BEFORE WE START…. A LITTLE EXPERIMENT

37 75

1. Grab a set of post-it and a pen; gather up in pairs

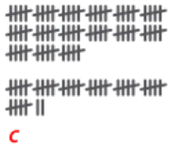
2. Try to come up with as many possible representations/encodings for the “data" above as you can, in the paper segments.

Feel free to be creative!

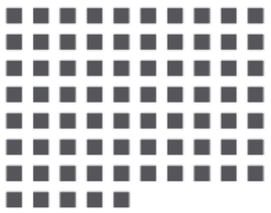
75, 37

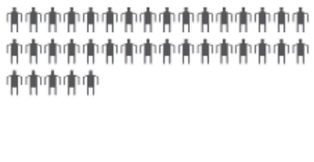
a

b



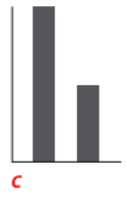
c





a

b



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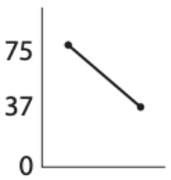
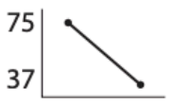
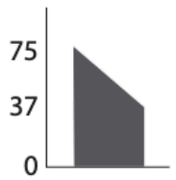


a



b

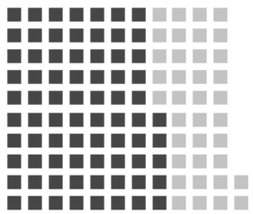


c

37 75

a

b



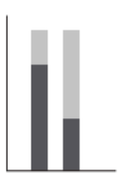
75, 37

a

b

c

a



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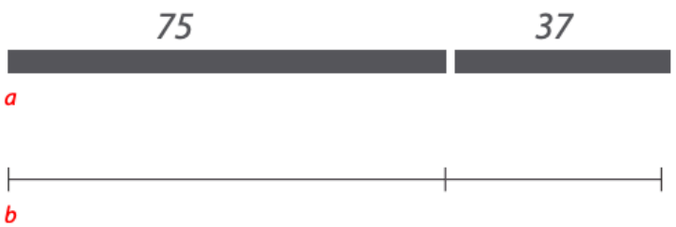


a

b

a

b

a

b

c

a

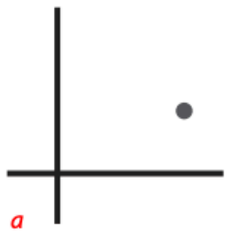
b

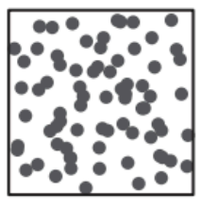
a

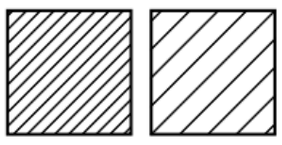
b

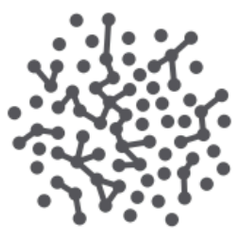
a

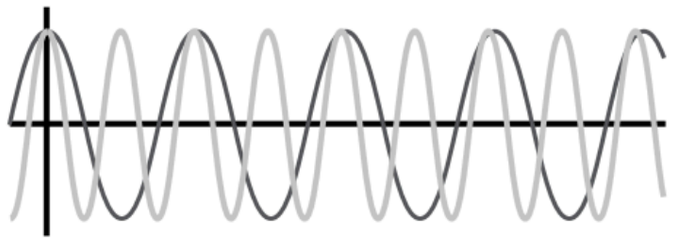
b

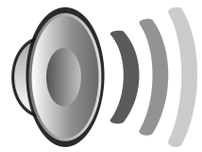








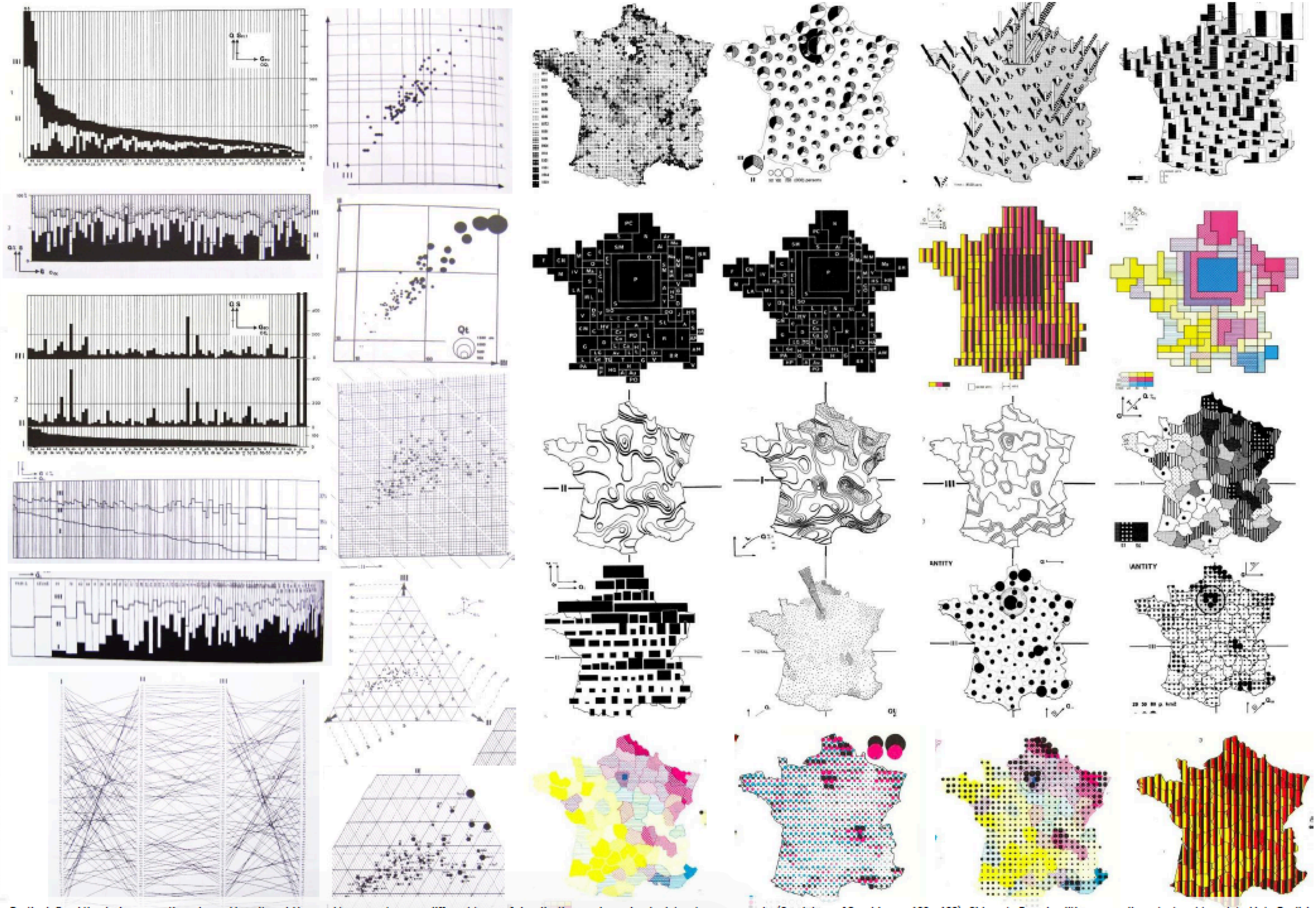




37Hz

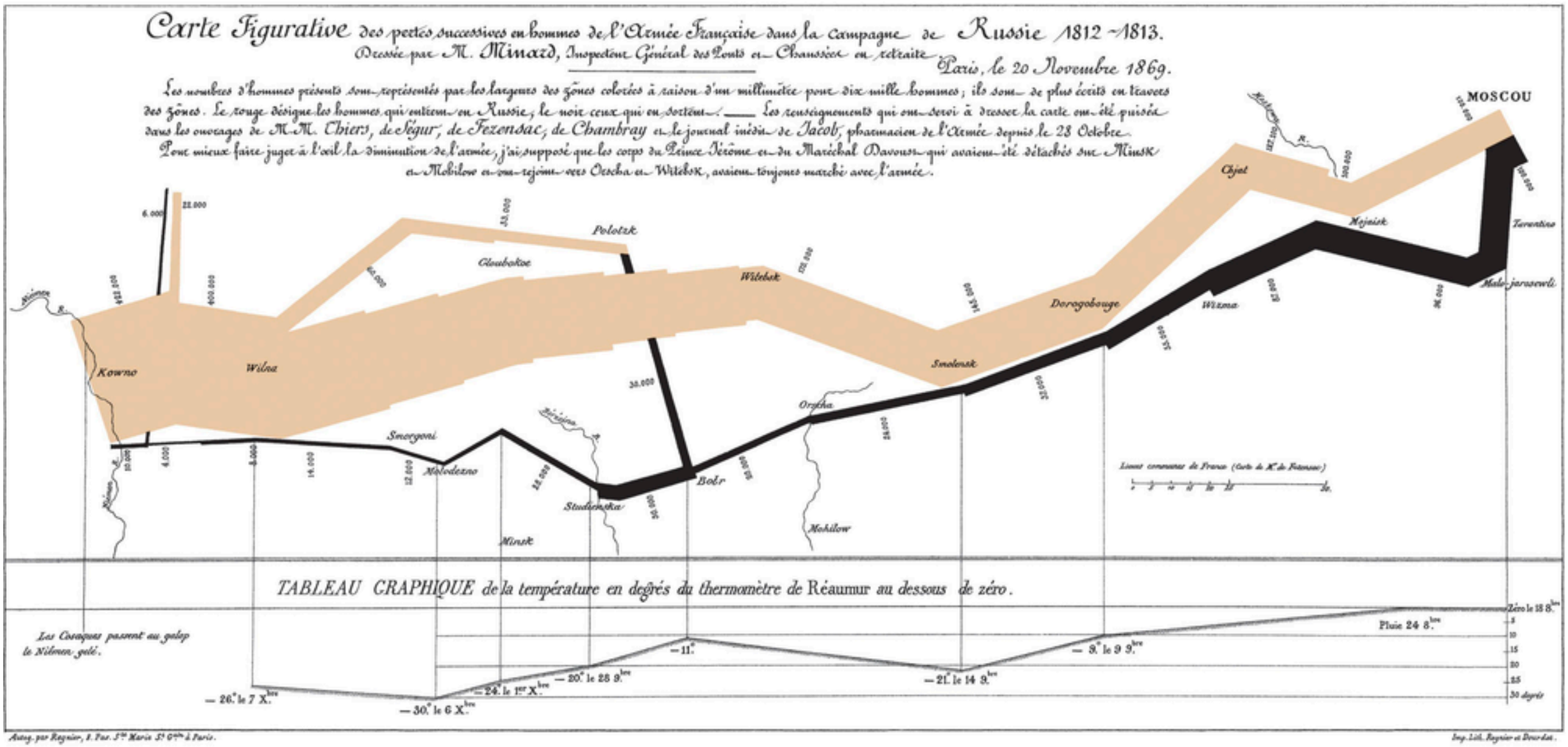
75Hz

Départements	Quantités (000)				Proportion %		
	I	II	III	Total	I	II	III
1 AIN	87	83	80	150	45	28	27
2 AISNE	96	74	66	193	29	37	34
3 ALLIER	65	45	57	167	38	27	34
4 Bses ALPES	15	8	13	35	43	24	33
5 Htes ALPES	16	6	13	35	44	21	35
6 ALPES Mmes	31	61	122	214	14	29	57
7 ARDECHE	48	32	25	105	45	31	24
8 ARDENNES	25	53	35	113	22	47	31
9 ARIEGE	33	17	14	64	52	26	22
10 AUBE	28	48	36	112	25	43	32
11 AUDE	50	20	32	102	49	19	32
12 AVEYRON	70	38	29	133	54	24	22
13 BOUCHES DU RH.	42	143	236	421	10	35	55
14 CALVADOS	70	55	69	194	36	28	36
15 CANTAL	45	13	20	78	58	16	26
16 CHARENTE	65	30	38	140	47	25	27
17 CHARENTE Mme	79	39	65	183	43	21	36
18 CHER	43	41	36	120	36	34	30
19 CORREZE	64	28	29	116	55	20	25
21 COTE D'OR	43	44	58	145	30	29	41
22 COTES DU NORD	131	30	67	228	58	15	27
23 CREUSE	58	13	17	88	66	15	19
24 DORDOGNE	104	34	41	179	58	19	23
25 DOUBS	35	67	39	142	25	47	28
26 DROME	46	38	35	119	39	31	30
27 EURE	48	52	45	145	33	36	31
28 EURE & LOIR	44	27	38	119	41	23	34
29 FINISTERE	184	26	89	329	56	23	27
30 GARD	40	31	32	144	28	26	36
31 HAUTE GARONNE	64	67	84	216	30	31	39
32 GERS	63	10	16	89	71	11	18
33 GIRONDE	115	107	170	322	36	27	43
34 HERAULT	62	69	71	173	36	23	41
35 ILLE & V.	137	68	82	279	49	24	29
36 INDRE	54	38	32	116	46	33	28
37 INDRE & L.	61	41	55	157	39	26	35
38 ISERE	68	136	78	282	24	48	28
39 JURA	39	34	27	100	39	34	27
40 LANDES	70	35	20	123	57	28	23
41 LOIR & CHER	51	27	30	108	47	25	28
42 LOIRE	56	160	82	298	19	54	27
43 Hte LOIRE	53	23	22	98	54	24	22
44 LOIRE INF.	101	108	105	314	32	34	34
45 LOIRET	51	51	34	136	38	38	25
46 LOT	41	10	16	67	61	15	24
47 LOT & GAR.	70	24	30	124	57	19	24
48 LOZERE	22	5	7	34	64	15	21
49 MAINE & L.	104	65	85	254	44	28	28
50 MANCHE	116	42	56	214	54	20	26
51 MARNE	44	37	67	148	30	34	46
52 Hte MARNE	25	28	28	81	31	35	34
53 MAYENNE	74	23	28	125	59	19	22
54 MEURTHE & M.	23	127	91	241	9	53	38
55 MEUSE	24	31	27	82	30	38	32
56 MORBIHAN	132	47	59	238	55	20	25
57 MOSELLE	36	173	94	303	12	57	31
58 NIEVRE	34	27	33	94	36	29	35
59 NORD	81	483	296	860	9	56	35
60 OISE	49	69	55	164	24	42	34
61 ORNE	65	30	35	130	50	23	27
62 P.D.C.	94	242	137	473	20	51	29
63 PUY DE DOME	89	79	63	232	38	34	28
64 Bses PYRENEES	89	49	62	191	47	25	32
65 Htes PYRENEES	37	27	28	92	40	29	31
66 PYRENEES ORIENT.	35	20	33	88	40	23	37
67 BAS-RHIN	36	122	114	312	24	39	37
68 Ht-RHIN	40	121	74	235	17	51	32
69 RHONE	44	215	194	453	10	47	43
70 Hte SAONE	34	32	23	89	38	36	26
71 SAONE & L.	84	77	62	233	61	33	26
72 SARTHE	87	45	58	190	46	24	30
73 SAVOIE	44	38	35	117	38	32	30
74 Hte SAVOIE	52	42	45	139	37	30	33
1 PARIS	2	575	940	1517	0	38	62
75 SEINE	8	574	550	1132	1	51	48
76 SEINE INF.	75	152	174	401	19	38	43
77 SEINE & M.	37	72	76	185	20	39	41
78 SEINE & O.	46	320	356	730	6	45	49
79 DEUX-SEVRES	71	29	33	133	53	22	25
80 SOMME	57	60	61	186	31	38	33
81 TARN	55	47	33	135	41	35	24
82 TARN & G.	44	13	18	75	59	17	24
83 VAR	53	50	81	184	29	31	44
84 VAUCLUSE	40	30	41	111	36	27	37
85 VENDEE	110	38	40	188	59	20	21
86 VIENNE	60	29	39	128	47	23	30
87 Hte VIENNE	64	47	45	156	41	30	29
88 VOSGES	36	85	43	174	21	54	25
89 YONNE	41	28	37	106	39	26	35
90 BELFORT	3	25	13	41	8	60	32
	5212	6705	6905	18825	28	35	37



Bertin defined the design space then showed how it could be used to generate many different types of visualizations; using a simple dataset as an example. (Semiology of Graphics, pg 100 ~ 138) . Side note French edition appendix on text, not translated into English.

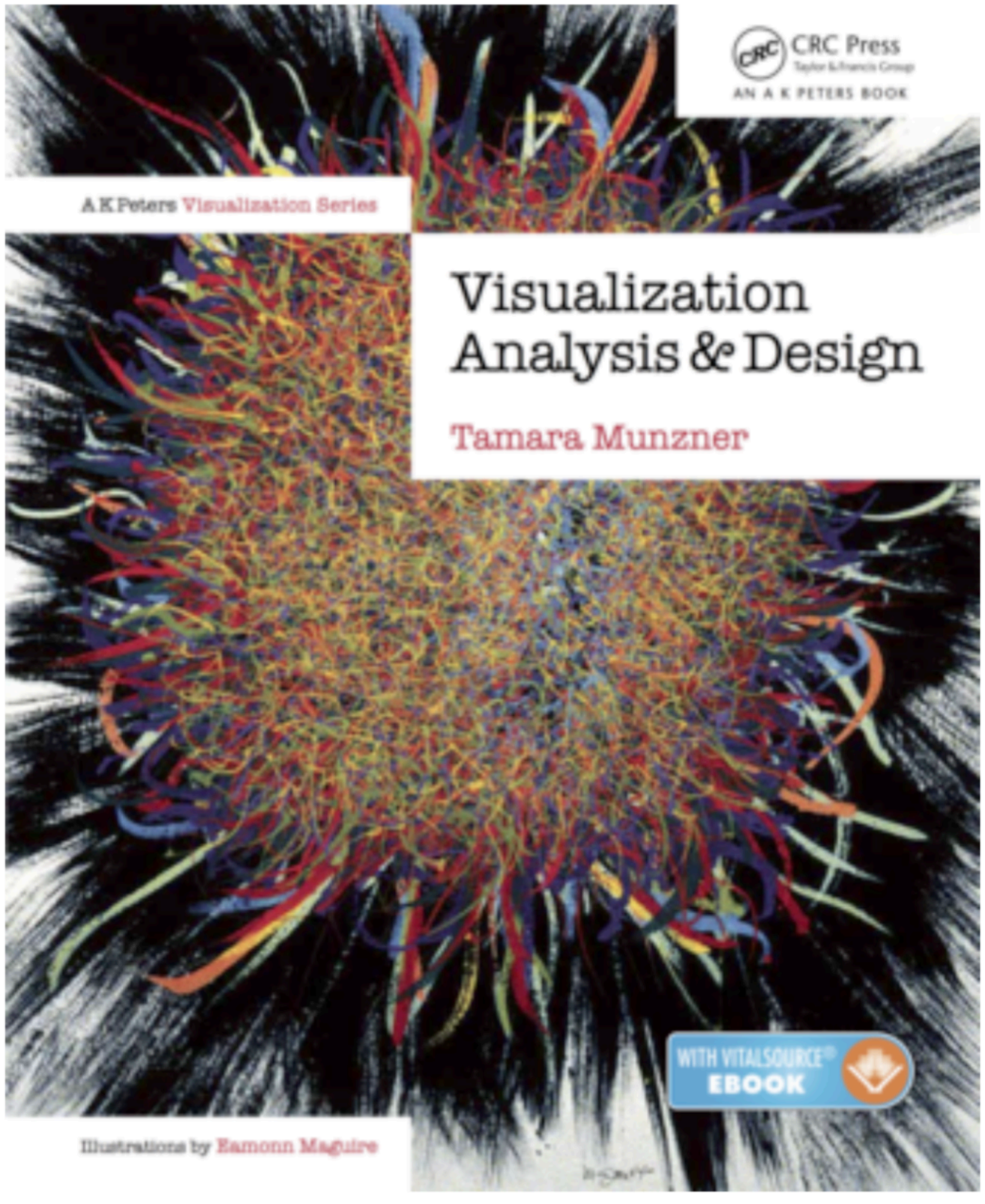
Visualization theory and principles



Text-book on data visualization

(1st of its kind)

If you can only get one,
THIS is the one!



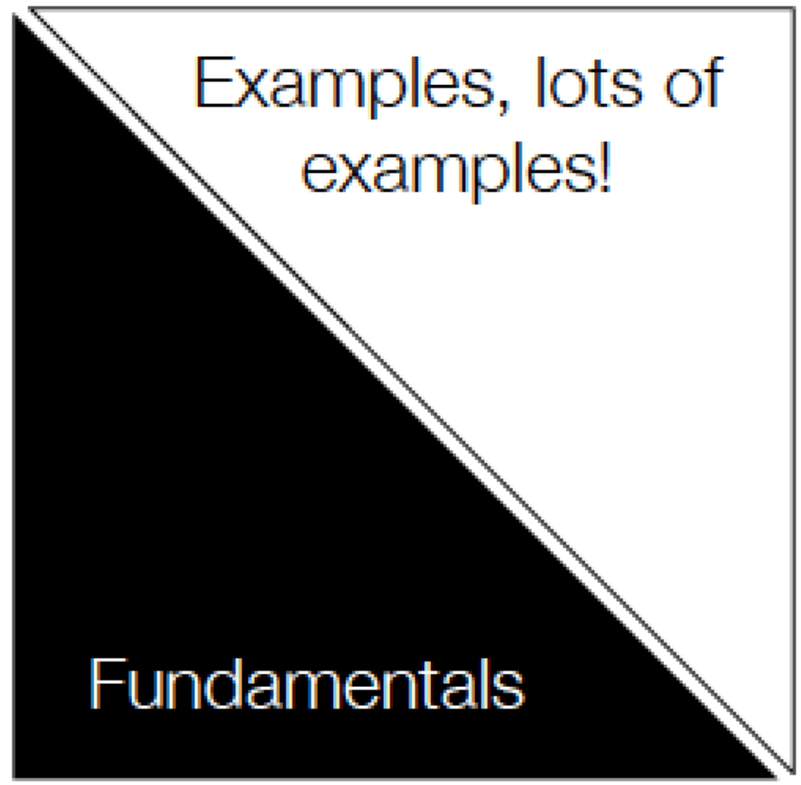
Munzner, Tamara. Visualization Analysis and Design. CRC Press, 2014.

TAKE AWAY MESSAGE…

It takes ***experience***!

But despite of that, we all have the "necessary prerequisites" to be a good visualization designer…

… we just need to learn how to ***see*** things a bit differently!

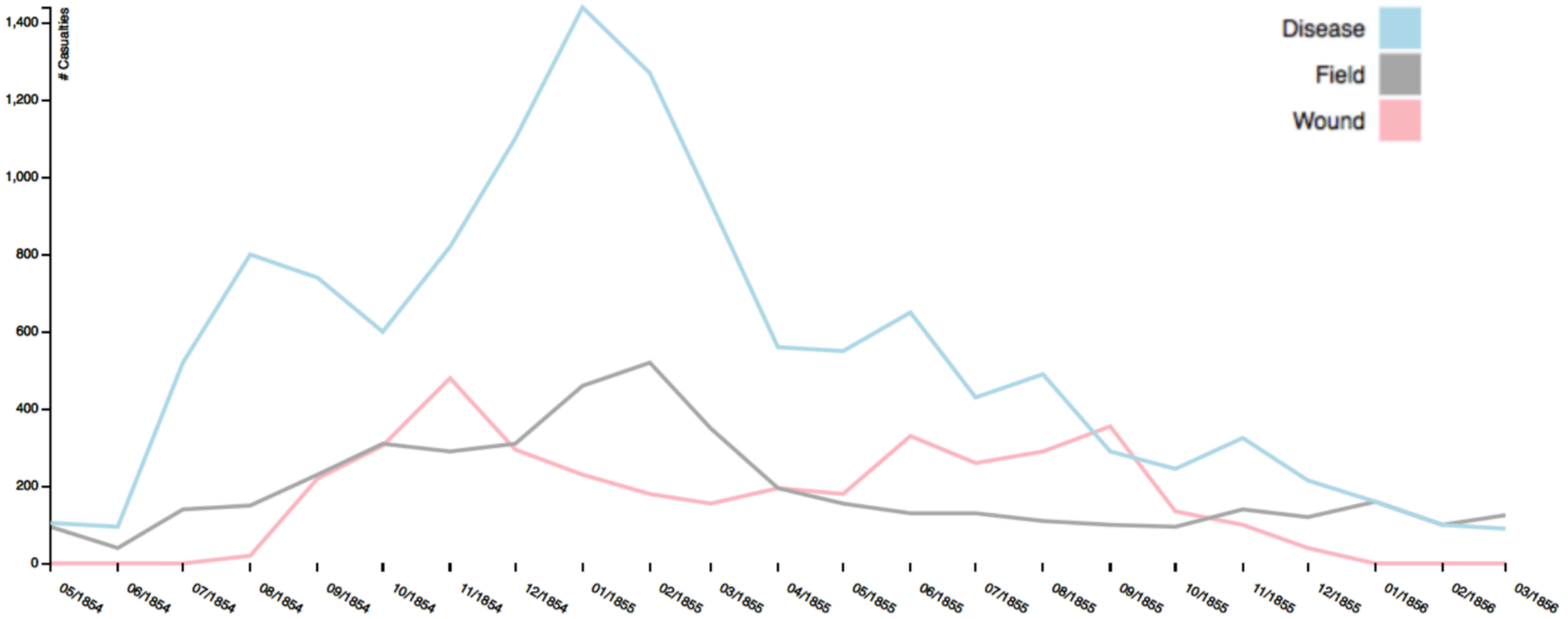


British Casualties in the Crimean War

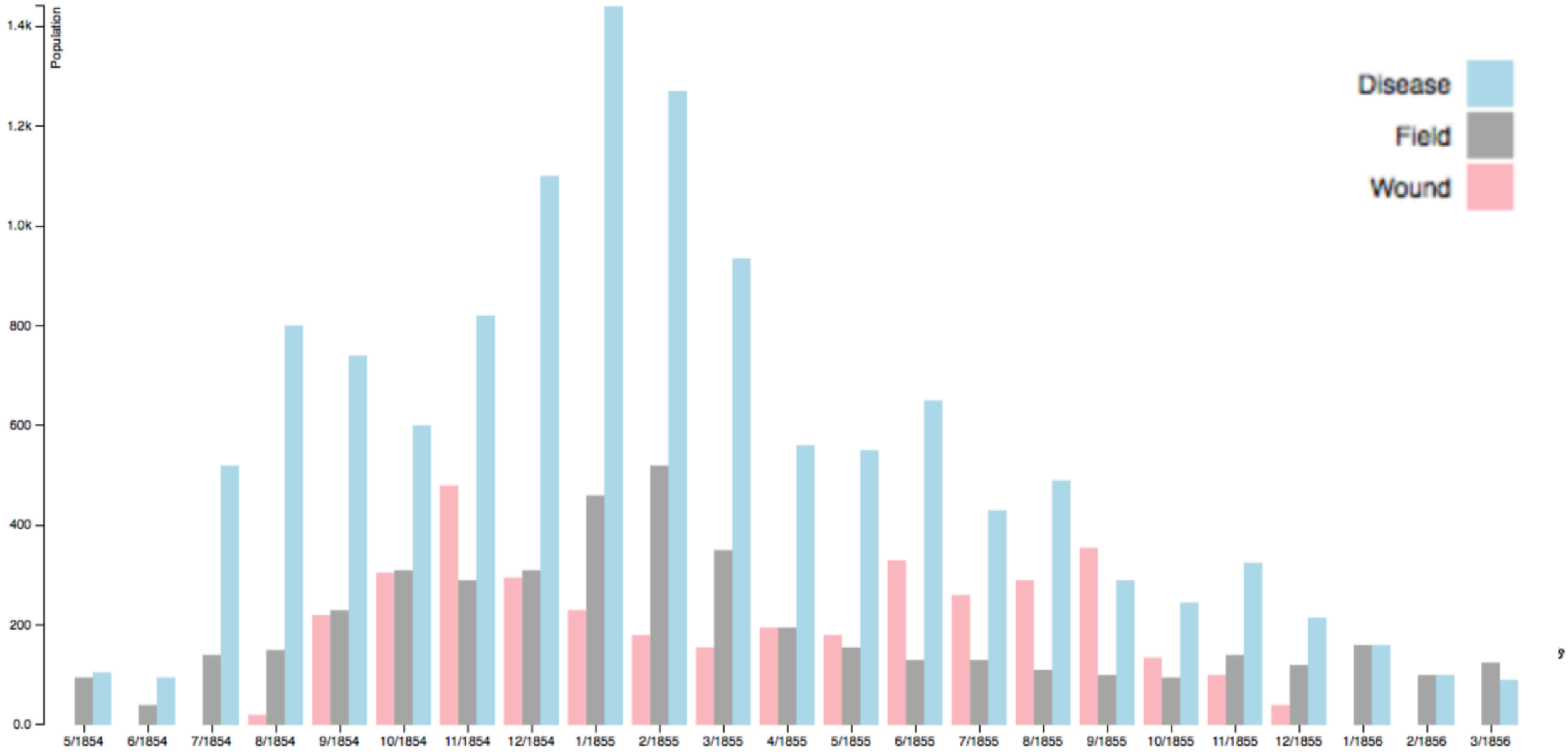
Data	Wound	Field	Disease
05/1854	0	95	105
06/1854	0	40	95
07/1854	0	140	520
08/1854	20	150	800
09/1854	220	230	740
10/1854	305	310	600
11/1854	480	290	820
12/1854	295	310	1100
01/1855	230	460	1440
02/1855	180	520	1270
03/1855	155	350	935
04/1855	195	195	560
05/1855	180	155	550
06/1855	330	130	650
07/1855	260	130	430
08/1855	290	110	490
09/1855	355	100	290
10/1855	135	95	245
11/1855	100	140	325
12/1855	40	120	215
01/1856	0	160	160
02/1856	0	100	100
03/1856	0	125	90

- Month with highest casualty rates in the field?
- Months in which deaths by wound exceeds deaths in the field?
- Month with highest total casualty rate?
- Months in which % of deaths by disease was below 50%?

