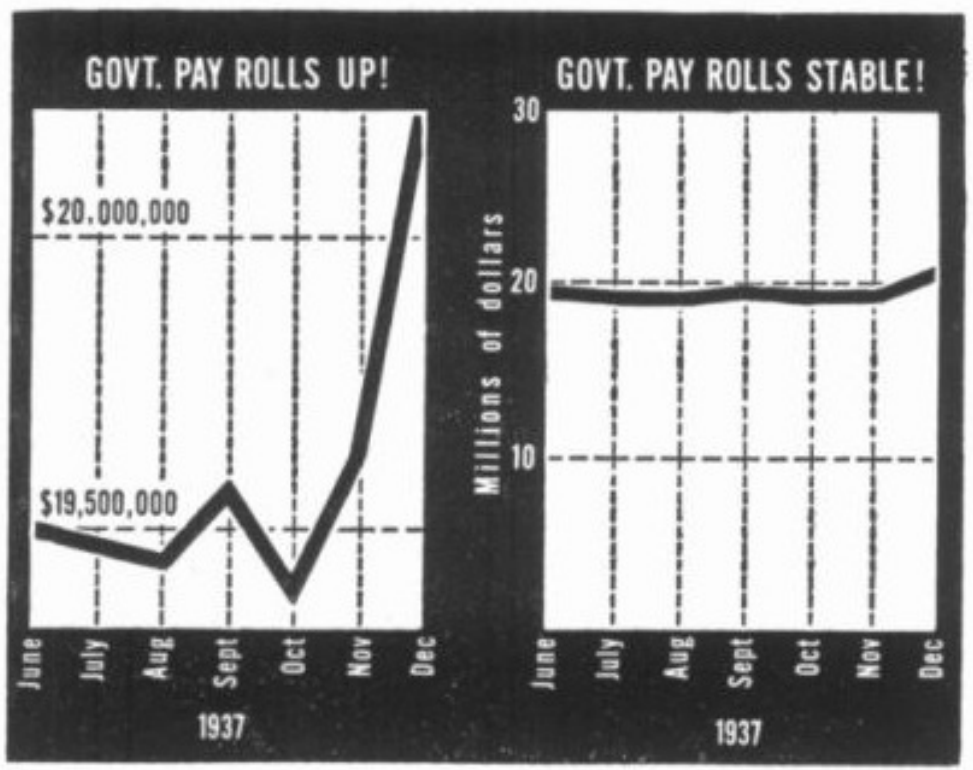
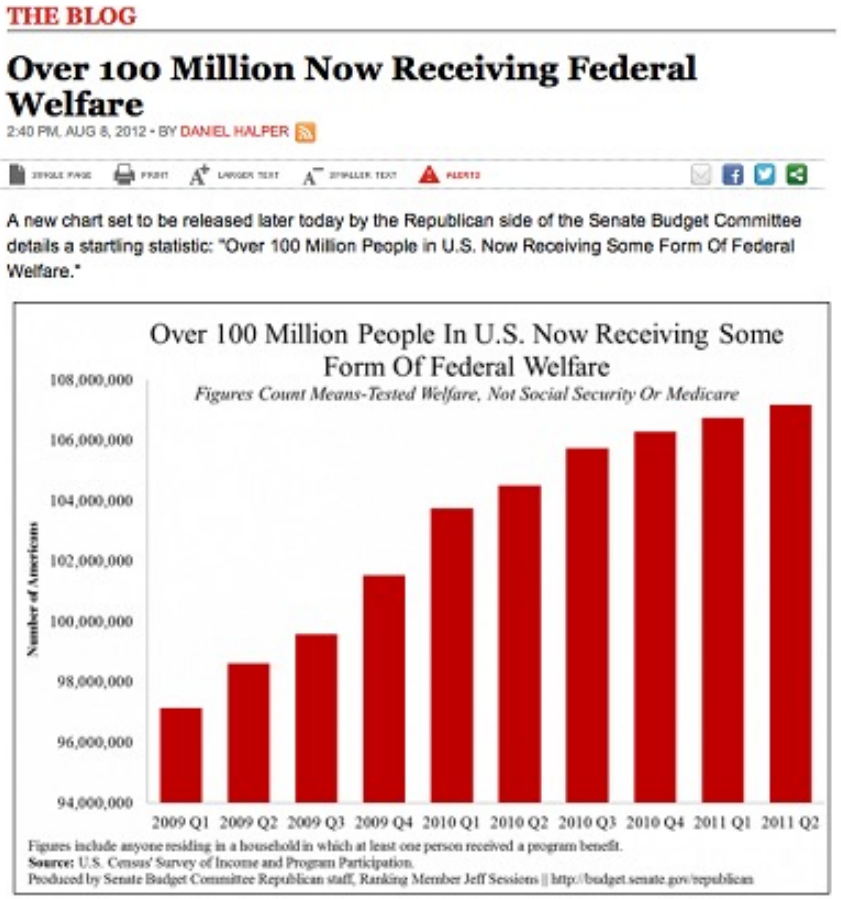
Design Tips

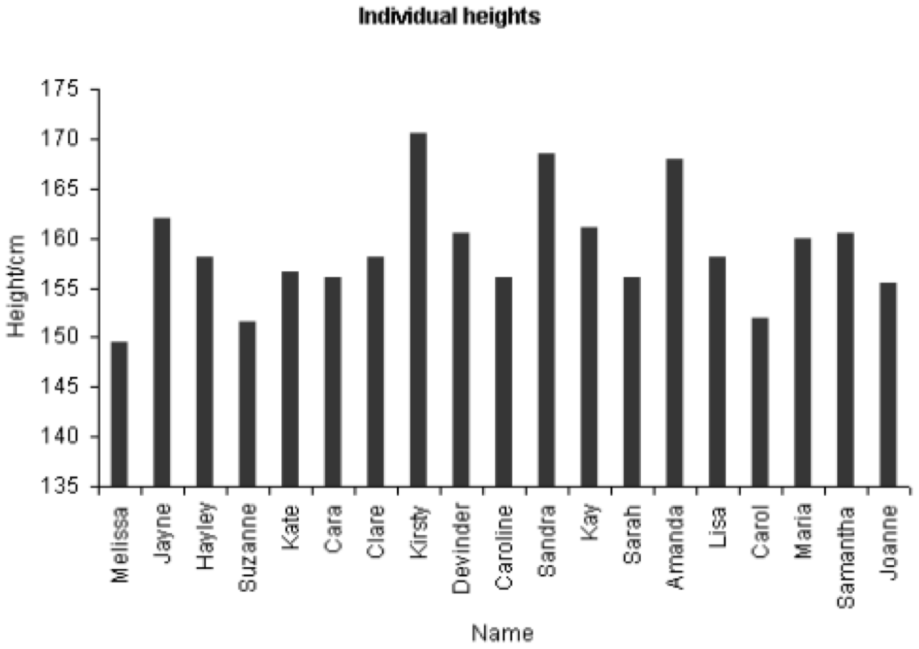
Gee-Whiz Graphs



How to lie with statistics. Huff. Govt payrolls in 1937

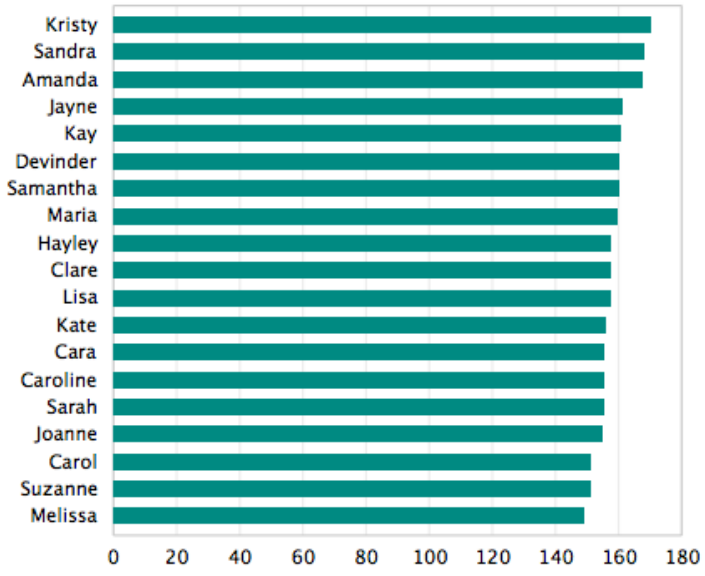


Include Zero?

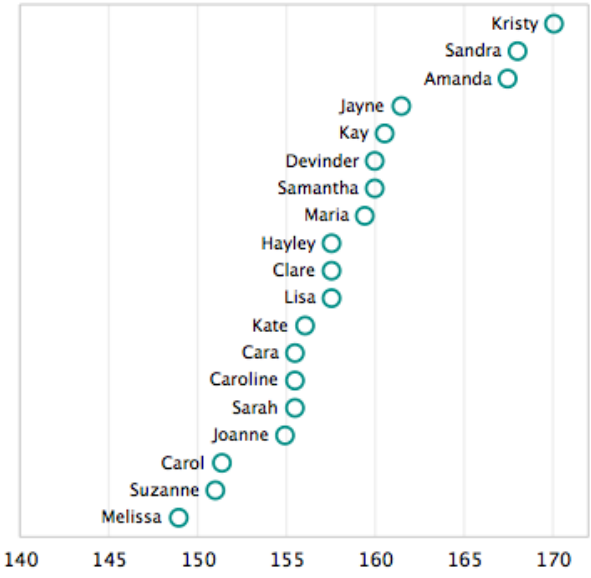


This violates the expressiveness principle!

Bar length encodes the amount

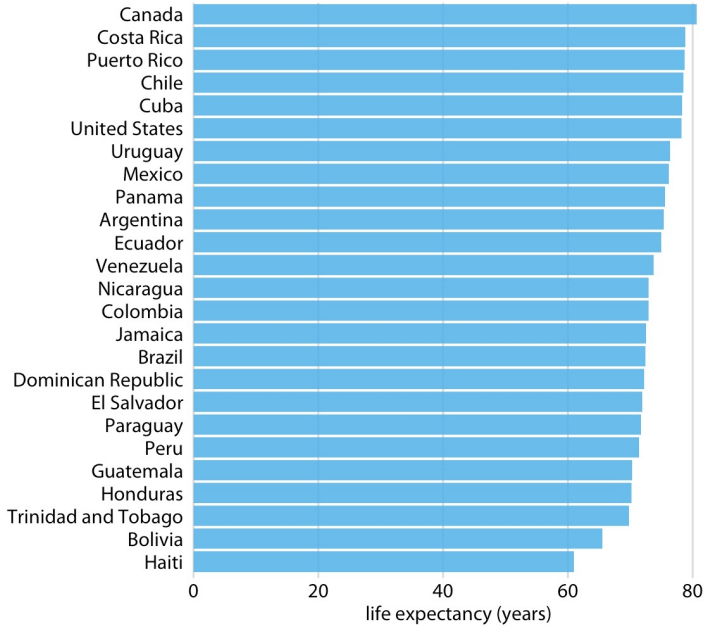


Q-Ratio
“We care about the amount shown”

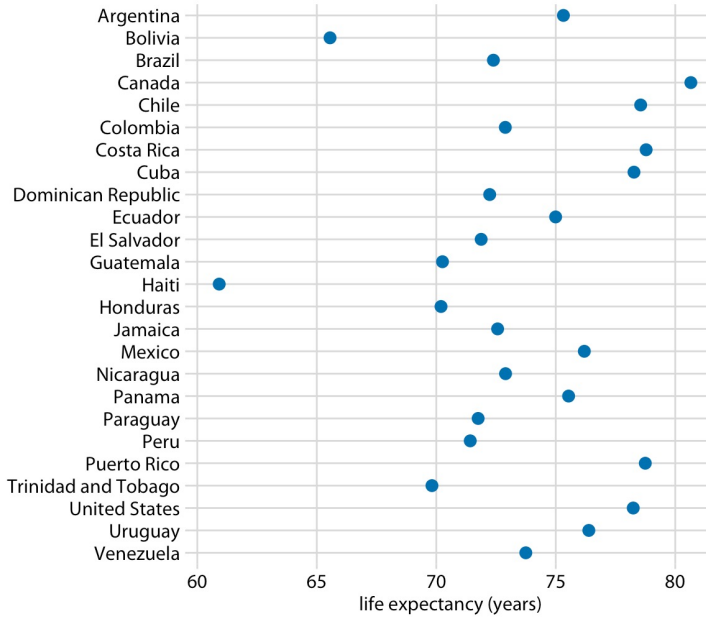


Q-Interval
“We care about the relative position”

