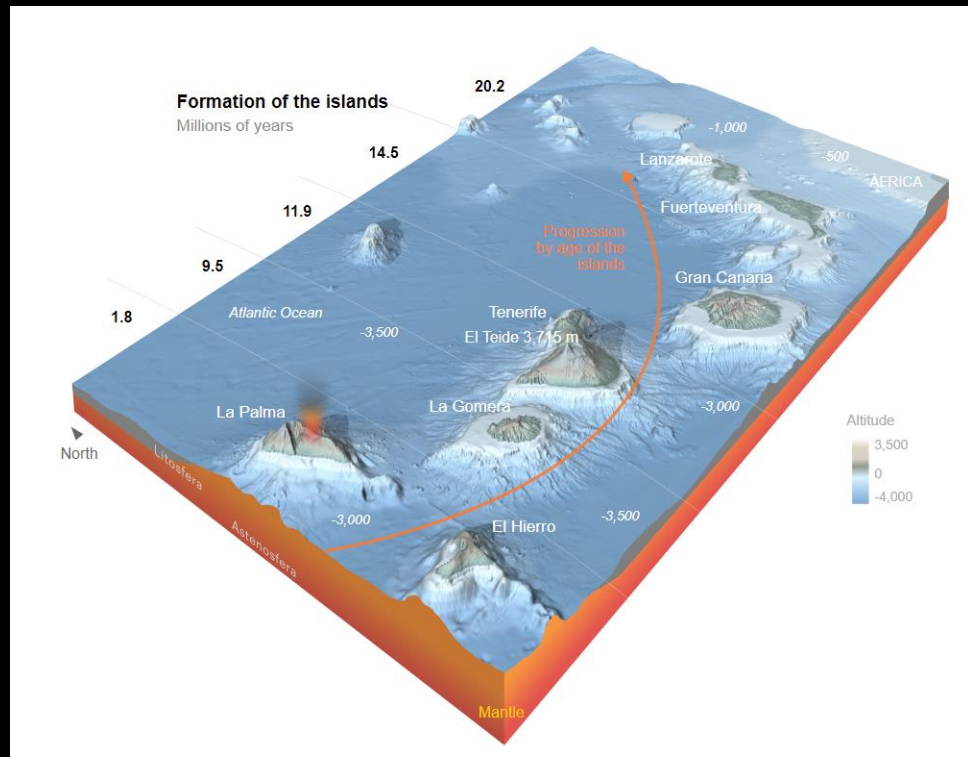


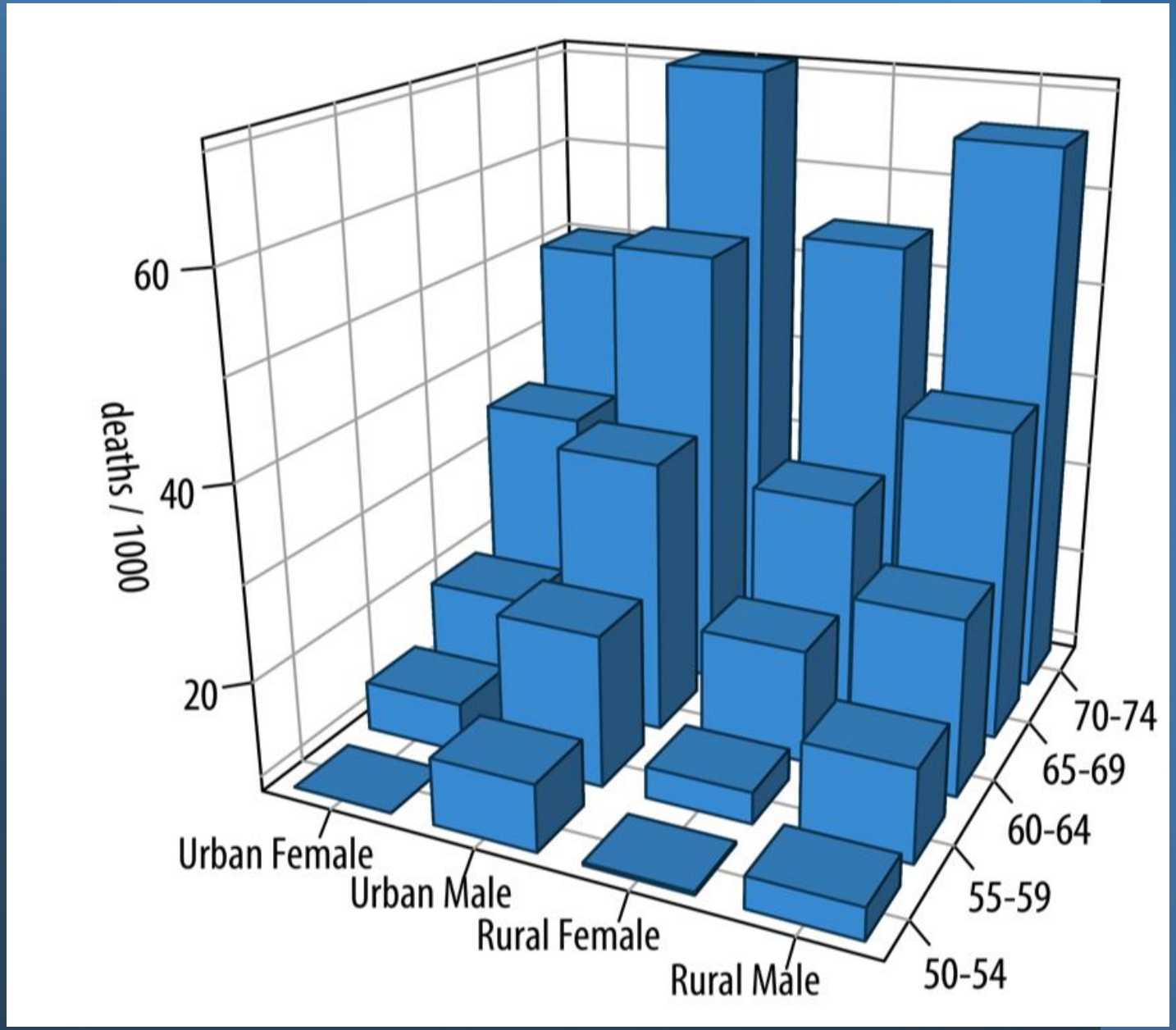
From https://clauswilke.com/dataviz/no-3d.html

When to use 3D?

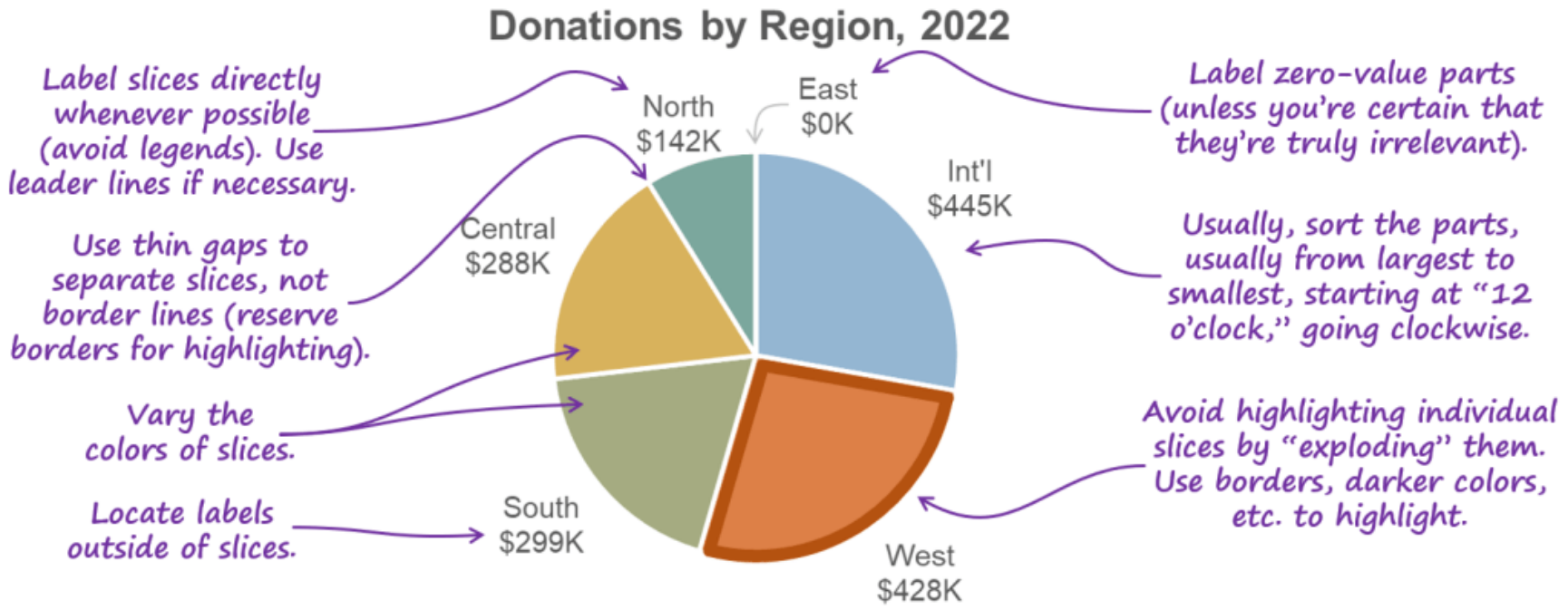
- When your data has 3D position






60
40
20
deaths / 1000
Urban Female
Urban Male
Rural Female
Rural Male
70-74
65-69
60-64
55-59
50-54

Pie Charts – Use Carefully

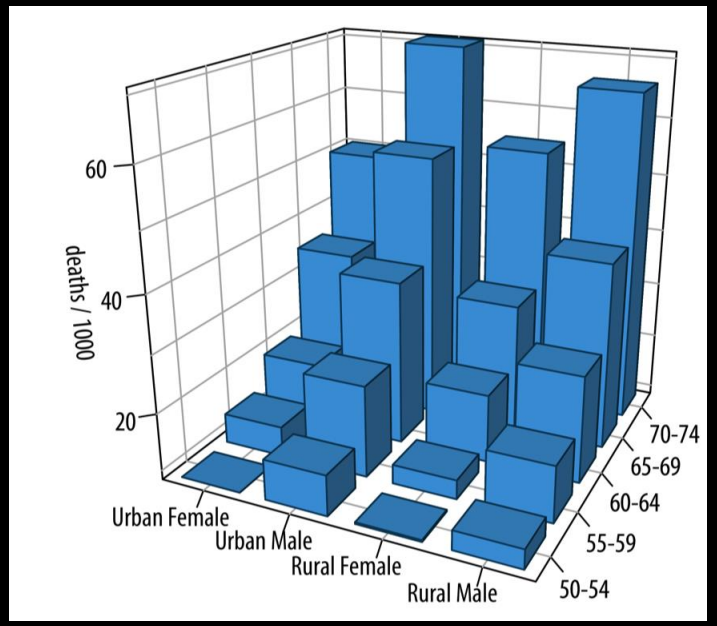


Small Multiples

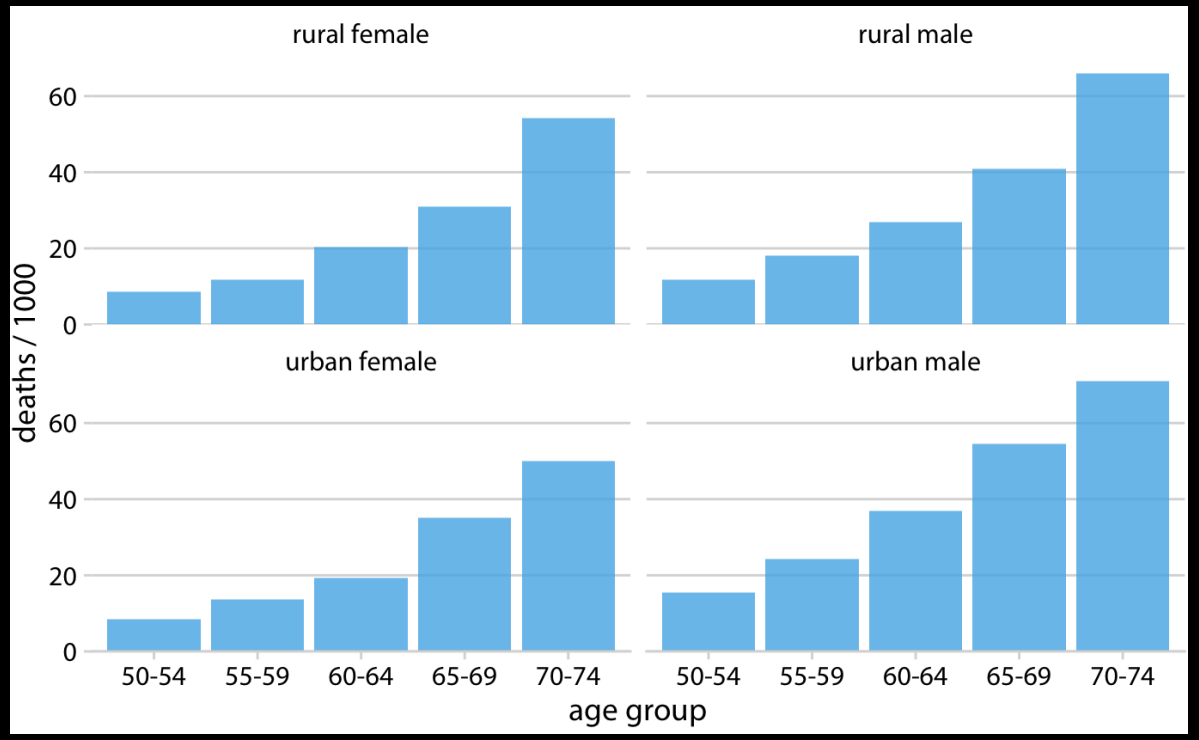
Break complicated charts into smaller, simplified charts