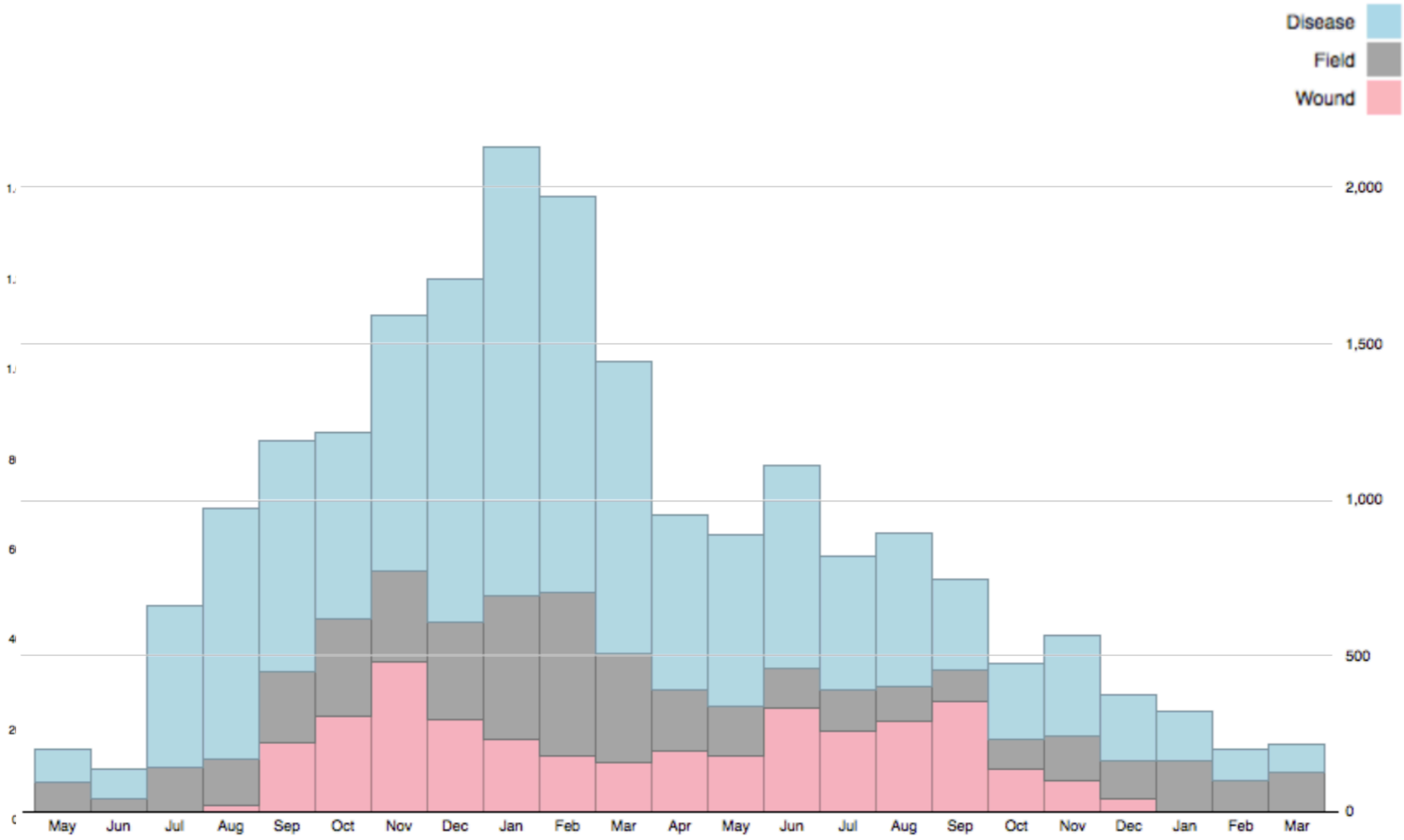
Month with highest casualty rates in the field?



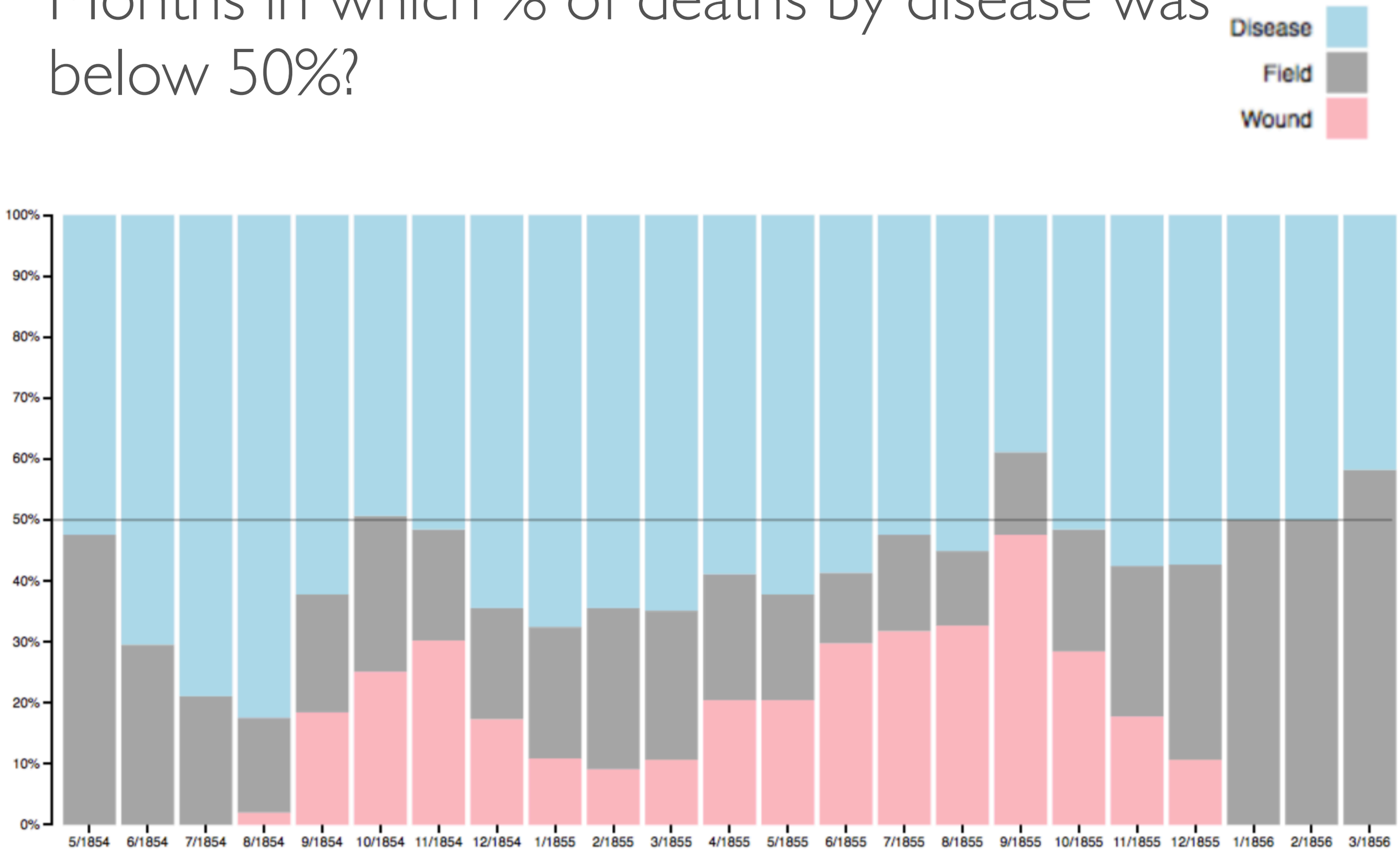
Months in which deaths by wound exceeds deaths in the field?



Month with highest total casualty rate?

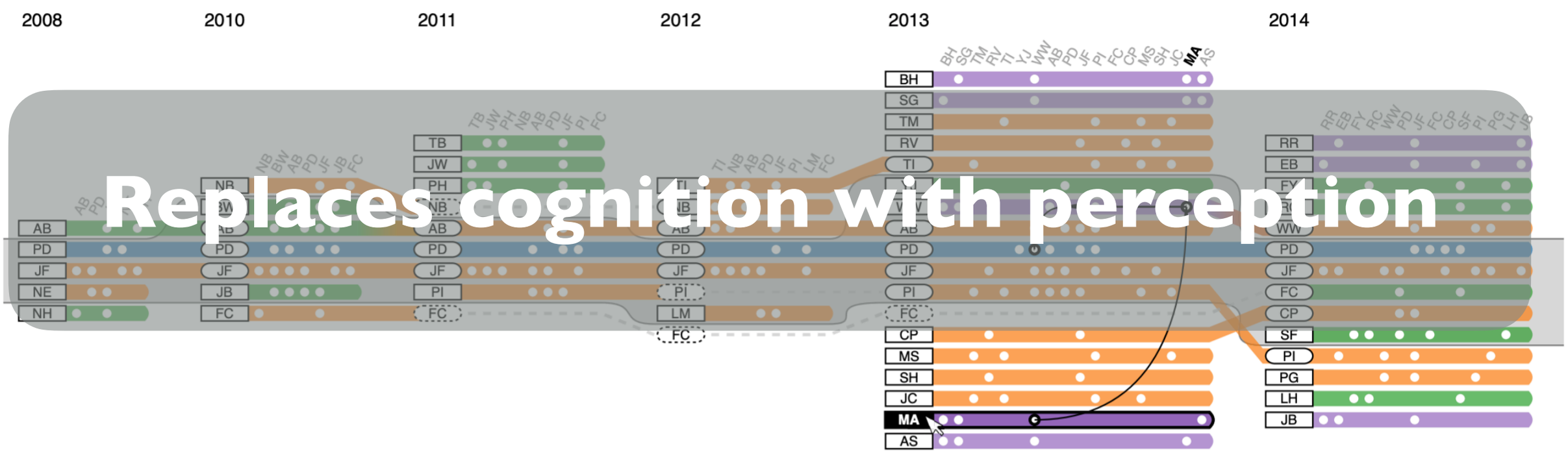


Months in which % of deaths by disease was below 50%?



WHY VISUALIZATION?

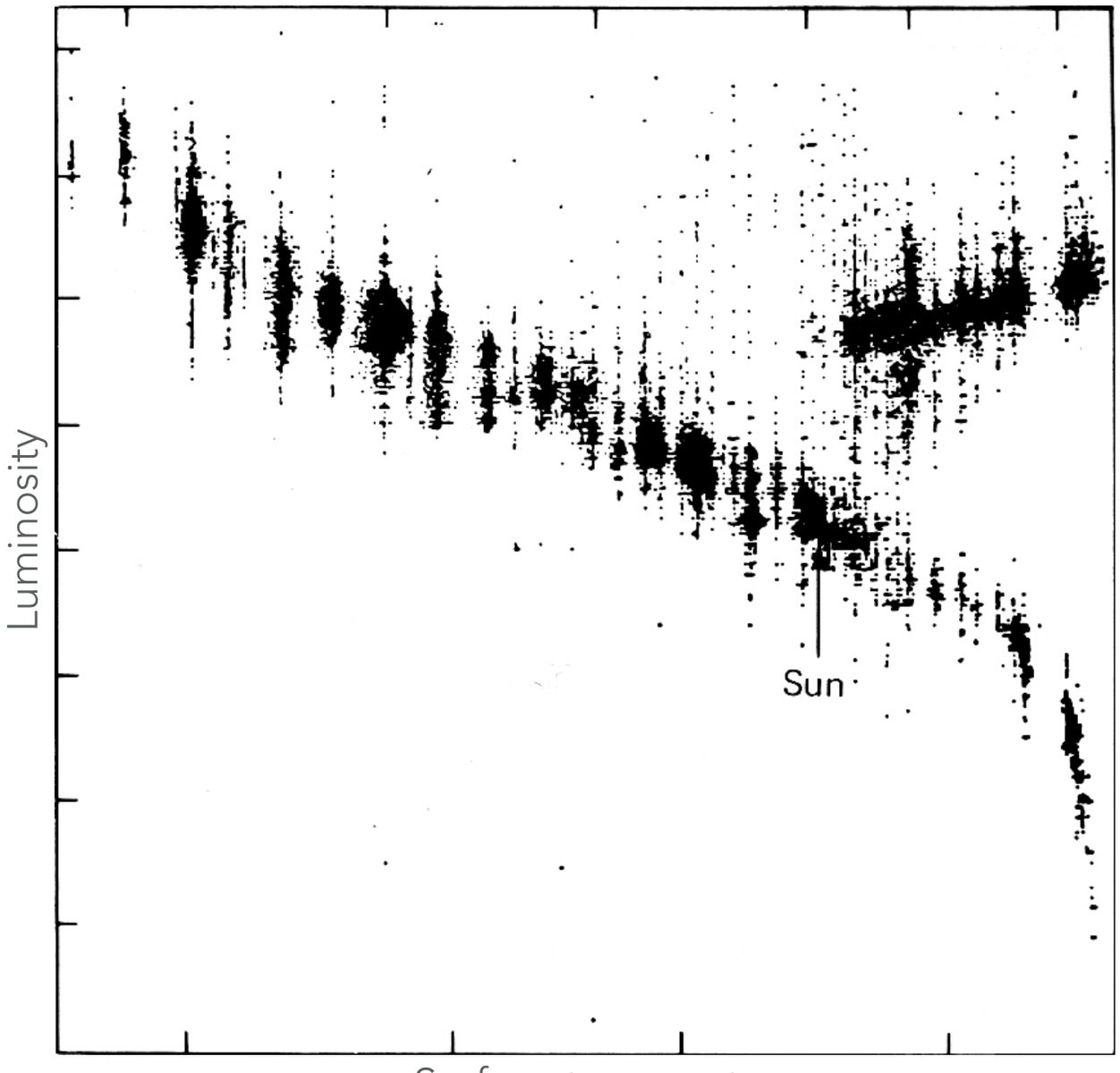
Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

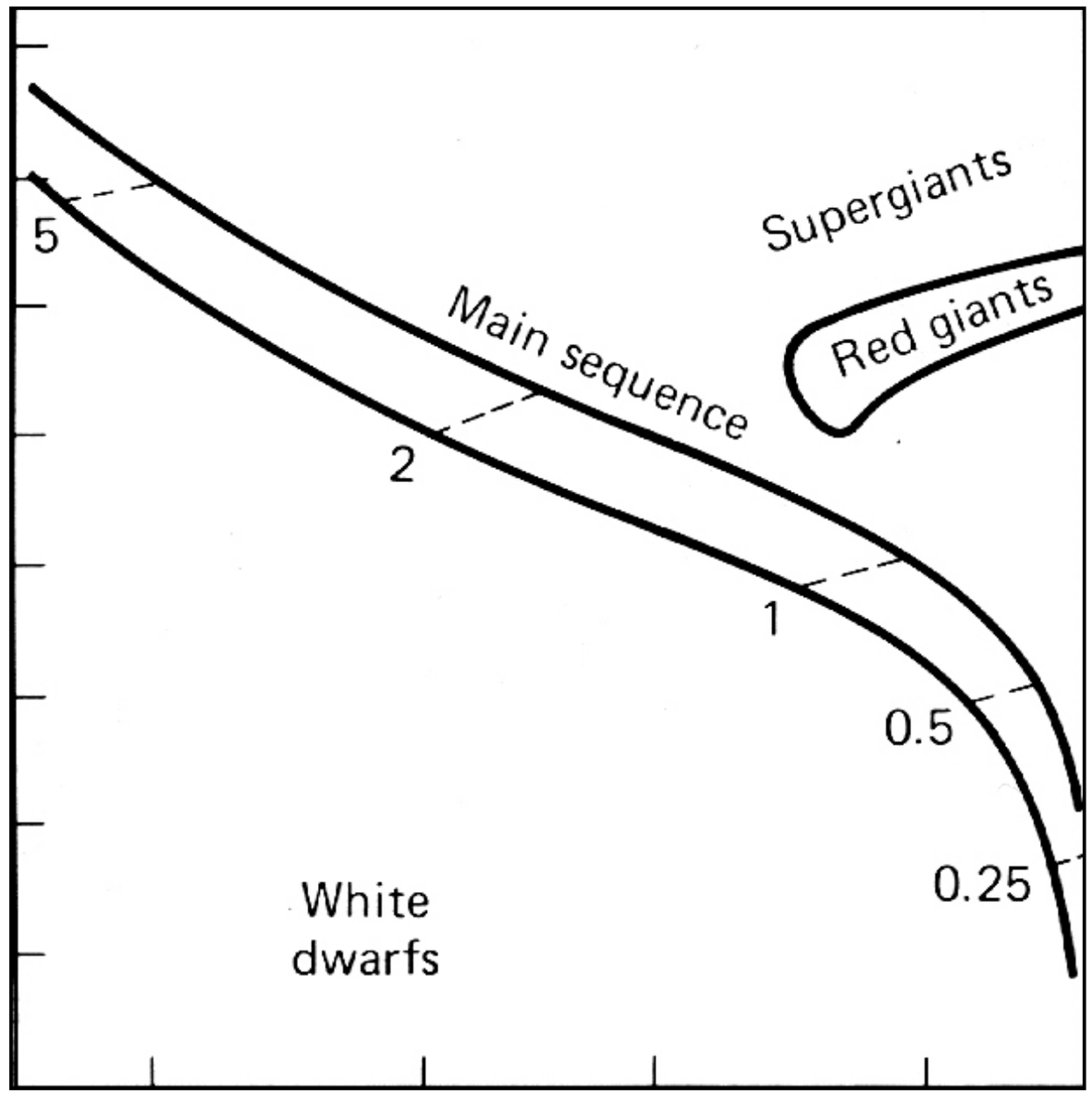


Replaces cognition with perception

https://jeffjianzhao.bitbucket.io/webapp/EgoLines/egolines-demo.html

PERCEPTION AND COGNITION

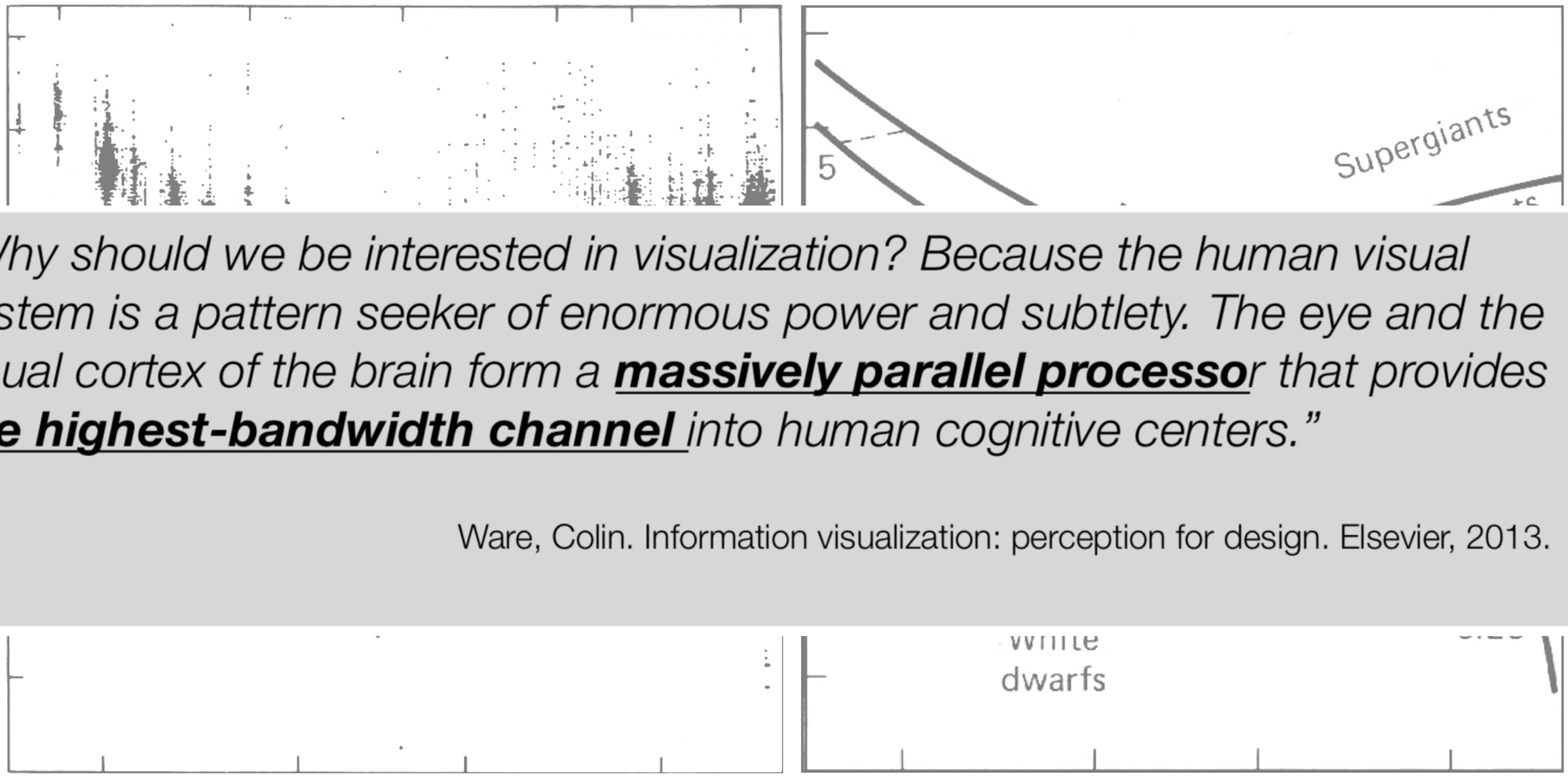




Hertzsprung Russell Diagram and its interpretation

[Source: J.D. Fekete et al. “The Value of Information Visualization”, 2008]

PERCEPTION AND COGNITION



"Why should we be interested in visualization? Because the human visual system is a pattern seeker of enormous power and subtlety. The eye and the visual cortex of the brain form a ***massively parallel processor*** *that provides* ***the highest-bandwidth channel*** *into human cognitive centers."*

Ware, Colin. Information visualization: perception for design. Elsevier, 2013.