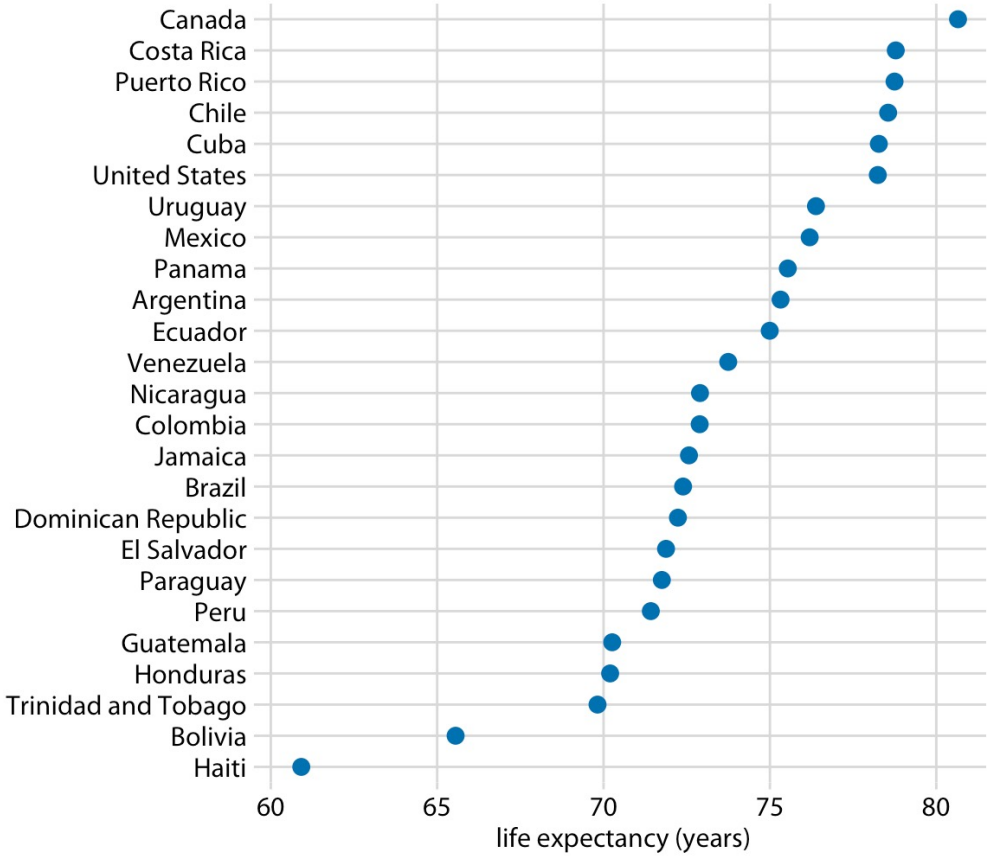
Include Zero?



The bars are draw attention away from the key feature of the data: the differences in life expectancy among the different countries.



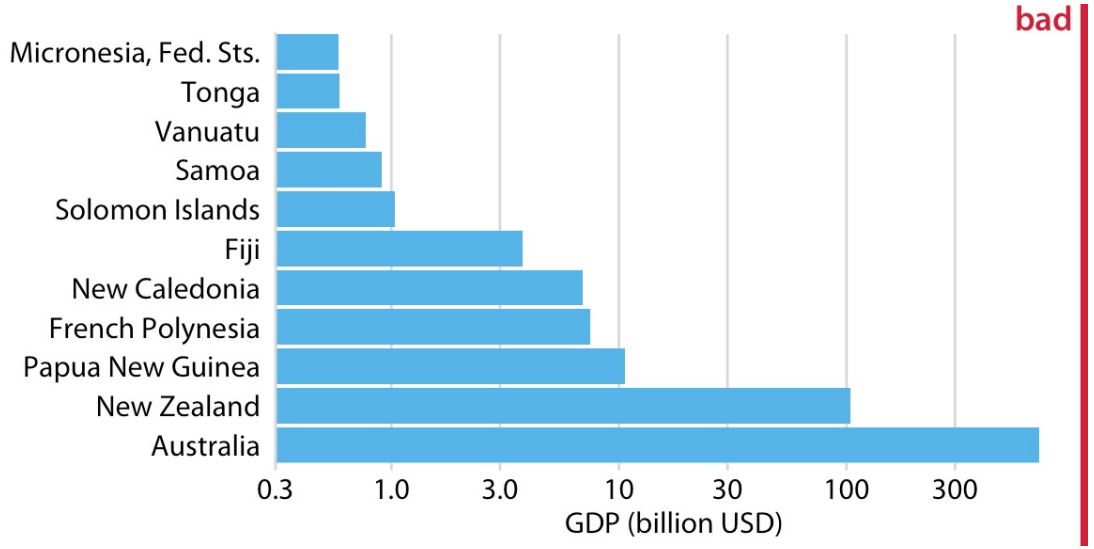
The countries are ordered alphabetically, which causes a dots to form a disordered cloud of points. This makes the figure difficult to read.

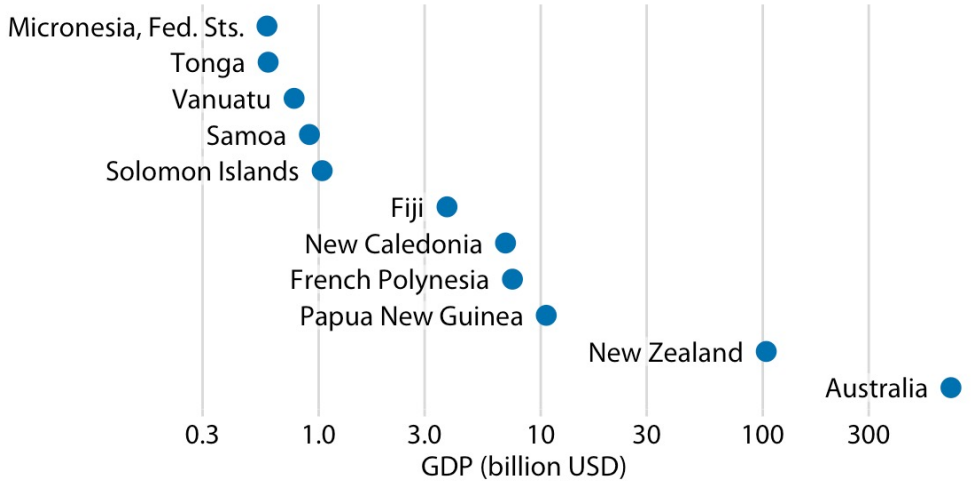


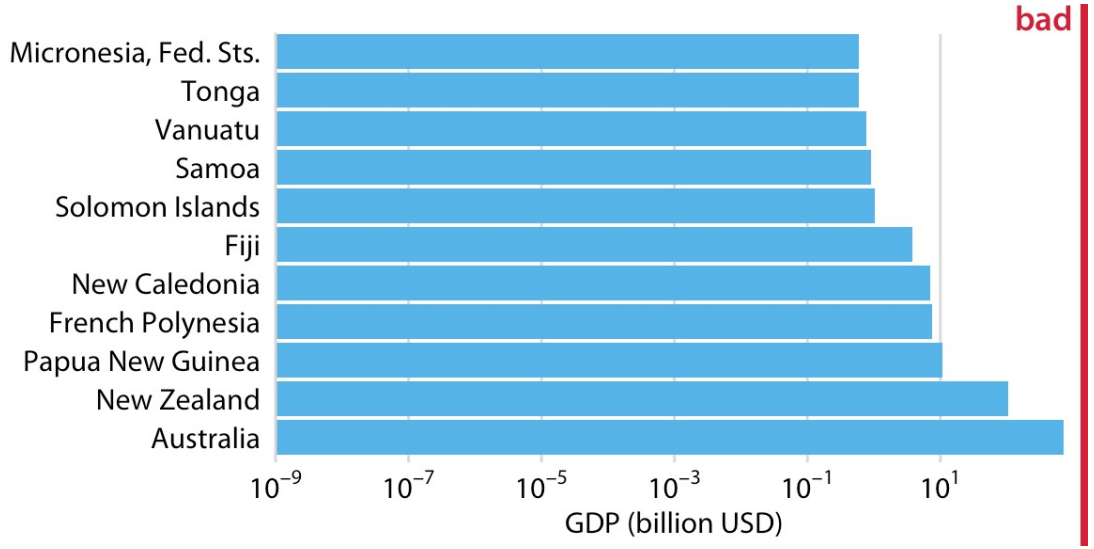
Can be made better by removing the y-axis and labeling each dot: avoids generating the visual perception of a magnitude conveyed by the distance from the name to the dot

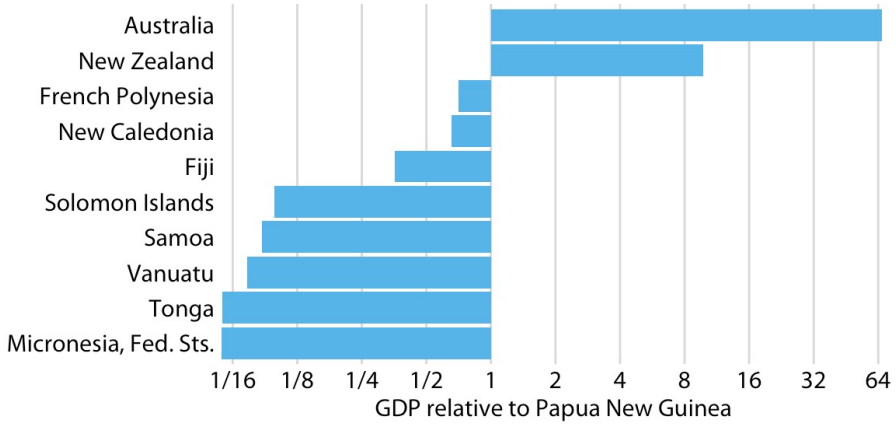
Bar vs. Dot Plots

Fundamentals of Data Visualization, Wilke









Zero, Bars, Dots & Log Scales

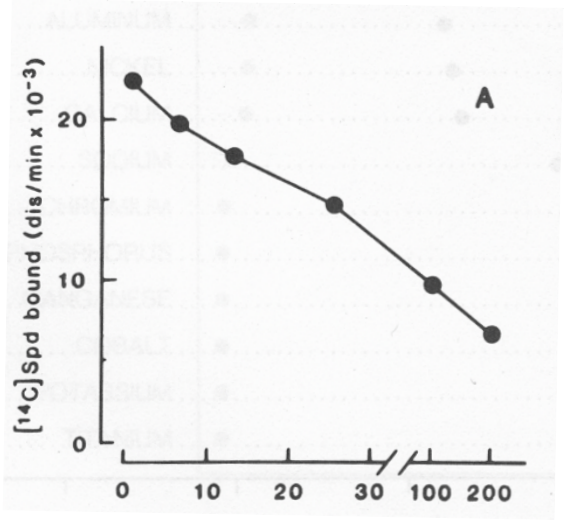
Fundamentals of Data Visualization, Wilke

More about Log Scales

Address data skew

e.g., long tails, outliers

Enables comparison within and across multiple orders of magnitude.