Use alignment and repetition to highlight differences

Needs appear in order and same scales, sizes, & shape

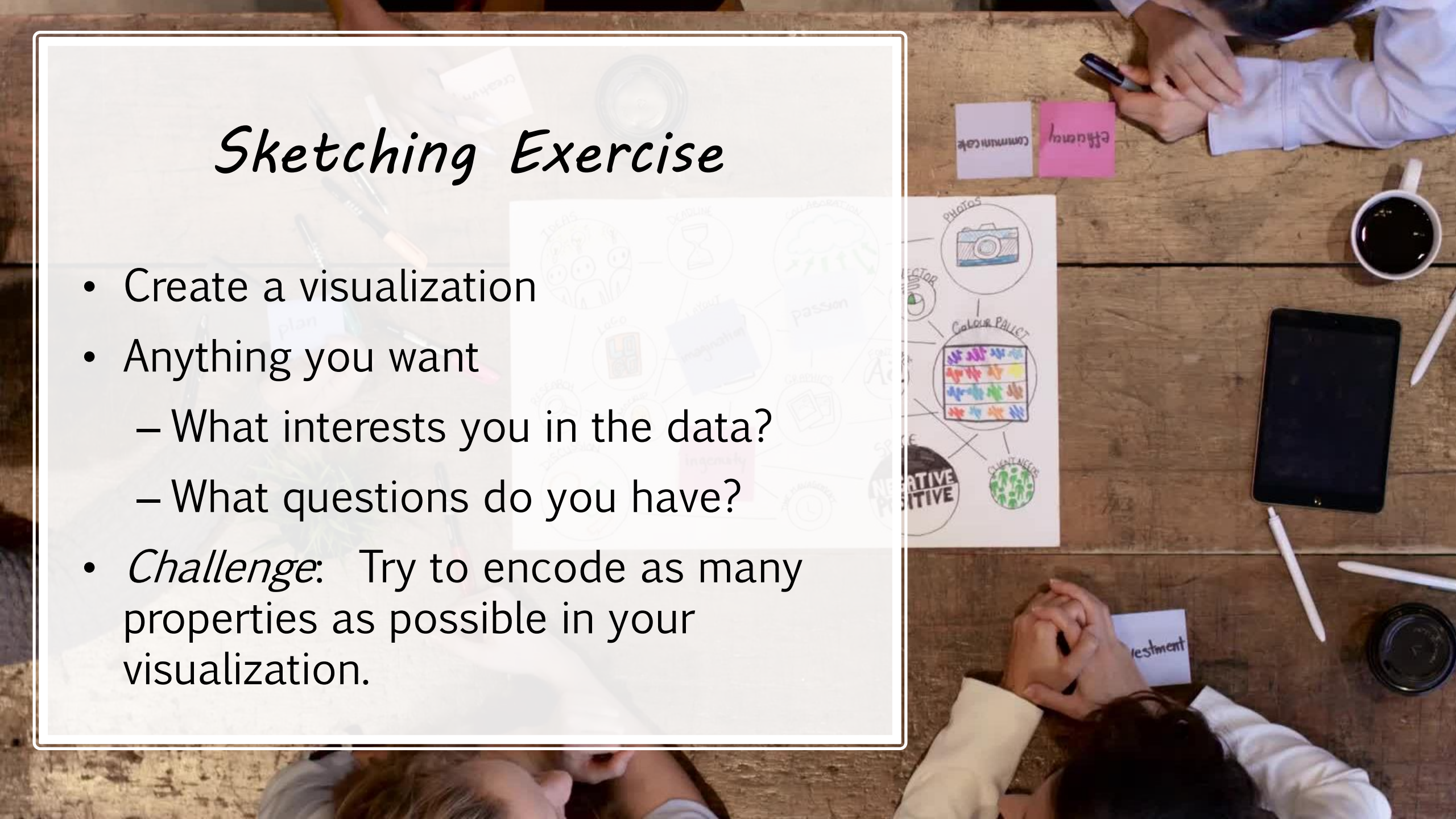


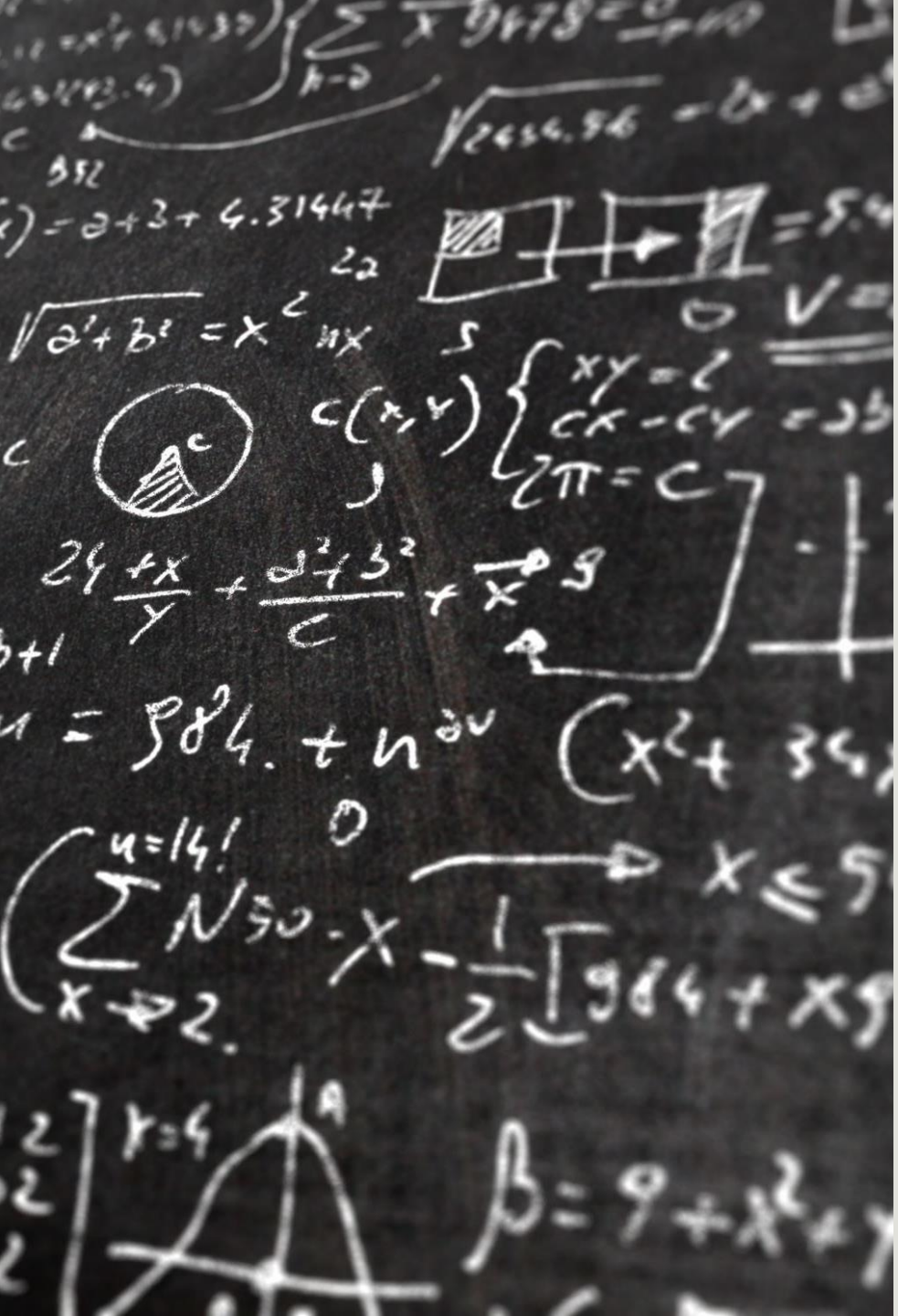
From https://clauswilke.com/dataviz/no-3d.html



Sketching Exercise

- Create a visualization
- Anything you want
  - What interests you in the data?
  - What questions do you have?
- *Challenge*: Try to encode as many properties as possible in your visualization.





Sketching

Fast & easy

- Encourages exploration
- Easier to iterate & discard

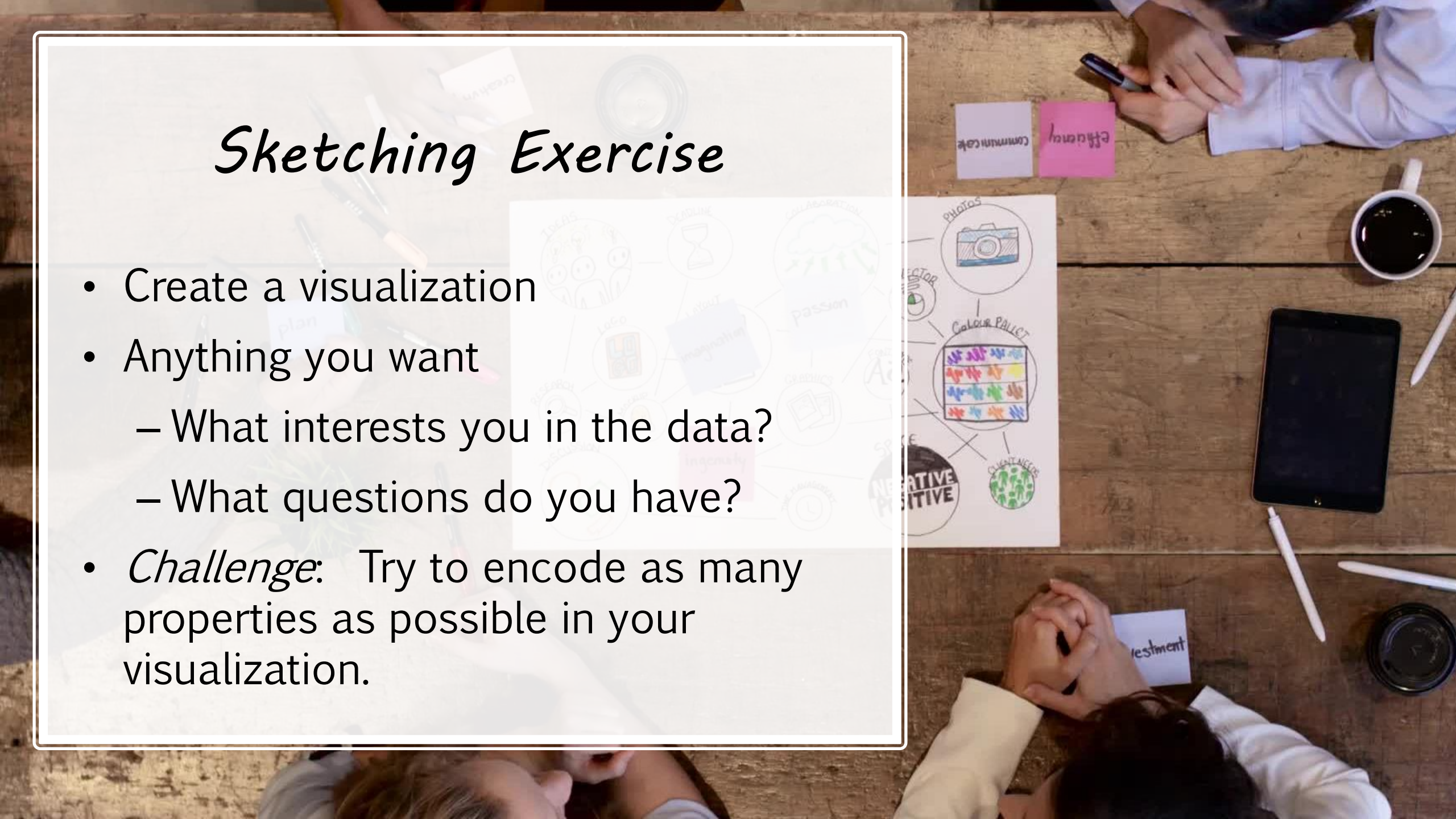
Not bound by software / data limitations

Learn about your data / find problems

Explore the “design space” rather than software capabilities

Sketching Exercise

- Create a visualization
- Anything you want
  - What interests you in the data?
  - What questions do you have?
- *Challenge*: Try to encode as many properties as possible in your visualization.