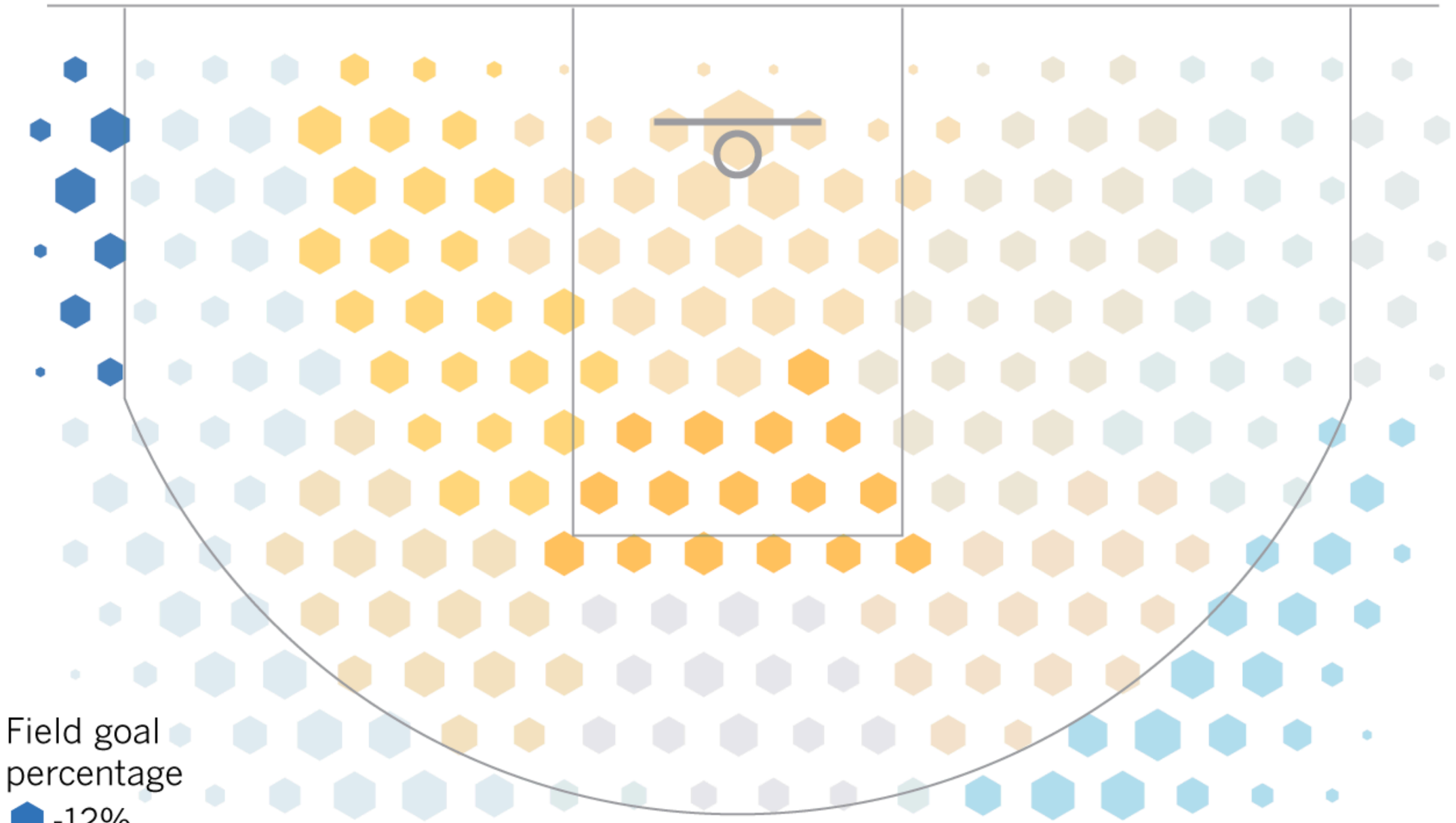
Hertzsprung Russell Diagram and its interpretation

[Source: J.D. Fekete et al. "The Value of Information Visualization", 2008]

1424164963575984759217659684748917284822859588198294509685048506958476121240440746748989851714959691245676596080208606083654164964575906439804792485769607812859607999187128452681014959691245677818742416496457576596081495969124567012859607991649645751278799187128452984969122359164964575958819825096357659608059600

14241649635759847592176596847489172848 2
28595881982945096850485069584761212404 4
07467489898517149596912456765960802086 0
60836541649645759064398047924857696078 1
28596079991871284526810149596912456778 1
87424164964575765960814959691245670128 5
96079916496457512787991871284529849691 2
22359164964575958819825096357659608059 6

Kobe Bryant vs. league average (1996-2016)



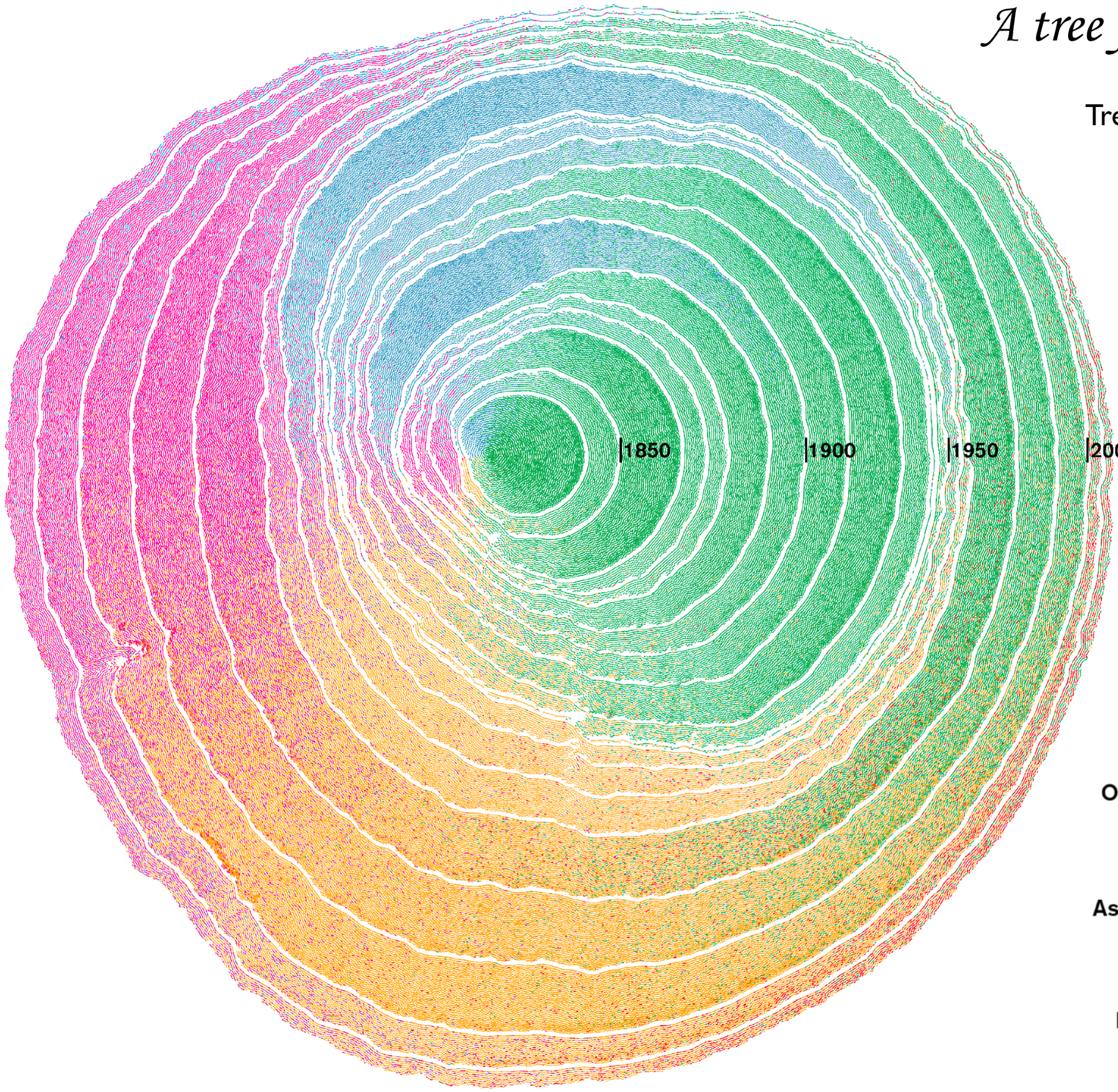
Field goal percentage
-12%
-8%
-4%
average
+4%
+8%
+12%

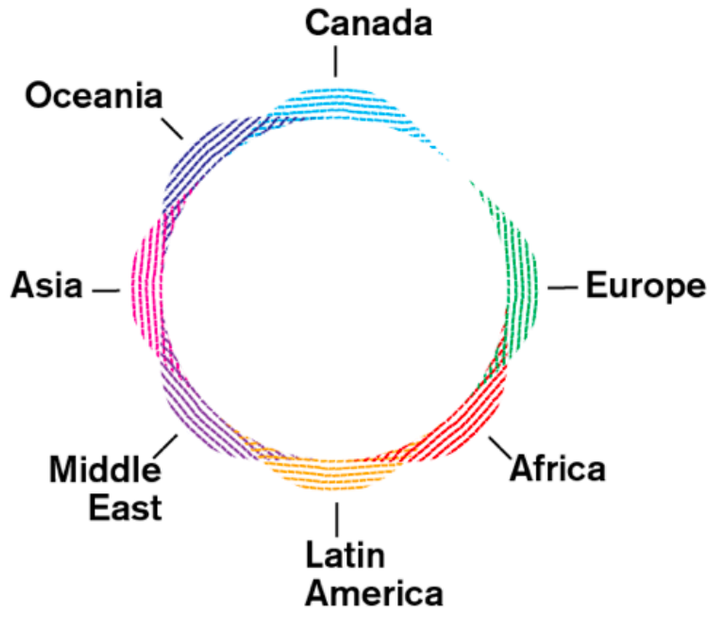
Source: stats.nba.com, toddwschneider.com

Joe Fox / @latimesgraphics

A tree for U.S. immigration

Tree rings showing immigration for
1830-2016
Each dot corresponds to
100 immigrants



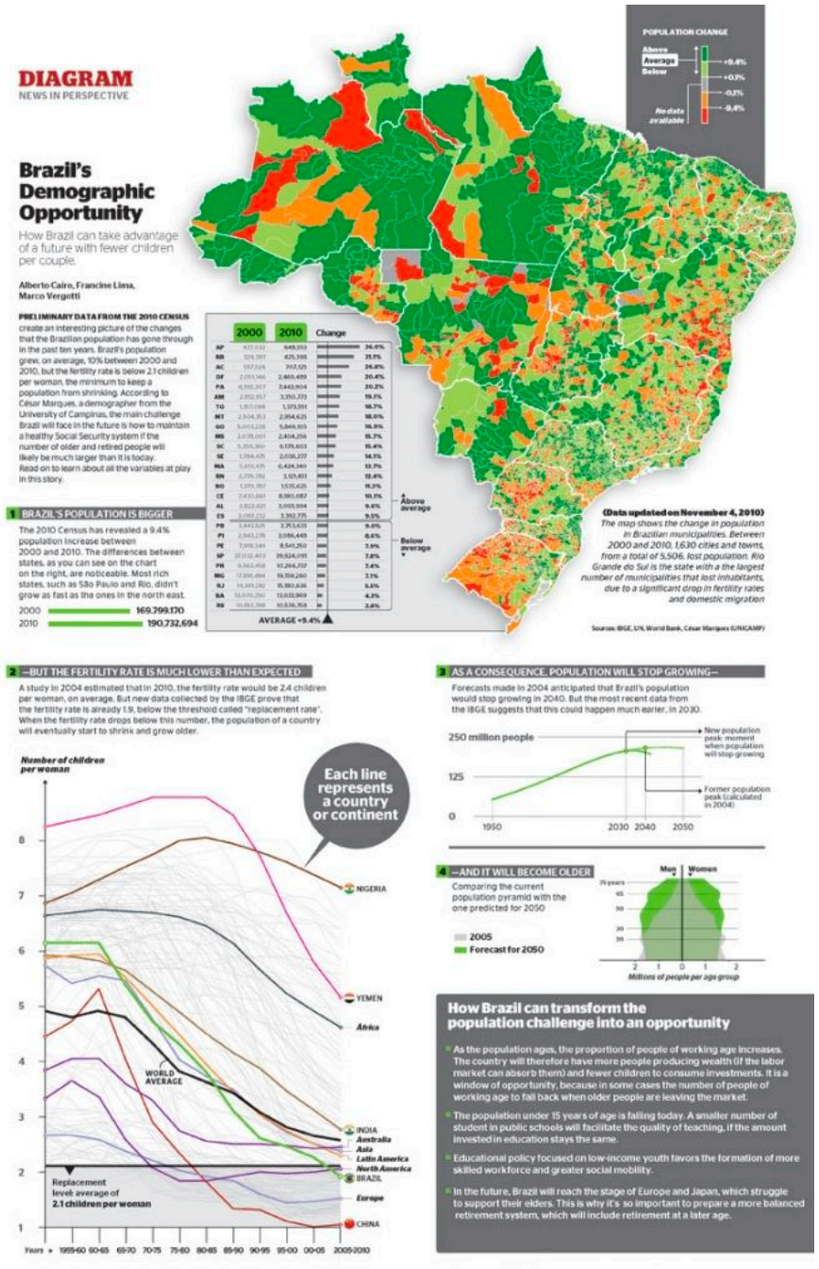


Pedro Cruz. Simulated Dendrochronology of U.S. immigration

MAIN USES OF DATA VISUALIZATION

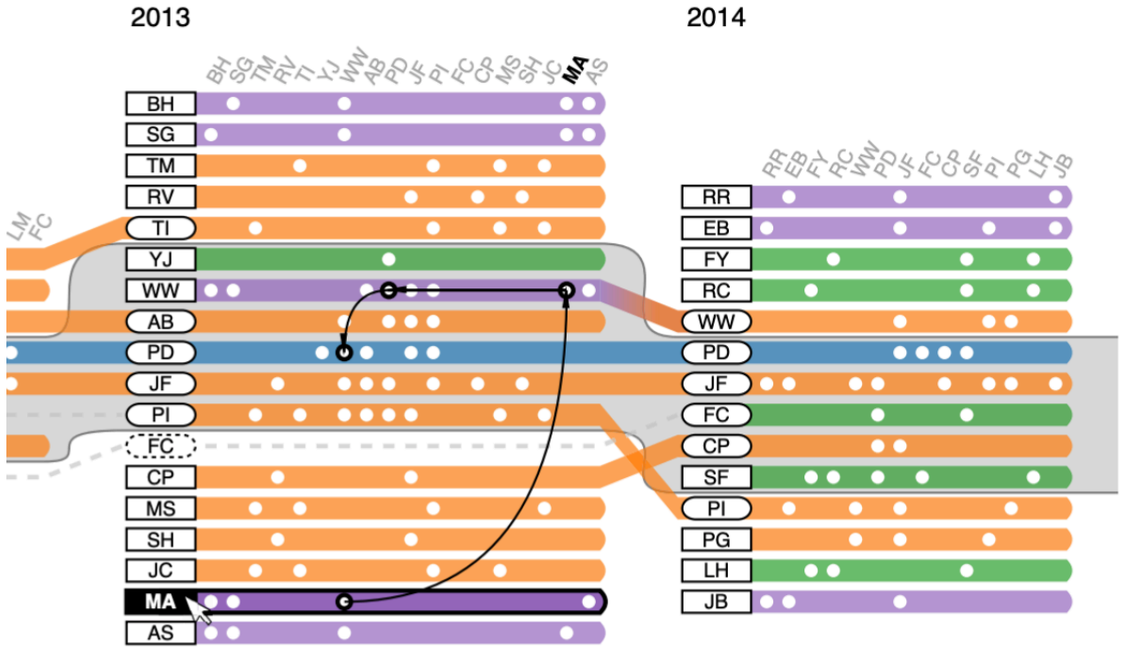
EXPLANATORY

Storytelling



EXPLORATORY

Acquiring insights



This is your brain on visualization….

PERCEPTION FUNDAMENTALS

Visualization design is based on the mapping between data and visual representation

Data  **Graphics**

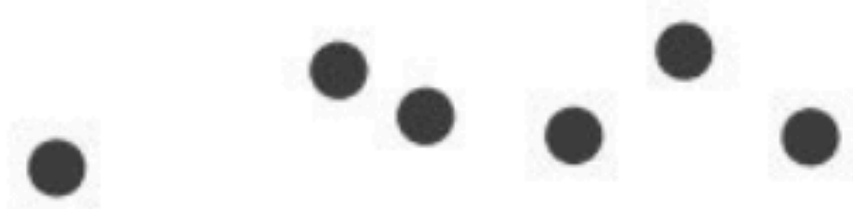
Which representations can I use to encode data?

Which representations are more suitable to ensure I'm conveying the right message?

MARKS

Geometric primitives

Points



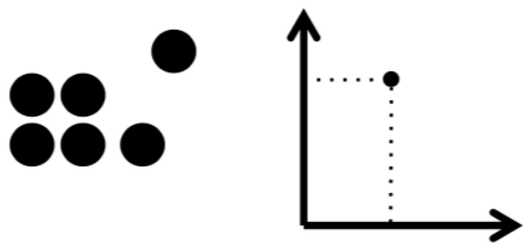
Lines

Areas

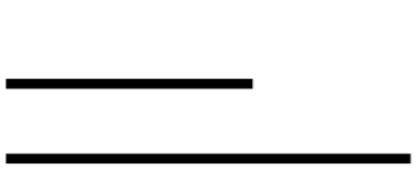
CHANNELS (VISUAL VARIABLES)

Control appearance of marks

Position



Size- Length

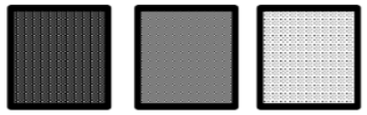


Size- Area

Size- Volume

Format

Texture



Orientation/Direction

Angle

Color

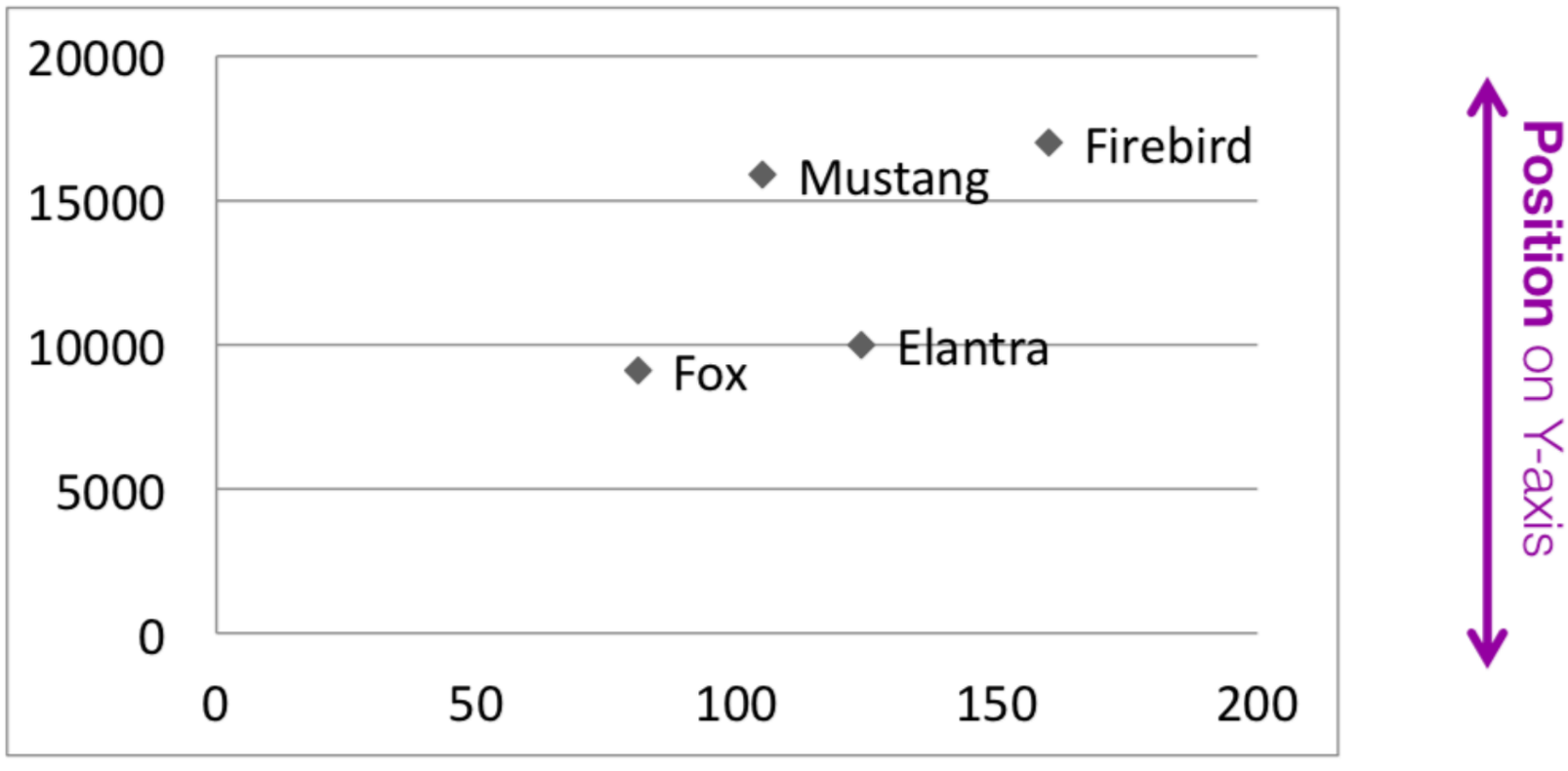
Color - Hue

Color - Saturation

Color - *Luminance*

MAPPING DATA TO VISUAL VARIABLES

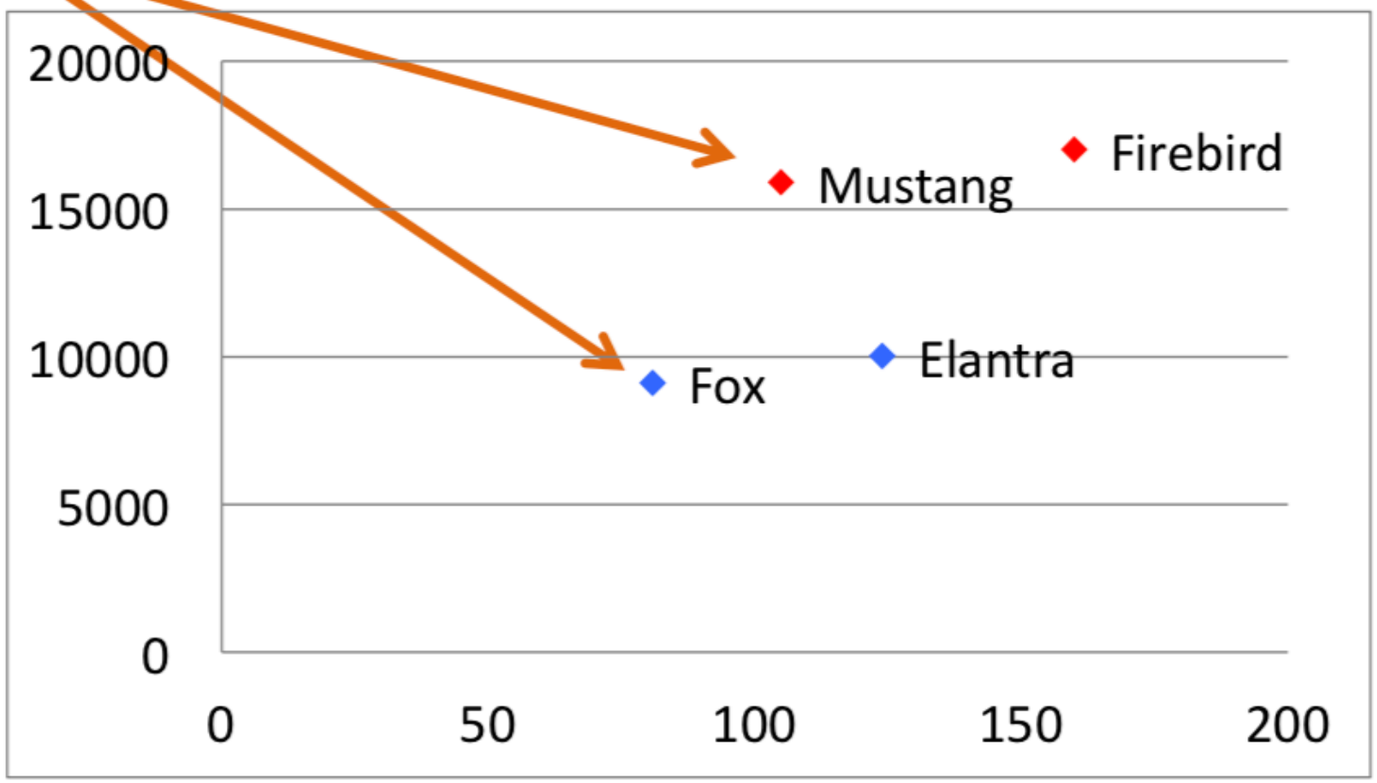
Model	Type	HP	Price	*Number Airbags*
Volkswagen Fox	Compact	81	9100	0 (no airbag)
Hyundai Elantra	Compact	124	10000	0 (no airbag)
Pontiac Firebird	Sport	160	17000	2 (driv. & pass.)
Ford Mustang	Sport	105	15900	1 (driver)



MAPPING DATA TO VISUAL VARIABLES

Model	Type	HP	Price	*Number Airbags*
Volkswagen Fox	Compact	81	9100	0 (no airbag)
Hyundai Elantra	Compact	124	10000	0 (no airbag)
Pontiac Firebird	Sport	160	17000	2 (driv. & pass.)
Ford Mustang	Sport	105	15900	1 (driver)

Color (Hue)



Position on Y-axis

Position on X-axis

MAPPING DATA TO VISUAL VARIABLES

Model	Type	HP	Price	*Number Airbags*
Volkswagen Fox	Compact	81	9100	0 (no airbag)
Hyundai Elantra	Compact	124	10000	0 (no airbag)
Pontiac Firebird	Sport	160	17000	2 (driv. & pass.)
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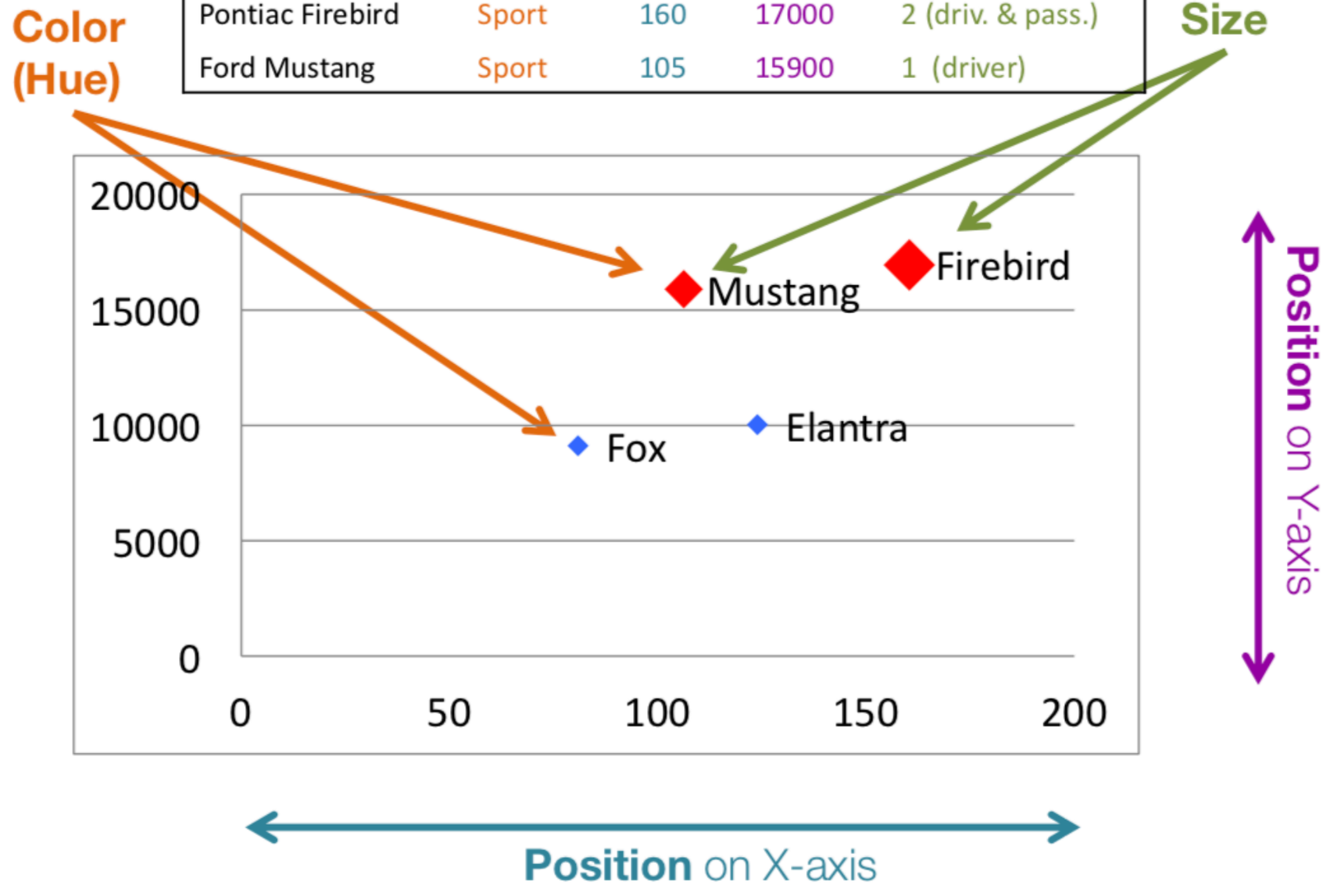


Which representations can I use to encode data?