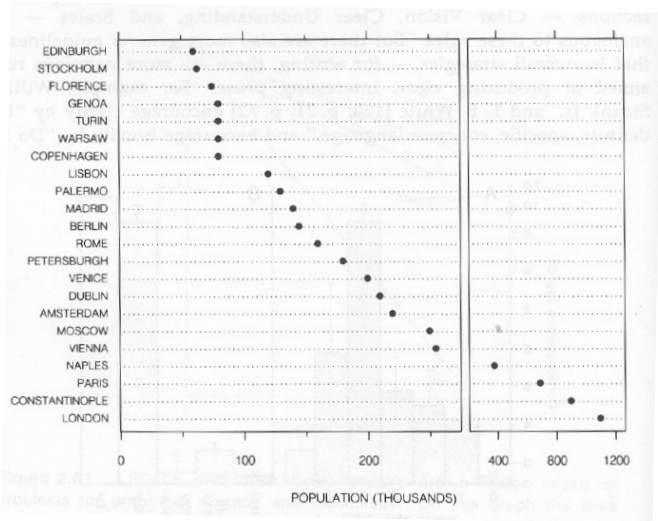
Violates Expressiveness!

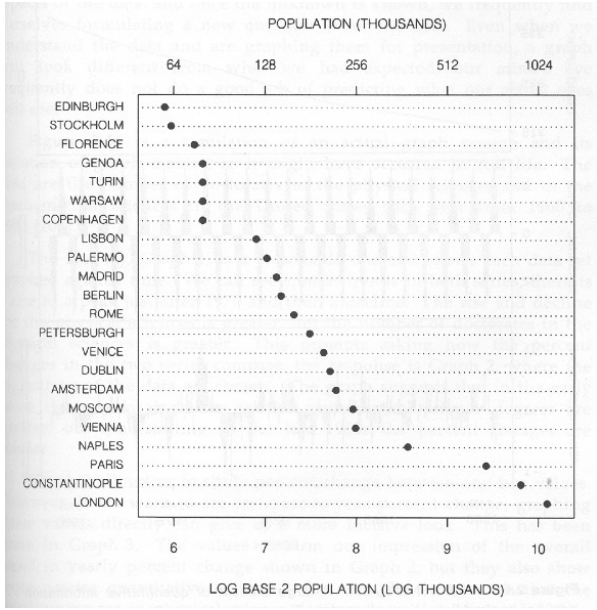
Focus on multiplicative factors

e.g., The GDP of Australia is 64 times that of Papa New Guinea

The logarithm transforms × to +!

Percentage change, not linear difference.



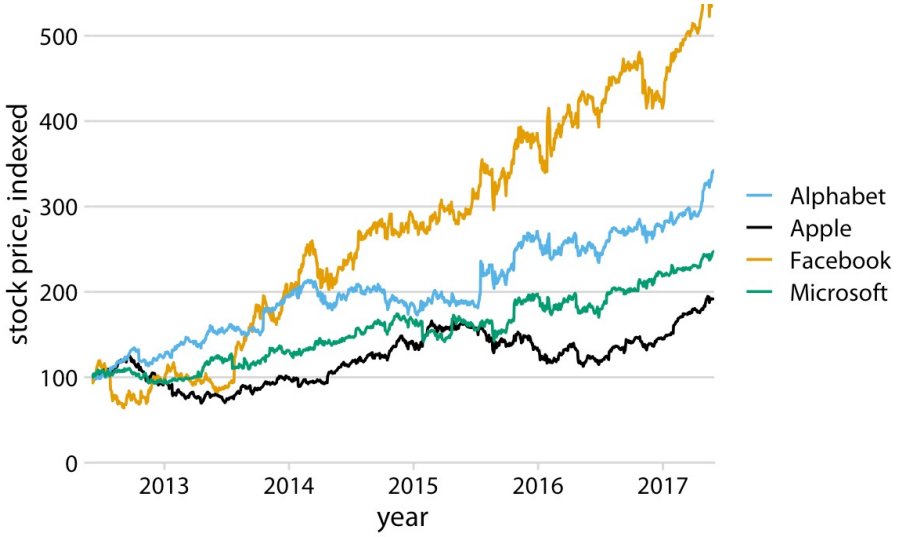


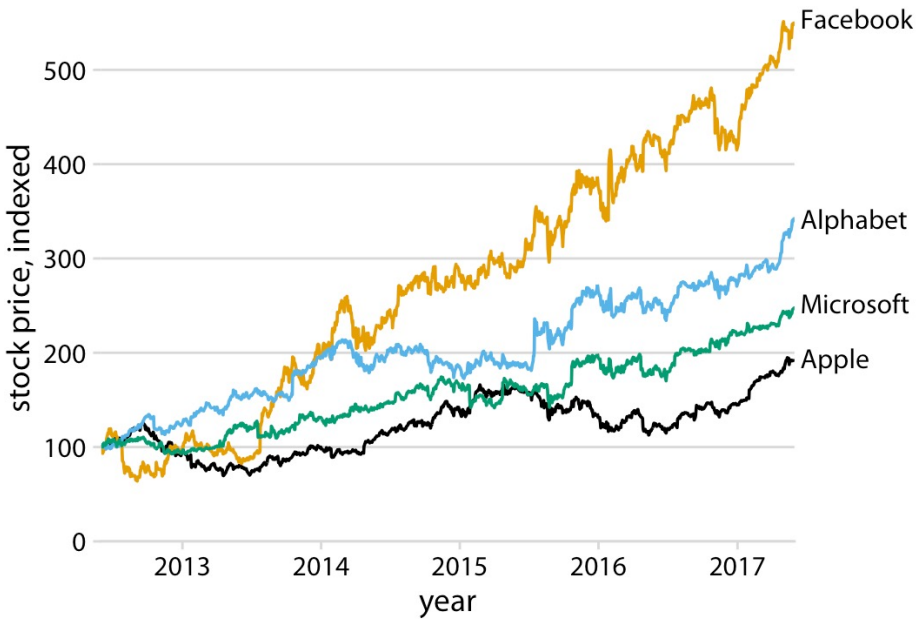
Scale breaks vs. Log scales: Cognitive vs. Perceptual Effort

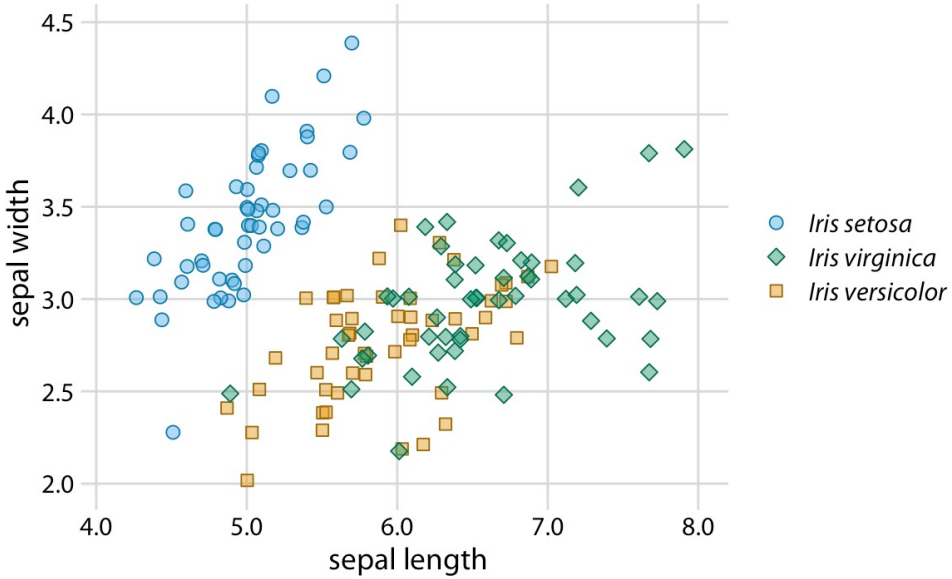
Constraint: **positive, non-zero values**

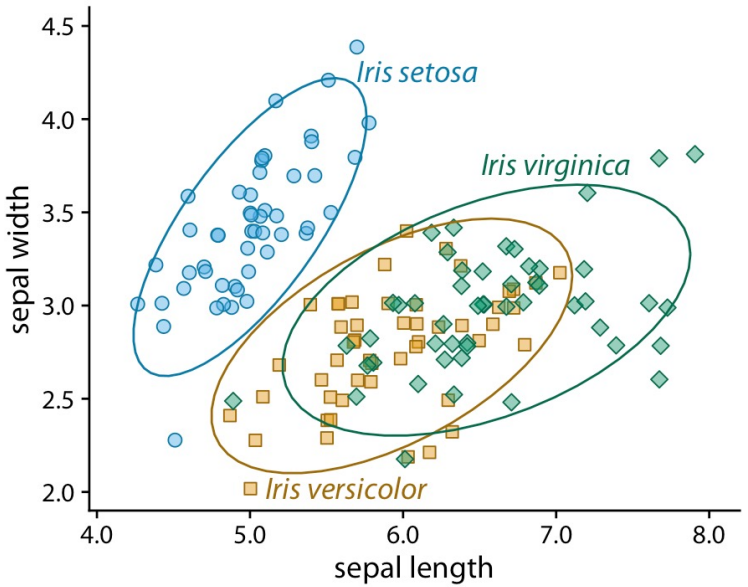
Constraint: **audience familiarity?**

The Elements of Graphing Data [Cleveland, 85]