Magnitude Channels: Ordered Attributes

- Position on common scale
- Position on unaligned scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Depth (3D position)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

Same

Same

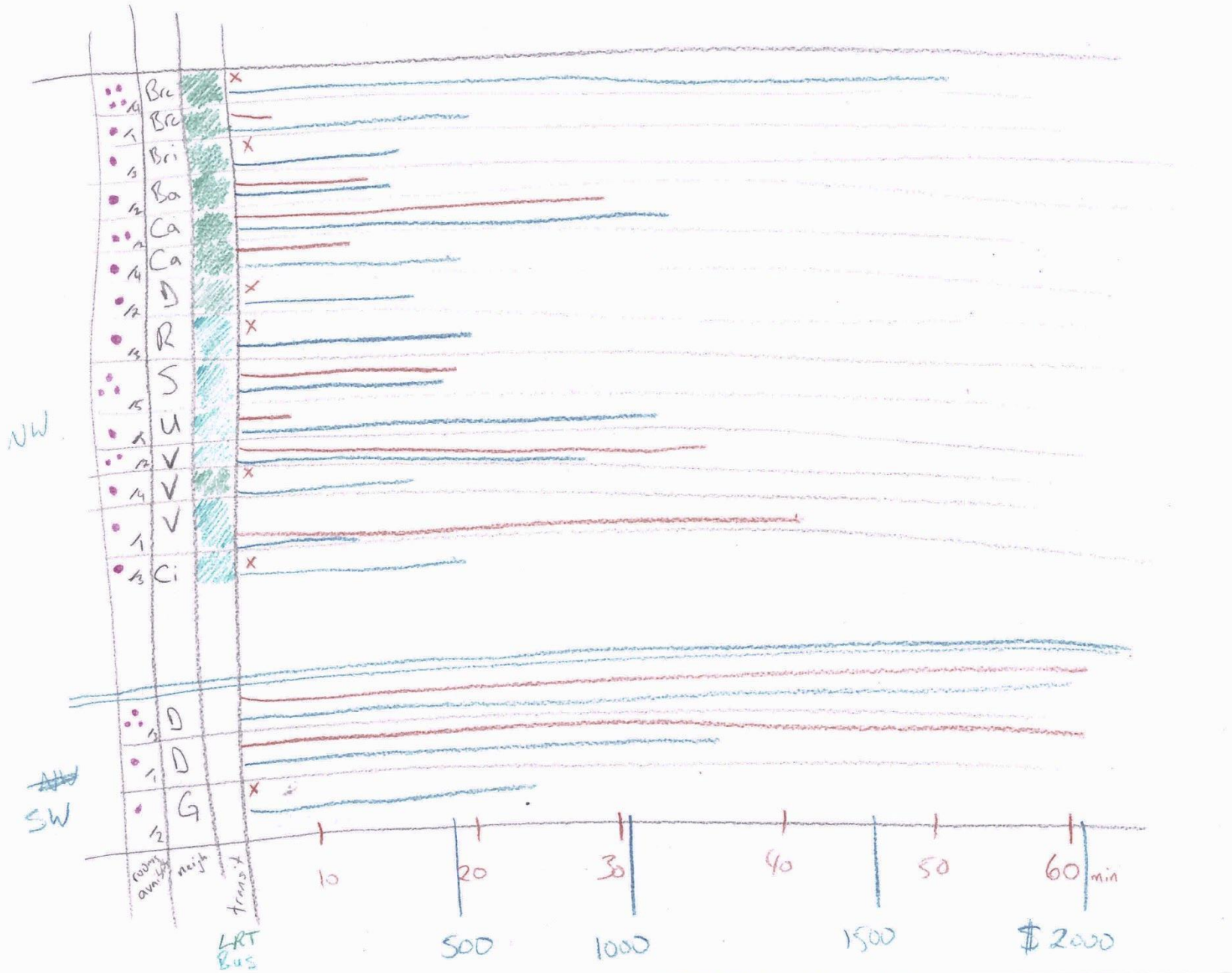
Most ▲

Effectiveness

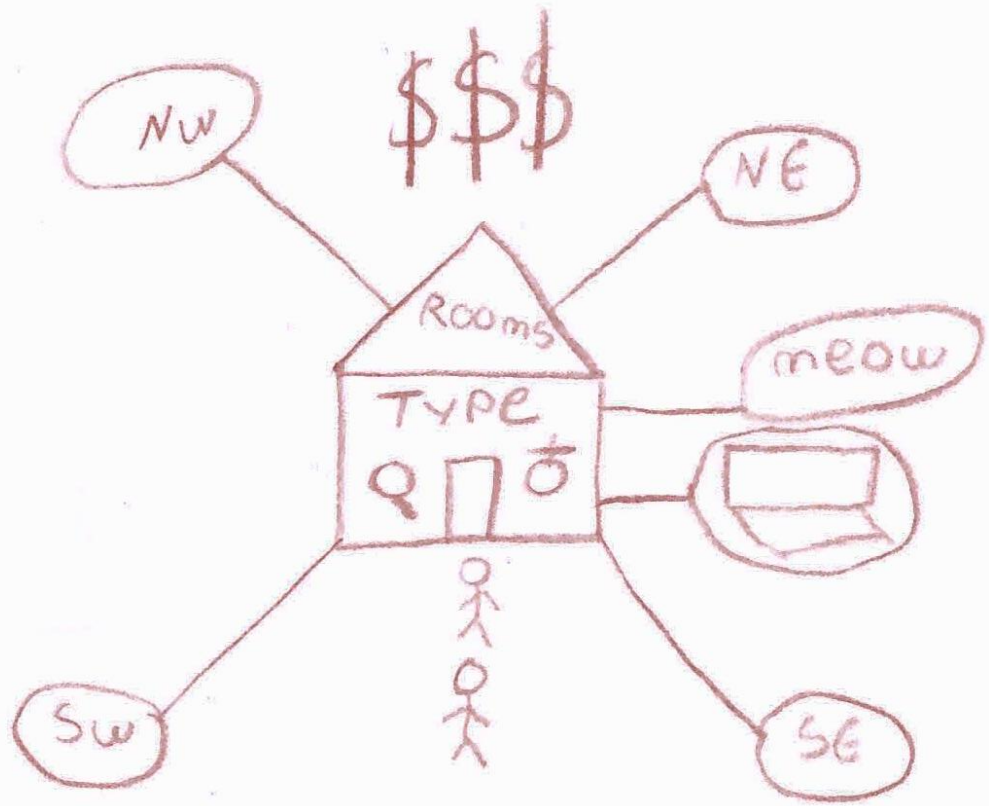
▼ Least

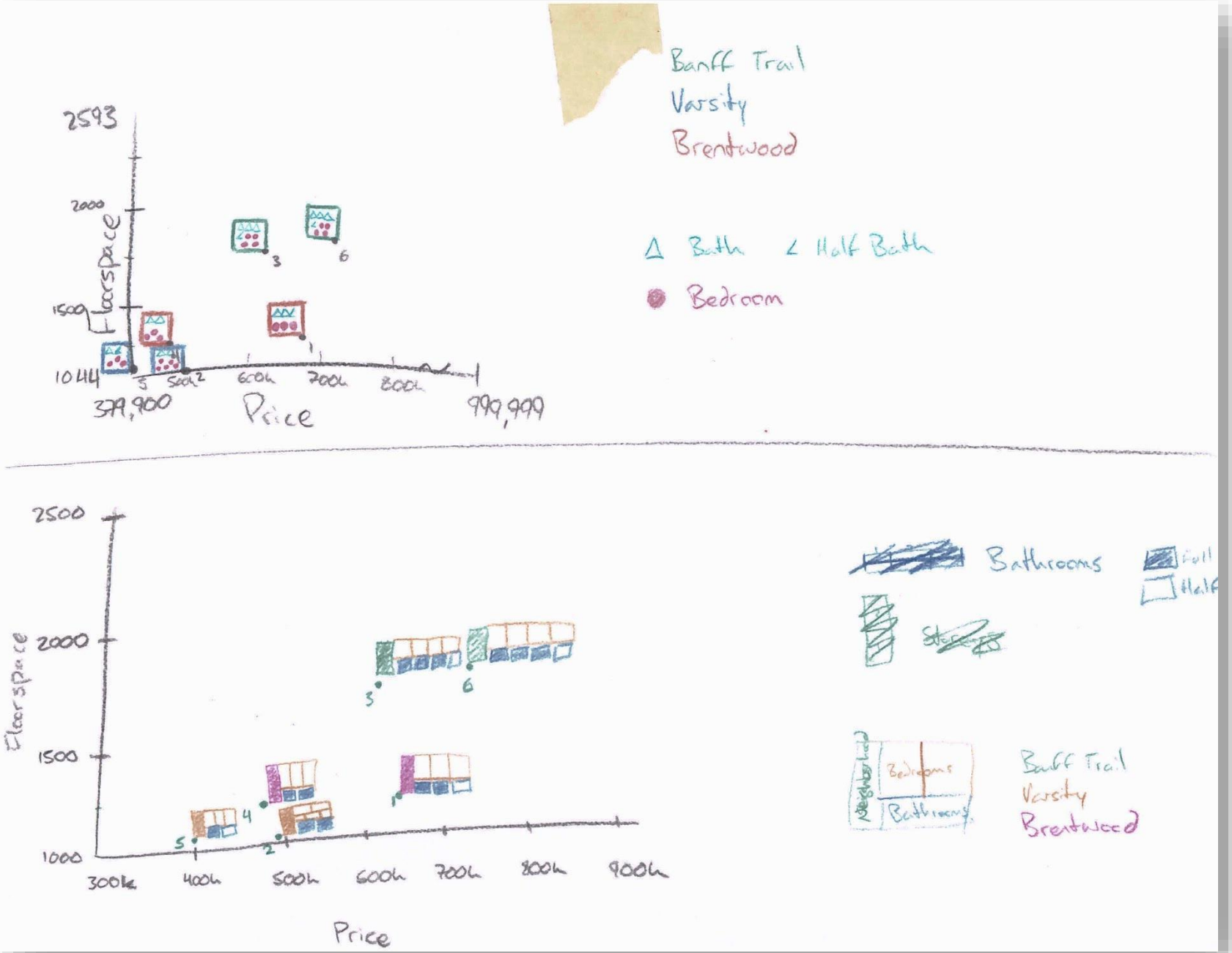
Identity Channels: Categorical Attributes

- Spatial region
- Color hue
- Motion
- Shape



NW
SW
Brc
Brc
Bri
Ba
Ca
Ca
D
R
S
U
V
V
V
Ci
D
D
G
rooms avail
neigh
transit
LRT
Bus
10
20
30
40
50
60 min
500
1000
1500
$ 2000


$$$
NW
NE
Rooms
meow
TYPE
SW
SE


Banff Trail
Varsity
Brentwood
Bath
Half Bath
Bedroom
2593
2000
1500
1044
Floorspace
379,900
Price
999,999
2500
2000
1500
1000
Floorspace
300k
400k
500k
600k
700k
800k
900k
Price
Bathrooms
Bedrooms
Bathrooms
Banff Trail
Varsity
Brentwood