Expressiveness principle:
use adequate/suitable data representations

Encodings should convey all, and only, the information of associated attributes.

e.g. Ordinal data representation should convey "order"; similarly, "categorical data" should not be shown in a way that implies order.

Mackinlay, Jock. "Automating the design of graphical presentations of relational information." ACM Transactions on Graphics (TOG) 5.2 (1986): 110-141.

Which representations are more suitable to ensure I'm conveying the right message?

Effectiveness principle:
choosing the best representation to your data

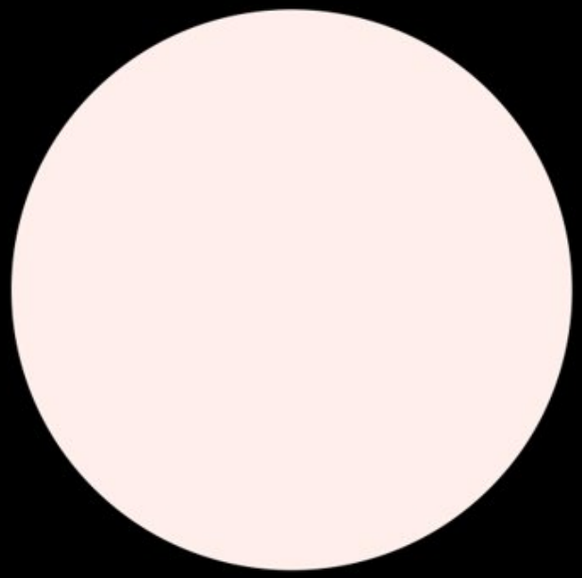
Importance of attributes should match the "saliency" of the channel;

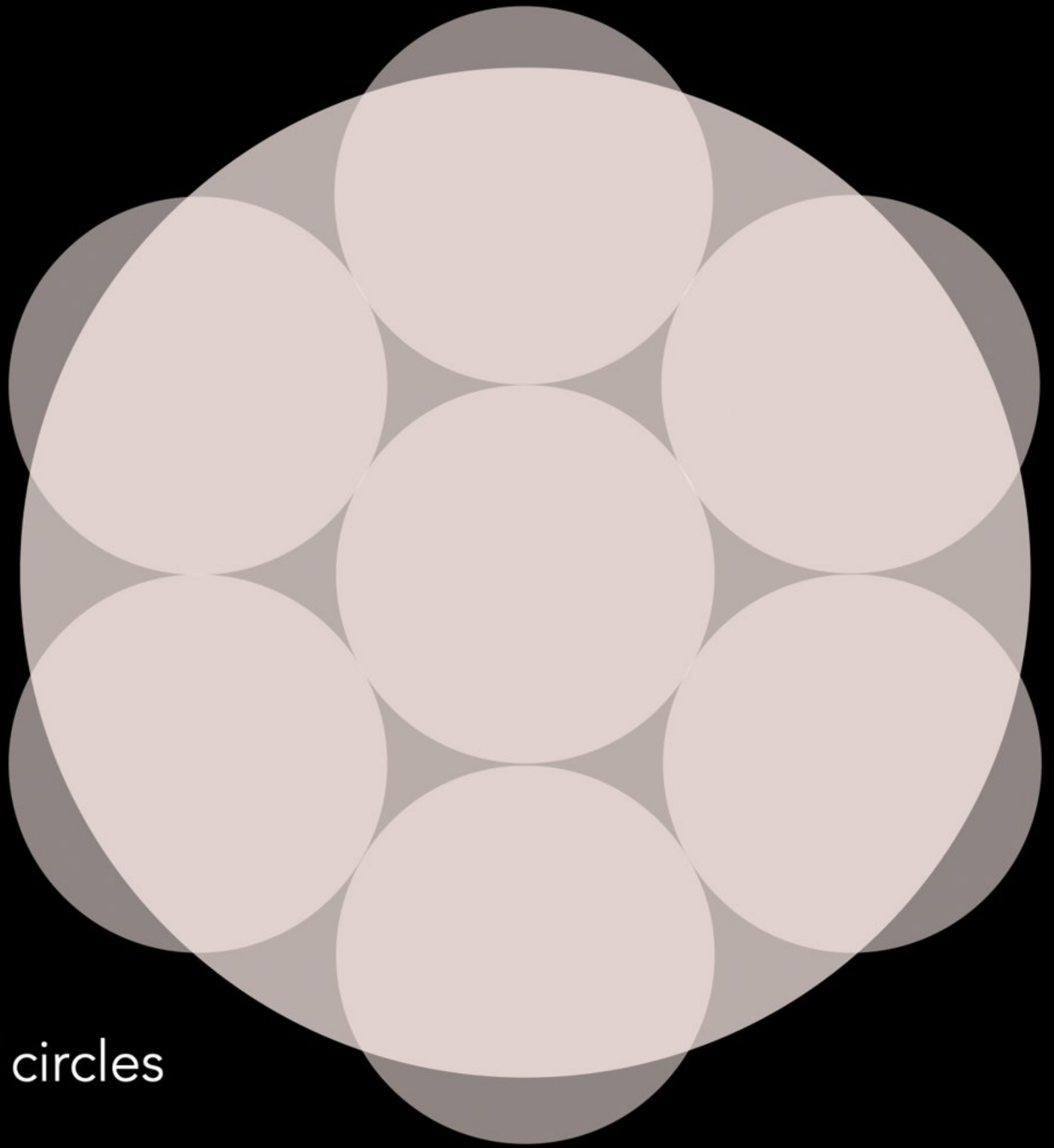
Most important attributes should be encoded using the most effective and noticeable channels.

Mackinlay, Jock. "Automating the design of graphical presentations of relational information." ACM Transactions on Graphics (TOG) 5.2 (1986): 110-141.

Compare **area** of circles

Compare **length** of bars



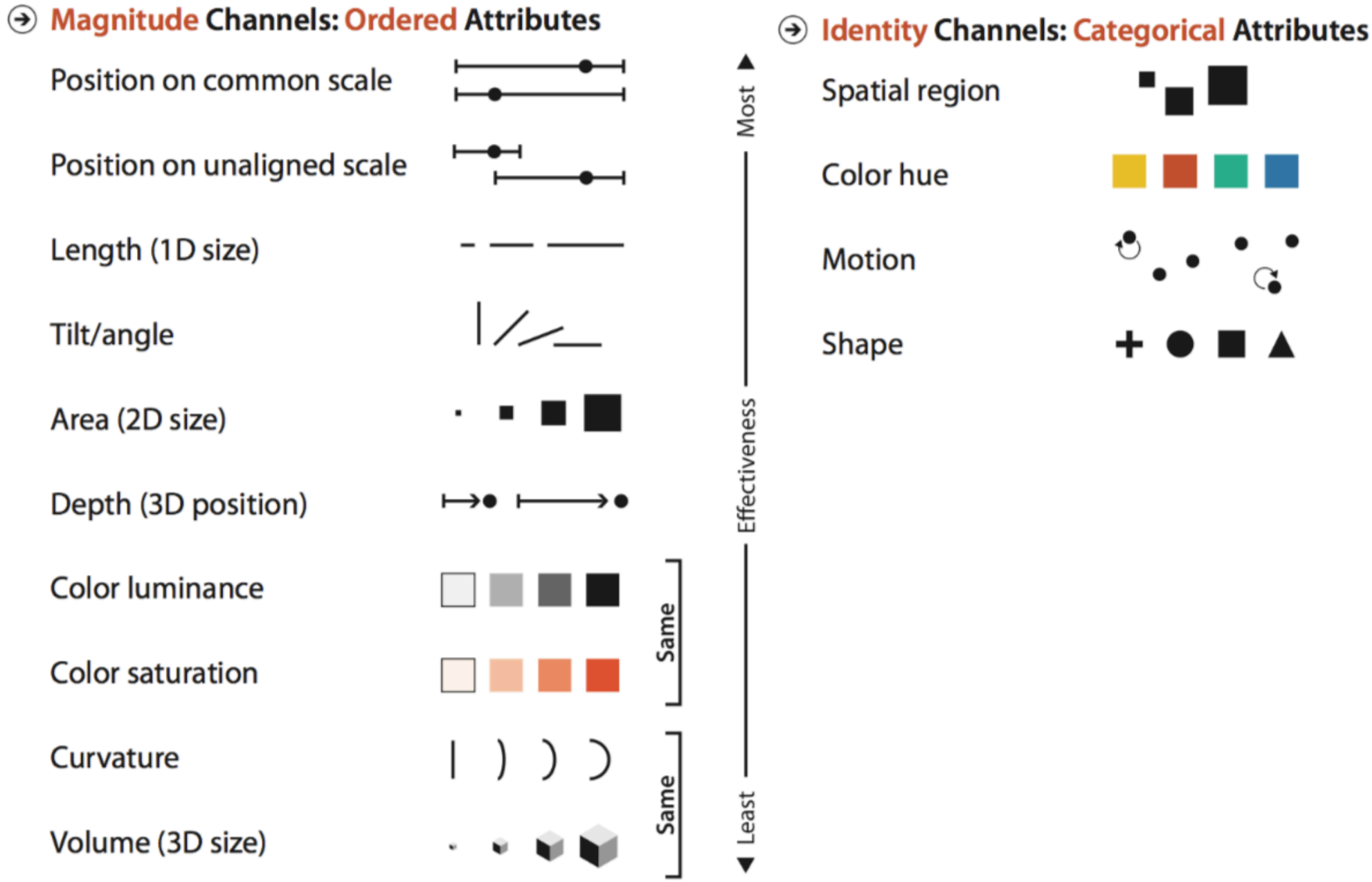


Compare the **area** of circles

Compare **length** of bars

EFFECTIVENESS PRINCIPLE

Some variables are perceptually better than others



Munzner, Tamara. Visualization Analysis and Design. CRC Press, 2014.