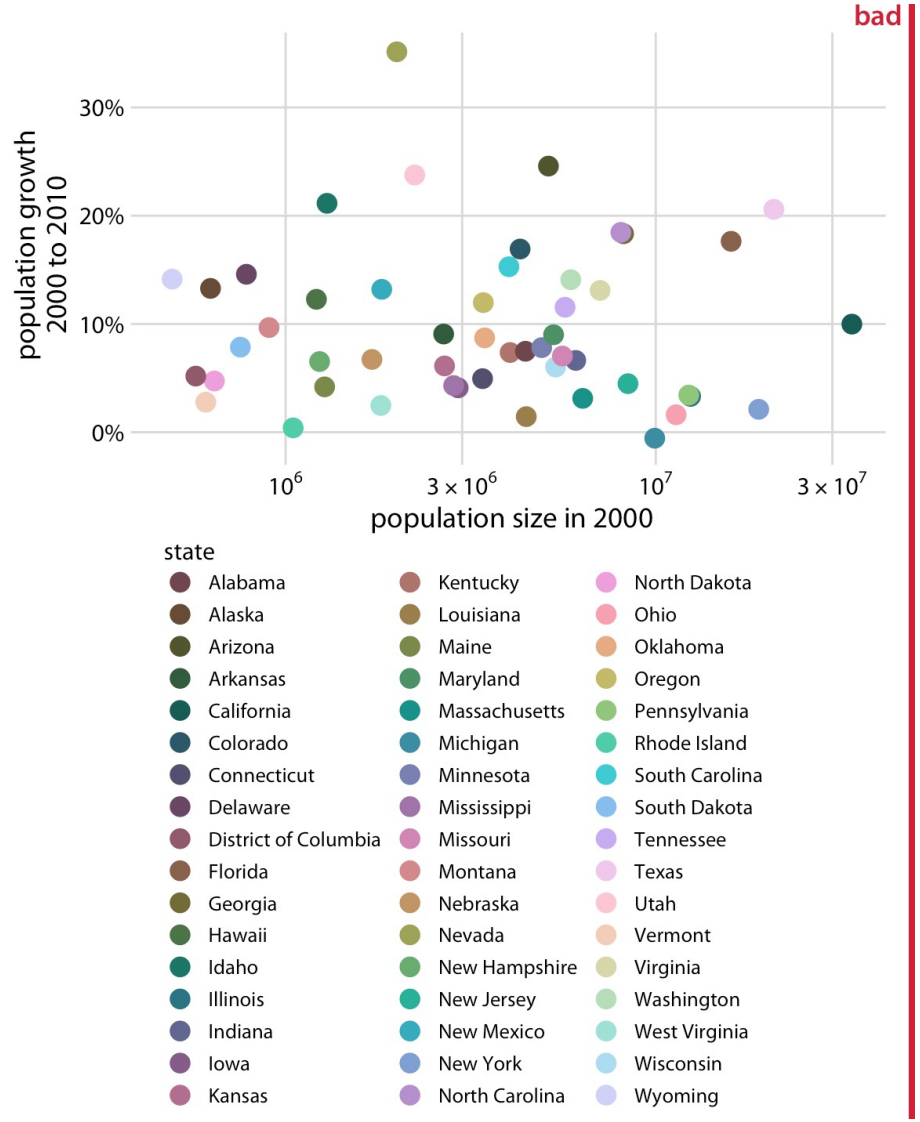


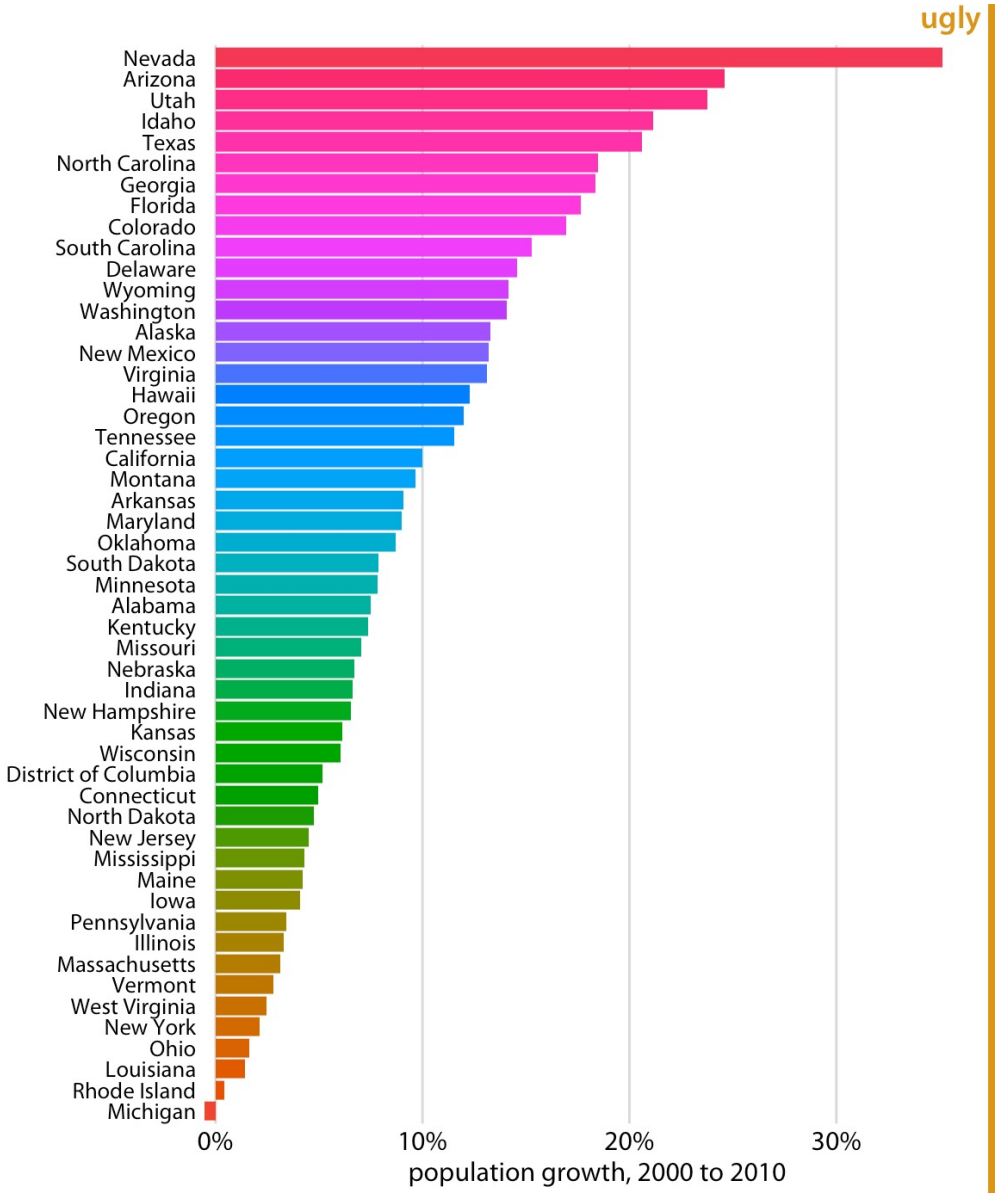




Legends

Fundamentals of Data Visualization, Wilke





Color

Fundamentals of Data Visualization, Wilke

Graphical Perception
How we see things?

Can you see a difference?	Signal Detection
Can you tell how big the difference is?	Magnitude Estimation
How quickly can you find information?	Visual Salience
How do we perceptually group things?	Gestalt Grouping

How we process visual information matters

Signal Detection
“Can you see a difference?”

Which square is brighter?

Which square is brighter?

RGB (128, 128, 128)

RGB (134, 134, 134)

RGB (144, 144, 144)

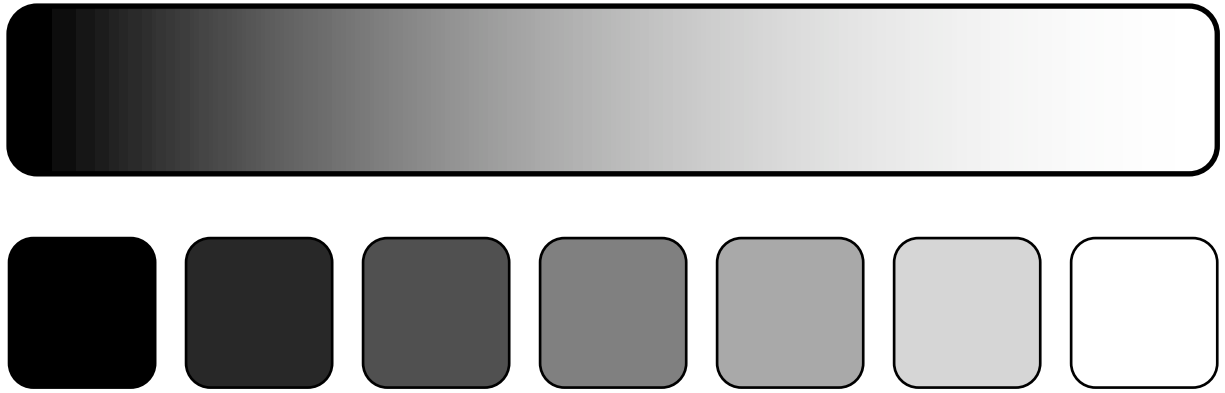
Which square is brighter?

$$\Delta I = kI$$

The "Just Noticeable Difference" ΔI is the minimum amount the stimulus intensity must be changed in order to produce a noticeable variation in sensory experience.

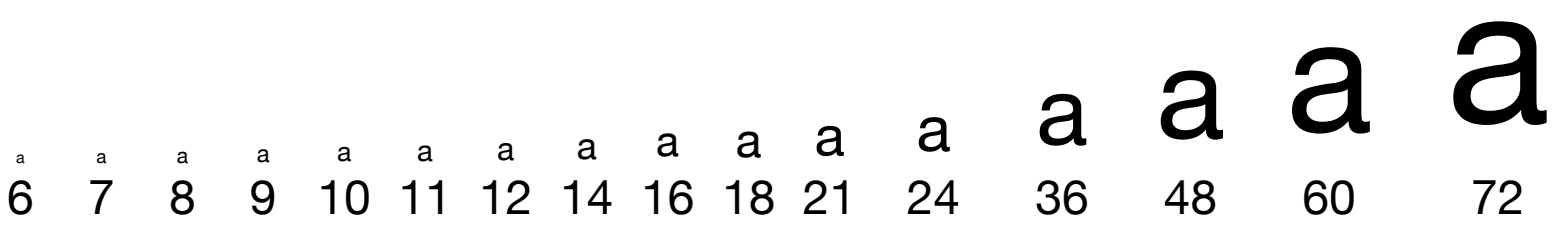
Weber's Law states that the JND is a constant Weber fraction k of the initial stimulus.

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



Most continuous variation in stimuli are perceived in discrete steps

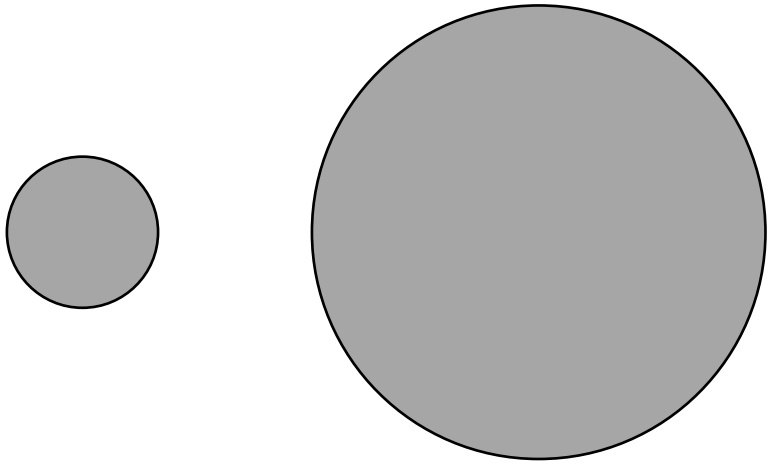
Ratios more important than magnitude



Weber's Law of Just Noticeable Difference

Magnitude Estimation
“How big is the difference?”

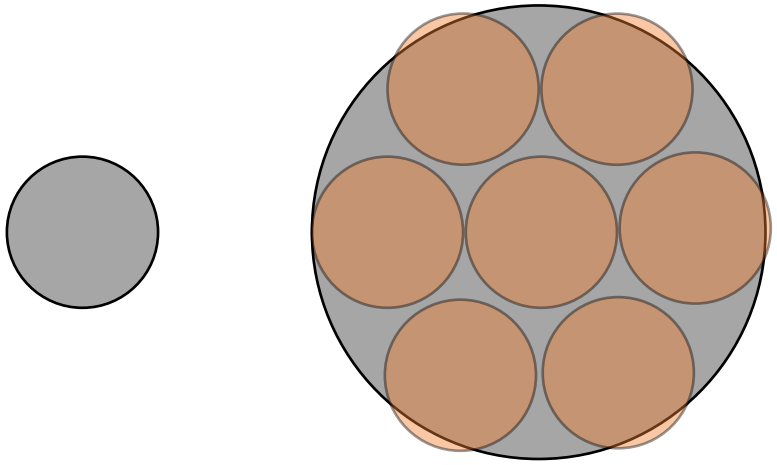
Compare the area of circles



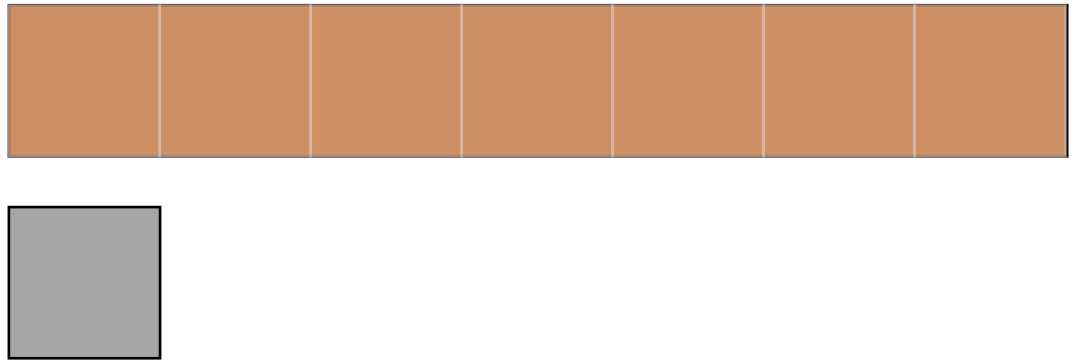
Compare the length of bars

How much bigger?

Compare the area of circles



Compare the length of bars



How much bigger?

Our perceived sensation of increases in length are linear in increases of the actual length

Our perceived sensation of increases in area are not!