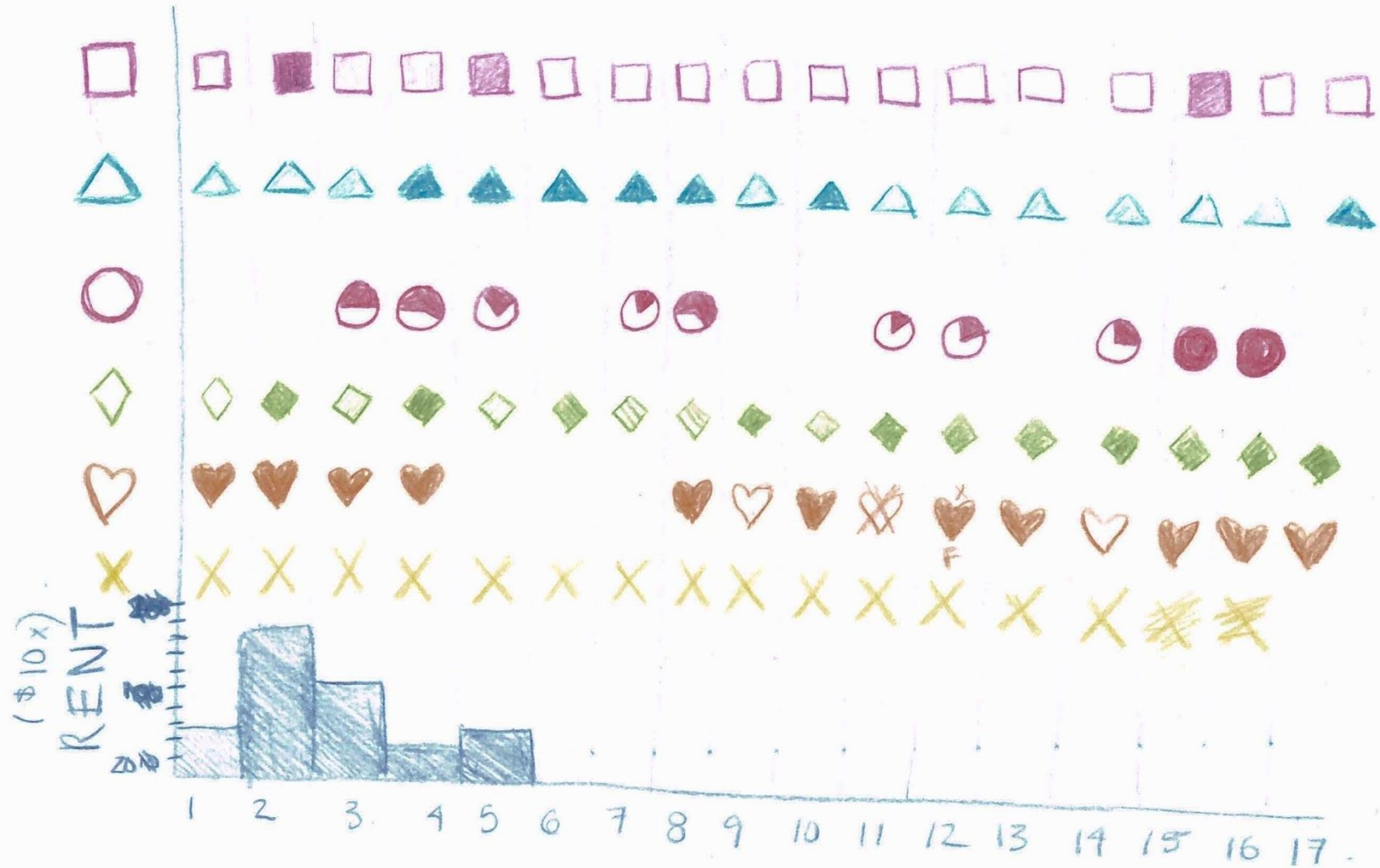

RENT
($10x)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Chart Types

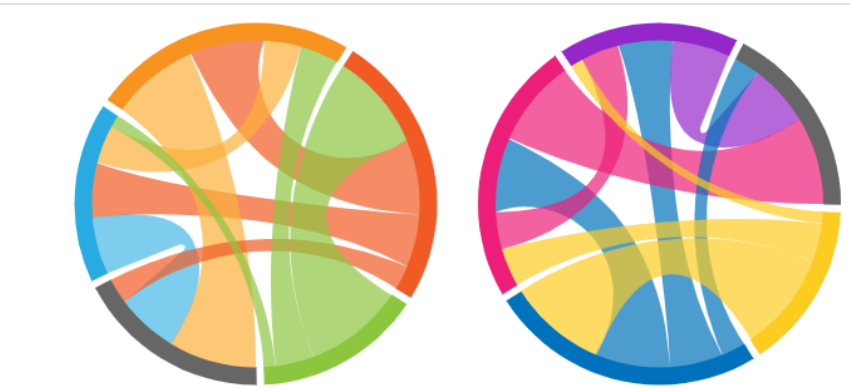
https://datavizcatalogue.com/

https://flowingdata.com/chart-types/

Image from https://datavizcatalogue.com/

Data Vis Catalog

Chord Diagram



Description

This type of diagram visualises the inter-relationships between entities. The connections between entities are used to display that they share something in common. This makes Chord Diagrams ideal for comparing the similarities within a dataset or between different groups of data.

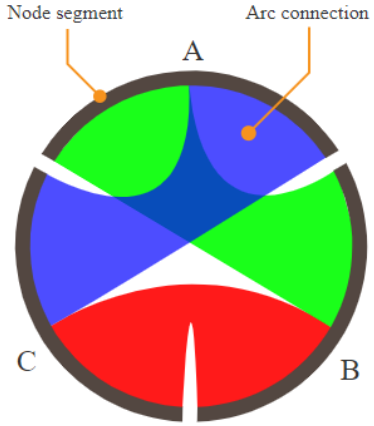
Nodes are arranged along a circle, with the relationships between points connected to each other either through the use of arcs or Bézier curves. Values are assigned to each connection, which is represented proportionally by the size of each arc. Colour can be used to group the data into different categories, which aids in making comparisons and distinguishing groups.

Over-cluttering becomes an issue with Chord Diagrams when there are too many connections displayed.

Functions

Comparisons Relationships

Anatomy



	A	B	C
A		10	10
B	10		10
C	10	10	

A 10 B
B 10 C
C 10 A

Data Visualization Tools

At academic institutions we see a wide variety of data

Focusing on free

1. Preparing Data
2. Visualization

Data Tools:

Data Wrangler / Alteryx Designer Cloud

DataWrangler alpha

alteryx

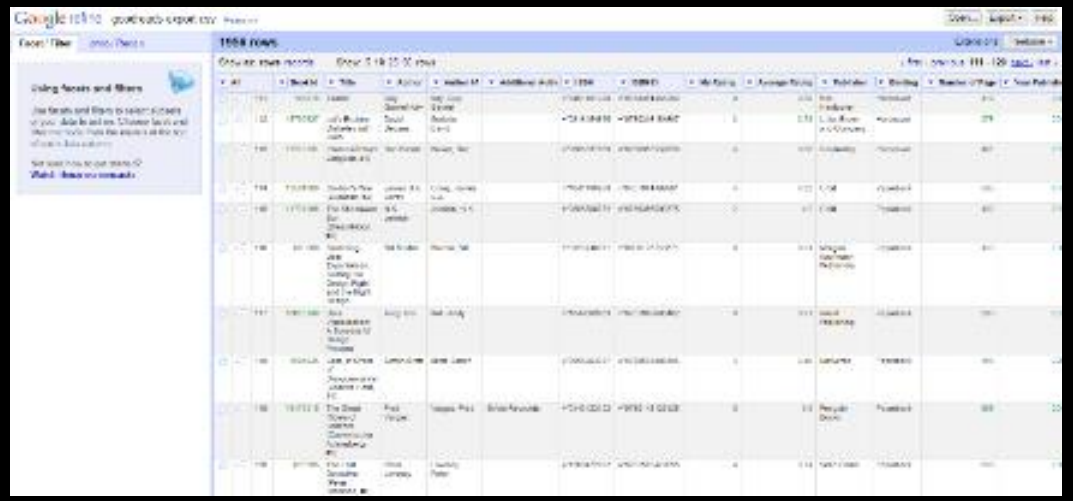
http://vis.stanford.edu/wrangler

https://www.alteryx.com/products/designer-cloud

- Interactive tool for cleaning & rearranging
- Suggests changes
- Wrangler: web tool – data to external site (1000 lines)
- Import: text, CSV, JSON
- Export: CSV, JSON, TDE (Tableau)

Data Tools: Open Refine

http://openrefine.org/



- Consolidate spelling
- Auto-detect outliers
- Sorting & filtering
- Auto-suggests changes
- Import: Excel, XML, JSON, RDF, CSV
- Export: Excel, CSV, ODF, HTML

Data Tools: Tabula

http://tabula.nerdpower.org/

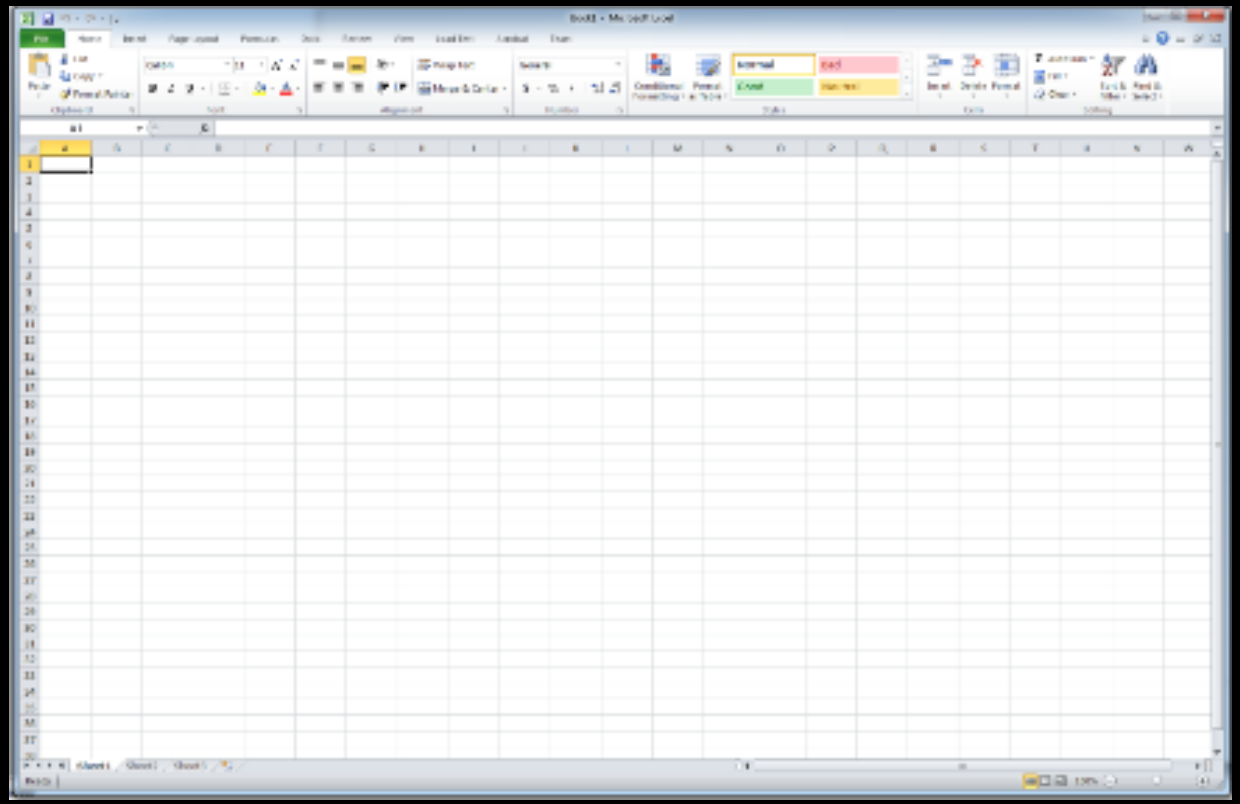
- Extract data from PDFs
- Stand-alone app for Windows/Mac
- Interactively select table
- Output: CSV, Excel

Visualization Tools

- General Purpose
- Special Purpose
  - Text Analysis
  - Sets
  - Maps
  - Networks / Graphs
  - Timelines
- Colour

Excel

- Simple charts
- Hard to customize
- Can do anything!