ATTRIBUTE TYPES

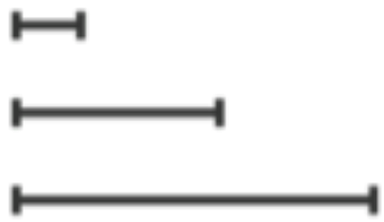
Not Ordered

Ordered

Categorical

Ordinal

Quantitative



Ordering Direction

Sequential

Diverging

Circular

ATTRIBUTE TYPES

Not Ordered

Ordered

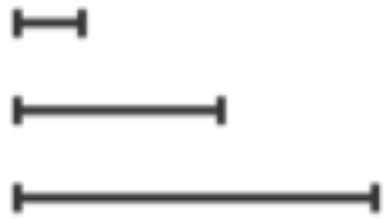
Categorical

= , ≠

Ordinal

= , ≠ , <, >

Quantitative



= , ≠ , <, >, +, -, ÷

ATTRIBUTE TYPES

Not Ordered

Ordered

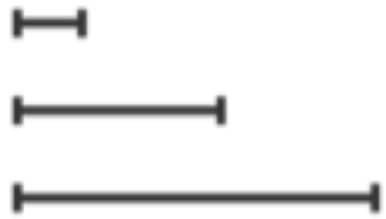
Categorical

= , ≠

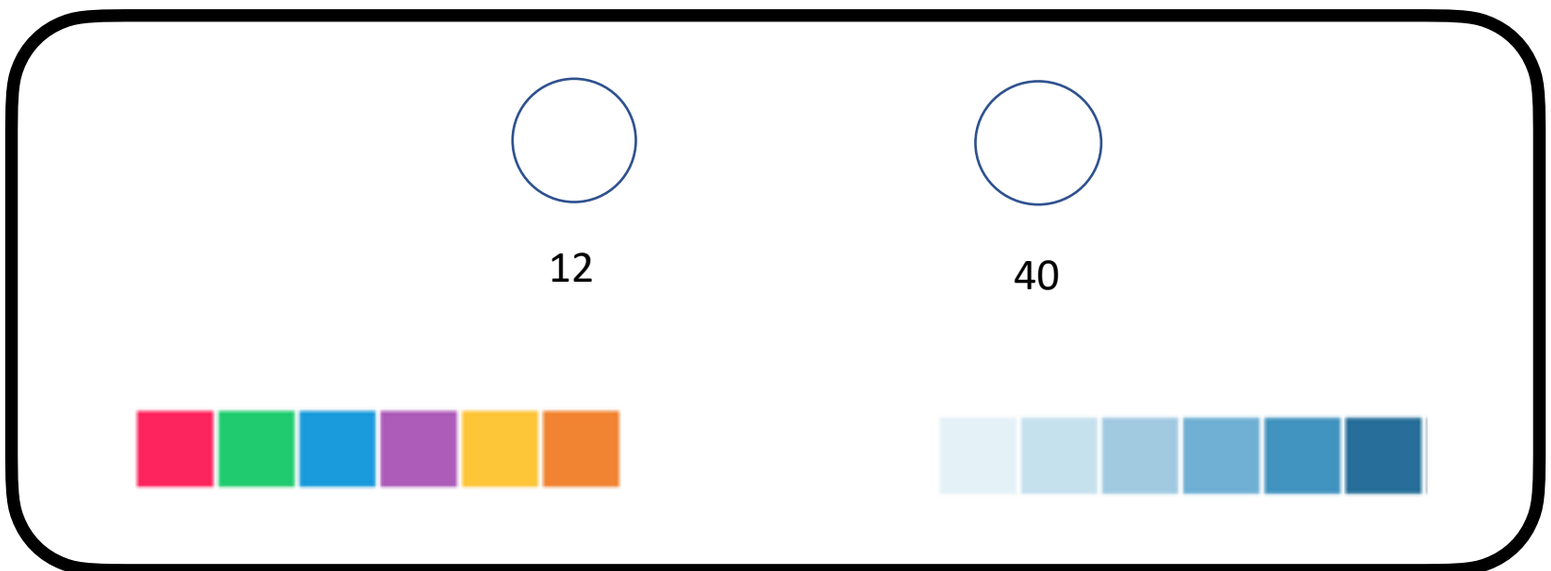
Ordinal

= , ≠ , <, >

Quantitative



= , ≠ , <, >, +, -, ÷



ATTRIBUTE TYPES

Not Ordered

Ordered

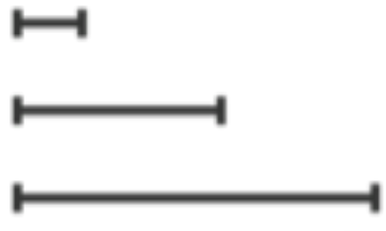
Categorical

= , ≠

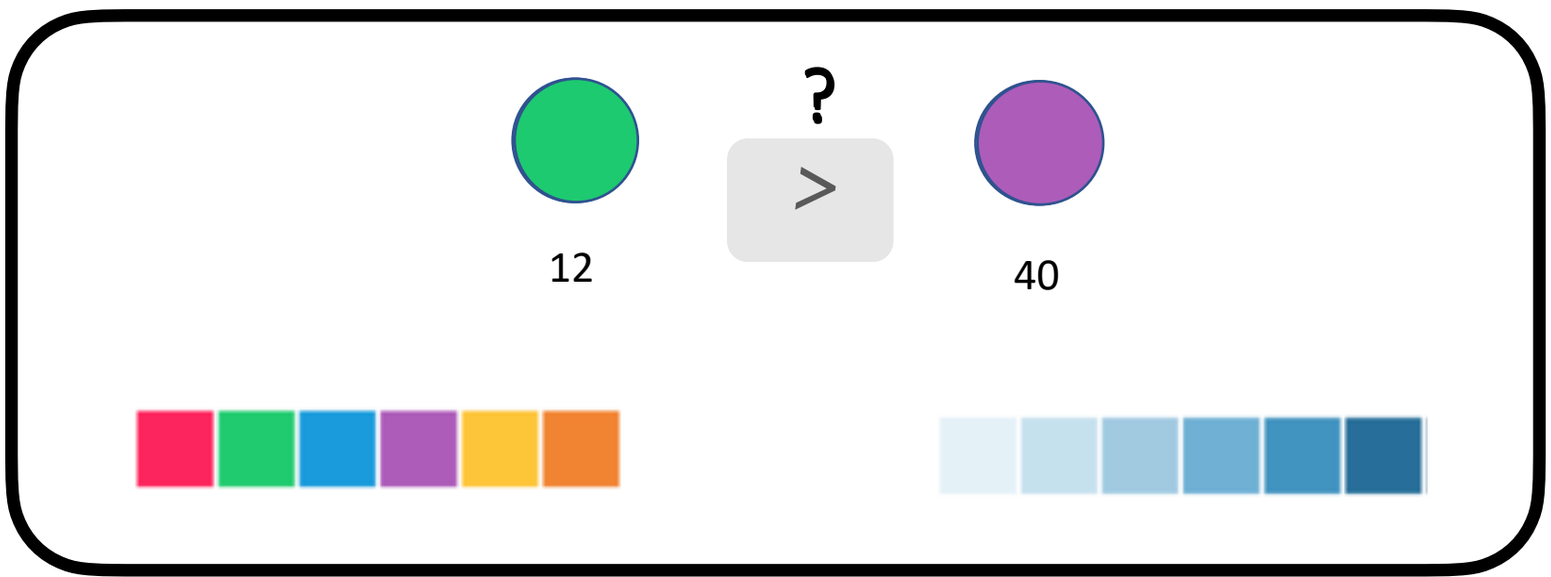
Ordinal

= , ≠ , <, >

Quantitative



= , ≠ , <, >, +, -, ÷



ATTRIBUTE TYPES

Not Ordered

Ordered

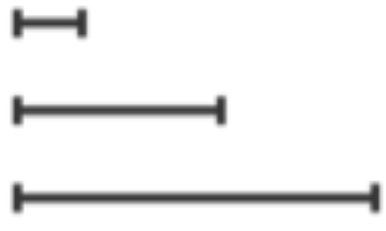
Categorical

= , ≠

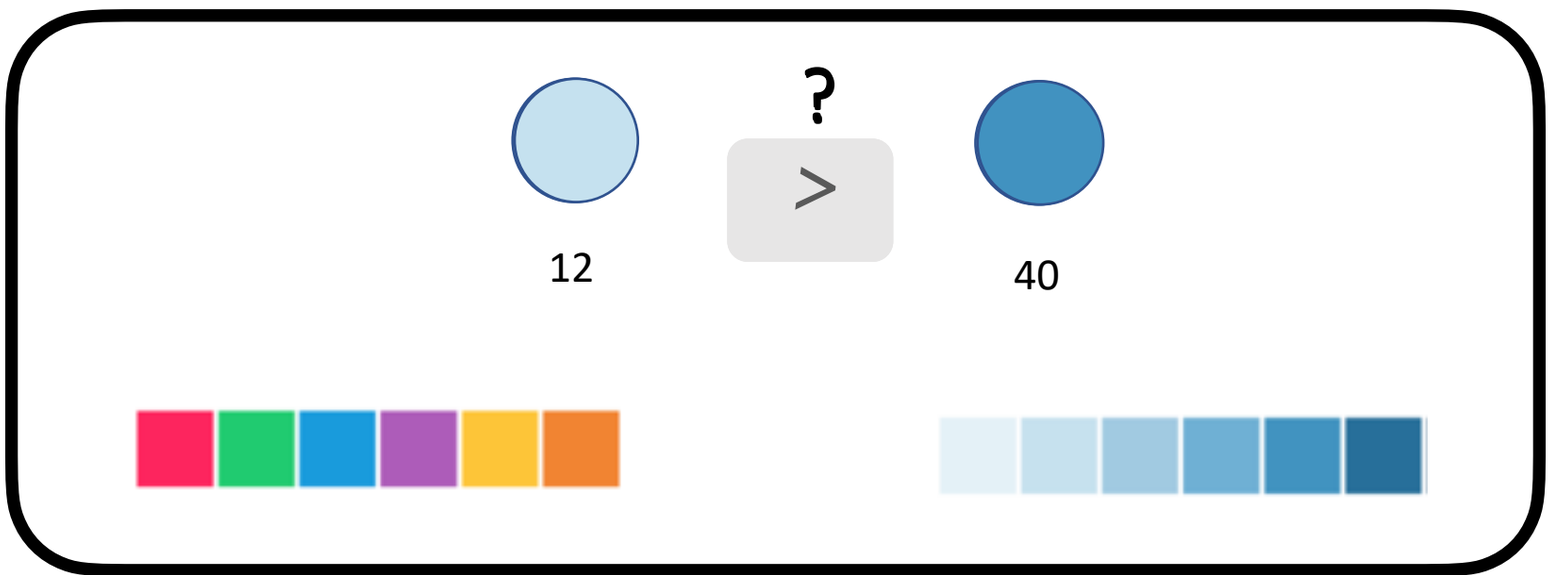
Ordinal

= , ≠ , <, >

Quantitative



= , ≠ , <, >, +, -, ÷



ATTRIBUTE TYPES

Not Ordered

Ordered

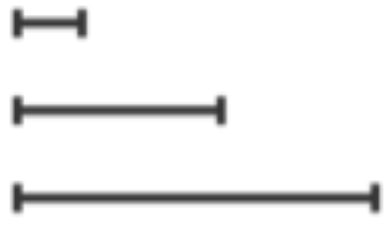
Categorical

= , ≠

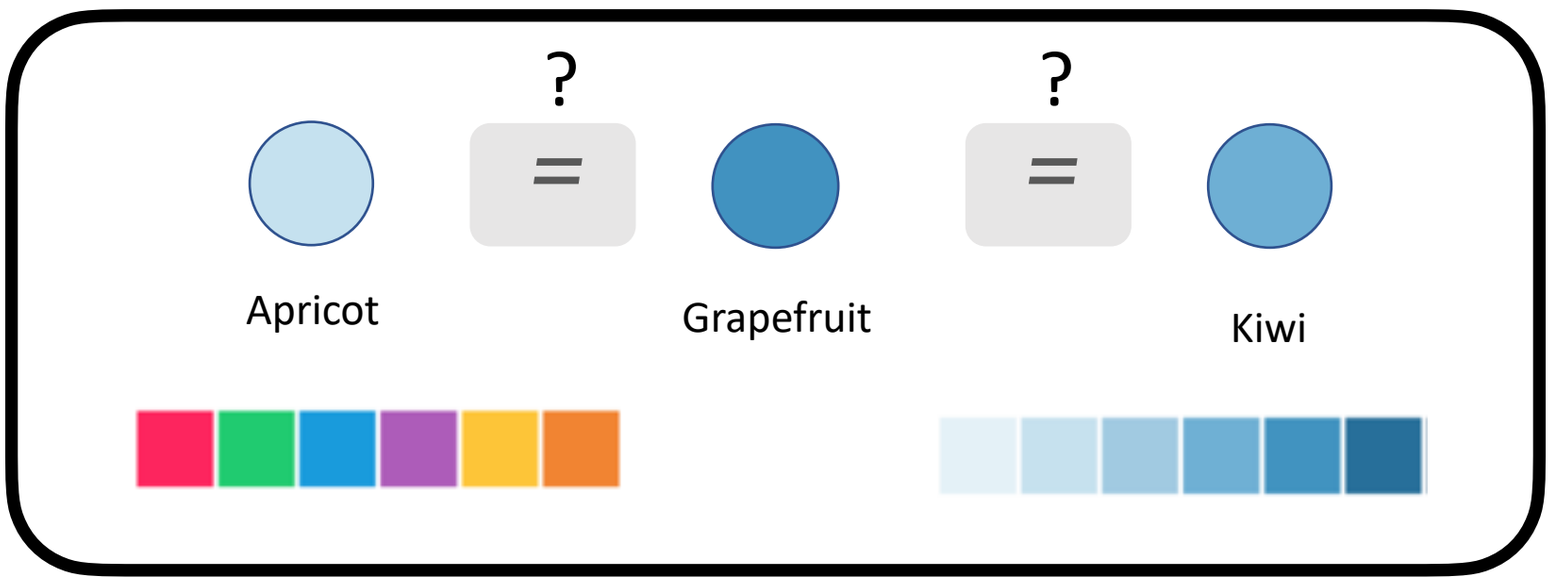
Ordinal

= , ≠ , <, >

Quantitative

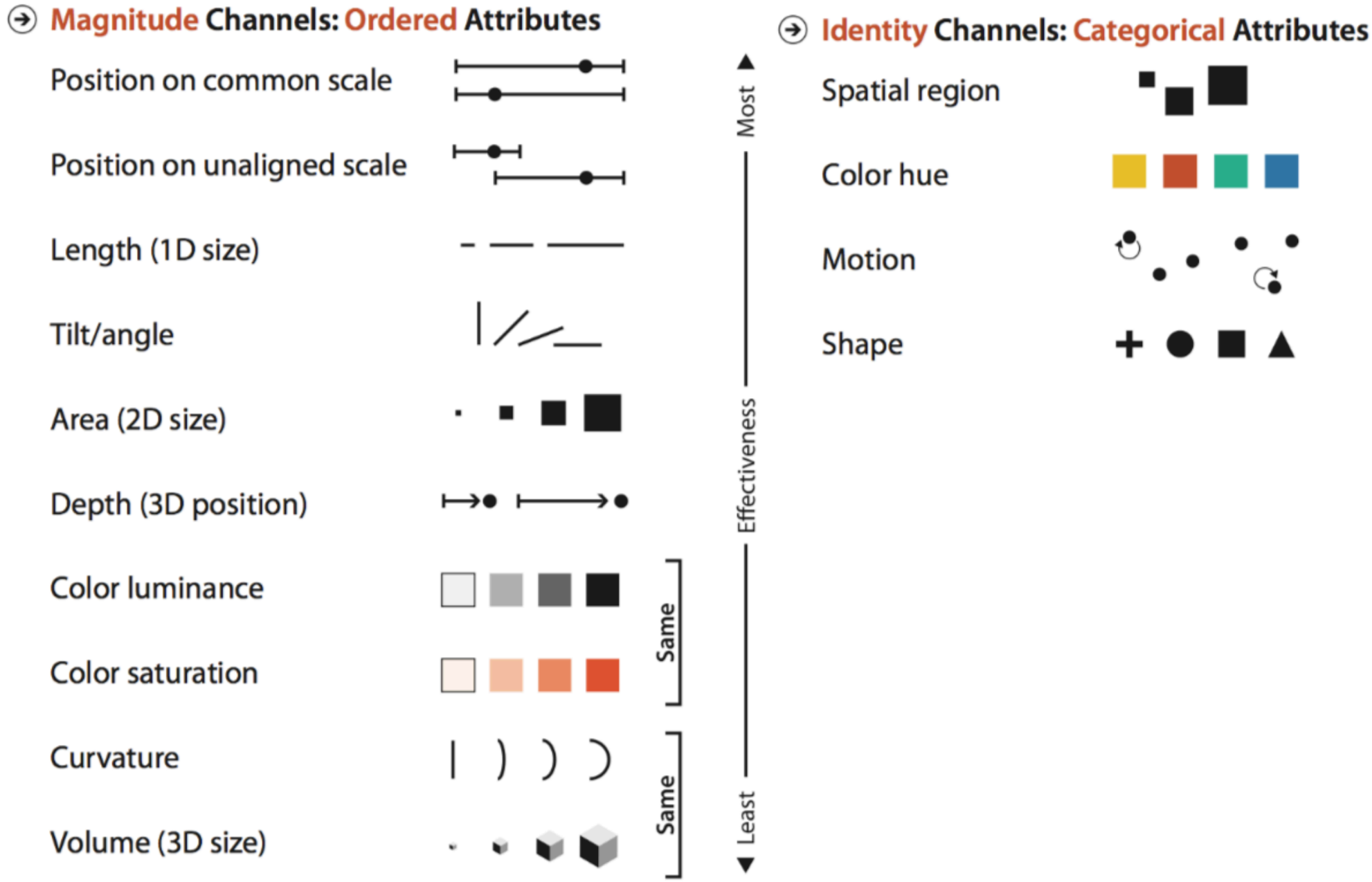


= , ≠ , <, >, +, -, ÷



EFFECTIVENESS PRINCIPLE

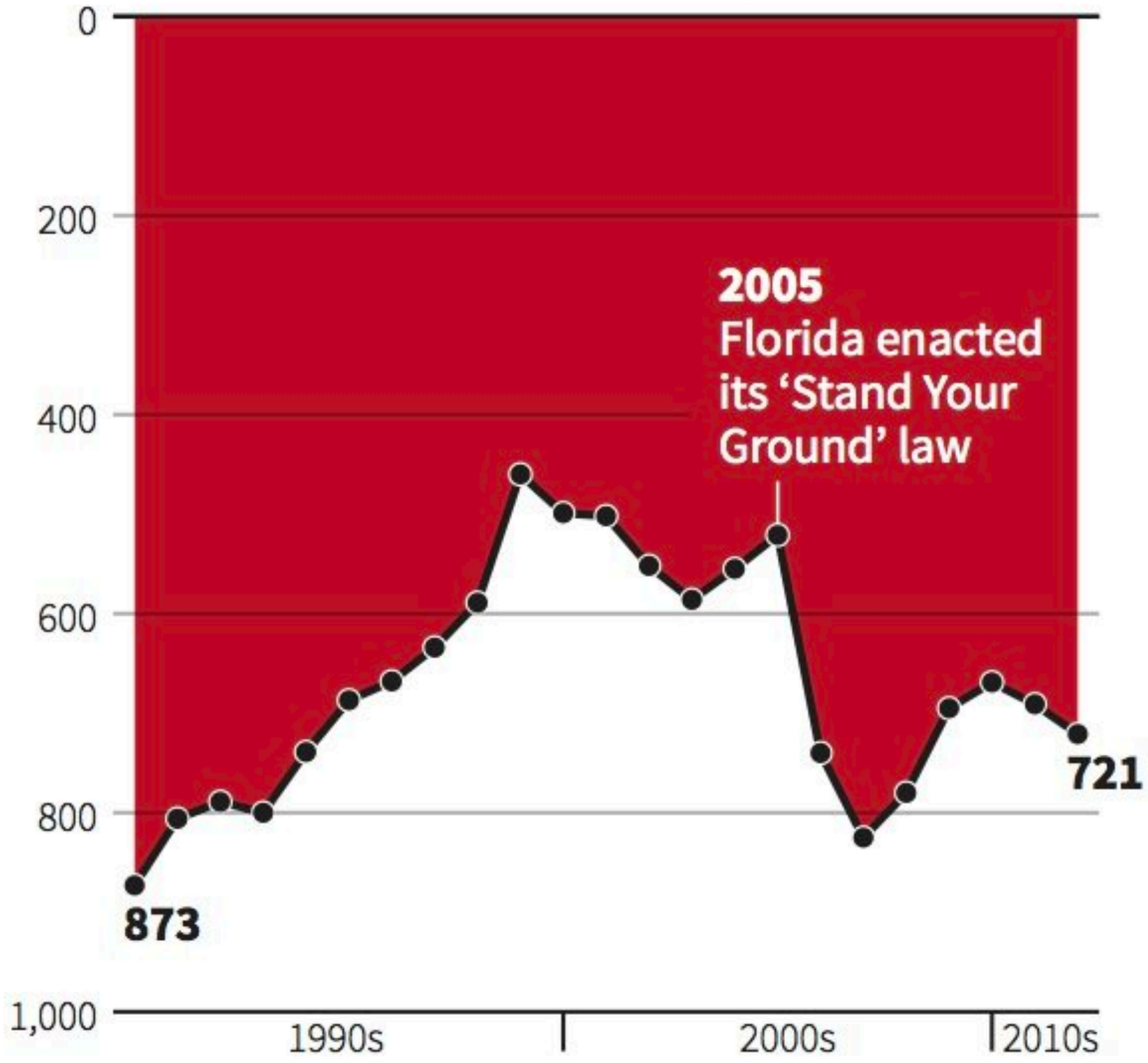
Some variables are perceptually better than others

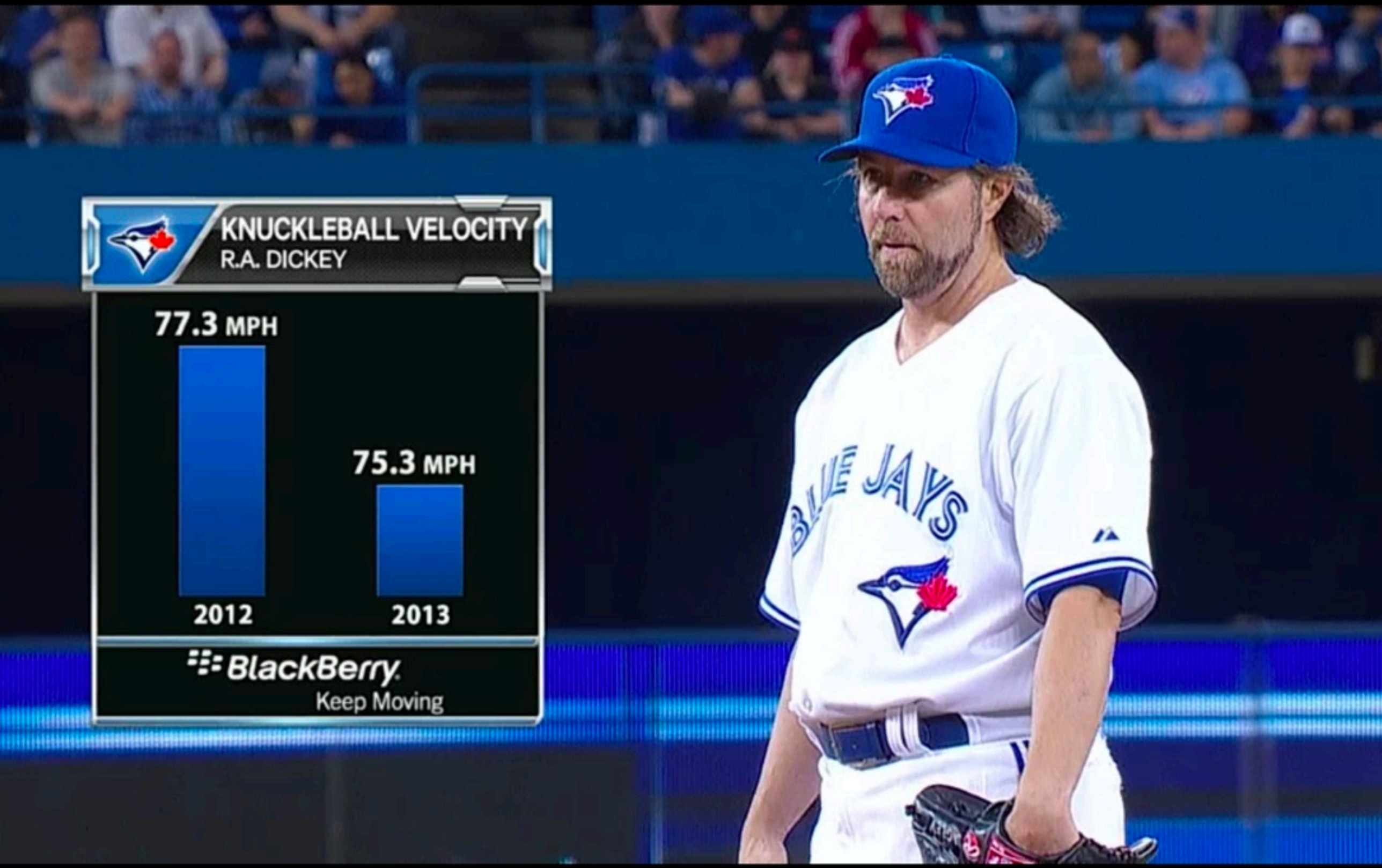


Munzner, Tamara. Visualization Analysis and Design. CRC Press, 2014.

Gun deaths in Florida

Number of murders committed using firearms




KNUCKLEBALL VELOCITY
R.A. DICKEY
77.3 MPH
75.3 MPH
2012
2013
BlackBerry
Keep Moving
BLUE JAYS

COLORMAPS

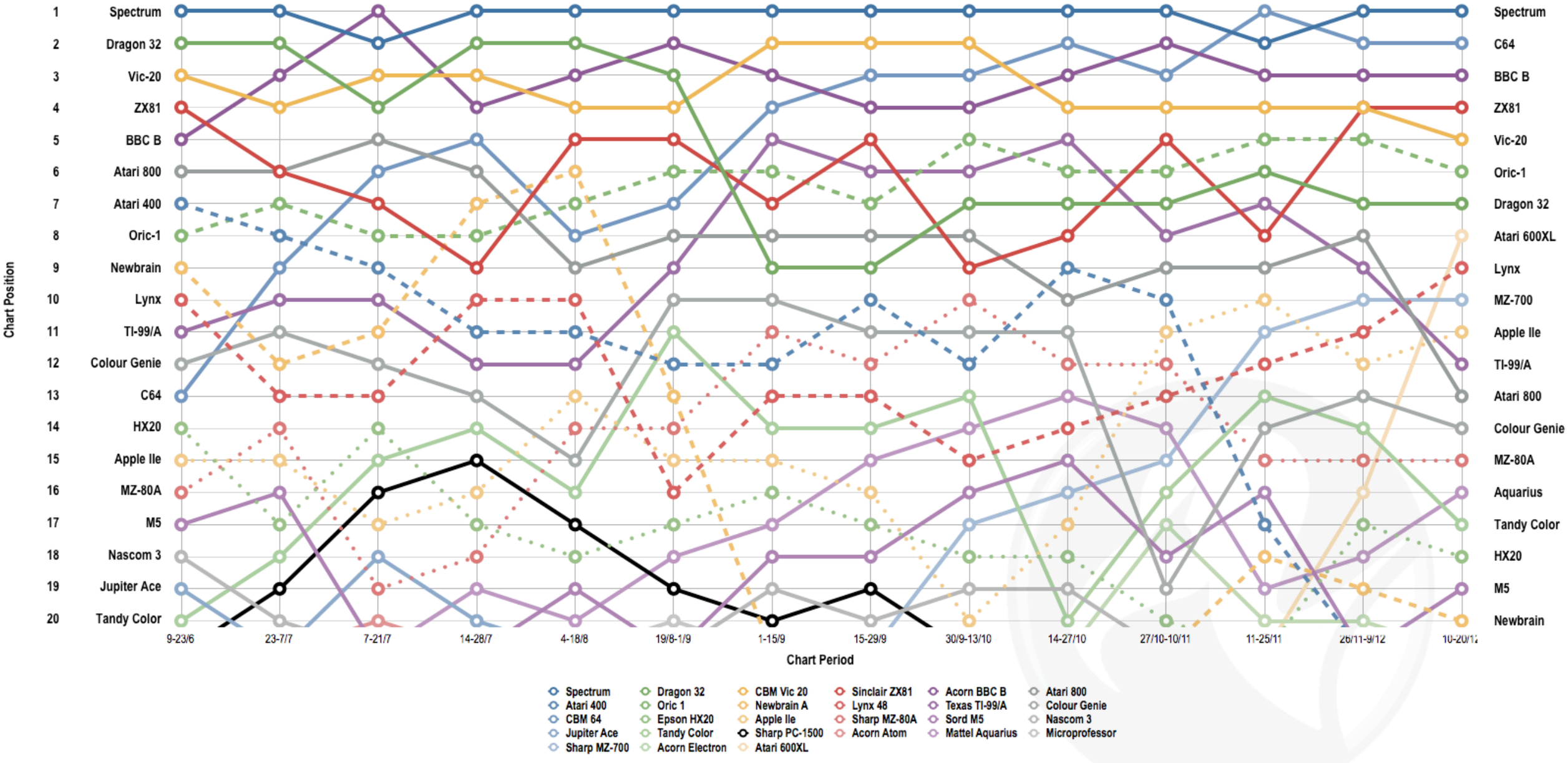
Not Ordered

Categorical

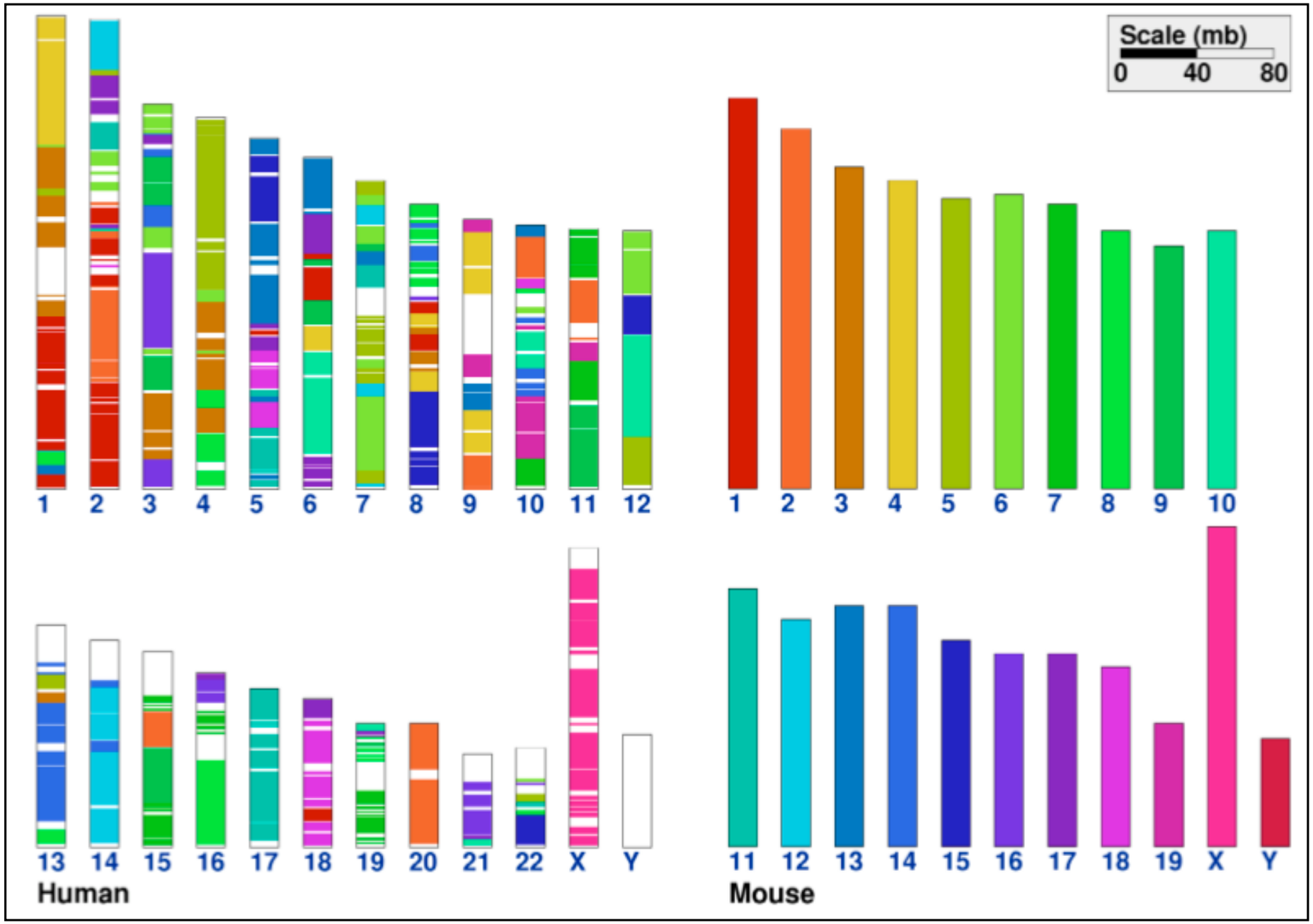
Ordered

Ordinal, Quantitative

COLOR DISCRIMINABILITY



COLOR DISCRIMINABILITY



Cinteny: flexible analysis and visualization of synteny and genome rearrangements in multiple organisms. Sinha and Meller. BMC Bioinformatics, 8:82, 2007.

PERCEPTUAL LINEARITY

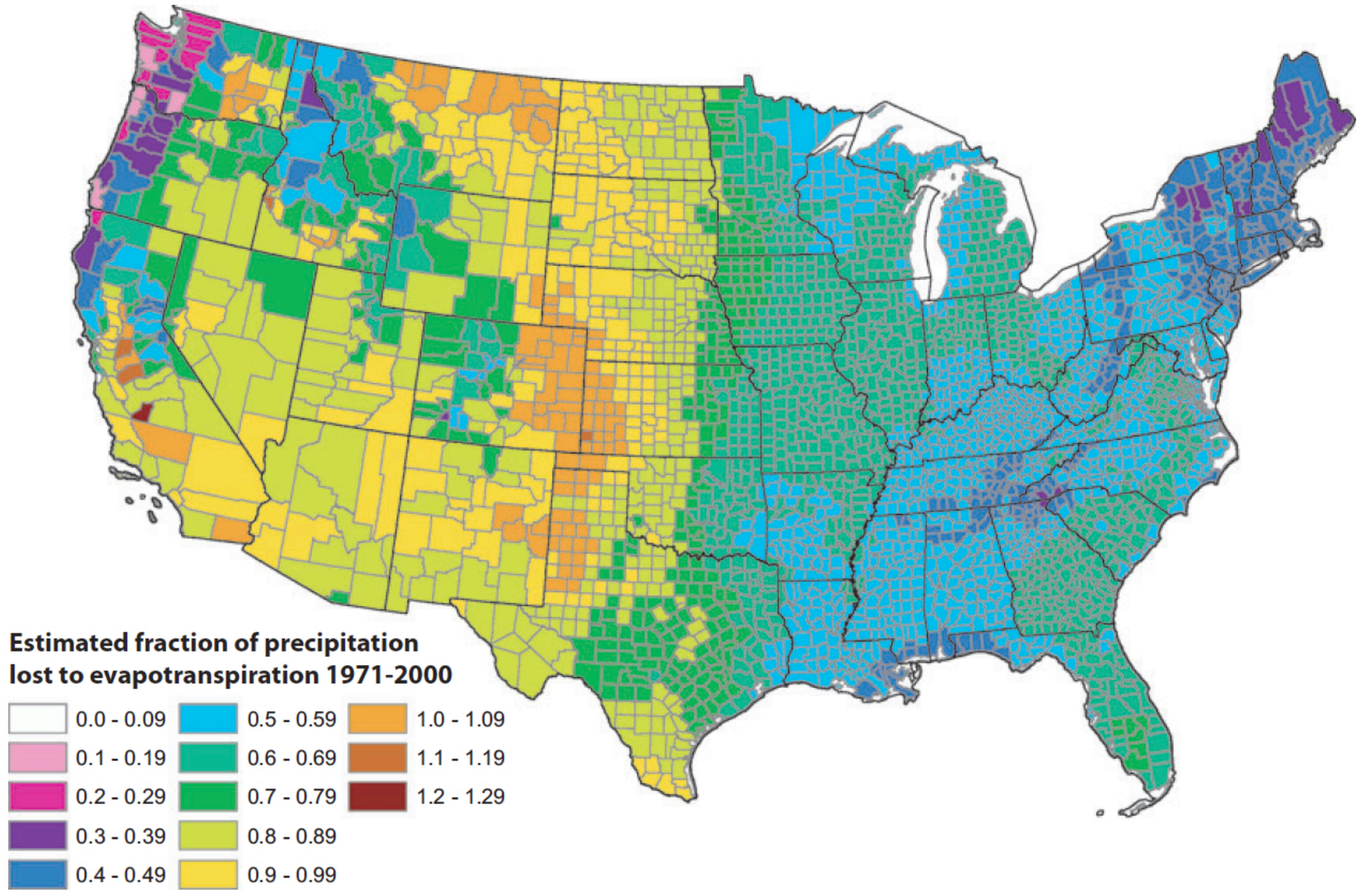


FIGURE 13. Estimated Mean Annual Ratio of Actual Evapotranspiration (ET) to Precipitation (P) for the Conterminous U.S. for the Period 1971-2000. Estimates are based on the regression equation in Table 1 that includes land cover. Calculations of ET/P were made first at the 800-m resolution of the PRISM climate data. The mean values for the counties (shown) were then calculated by averaging the 800-m values within each county. Areas with fractions >1 are agricultural counties that either import surface water or mine deep groundwater.

COLORMAPS

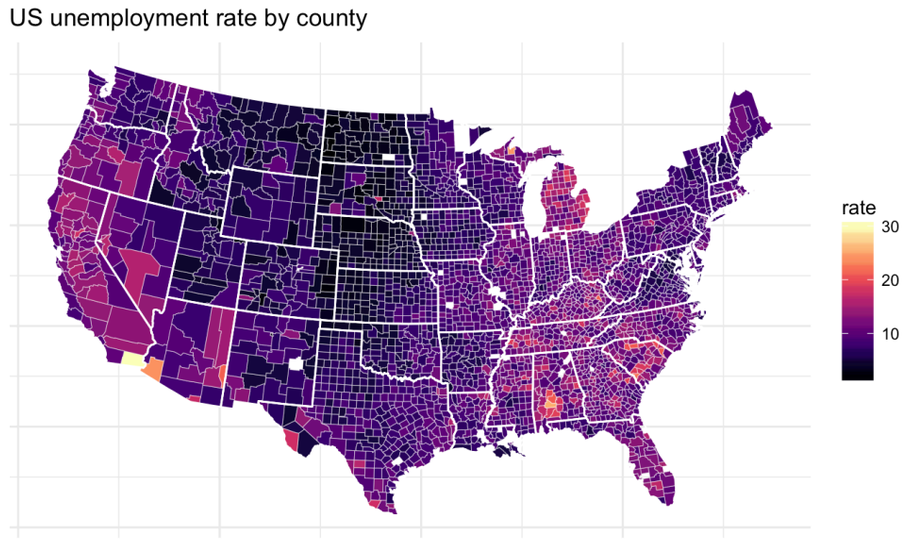
Not Ordered

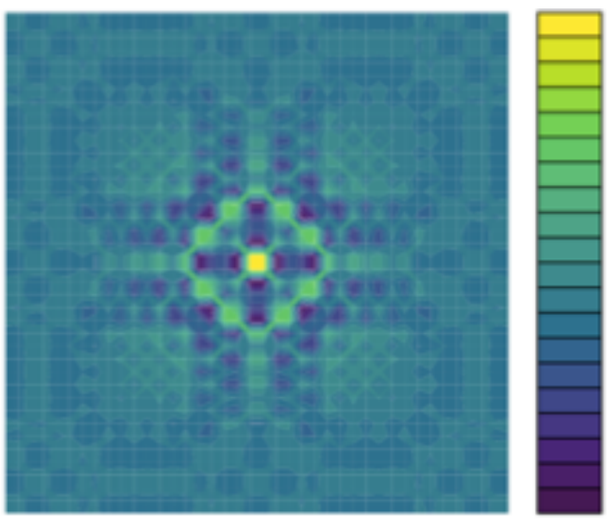
Categorical

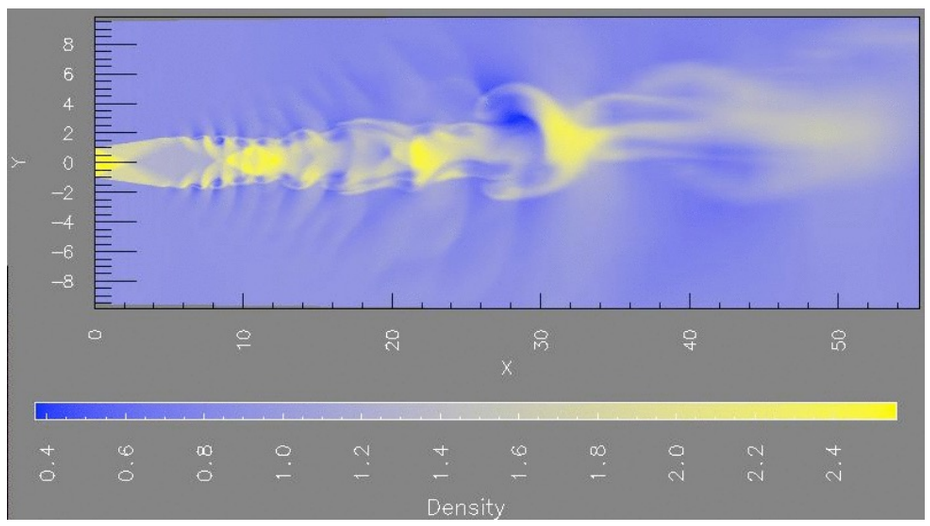
Ordered

Ordinal, Quantitative

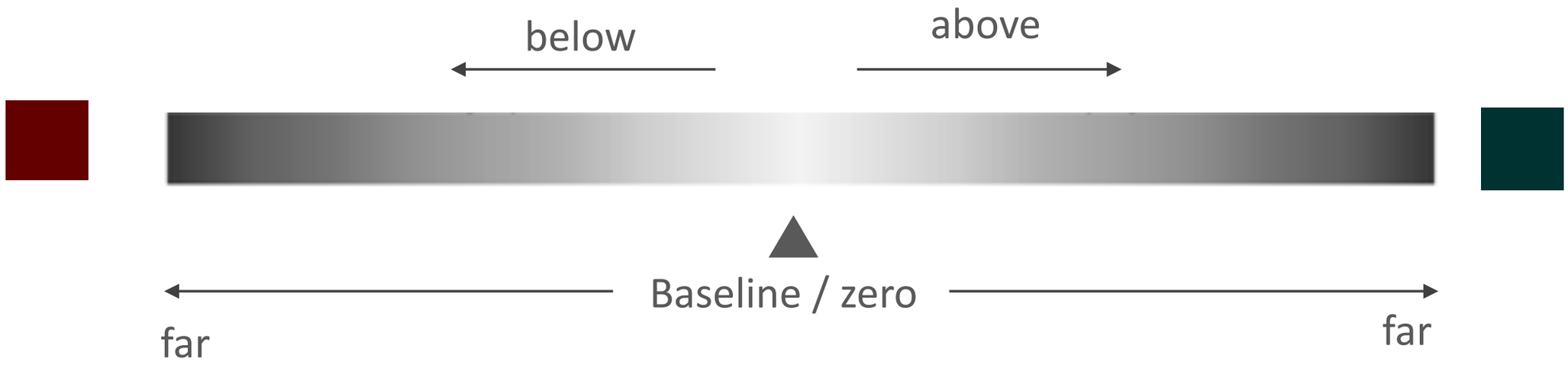
ORDERED COLORMAPS







DIVERGING COLORMAPS

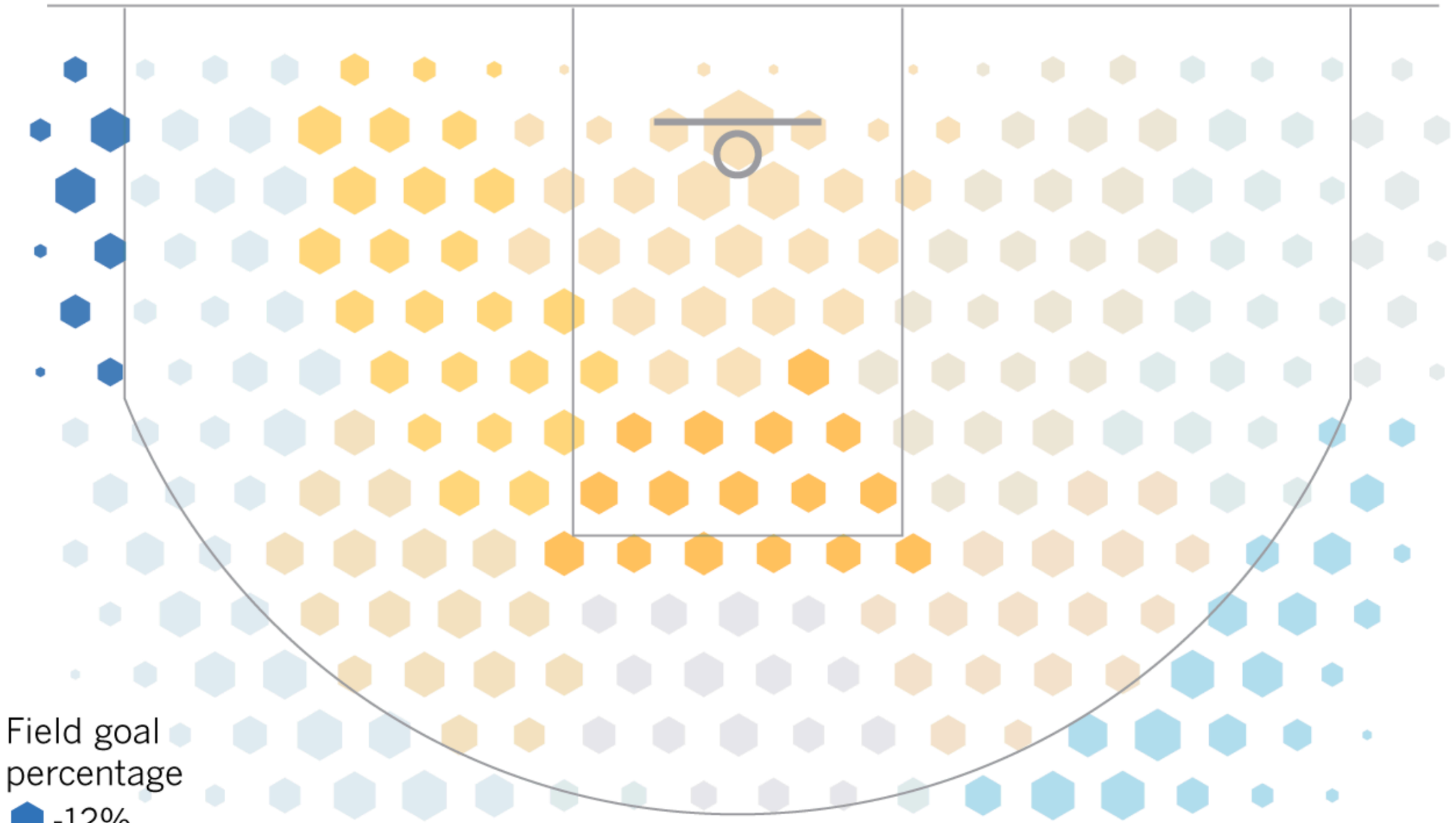


DIVERGING ORANGE-YELLOW-SEAFOAM

DIVERGING RED-YELLOW-BLUE

DIVERGING RED-BLUE

Kobe Bryant vs. league average (1996-2016)