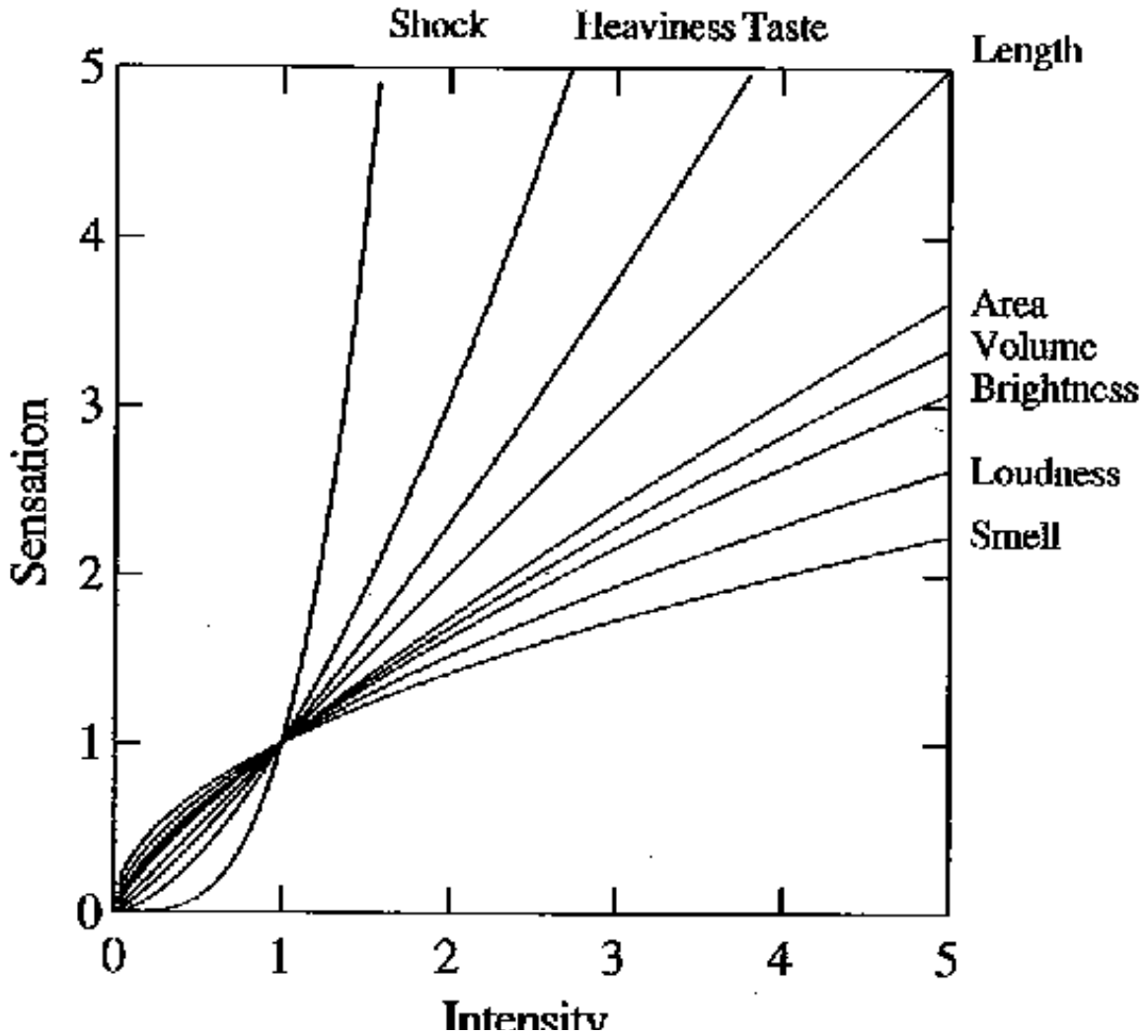
Steven's Power Law empirically describes these relationships!

Exponent
Emperically Determined

$$S = cI^p$$

Perceived Sensation

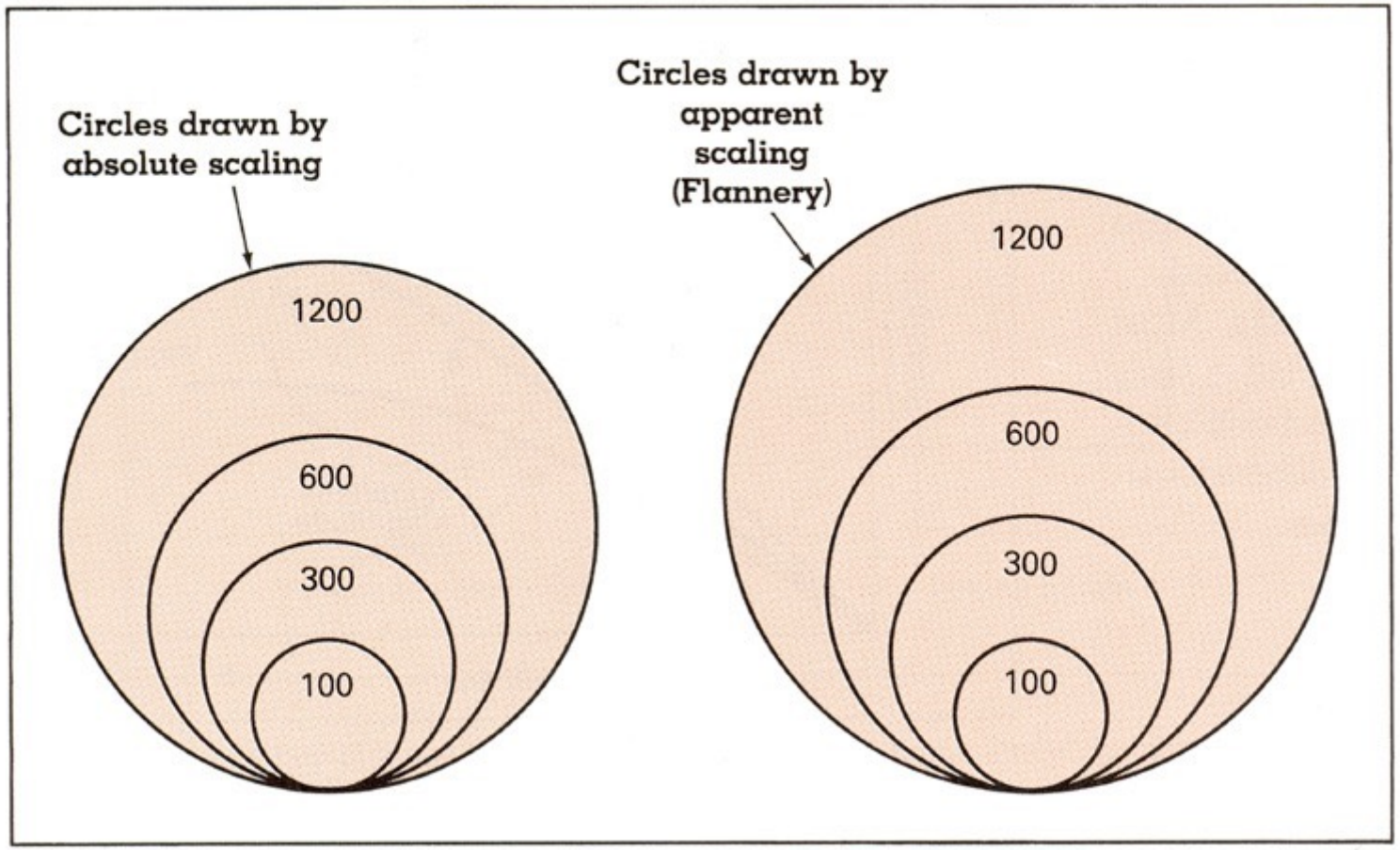
Physical Intensity



This is about our bias (not accuracy)

if $p > 1 \rightarrow$ overestimate (how does it feel to be shocked?)
if $p < 1 \rightarrow$ understimate (the area of the circle feels smaller)

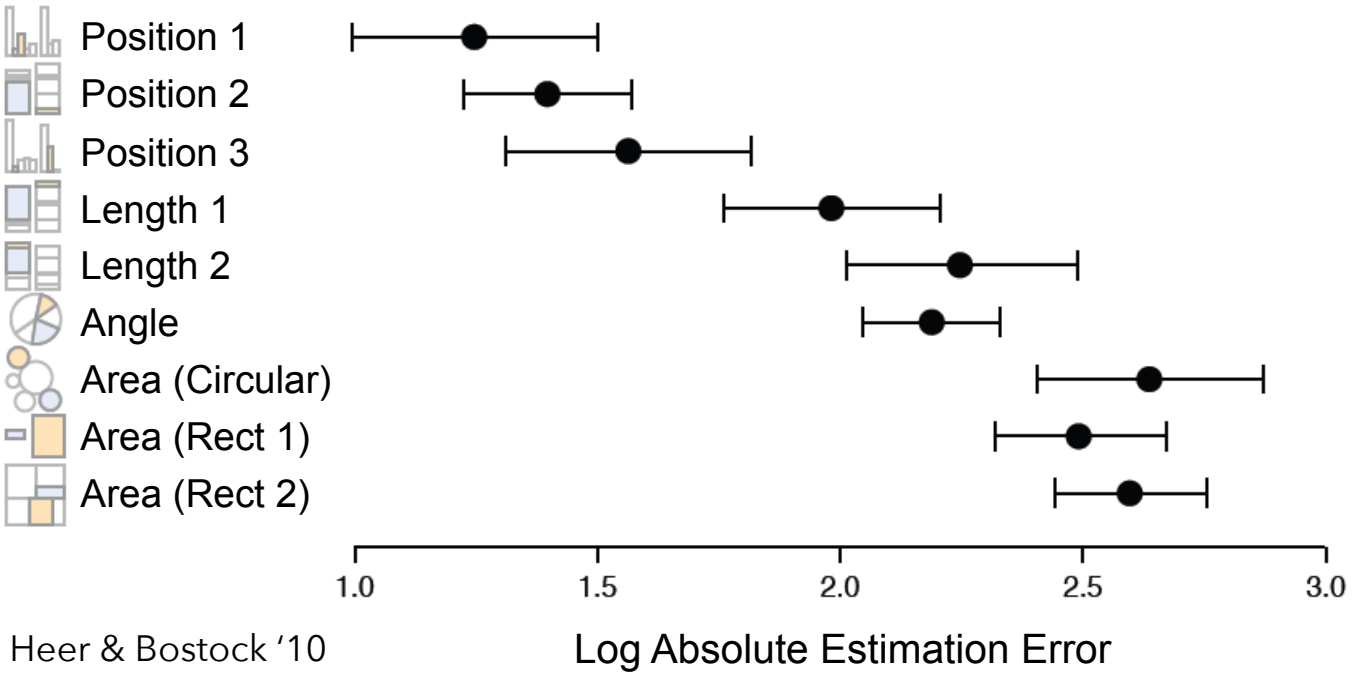
Steven's Power Law



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

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

Apparent magnitude scaling



Heer & Bostock '10

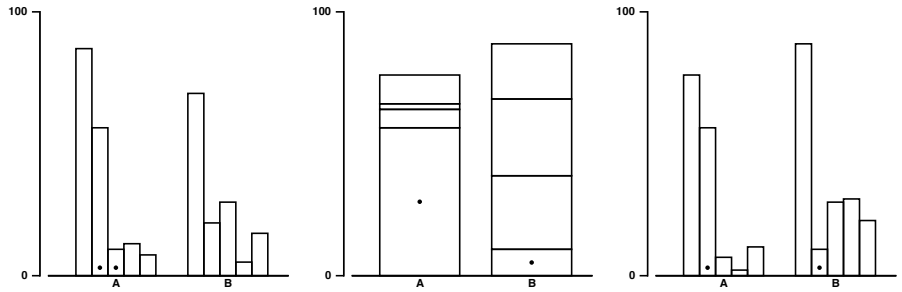


Figure 1: Stimuli for judgment tasks T1, T2 & T3. Subjects estimated percent differences between elements.

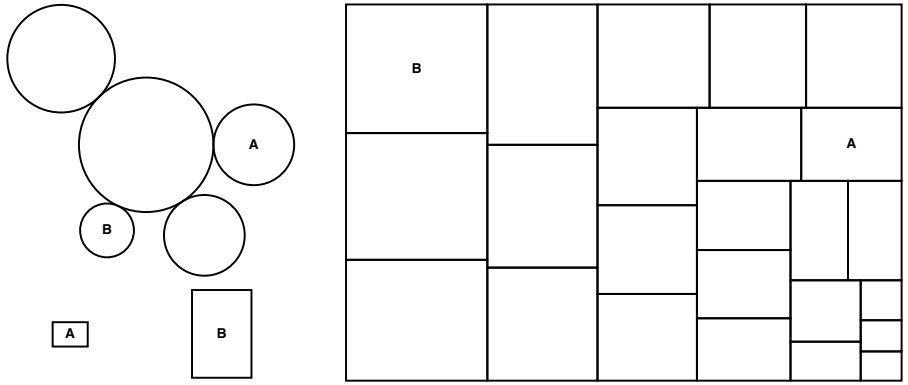


Figure 2: Area judgment stimuli. Top left: Bubble chart (T7), Bottom left: Center-aligned rectangles (T8), Right: Treemap (T9).