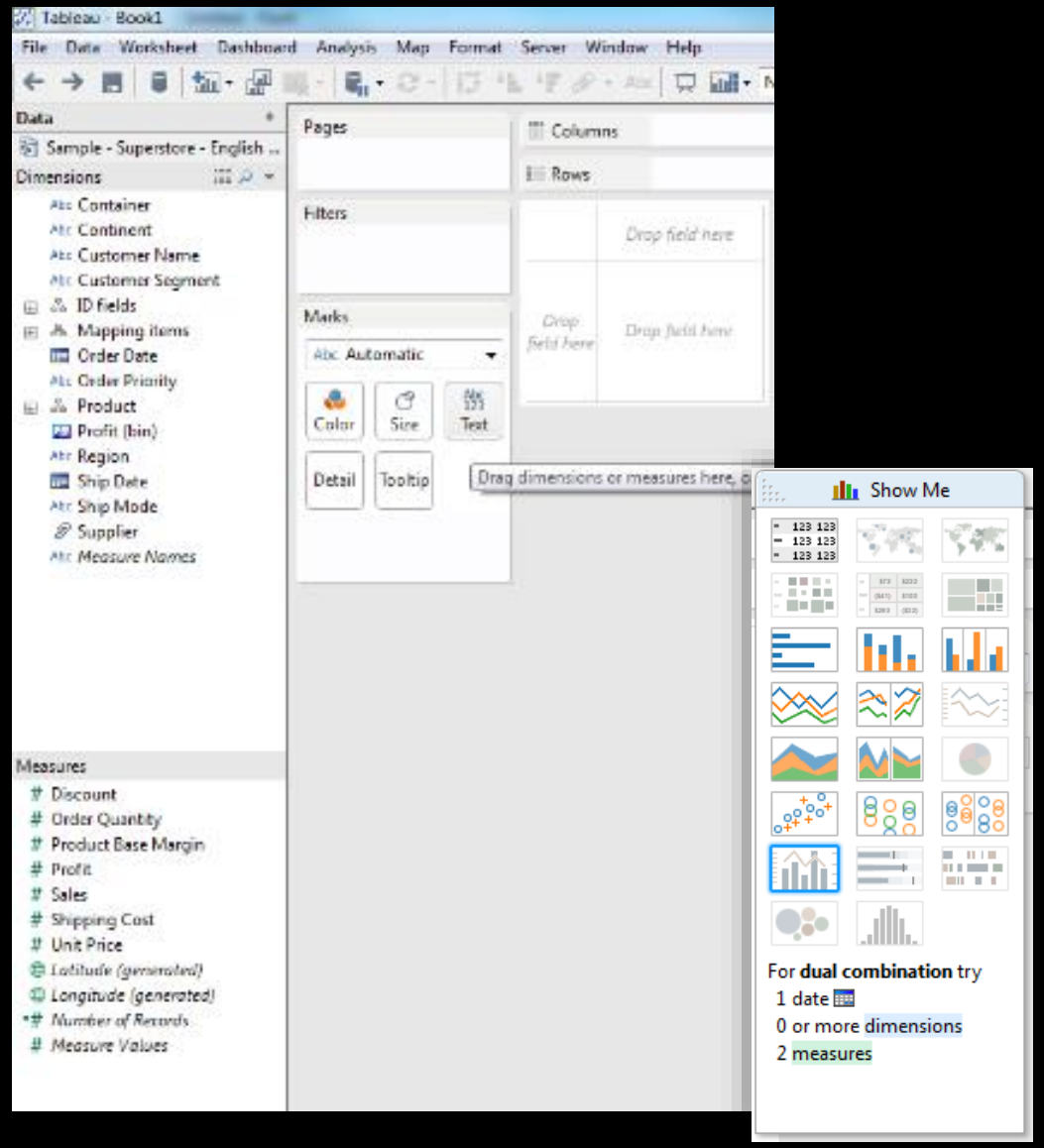


VIS Tools: Tableau

http://www.tableau.com/

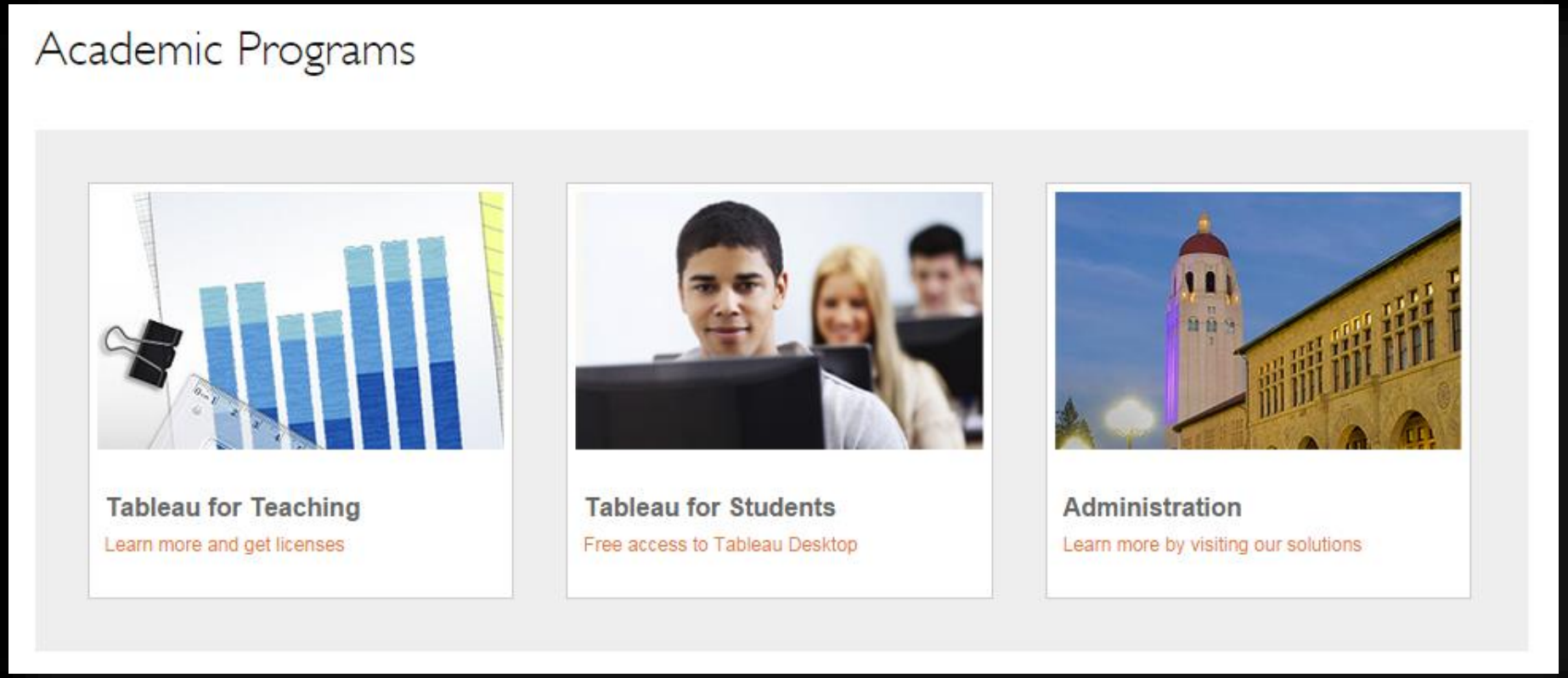
Strengths:

- Many chart types
- Interactive web output
- Access to underlying data
- Many data sources (live)
- Drag & drop – easy to experiment
- Maps
- Good defaults
- Link visualizations
- R can plugin
- Academic Program - Free for students



Student Program

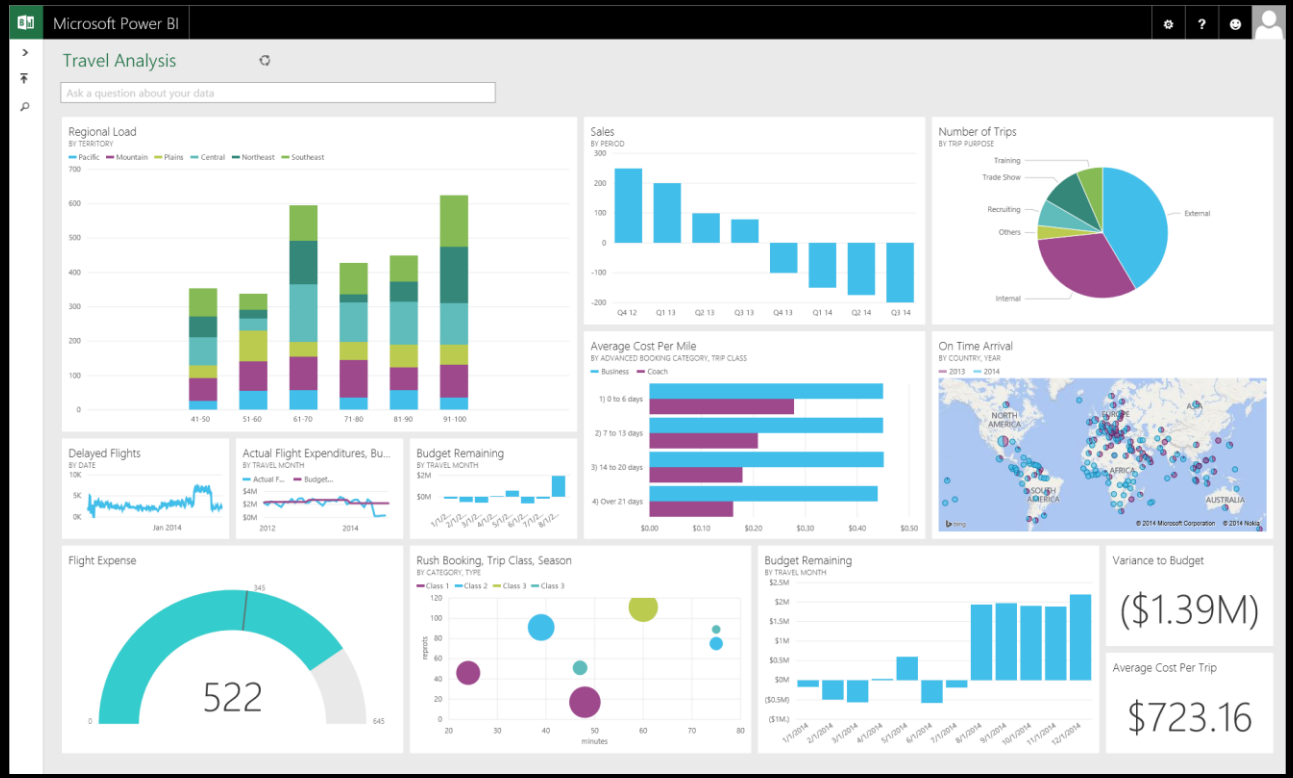
- Tableau desktop **free** for post-secondary students.
- http://www.tableau.com/academic



VIS Tools : POWER BI

https://powerbi.microsoft.com/en-us/

- Similar capabilities as tableau
- Can build plugins
- Better data modeling
- Not as customizable
- Exploration not as easy
- Lots of menus
- Less data capacity than Tableau

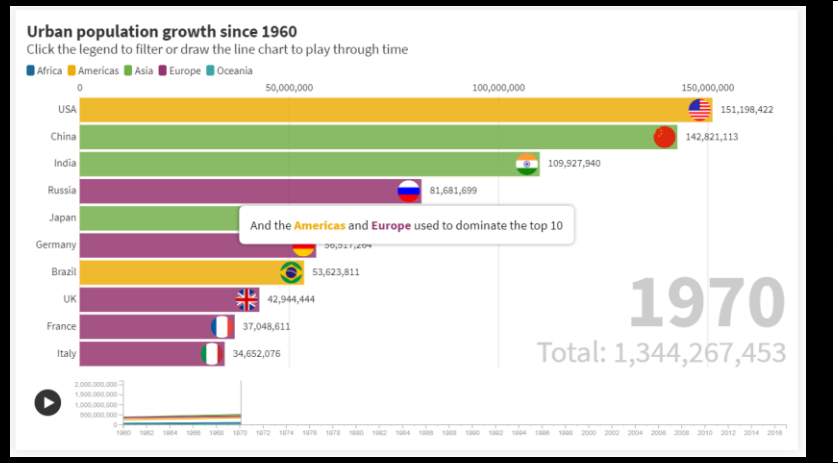


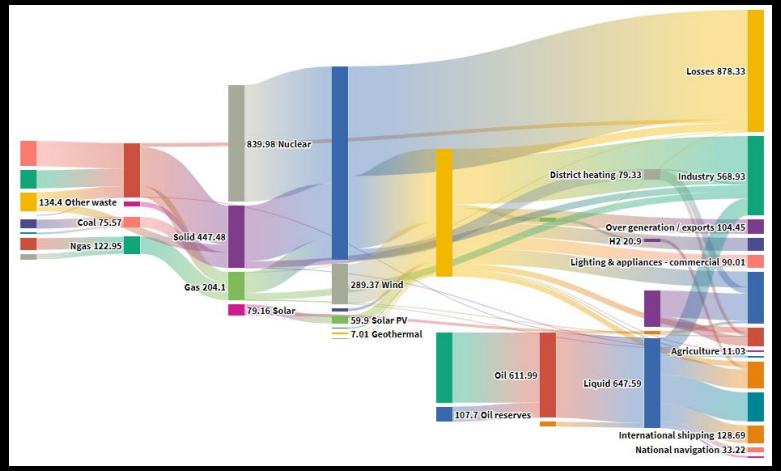
https://www.em360tech.com/microsoft-power-by-dashboard/

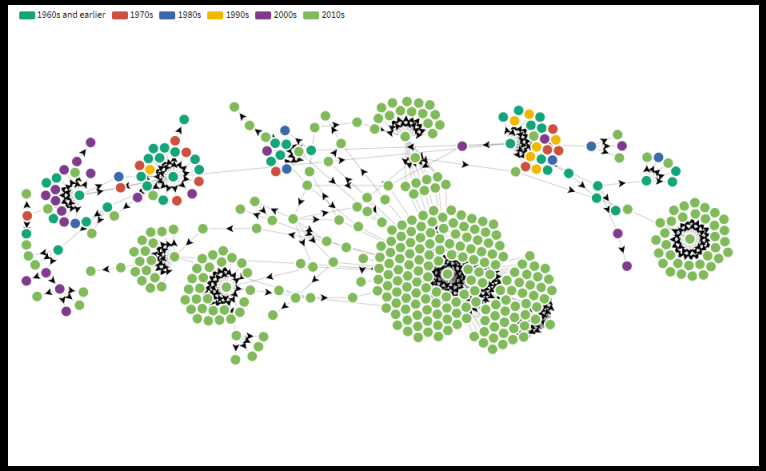
VIS Tools: Flourish

https://flourish.studio/

- Interactive visualizations that can be embedded in websites
- Free (data shared publicly), paid otherwise
- Stick to relatively small datasets



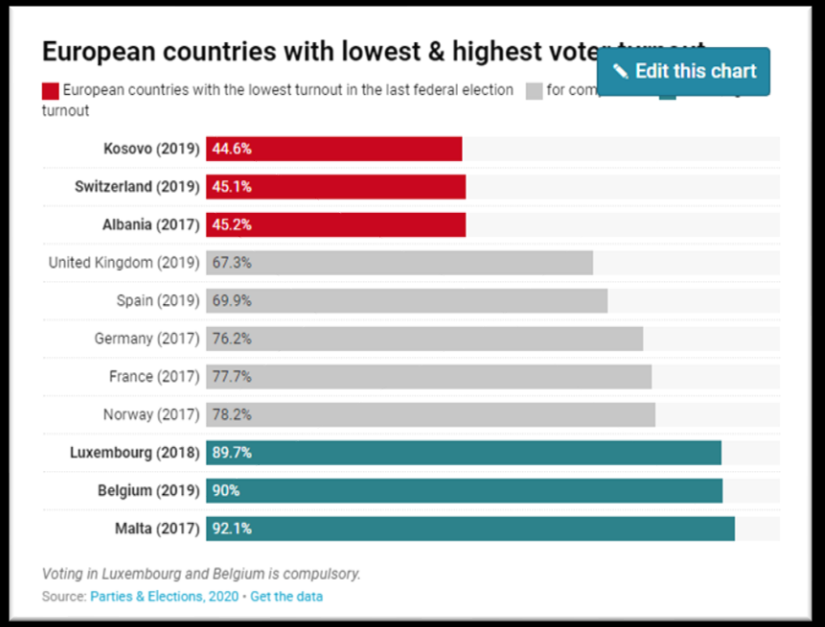


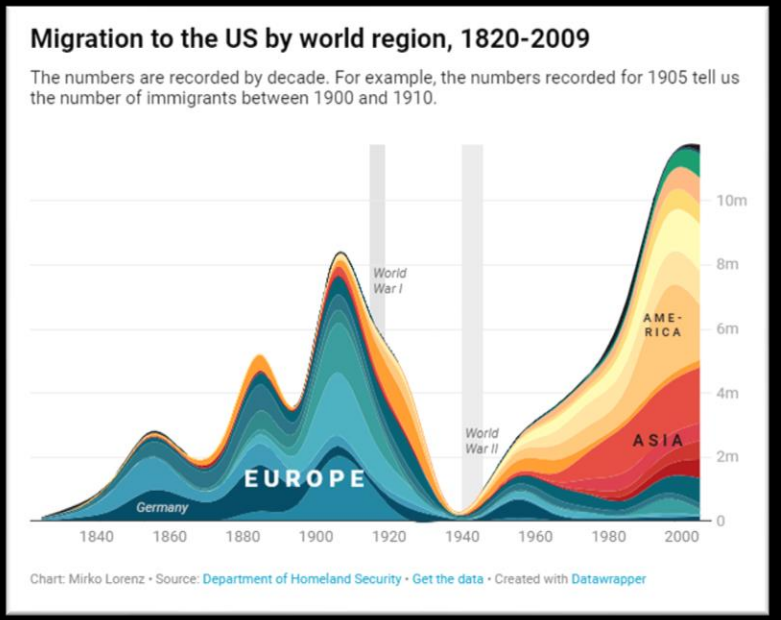


VIS Tools: Datawrapper

https://www.datawrapper.de/

- 20+ chart types
- Variety of mapping types (choropleth, symbols, locator)
- Free, but results have “Created with Datawrapper” watermark and you can only export PNG images (not PDF or SVG).