Field goal percentage
-12%
-8%
-4%
average
+4%
+8%
+12%

Source: stats.nba.com, toddwschneider.com

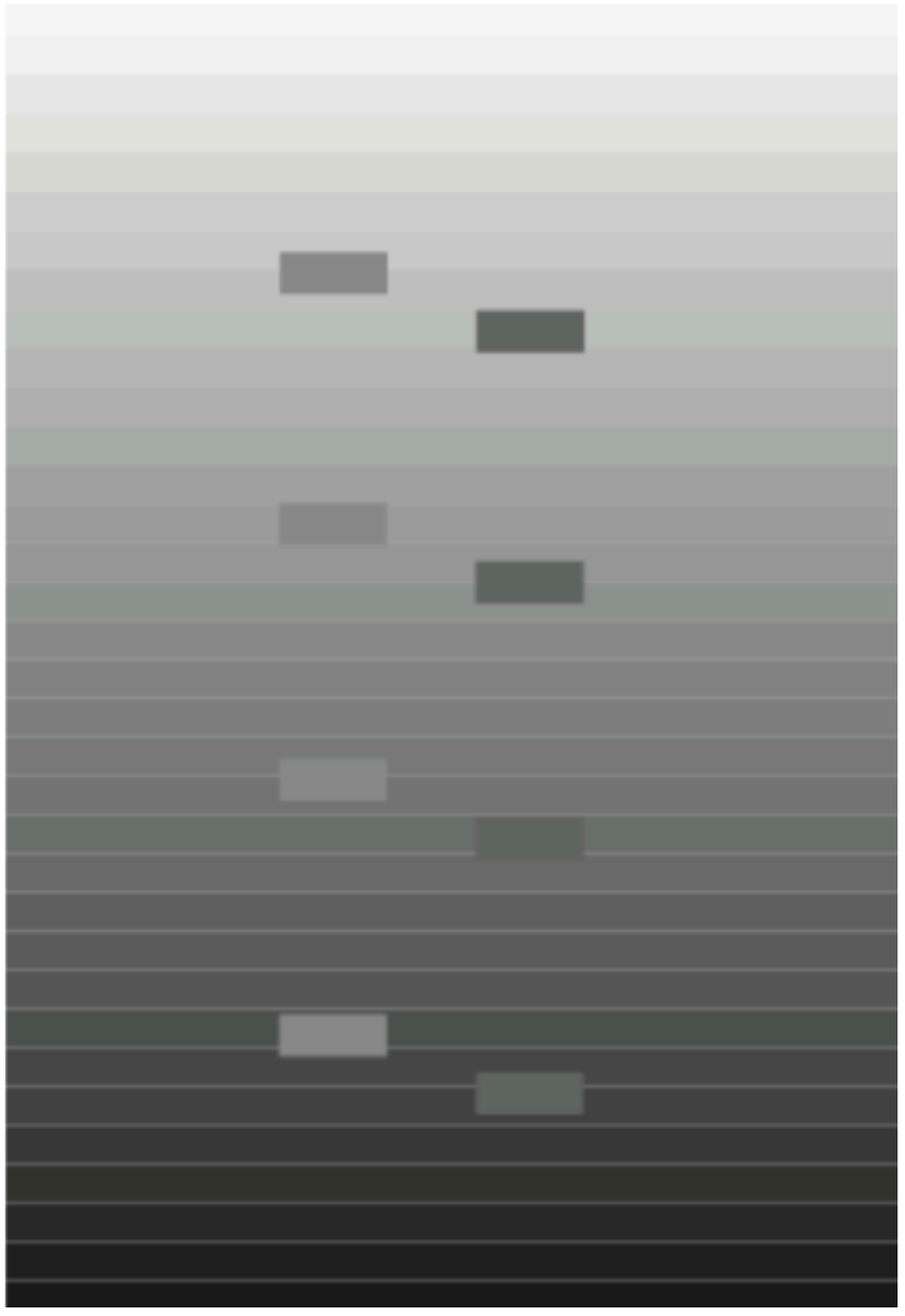
Joe Fox / @latimesgraphics

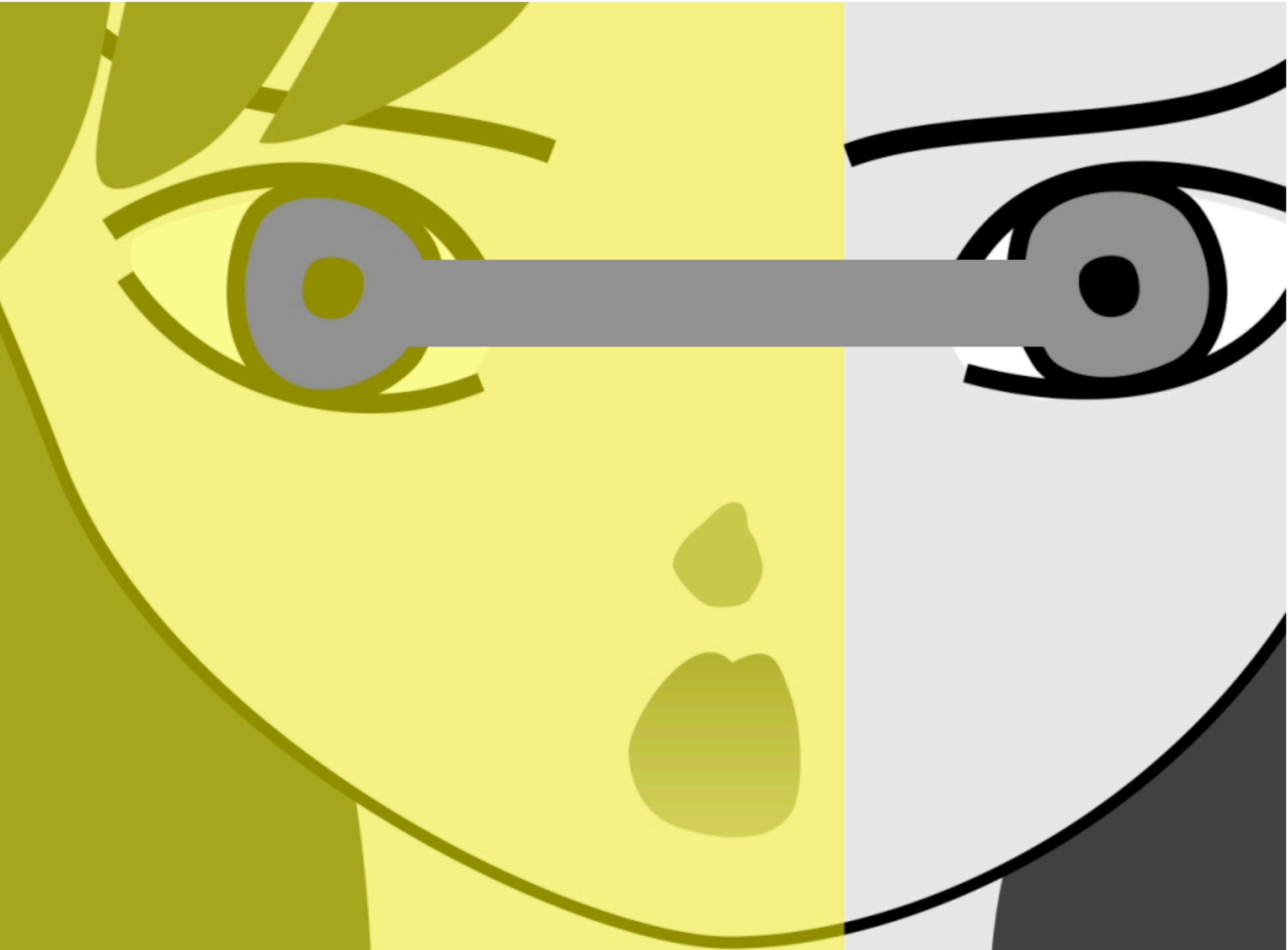
COLOR PERCEPTION IS LOCAL

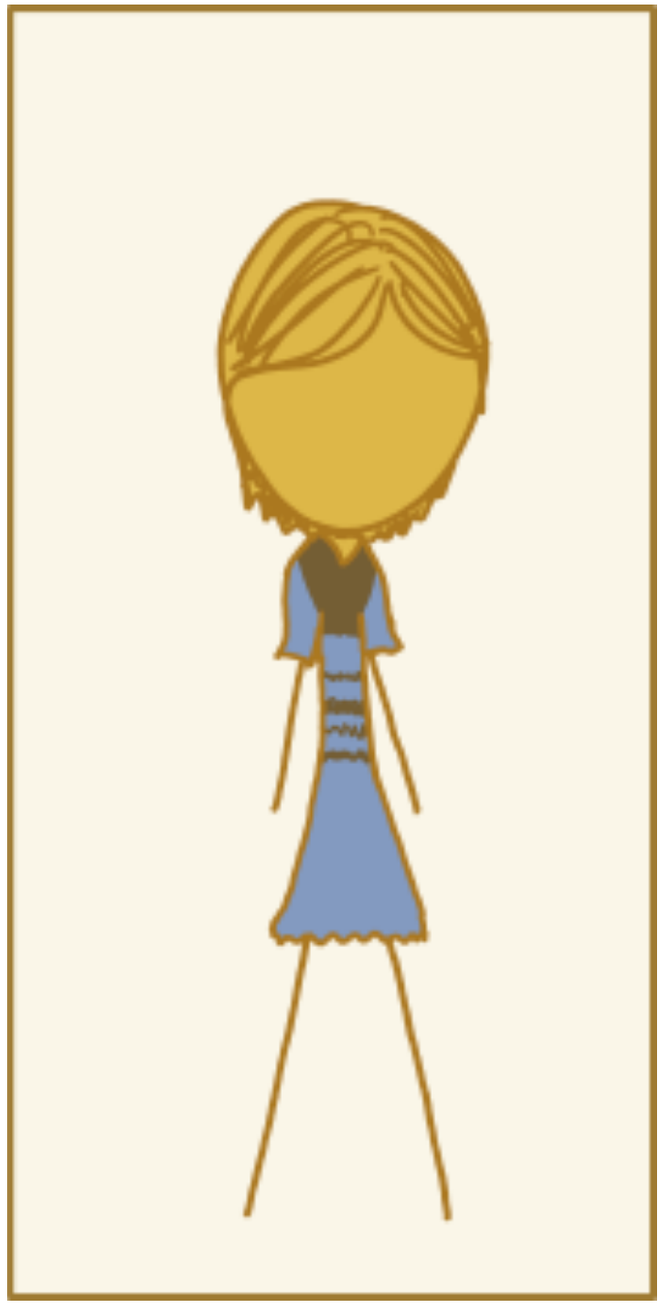
- Luminance perception is not absolute, but contrast relative ... and local!

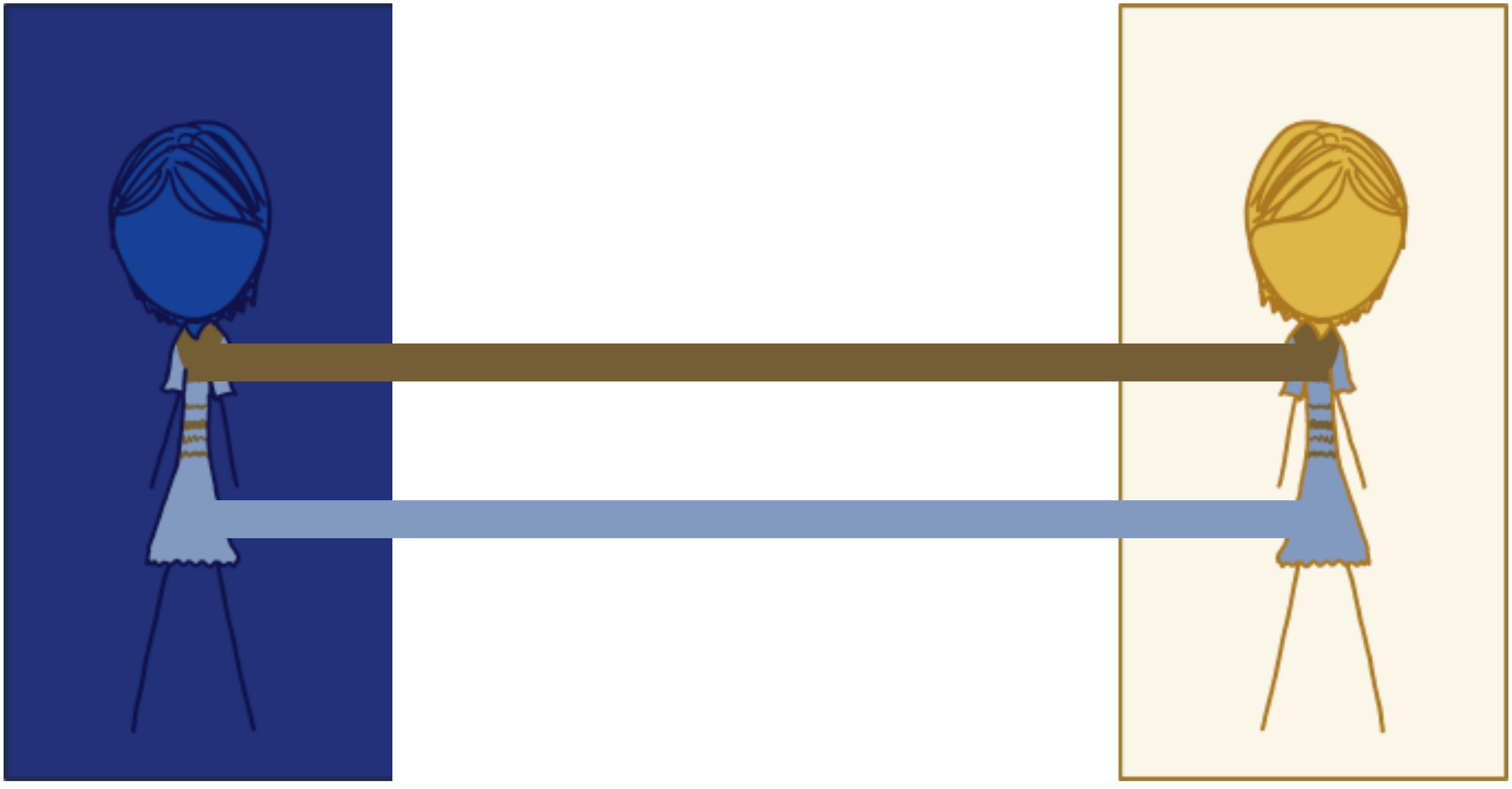
- Discern objects(foreground) from background

- Gray color scales are not recommended for more than 5 segments... too "imprecise" to convey quantitative data









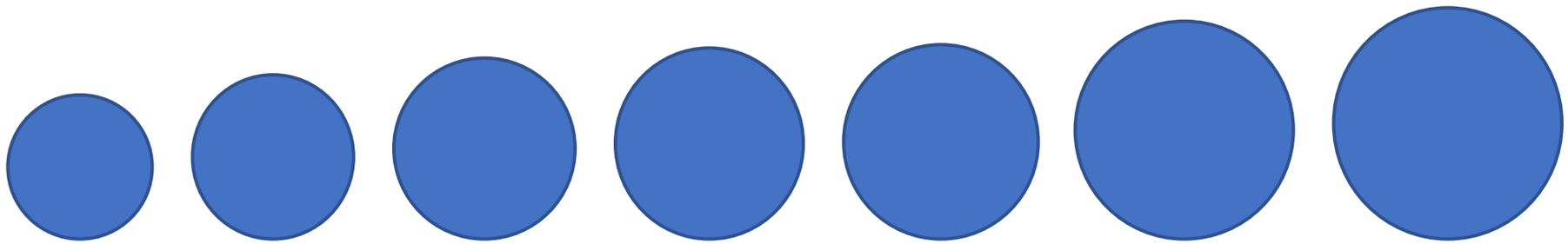
length?

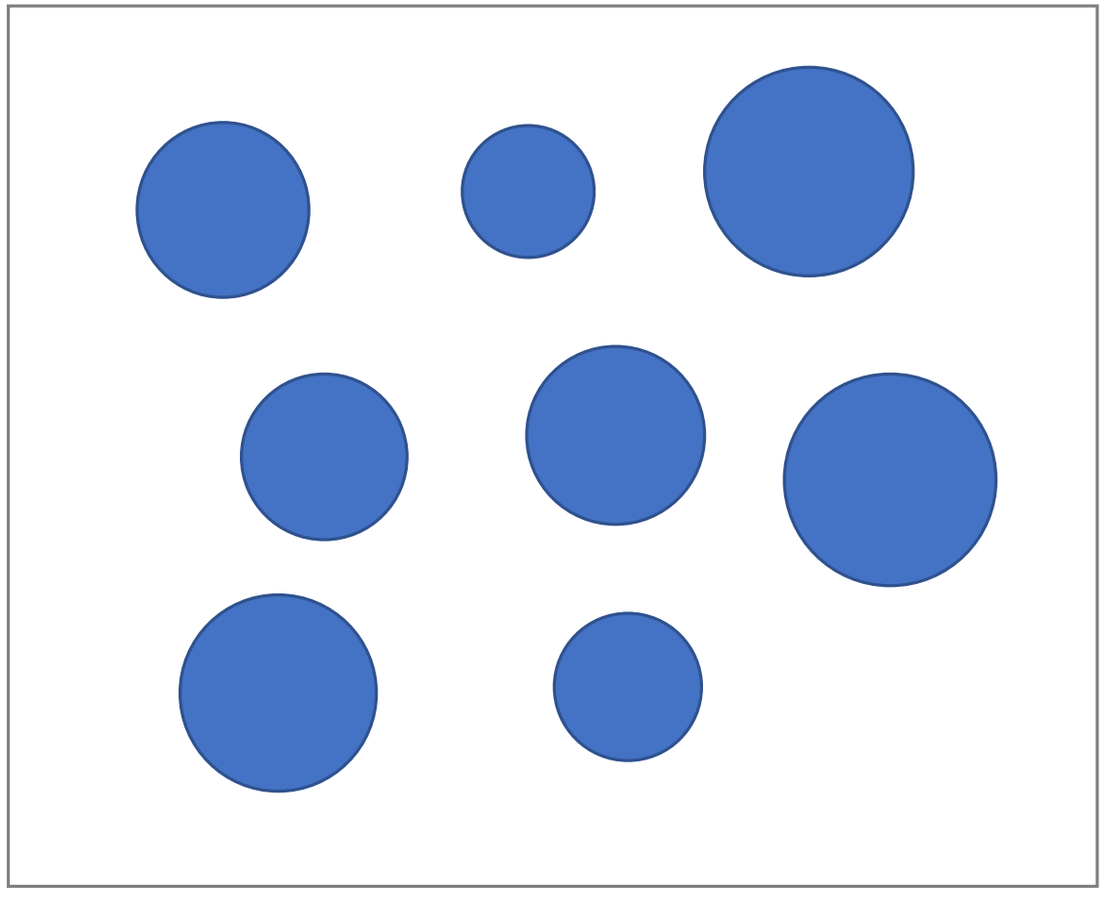
SIZE?