Perception experiments → empirical estimates of encoding effectiveness

Visual Salience
“How quickly can you find information?”

459290780597720987759726556651100498366452710746214465420707901473810974389701097143907097349266847858715819048630901889074257470723547456661420187740728498753106652

How many 3s?

4592907805977209877597265566511004983 6645
2710746214465420707901473810974389701 0971
4390709734926684785871581904863090188 9074
2574707235474566614201877407284987531 0665

How many 3s?

Information Visualization: Perception for Design
Ware, 2021

"Typically, tasks that can be performed on large multi-element displays in less than 200 to 250 milliseconds (msec) are considered preattentive.

Eye movements take at least 200 msec to initiate, and random locations of the elements in the display ensure that attention cannot be prefocused on any particular location, yet viewers report that these tasks can be completed with very little effort.

This suggests that certain information in the display is processed in parallel by the low-level visual system."

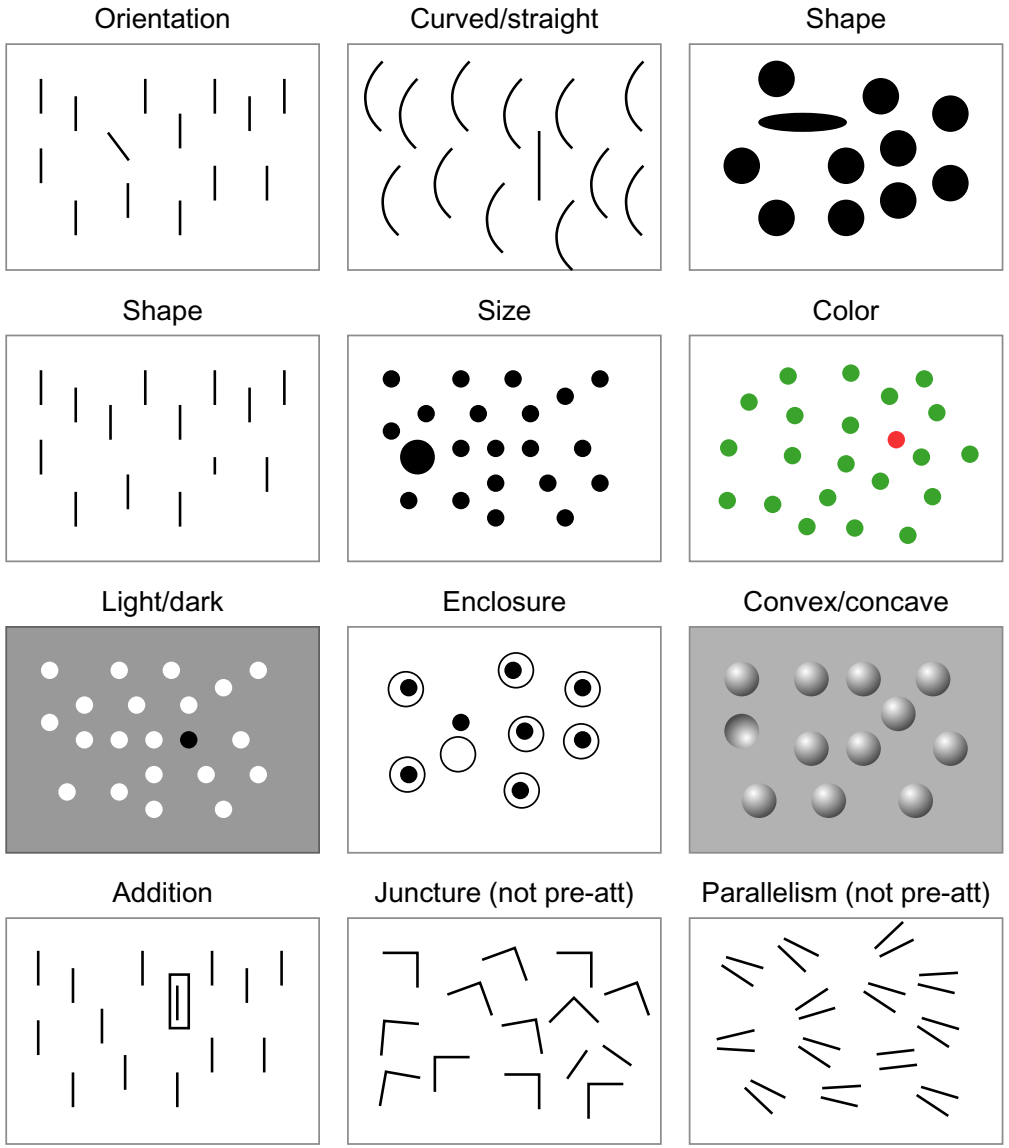
Perception in Visualization, Christopher G. Healey
https://www.csc2.ncsu.edu/faculty/healey/PP/index.html

What is a pre-attentive task?

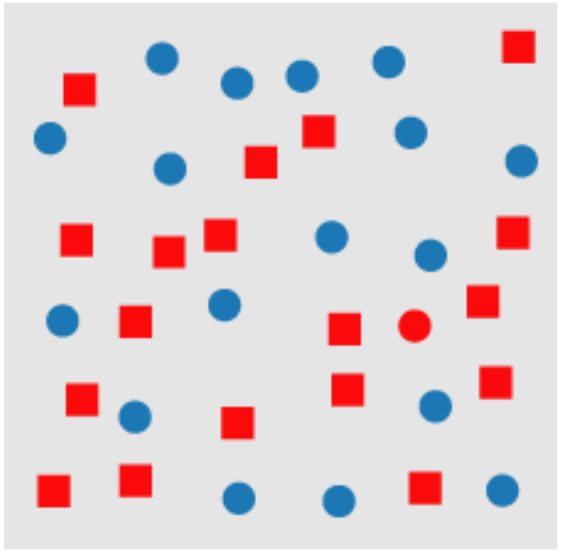
- target detection
- boundary detection
- region tracking
- counting and estimation

Perception in Visualization, Christopher G. Healey
https://www.csc2.ncsu.edu/faculty/healey/PP/index.html

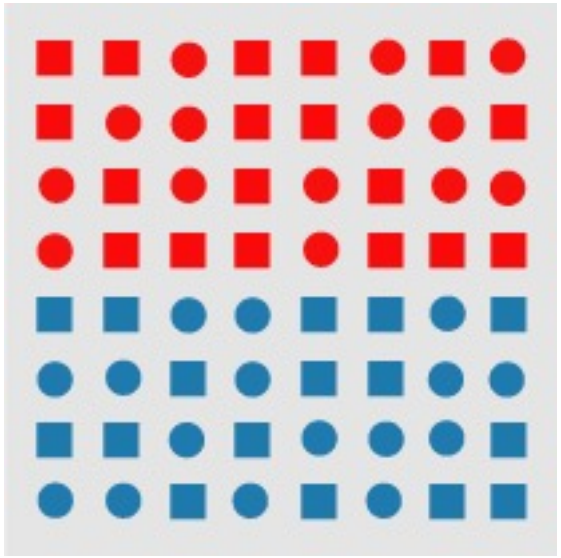
Pre-attentive visual tasks

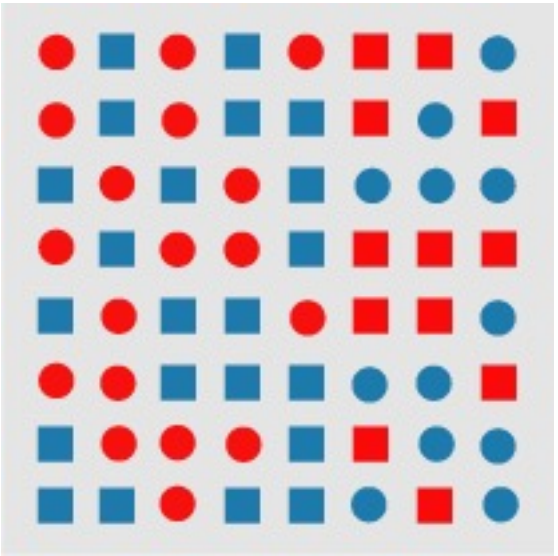


Pre-attentive Features



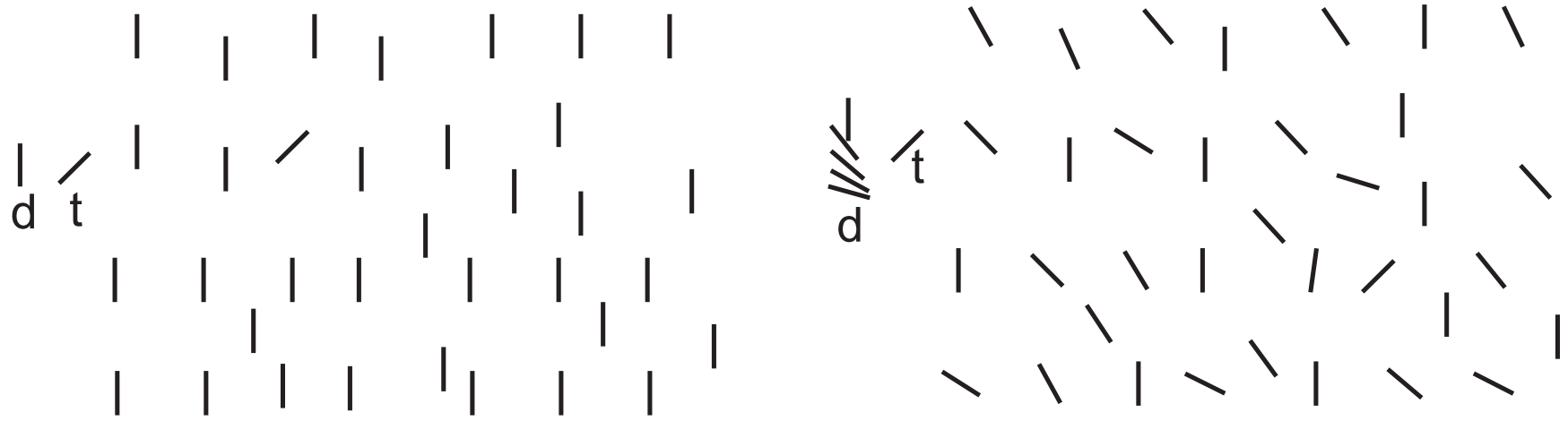
Most conjuctions are not pre-attentive!
Can you find the red circle?





Information Visualization: Perception for Design
Ware, 2021

Can you detect the boundary?