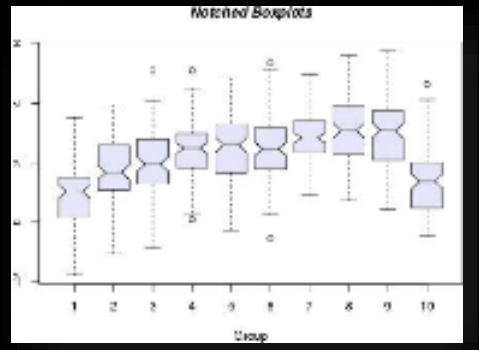


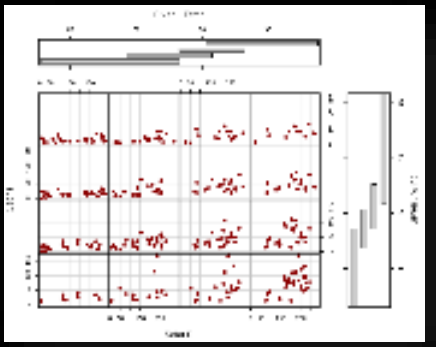


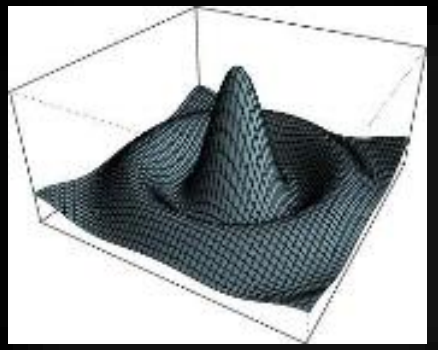
VIS Tools: R

http://www.r-project.org/

- Open-source software for statistics & graphics
- All sorts of advanced stats
  - Regression, linear/nonlinear models, time series analysis, clustering, nonparametric tests
- Data wrangling
- Charts & Plots
- Command line*
- Many add-ons (> 4400)
- 60+ Resources for R
  http://www.computerworld.com/article/2497464/business-intelligence/60-r-resources-to-improve-your-data-skills.html



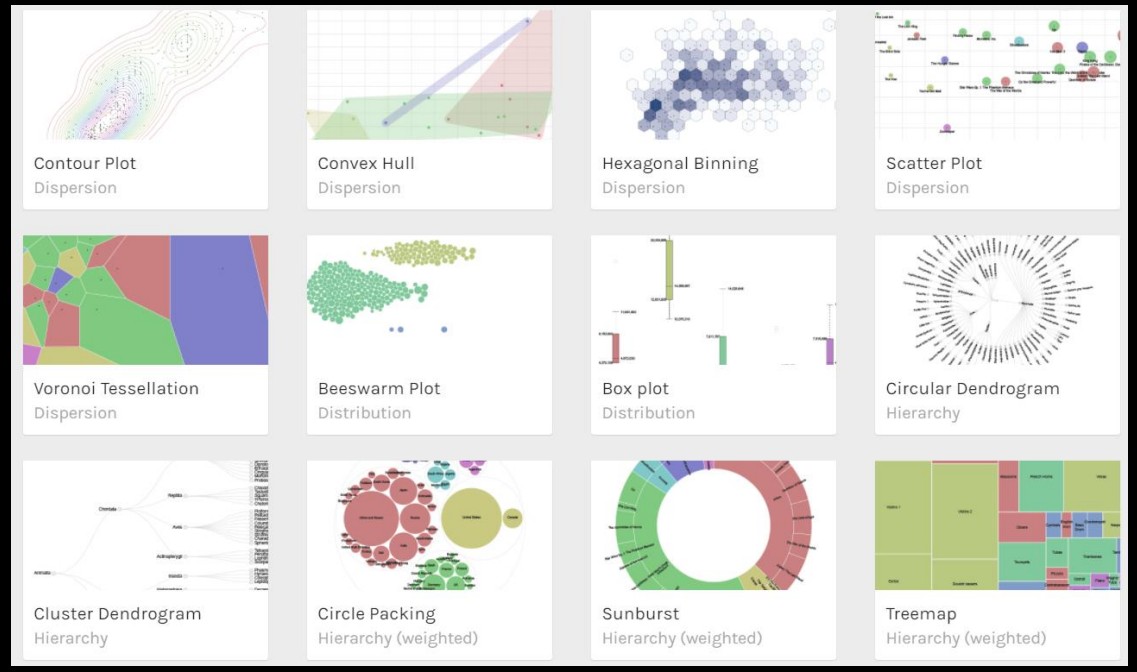


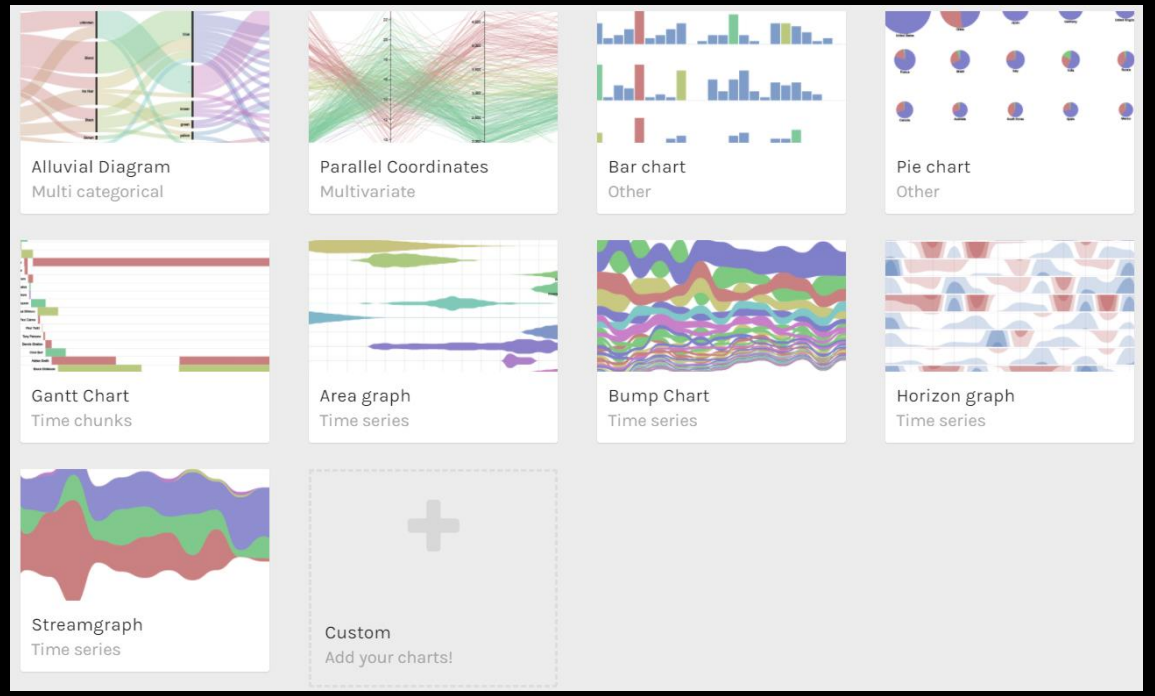


VIS Tools: RAWGraphs

https://rawgraphs.io/

- Create SVG graphics
- Data not uploaded (so remains private)
- 25+ chart types

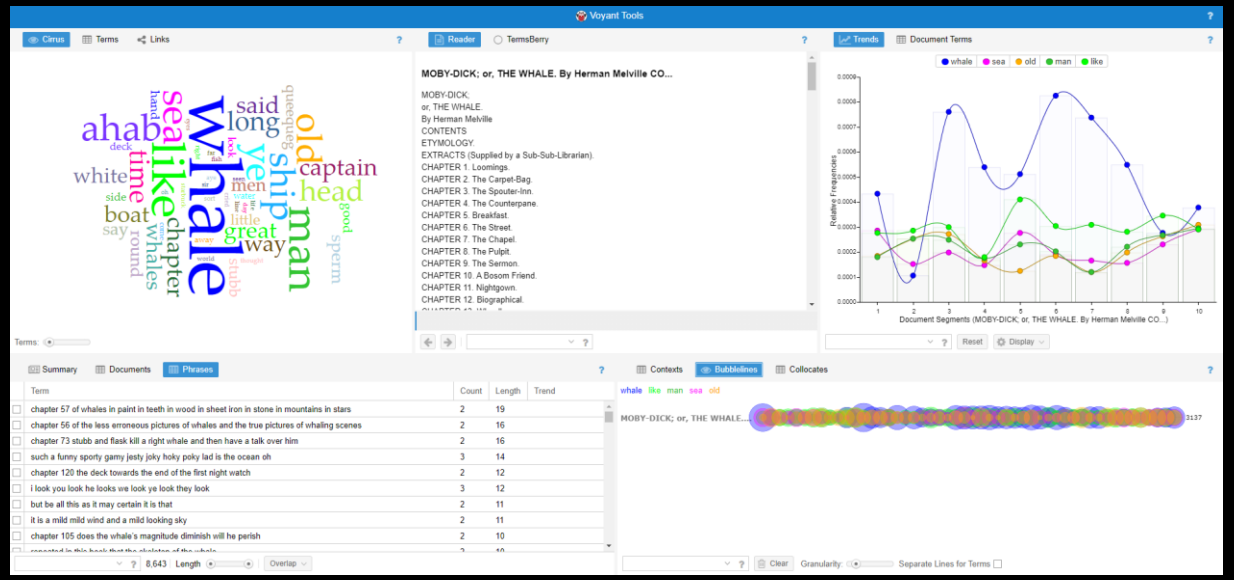




Text Analysis: Voyant

http://voyant-tools.org/

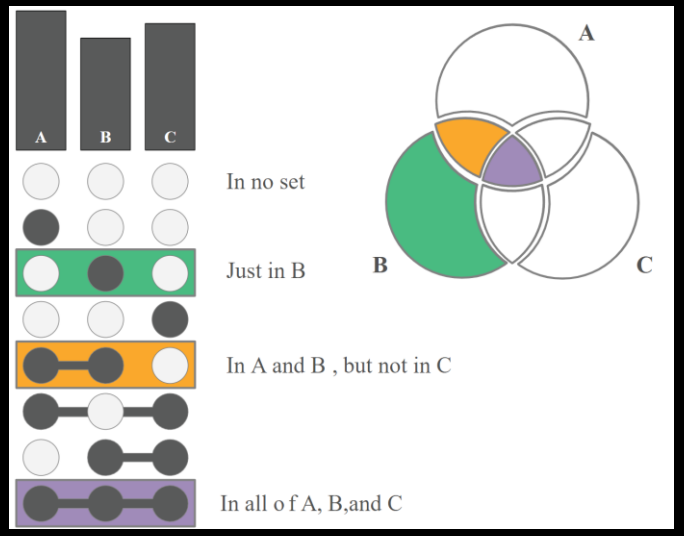
- Import: txt, HTML, XML, PDF, RTF, & Word
- Lexical analysis
  - frequency and distribution
- Export: XML, tsv, html widgets