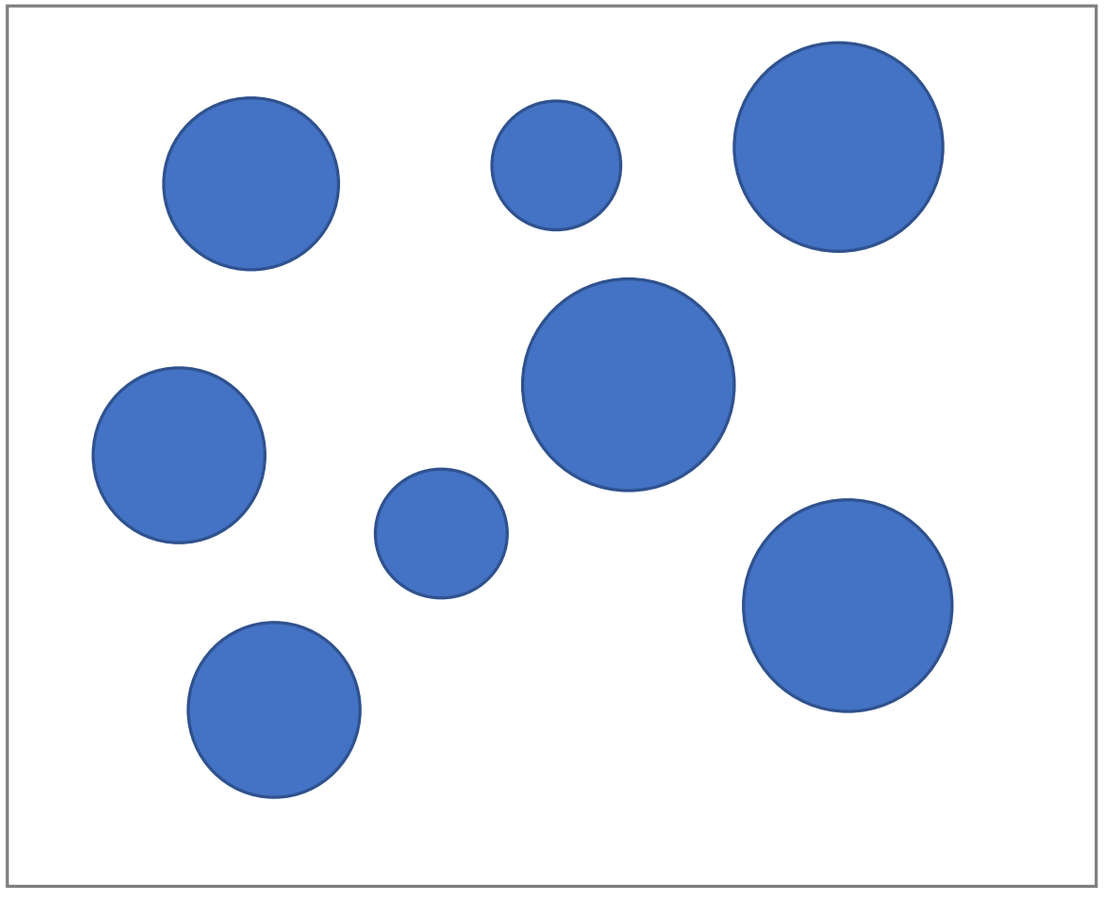

A
B

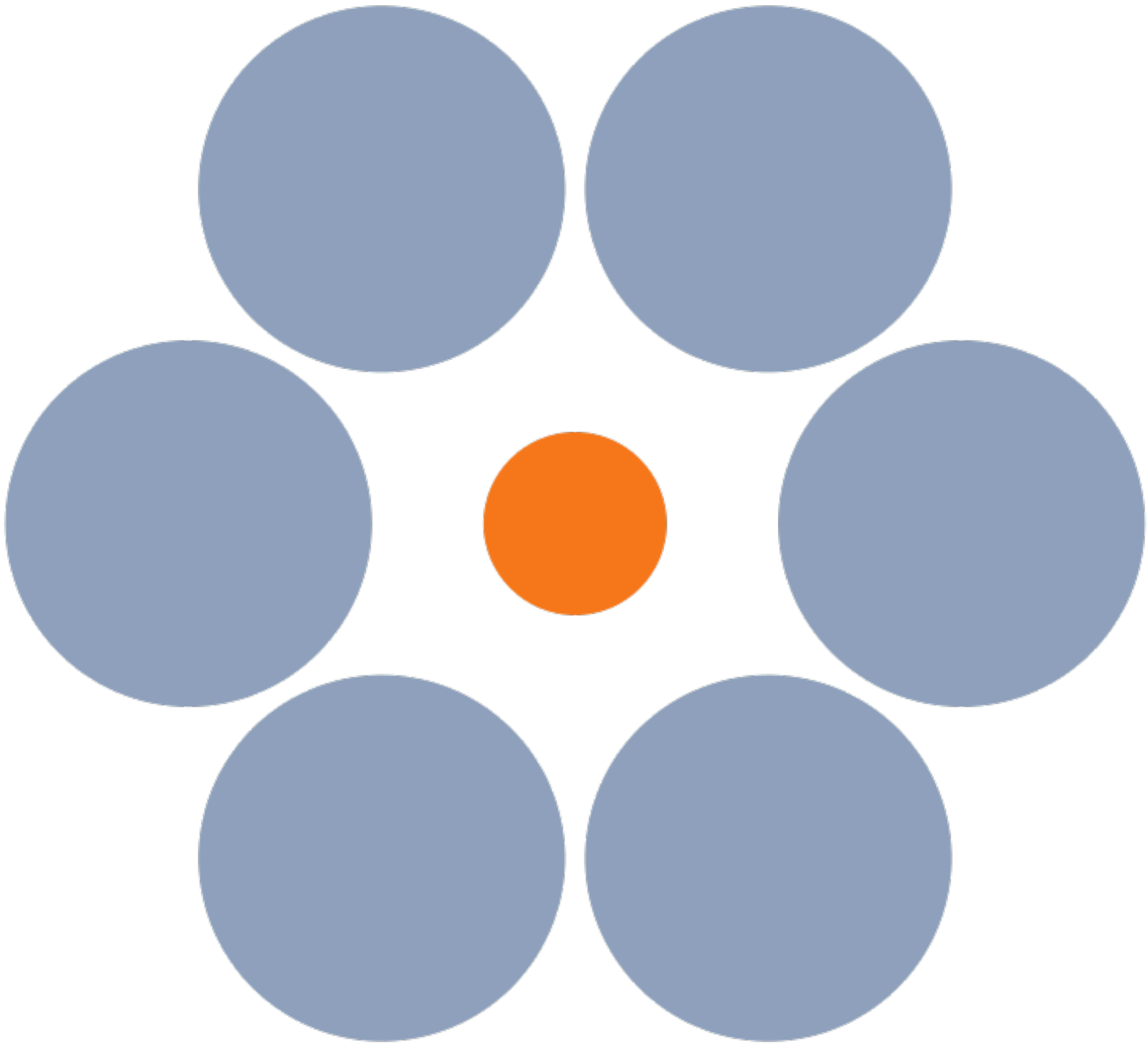

A
B


A
B



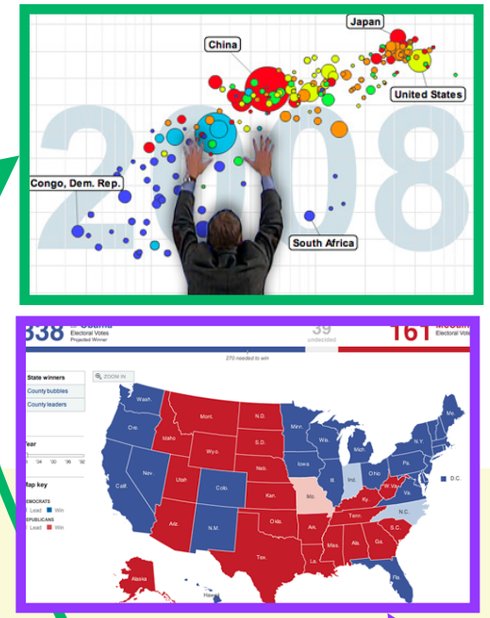




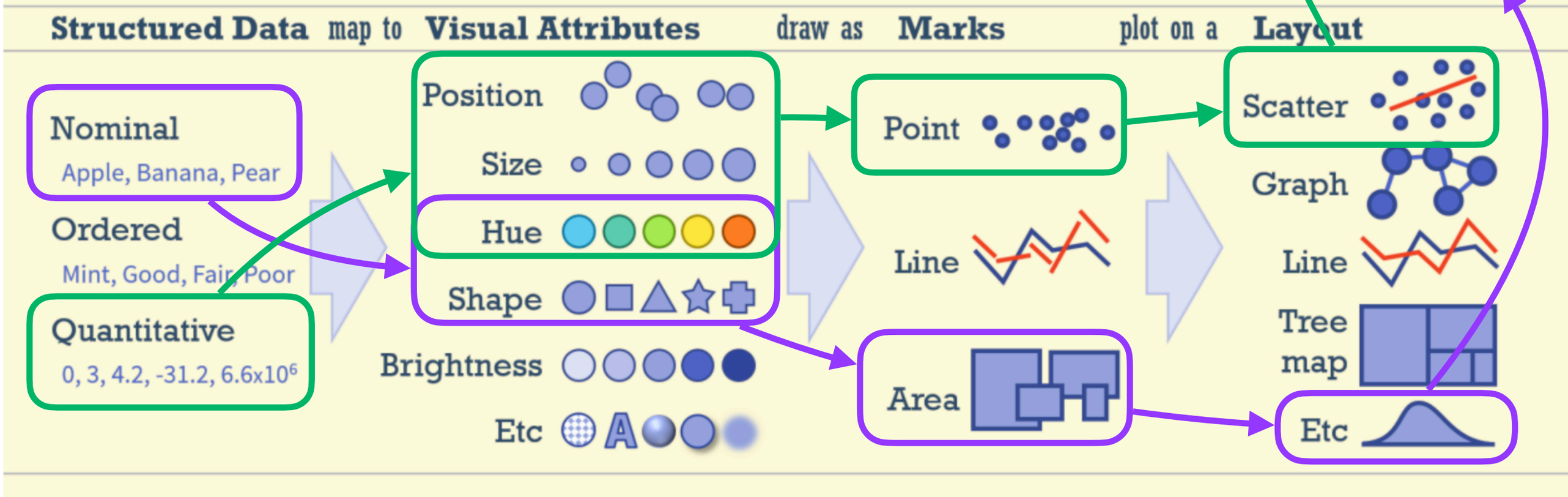


PUTTING IT ALL TOGETHER

VISUALIZATION ENCODING



Visualization Encoding Pipeline



KNOW YOUR USER'S TASK

"Every [designed] thing is best at something, and worst at something else"

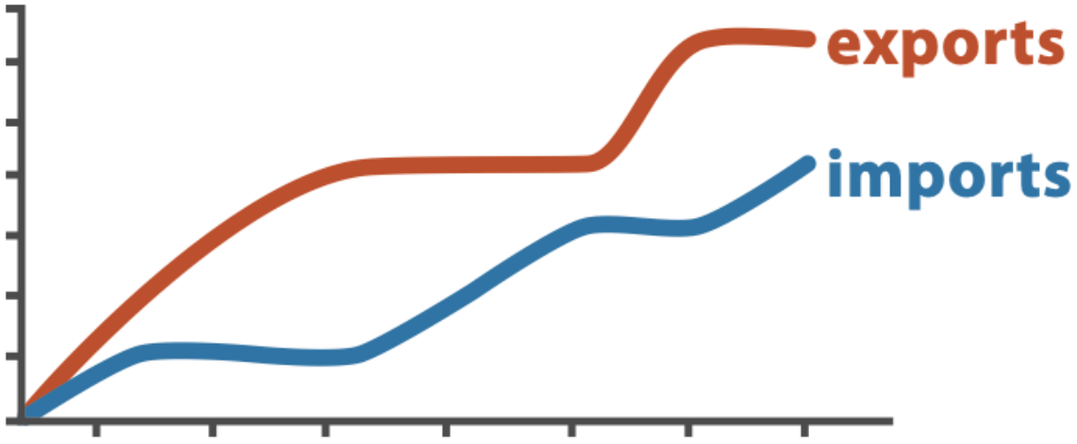
— Bill Buxton

"A tool that serves well for one task can be poorly suited for another, for exactly the same dataset. The task of the users is an equally important constraint for a vis designer as the kind of data that the users have"

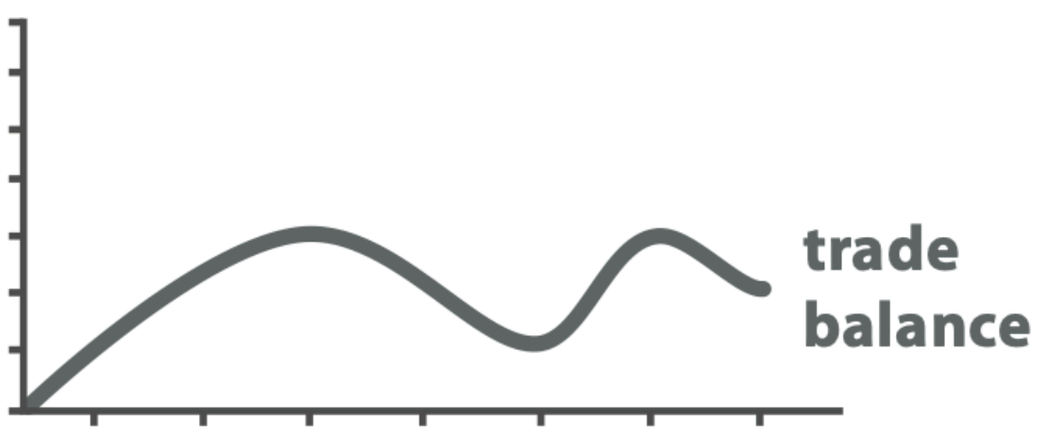
— Tamara Munzner

DON'T JUST DRAW WHAT YOU'RE GIVEN!

Decide what the right thing to show is
Create it with a series of transformations from the original dataset
Draw that



Original Data



trade balance = exports – imports

Derived Data

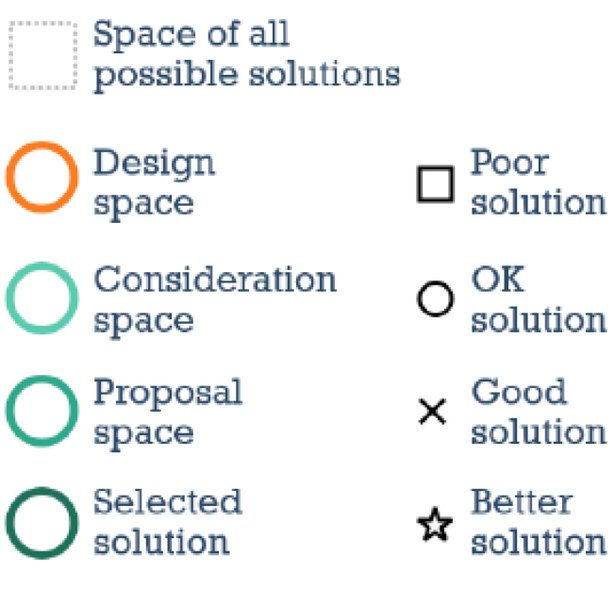
Examples, lots of examples!

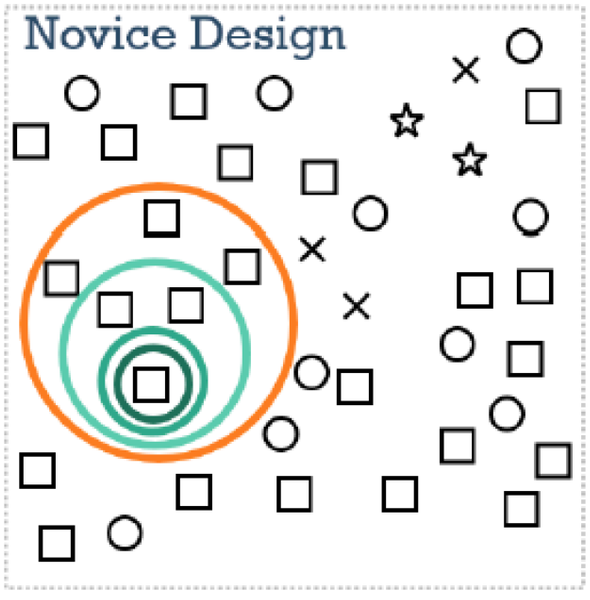
Fundamentals

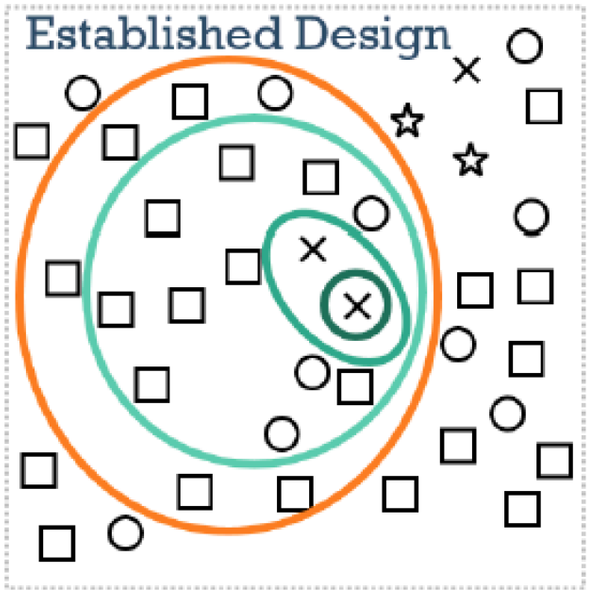
DESIGN SPACE?

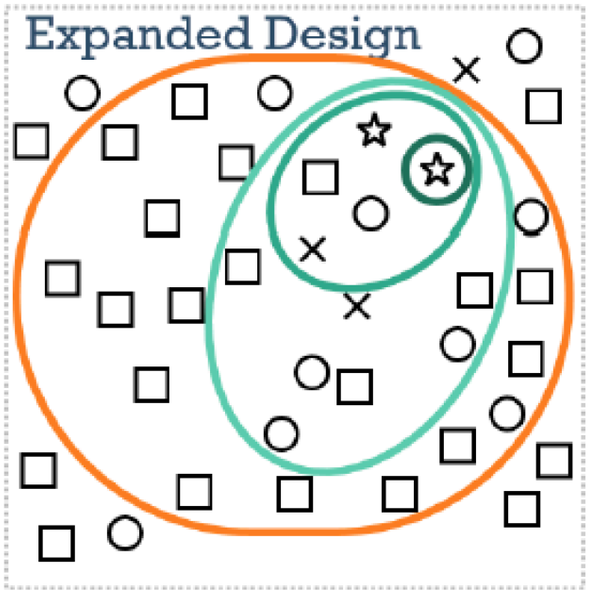
The set of possible design elements, parameters, and configurations that meet the specific application objectives.

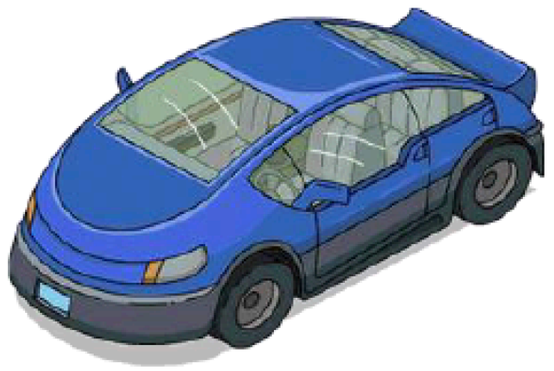
WHY DOES THE DESIGN SPACE MATTER?



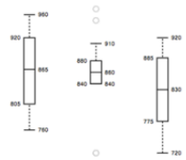








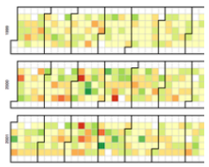
Box Plots



Bubble Chart

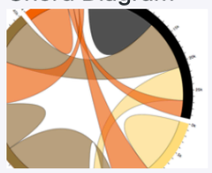
Bullet Charts

Calendar View



Non-contiguous Cartogram

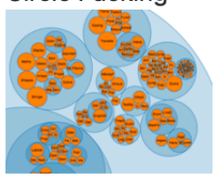
Chord Diagram



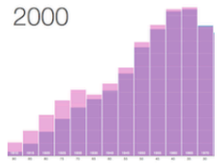
Dendrogram

Force-Directed Graph

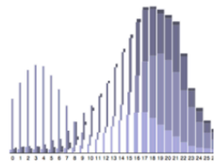
Circle Packing



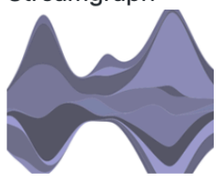
Population Pyramid



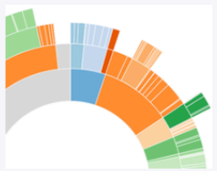
Stacked Bars



Streamgraph



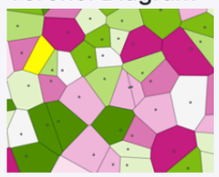
Sunburst

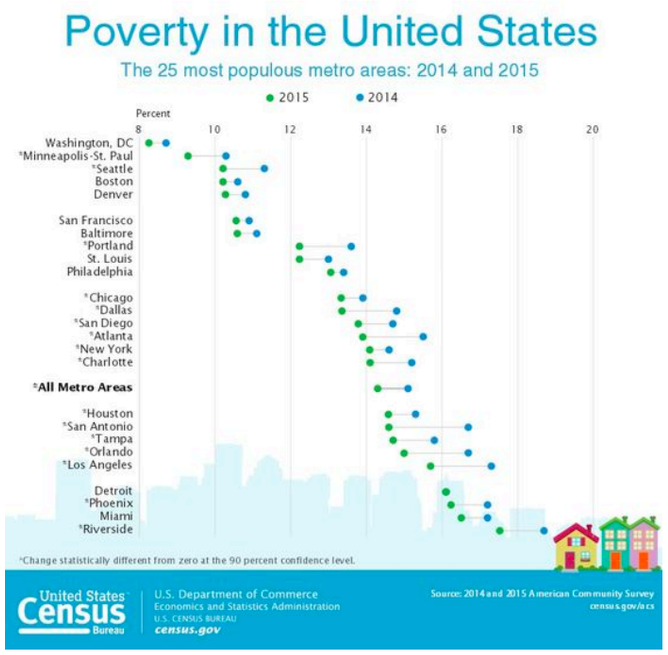


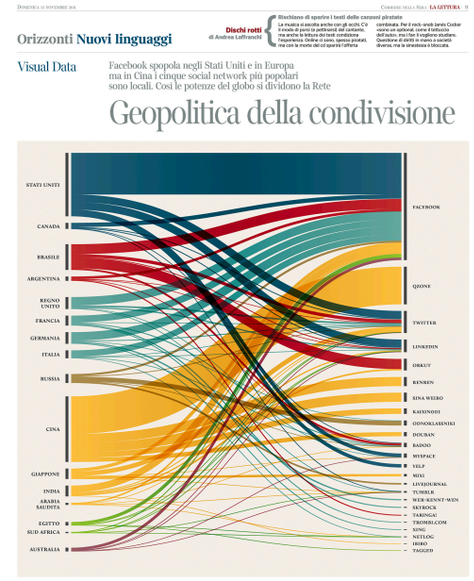
Node-Link Tree

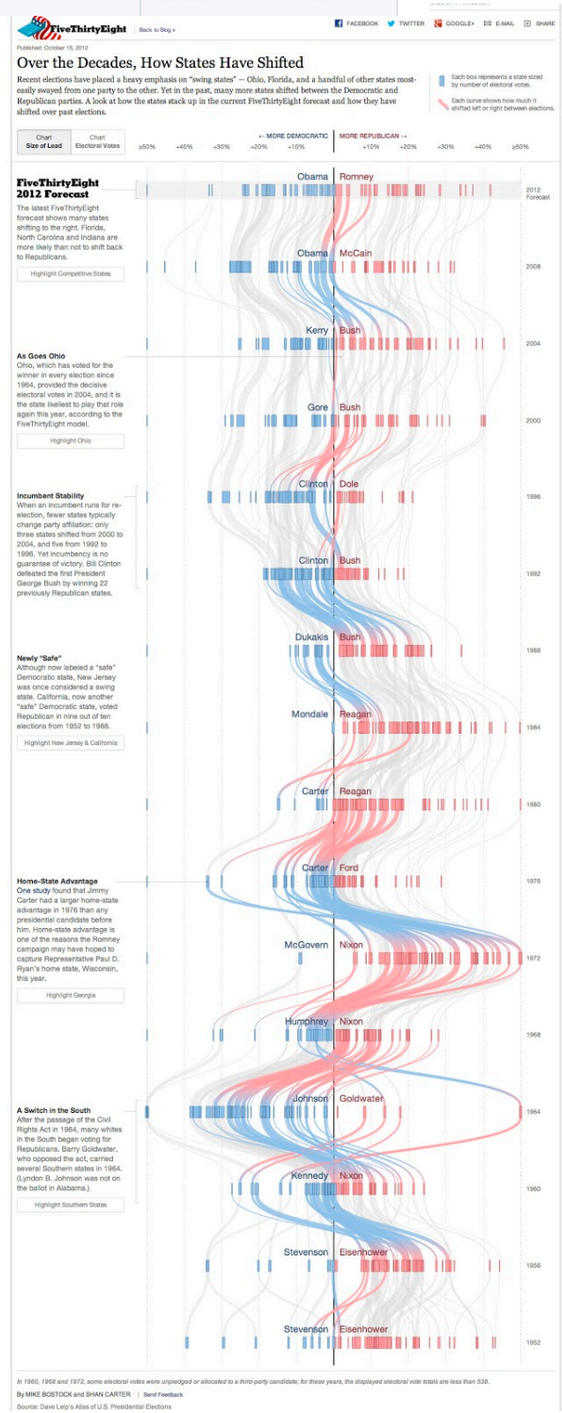
Treemap

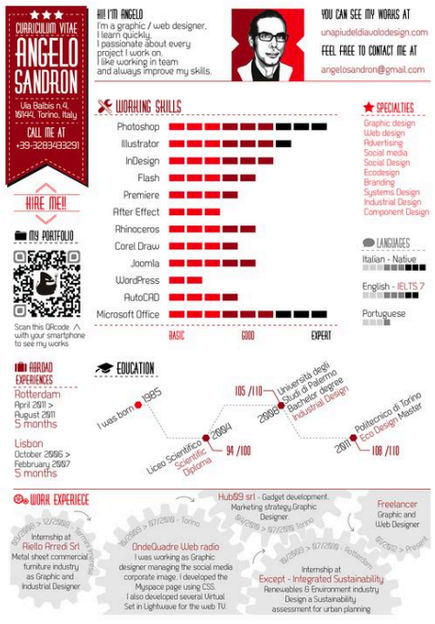
Voronoi Diagram

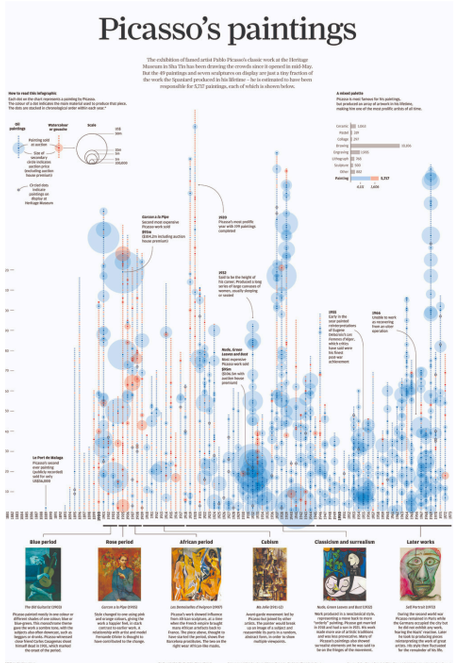


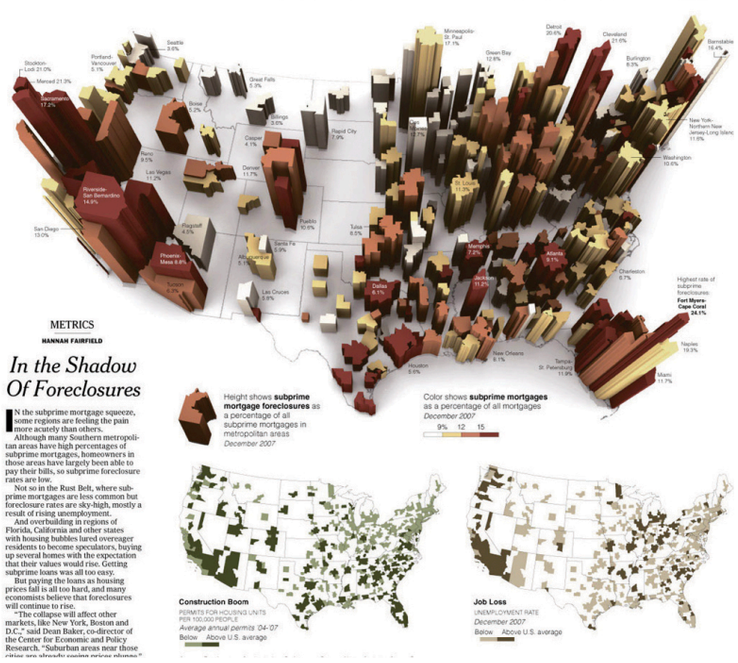










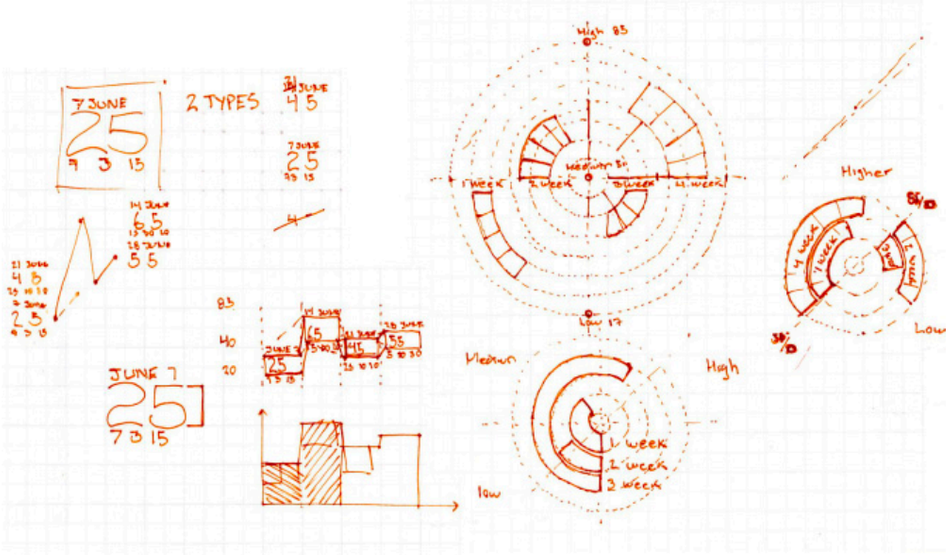


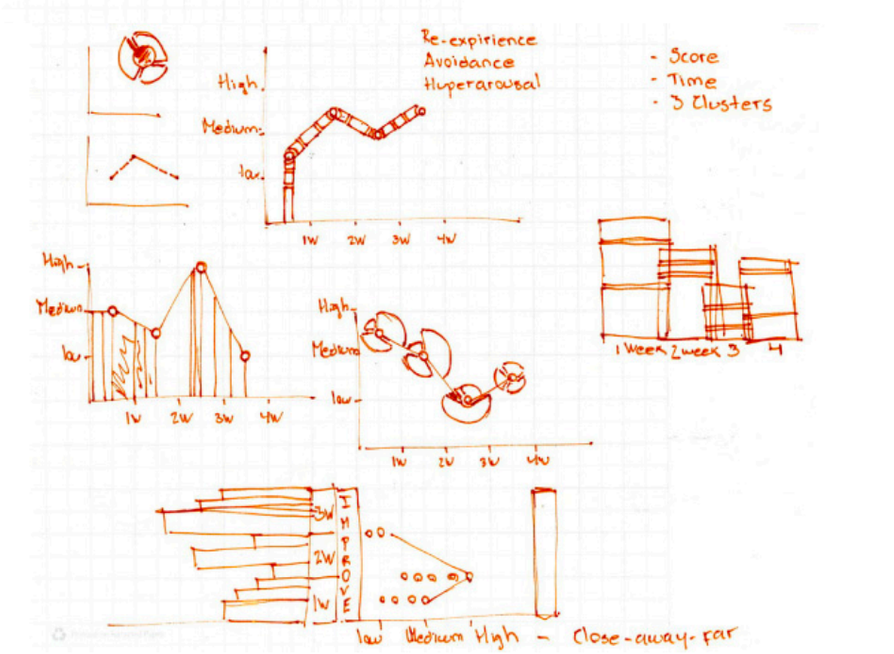
SKETCH!