Assymetric Processing

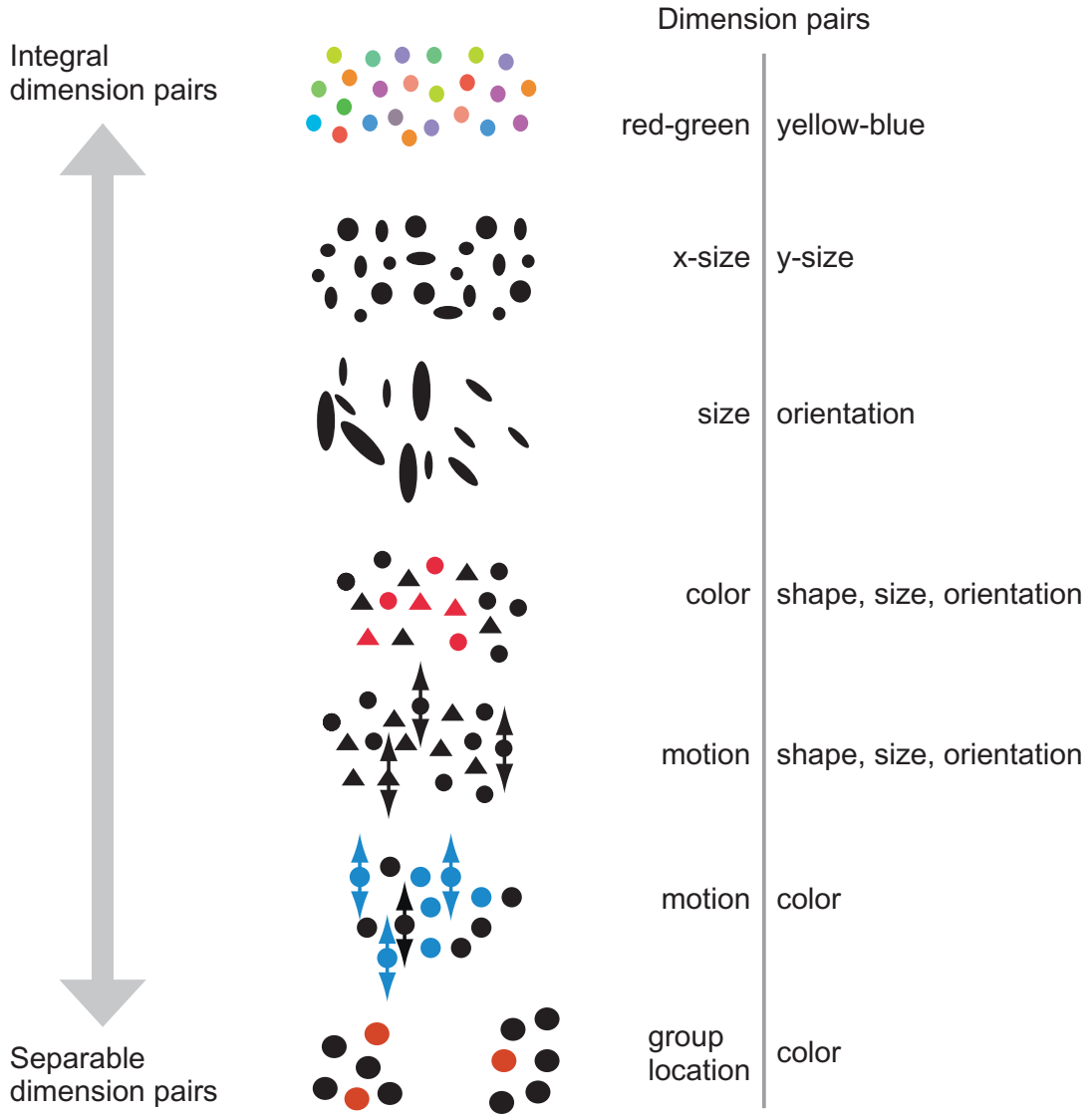
BROWN
GREEN
YELLOW
RED
BLACK
ORANGE
BLUE
PURPLE

RED
BLUE
GREEN
ORANGE
BLACK
PURPLE
BROWN
YELLOW

The Stroop Effect

"Will the color-coding scheme interfere with our perception of glyph size and therefore distort some perceived quantitative level?"

What if we use both color and size to represent a single variable—will this make the information clearer?"

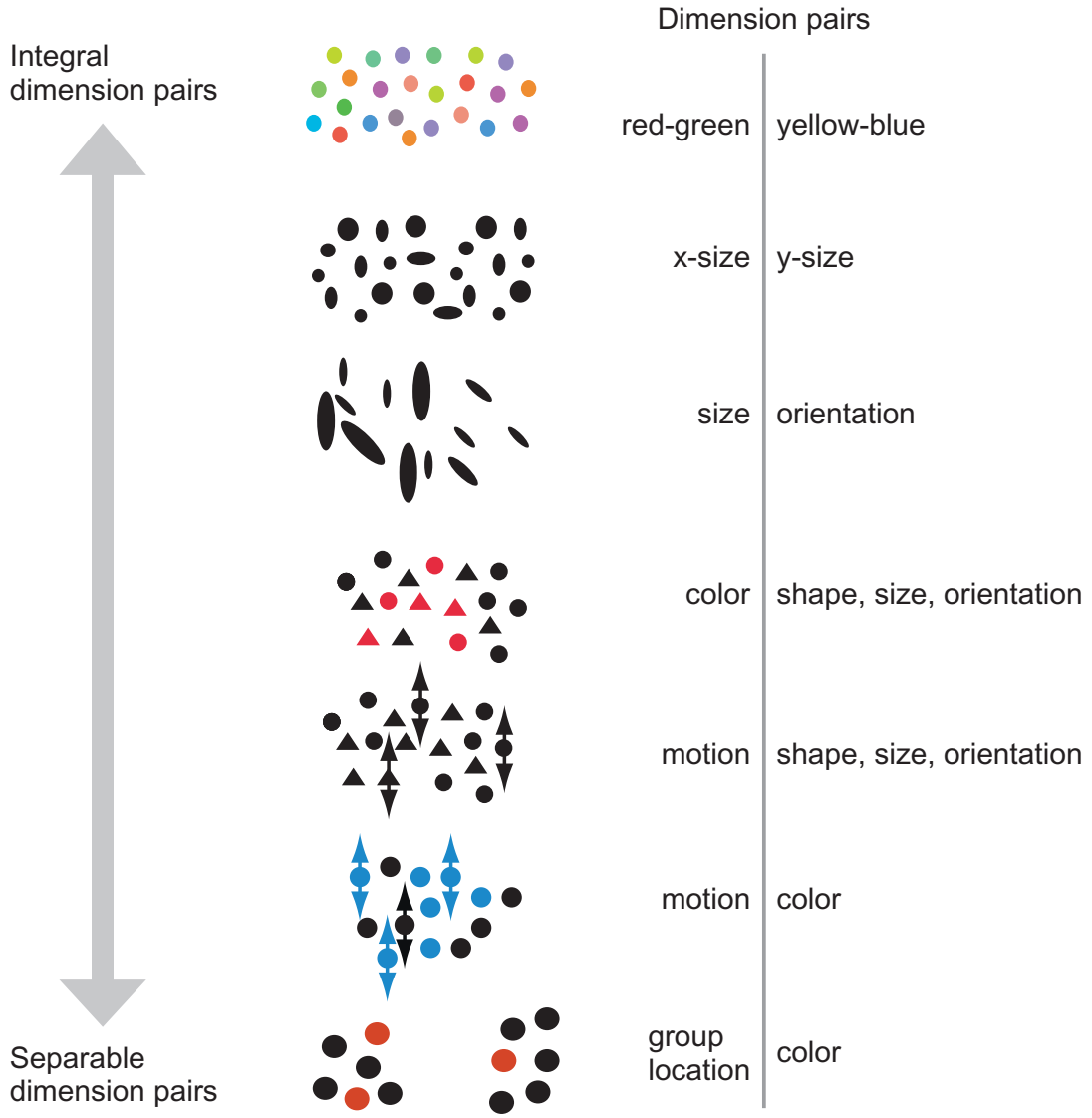


Integral & Separable Dimensions

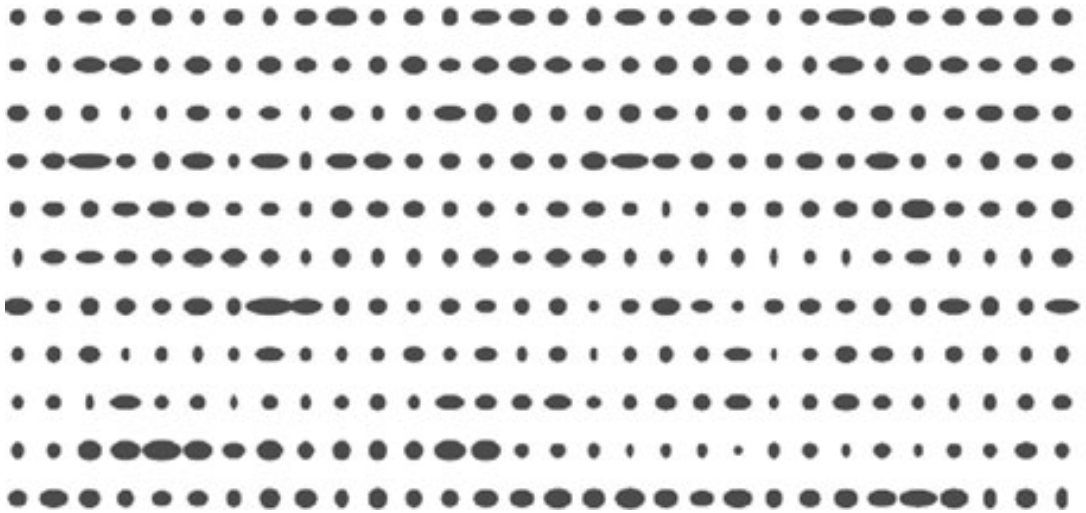
Integral & Separable Dimensions

With integral display dimensions, two or more attributes of a visual object are **perceived holistically** and not independently. (e.g. a rectangle is seen as the height and width)

Analytic processing: with separable dimensions, people tend to make separate judgments about each graphical dimension. It is easy to respond independently to questions about each dimension

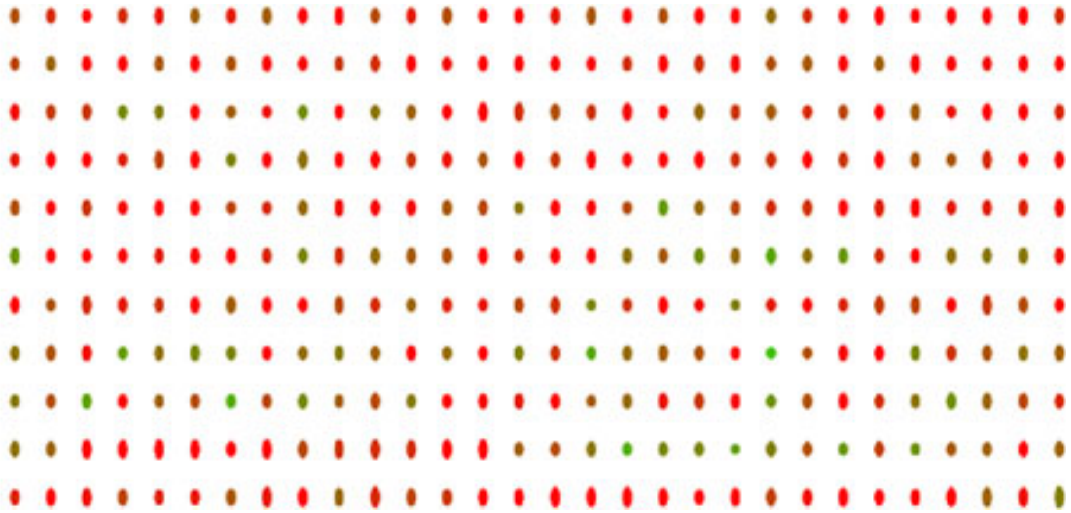


Obesity in 400 dutch men



Maping height to ellipse height and weight to width

x/y size are integral dimensions



Maping height to ellipse height and red/green to weight

shape and color are more separable dimensions

Integral & Separable Dimensions

Gestalt Grouping
“How the mind sees?”