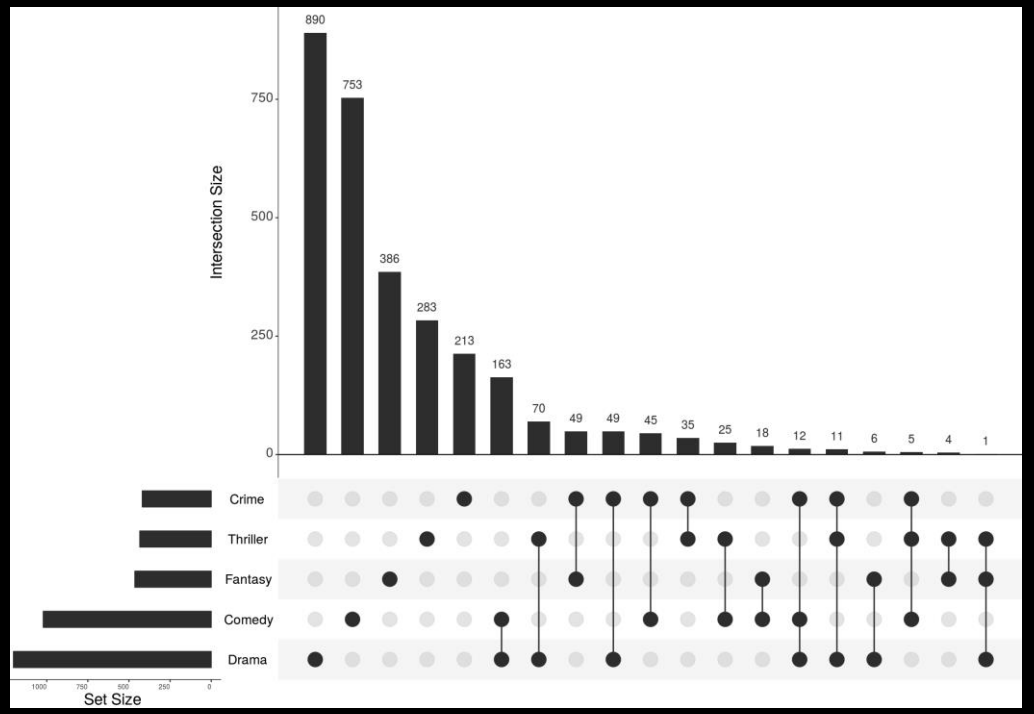


Sets: UpSet

https://upset.app

- Alternative to Venn diagram when you have 4-30 sets.
  - With fewer than 4, use a Venn diagram (e.g., https://bioinfogp.cnb.csic.es/tools/venny/index.html).
- Many implementations
  - Web tool, R library, javascript library, etc





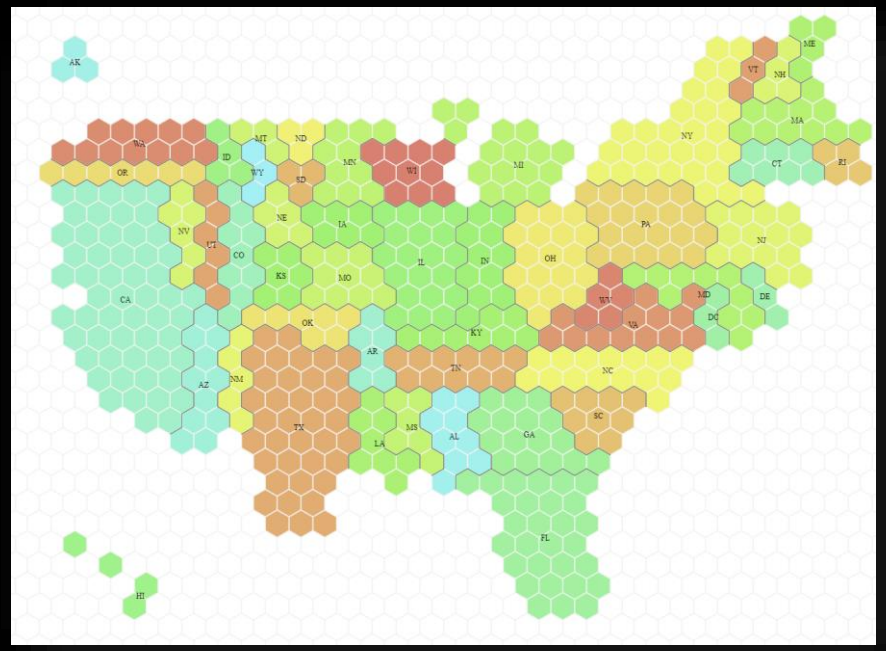
Images from https://upset.app/

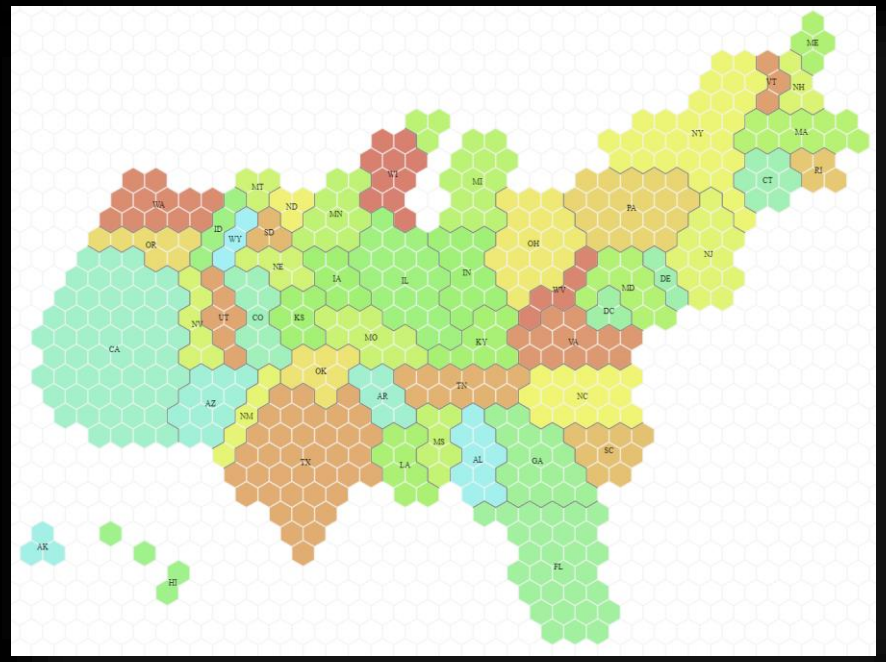
Maps/GIS: TILEGRAMS

TILEGRAMS

https://pitchinteractiveinc.github.io/tilegrams/

- Generates Cartograms (US, Brazil, Germany, France, Netherlands, Ireland)
- Exports TopoJSON and SVG



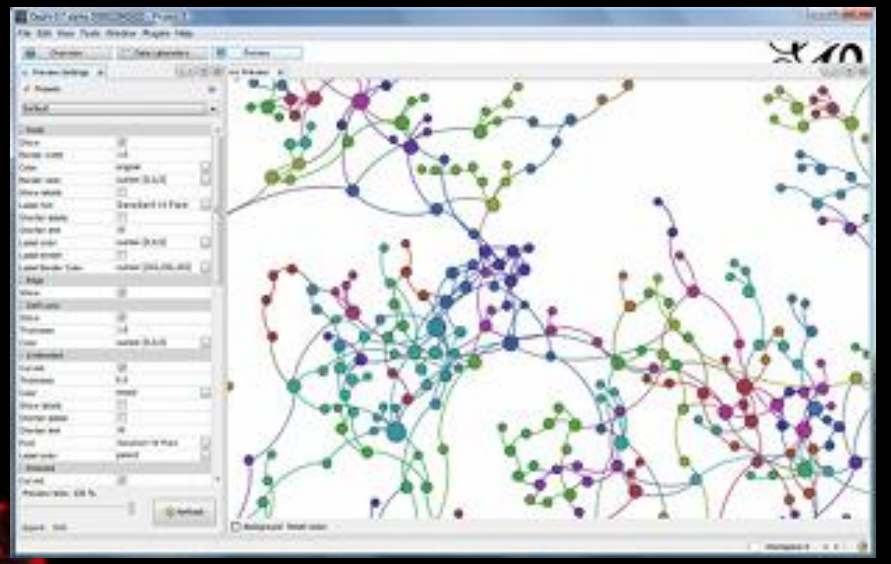


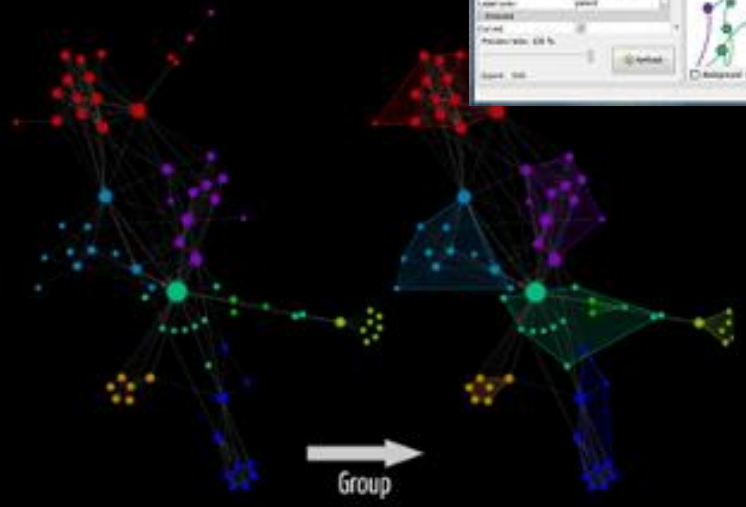
Graphs/Networks: Gephi

Gephi
makes graphs handy

http://gephi.github.io

- Windows/Linux/OS X
- Can handle 50K nodes & 1000K edges
- Interactive
  - Filter
  - Dynamic layout
  - Clustering/hierarchies





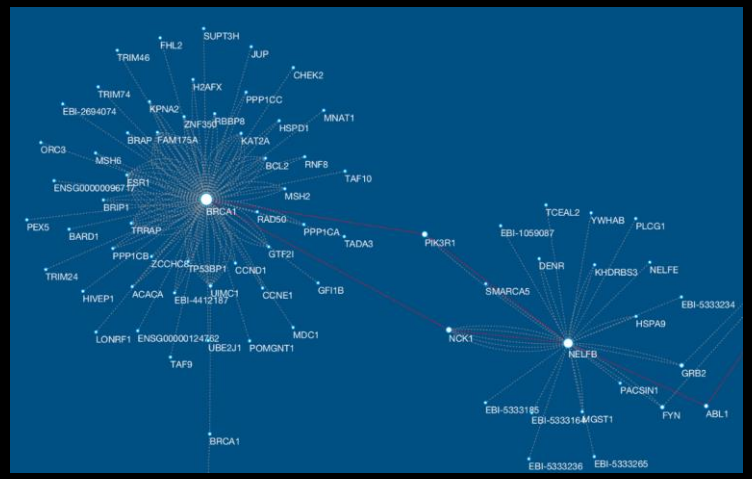
Graphs/Networks: Cytoscape

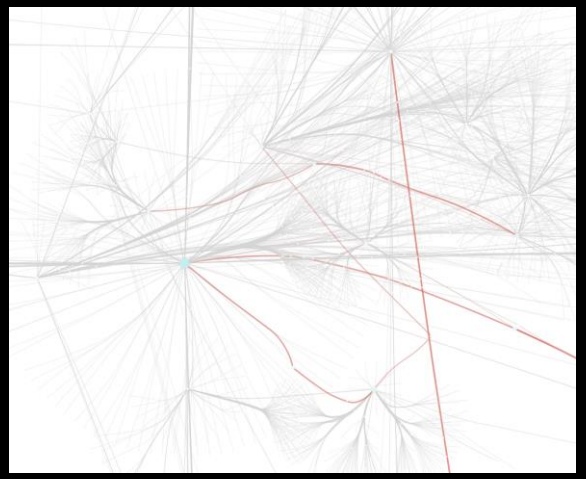
Cytoscape

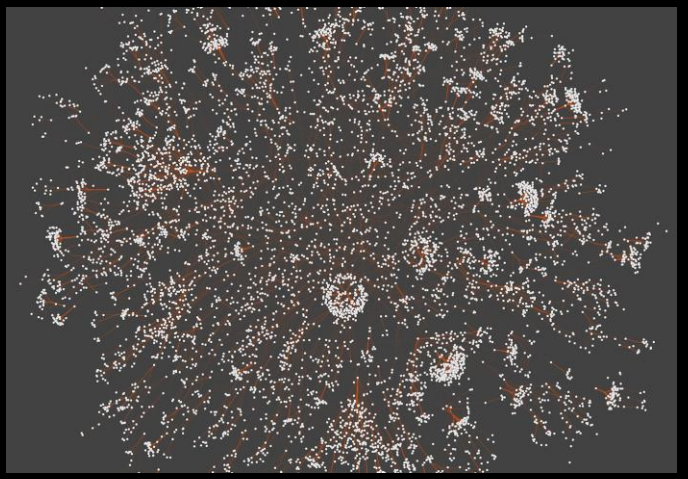
Network Data Integration, Analysis, and Visualization in a Box

https://cytoscape.org/

- Windows/Linux/OS X
- Created for bioinformatics
- Use cytoscape.js to bring your cytoscape projects to the web
- Apps (plugins) provide extra features