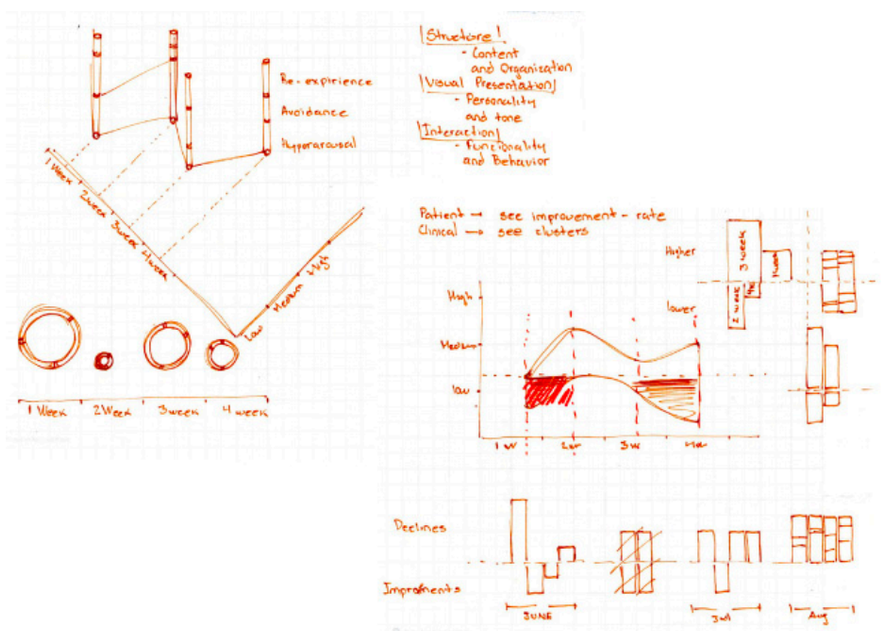
Don’t commit to a solution immediately; (easy to make, easy to discard)

Prototype ideas in early stages

Share and discuss your designs with other people

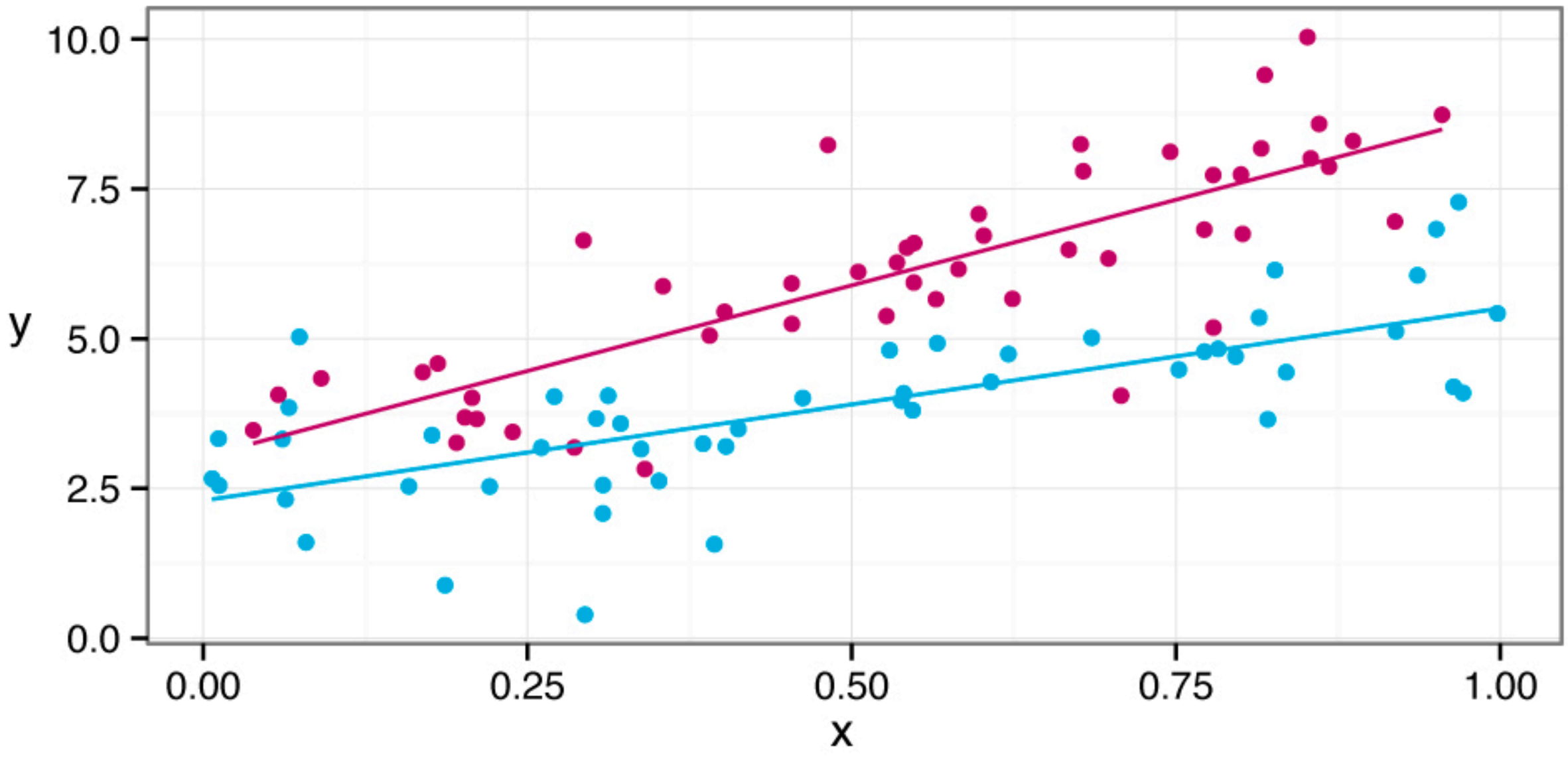






DON'T JUST GRAPH IT, FIT IT!

Graphing is needed, to see the details of the raw data
Fitting data to mathematical functions is needed too!
You can display both in the same graph…



REFERENCES

EXPAND YOUR HORIZON

Lookup

Visualization Catalogs

www.datavis.ca

http://www.datavis.ca/milestones/

(historical!)

www.infovis-wiki.net

http://www.visual-literacy.org/periodic_table/periodic_table.html

Color

http://colorbrewer2.org/

Color Brewer

http://tools.medialab.sciences-po.fr/iwanthue/

I Want Hue

To Reflect:

http://hint.fm/

F. Viégas & M. Wattenberg

www.edwardtufte.com/bboard

E. Tufte

http://fellinlovewithdata.com/

Fell in love with data

E. Bertini

http://datastori.es/ (podcasts)

E. Bertini & M. Stefaner

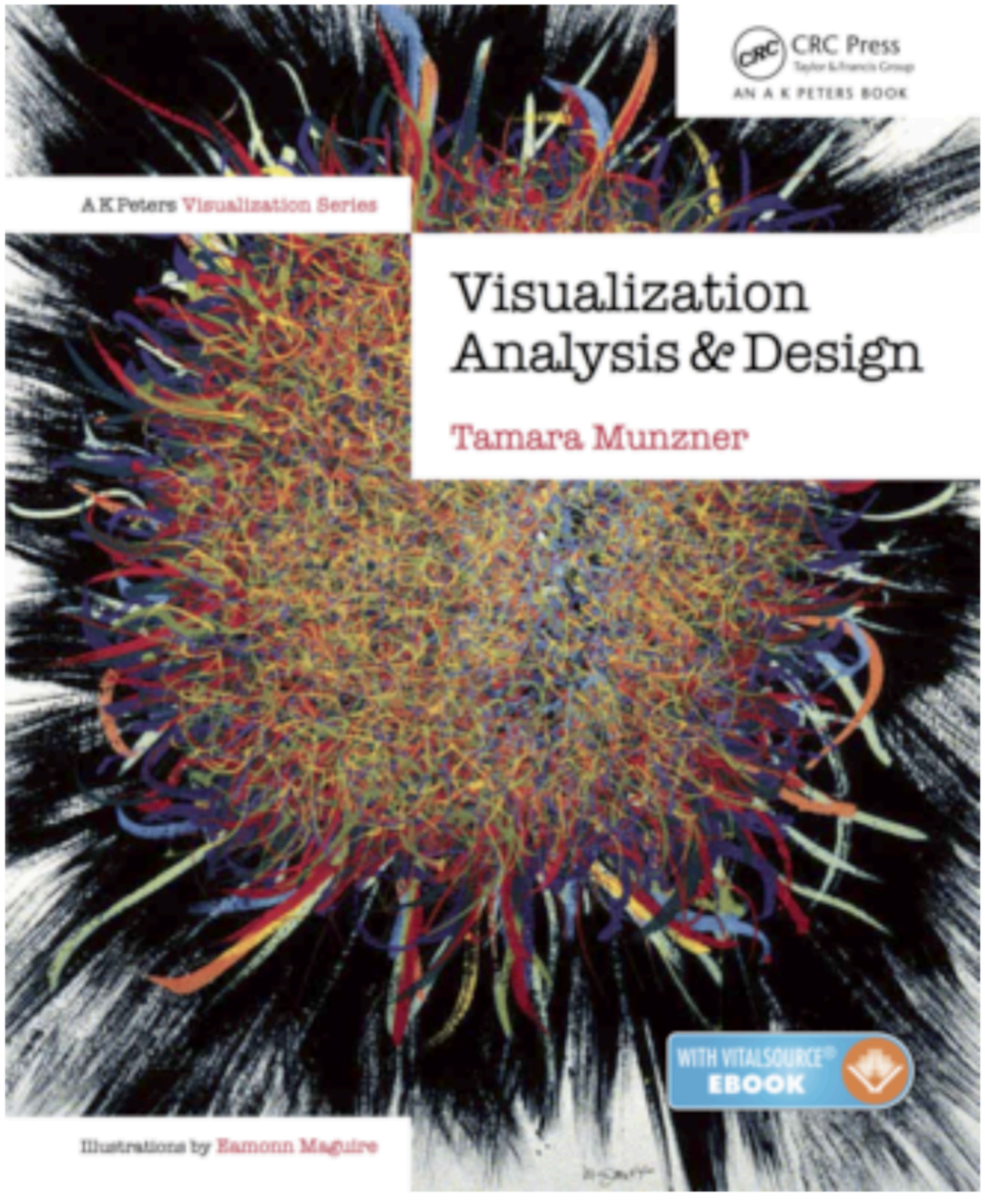
http://junkcharts.typepad.com/

Junk Charts: learn from others (mistakes)

Text-book on data visualization

(1st of its kind)

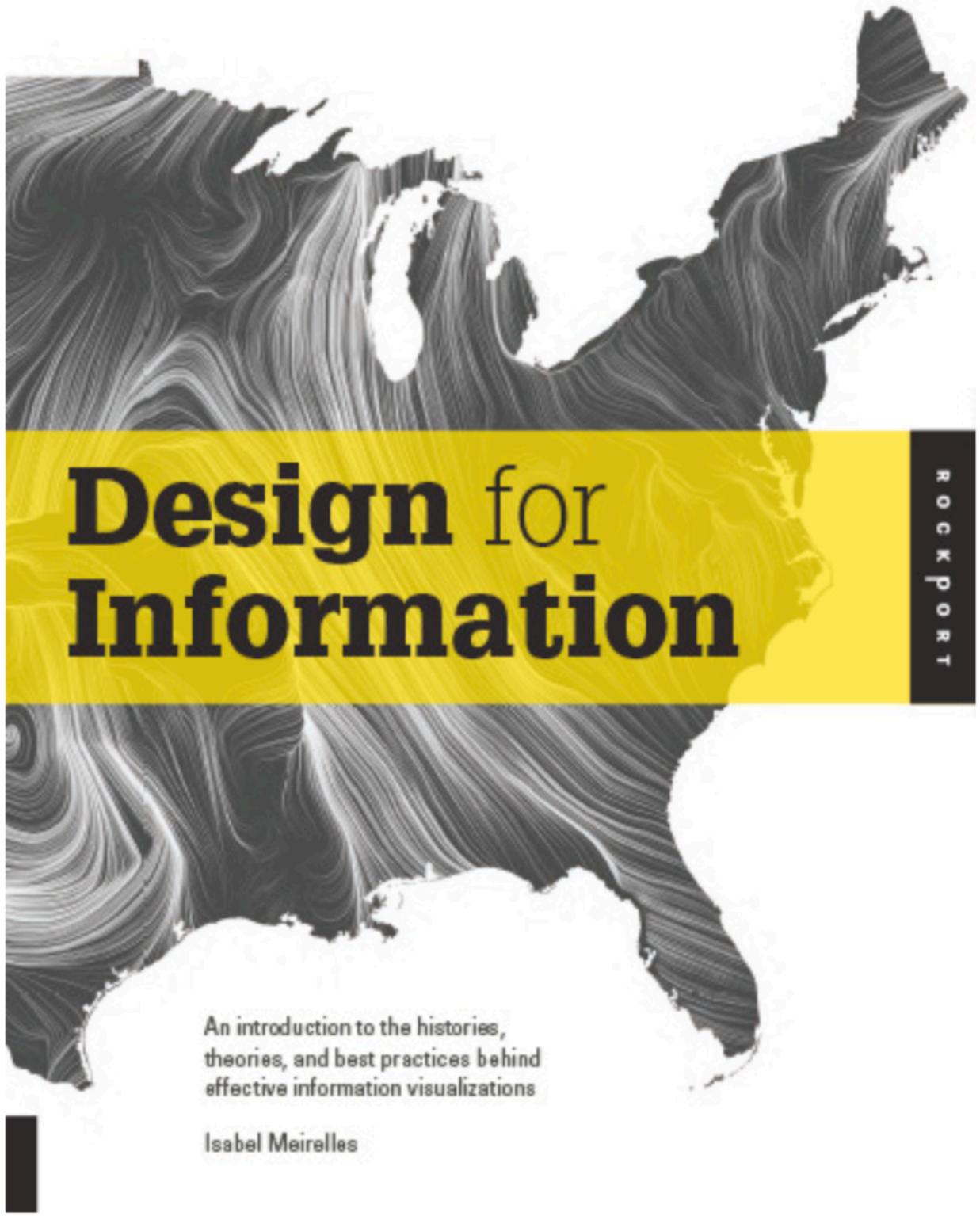
If you can only get one,
THIS is the one!



Munzner, Tamara. Visualization Analysis and Design. CRC Press, 2014.

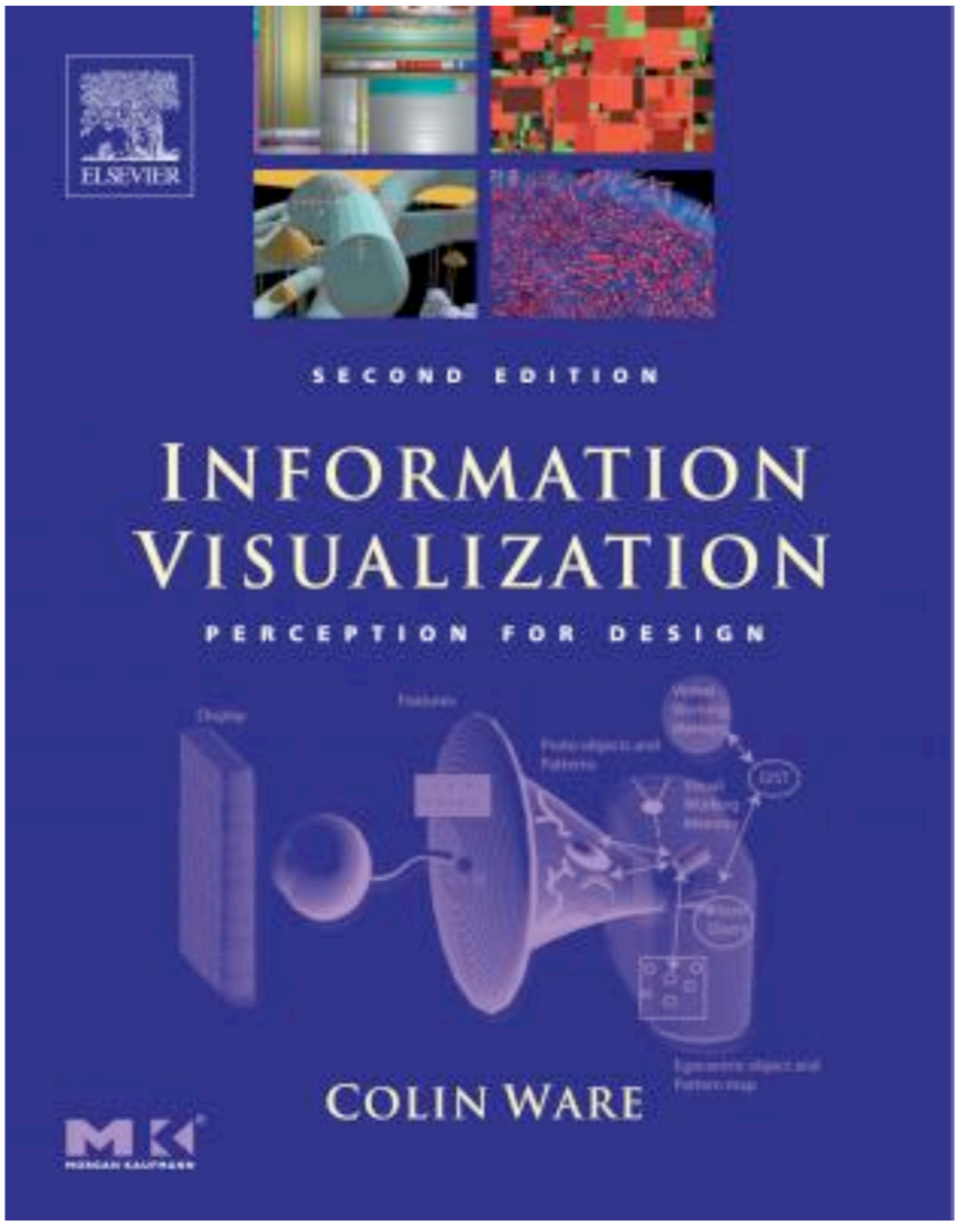
Infovis through examples, history and some free discussion. Very visual.

Beautiful!



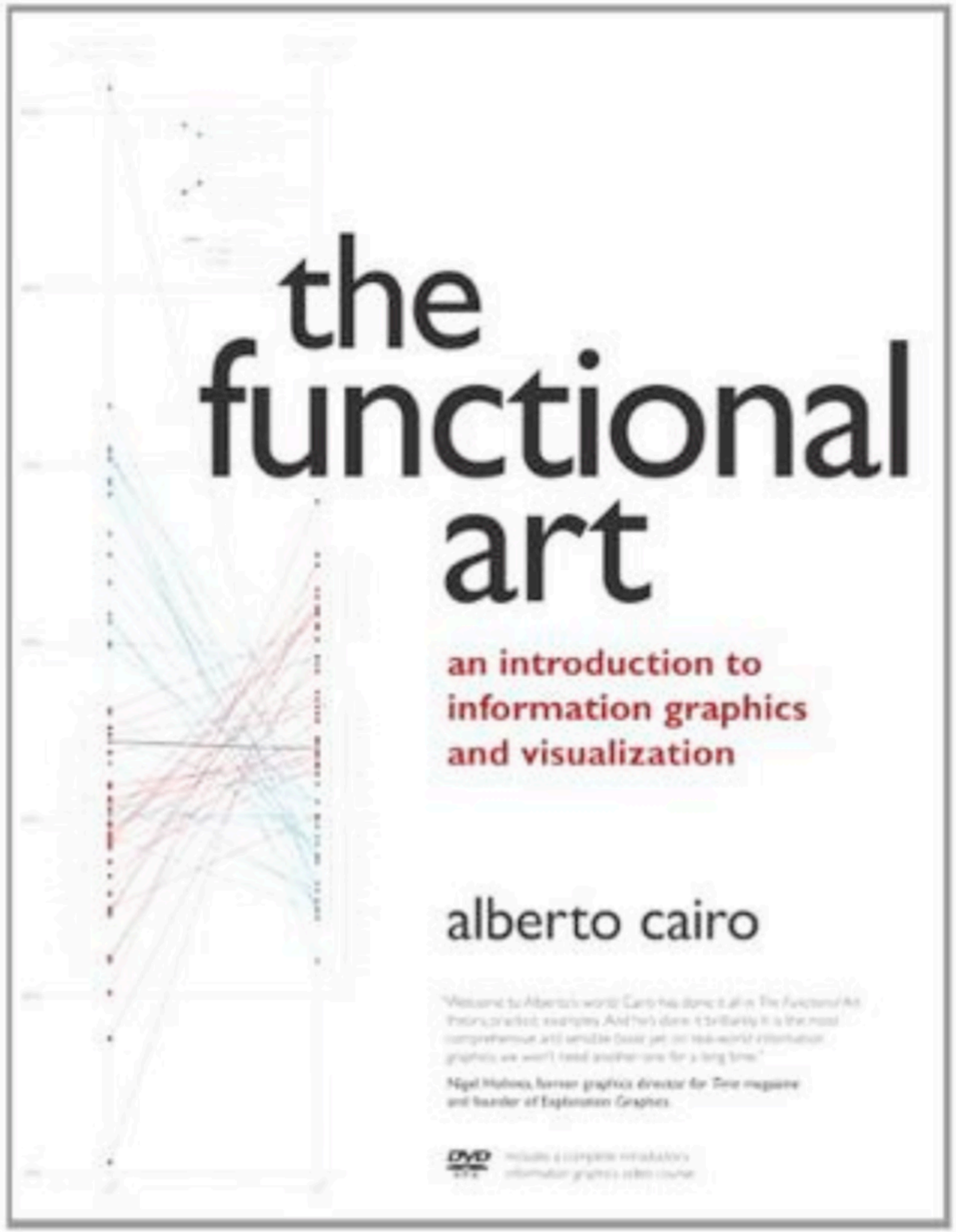
Meirelles, Isabel. Design for Information: An Introduction to the Histories, Theories, and Best Practices Behind Effective Information Visualizations. Rockport publishers, 2013.

All about perception, and the funny tricks our brain plays on us.



Ware, Colin. Information visualization: perception for design. Elsevier, 2013.

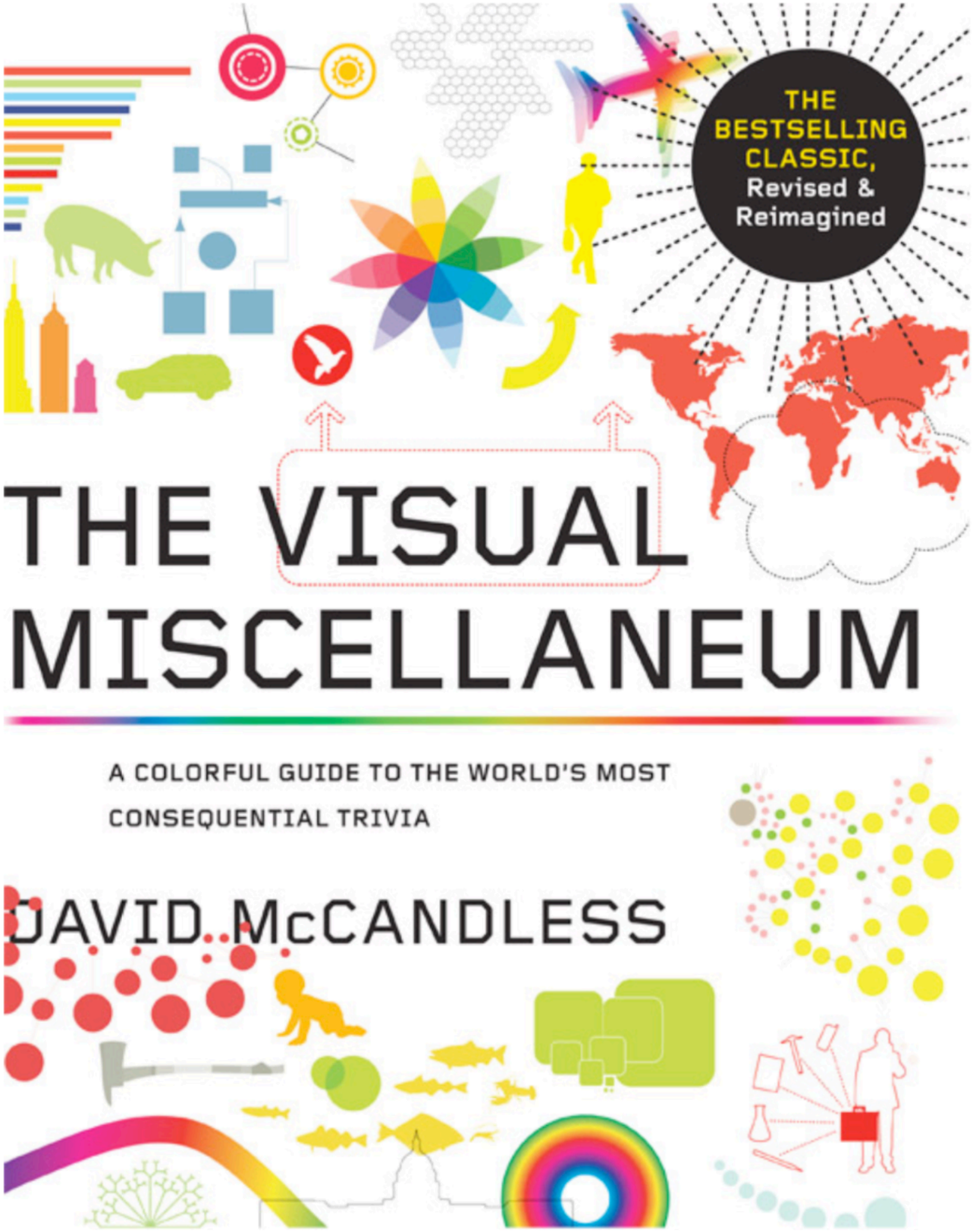
Focus on
infographics



Cairo, Alberto. The Functional Art: An introduction to information graphics and visualization. New Riders, 2012.

For inspiration!

Some excellent visualizations! And some so-so…



McCandless, David. The visual miscellaneum: a colorful guide to the world's most consequential trivia. Collins Design, 2009.