Time: Timeline JS

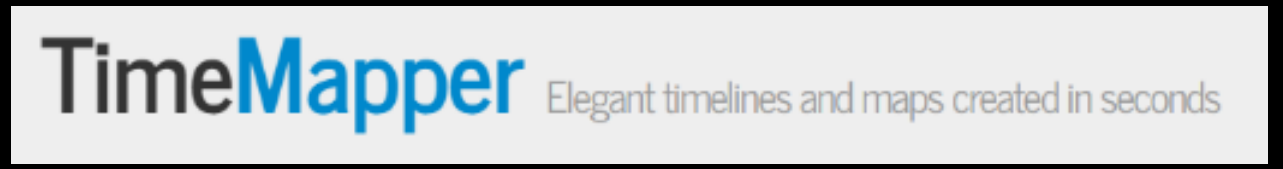
http://timeline.knightlab.com

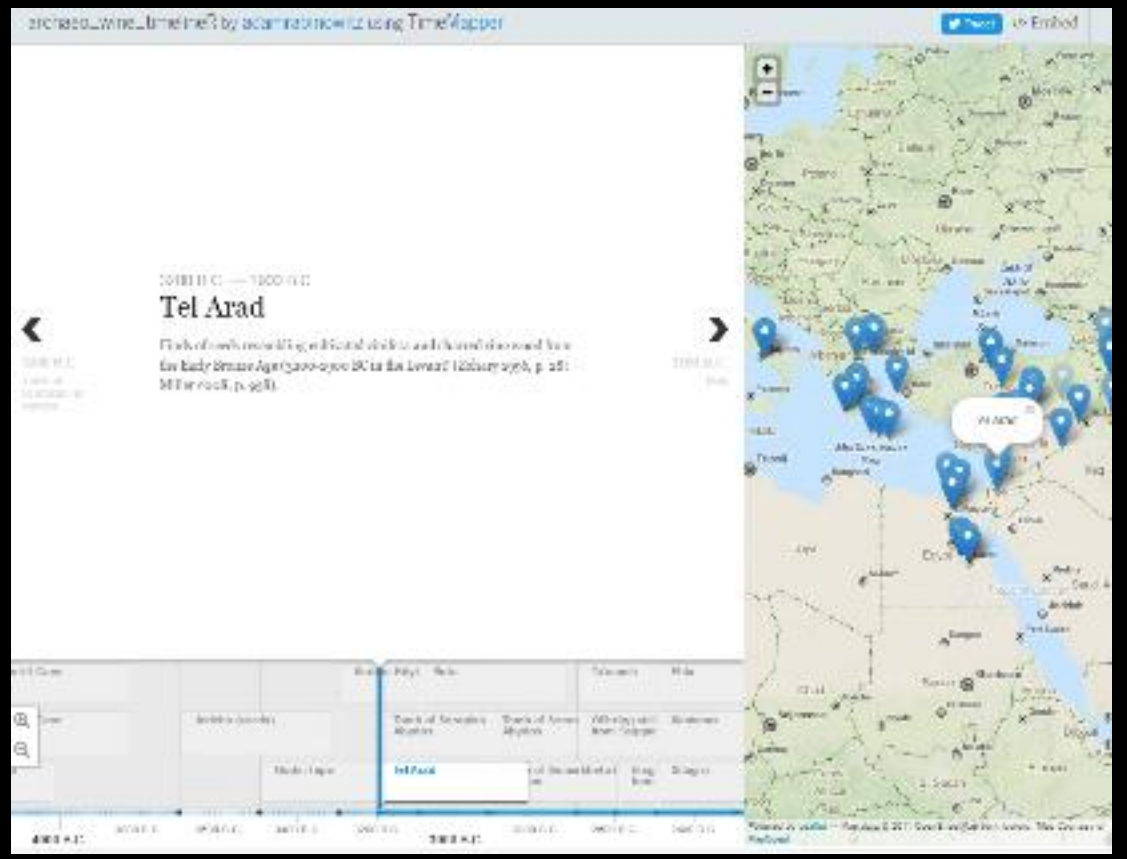
- Interactive, web timelines
- Link in URLs and web resources
- Build with Google spreadsheet
- Produces embeddable iframe widget

Time: TimeMapper

http://timemapper.okfnlabs.org

- Interactive, web timelines
- Built on Google spreadsheet data
- Adds a map with identified locations
- Creates web page that can be embedded into other sites





Colour

Adobe Color

- https://color.adobe.com/
- Pick great colour palettes
- Given this colour pick complementary colours

ColorBrewer

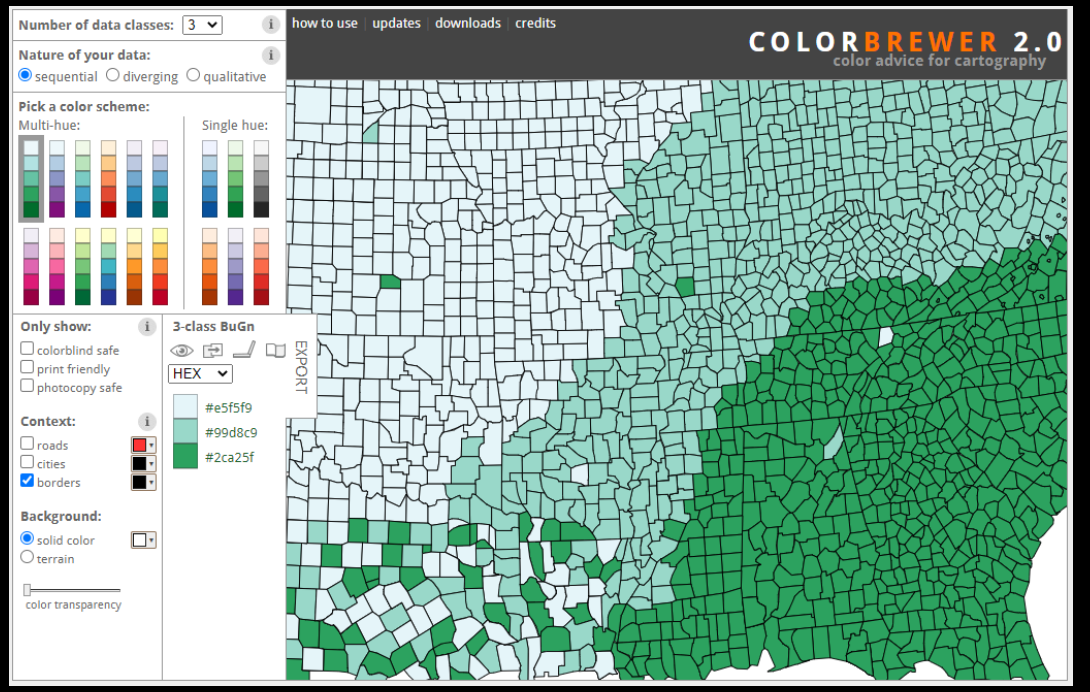
- http://colorbrewer2.org/
- Help in choosing colours for maps
- Colourblind, printing, etc.

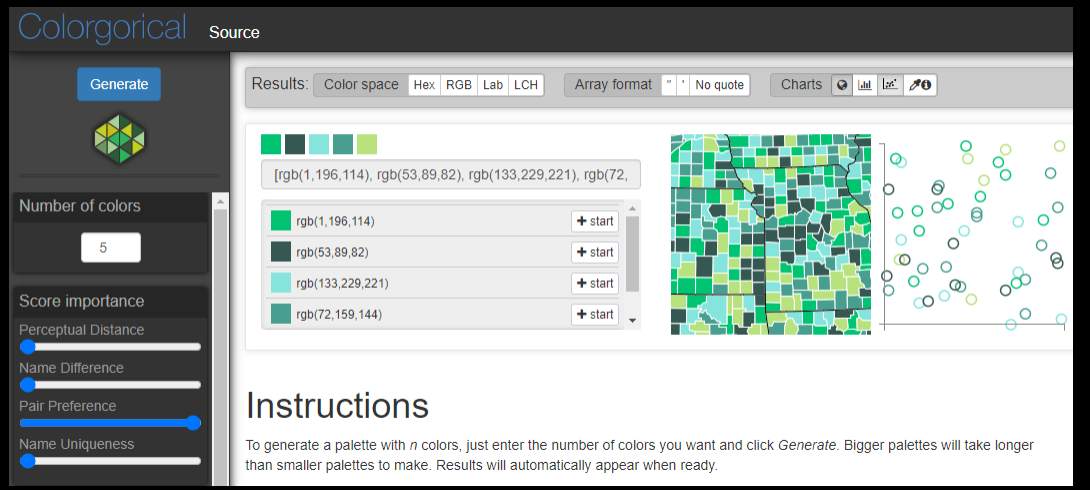
Colorgorical

- http://vrl.cs.brown.edu/color
- More options, shows both maps, bar charts, & scatterplot

Magic Color Picker

- https://text2color.com/picker.html
- AI that changes text to RGB colour codes



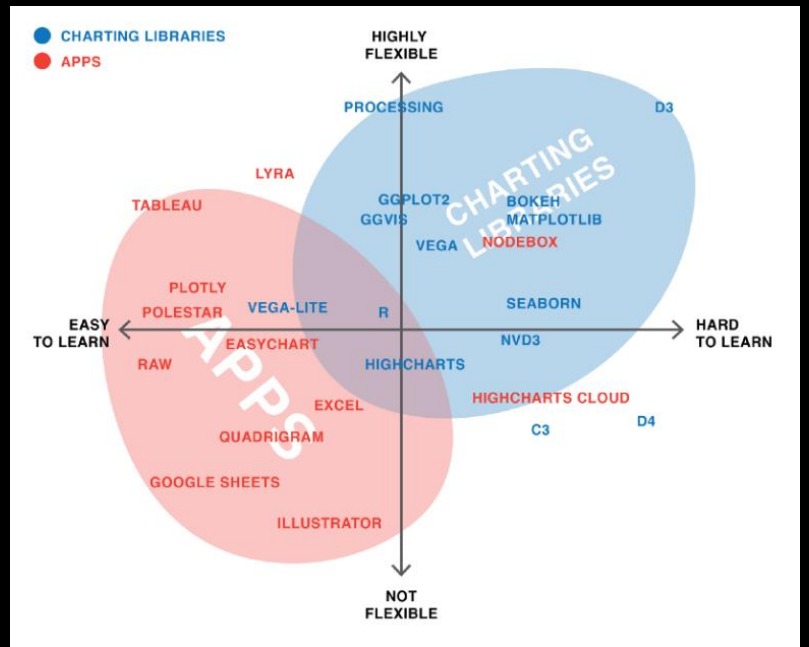


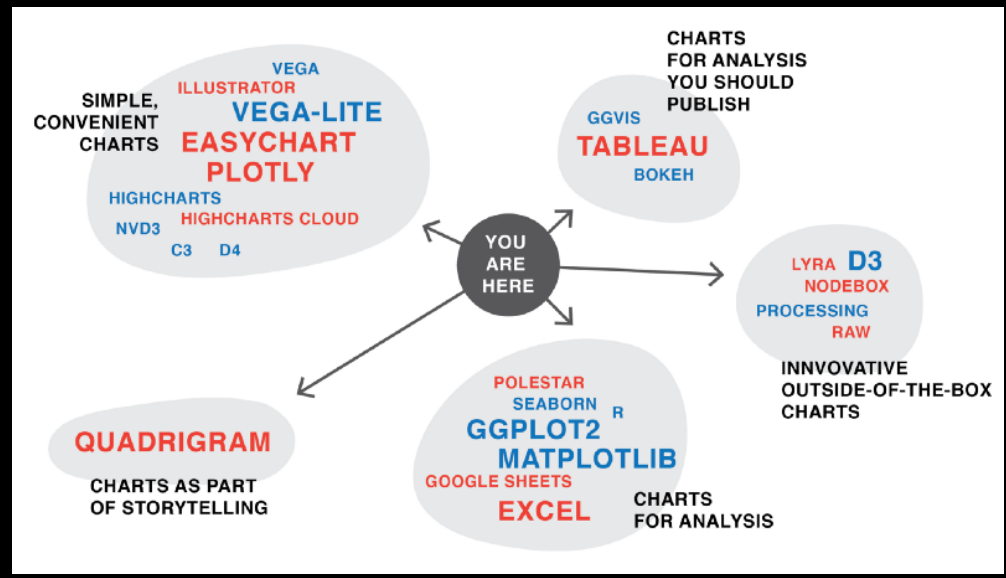
Resources – Data Vis Tools

Visualizing Data - https://www.visualisingdata.com/resources/

120+ visualization tools

Article on picking a vis tool –
https://source.opennews.org/articles/what-i-learned-recreating-one-chart-using-24-tools/





Visualization Resources: Books

Semiology of Graphics by Jacques Bertin

- *The book on visual variables*

Visual Display of Quantitative Information, Beautiful Evidence, Visual Explanations, *or* ***Envisioning Information*** by Edward Tufte

- *Beautiful examples of historic visualizations*

Visual Thinking for Design by Colin Ware

- Ties perception theory and design processes to visualization practices.

Beautiful Visualization by Steele & Iliinsky

- Combines techniques from artists, designers, scientists, and others.

Visual Analysis & Design by Tamara Munzner

- Good text book by long-time practitioner & prof

Visualization Resources: Websites

New York Times https://www.nytimes.com/interactive/2019/12/30/us/2019-year-in-graphics.html

- Dedicated team producing exceptional work.

Eagereyes https://eagereyes.org/

- Vis Researcher with criticism as well as overview from assorted research conferences.

Gapminder https://www.gapminder.org/

- Hans Rosling's stat software & data.

Visualizing Data https://www.visualisingdata.com/blog/

- Quarterly best visualizations posts, the little of visualization design

Flowing Data https://flowingdata.com/

- Daily posts showing various visualizations created by the site author and elsewhere.

Questions?

John Brosz, PhD

Data & Visualization Curator

jdlbrosz@ucalgary.ca

Slides at https://brosz.ca/slides/