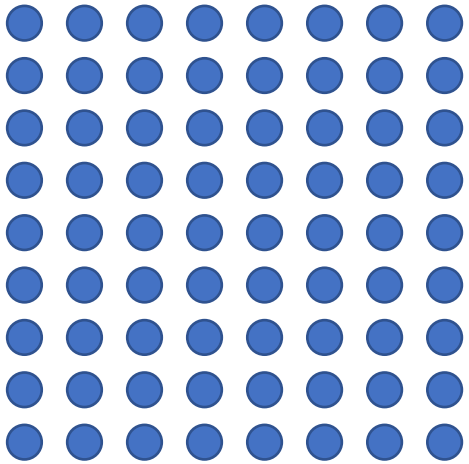
- Proximity
- Similarity
- Enclosure

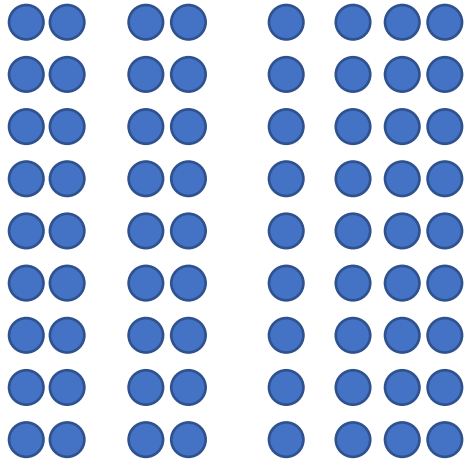
- Connectedness
- Continuity

- Figure & Ground

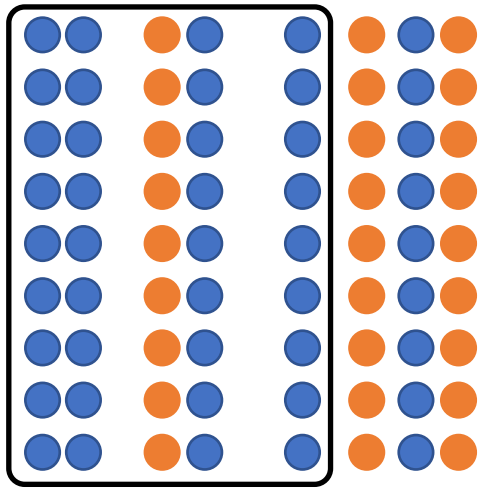
Gestalt Principles and high-level visualization guidelines

Proximity, Similarity & Encolsure

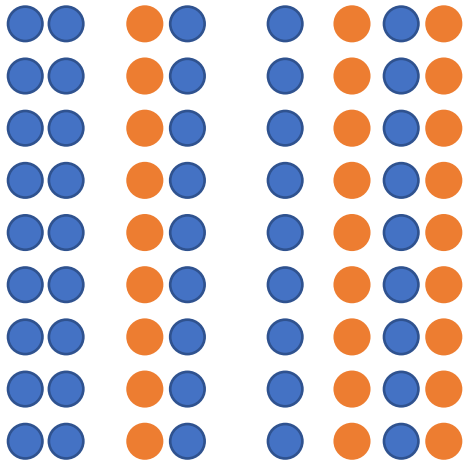




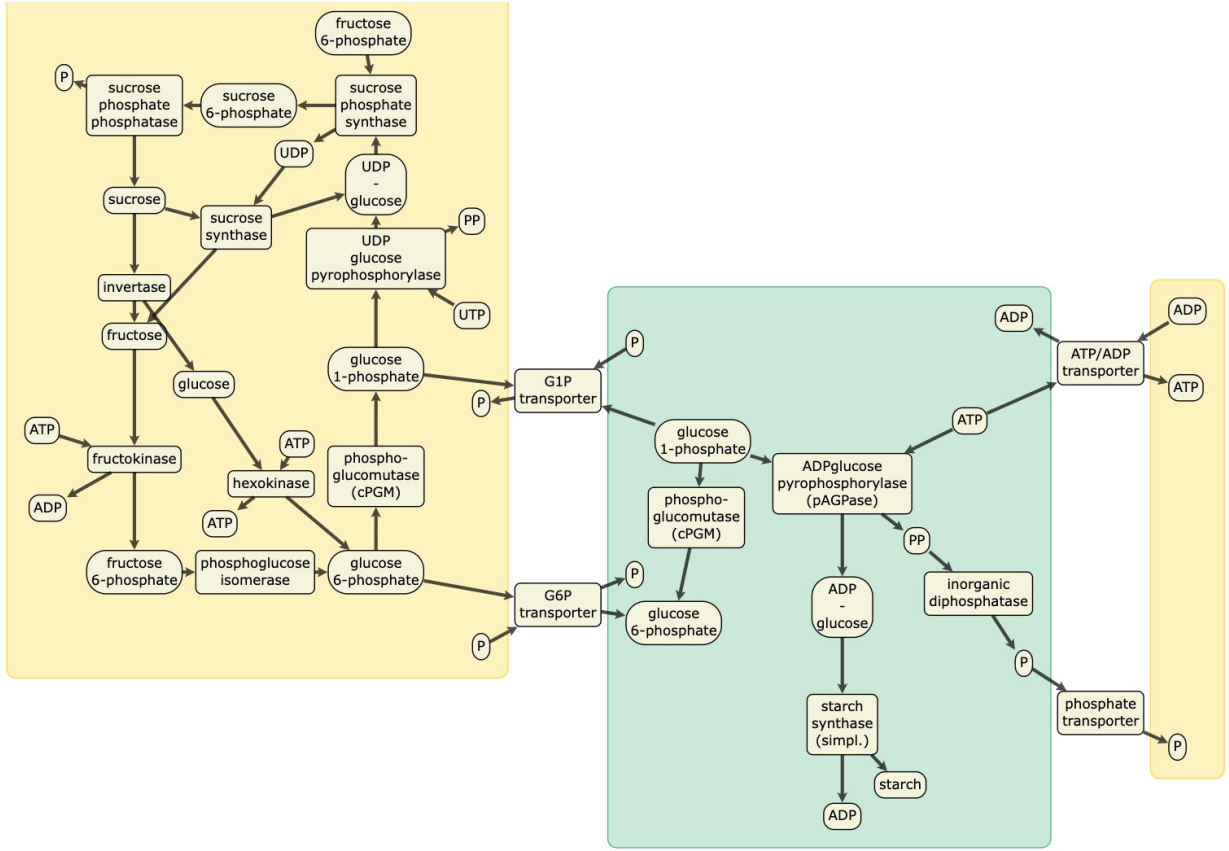
Proximity: things close together get grouped together



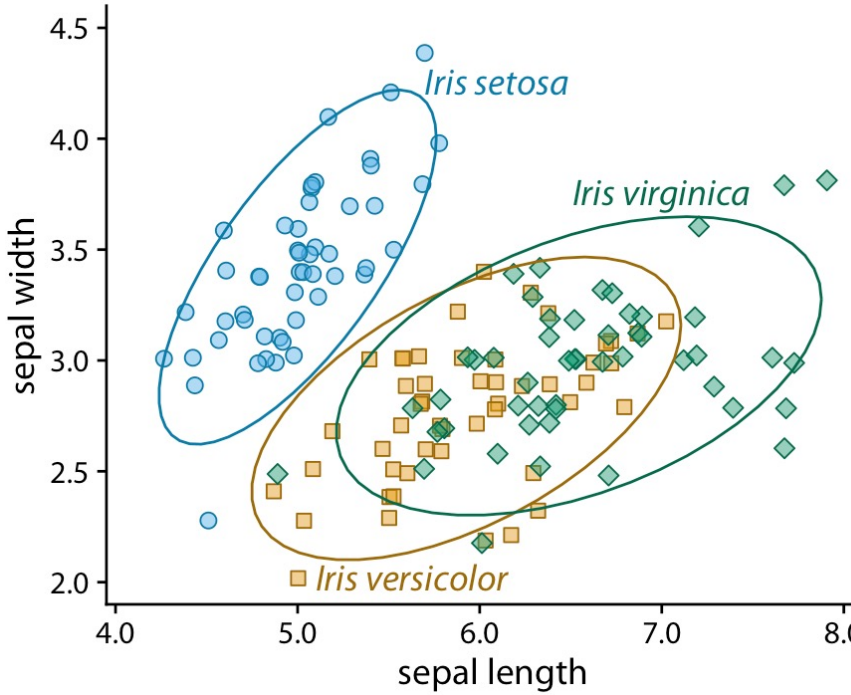
Enclosure: things contained in the same enclosure get grouped together

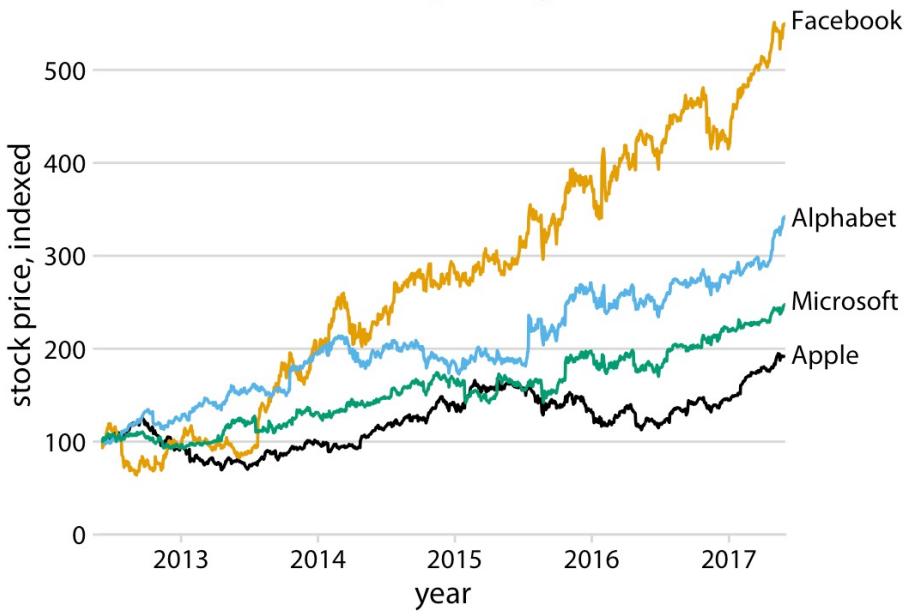


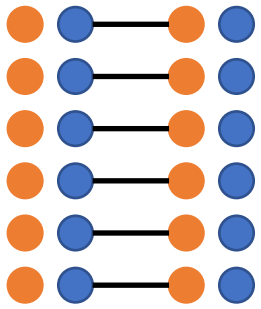
Similarity: things that look the same get grouped together


fructose 6-phosphate
P
sucrose phosphate phosphatase
sucrose 6-phosphate
sucrose phosphate synthase
UDP
UDP - glucose
sucrose
sucrose synthase
PP
UDP glucose pyrophosphorylase
UTP
invertase
fructose
glucose
glucose 1-phosphate
G1P transporter
ATP
fructokinase
ADP
ATP
hexokinase
ATP
phospho- glucomutase (cPGM)
fructose 6-phosphate
phosphoglucose isomerase
glucose 6-phosphate
G6P transporter
P
glucose 1-phosphate
phospho- glucomutase (cPGM)
glucose 6-phosphate
ADP
ATP/ADP transporter
ADP
ATP
ATP
ADPglucose pyrophosphorylase (pAGPase)
PP
ADP - glucose
inorganic diphosphatase
starch synthase (simpl.)
starch
ADP
P
phosphate transporter
P

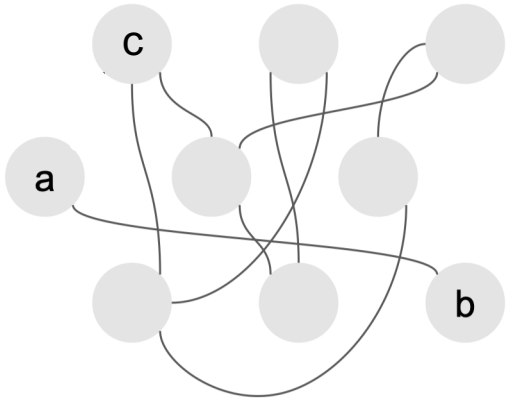
In practice

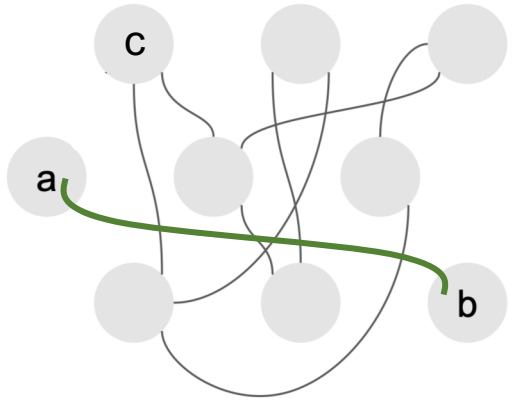

Iris setosa
Iris virginica
Iris versicolor
sepal width
sepal length
4.5
4.0
3.5
3.0
2.5
2.0
4.0
5.0
6.0
7.0
8.0

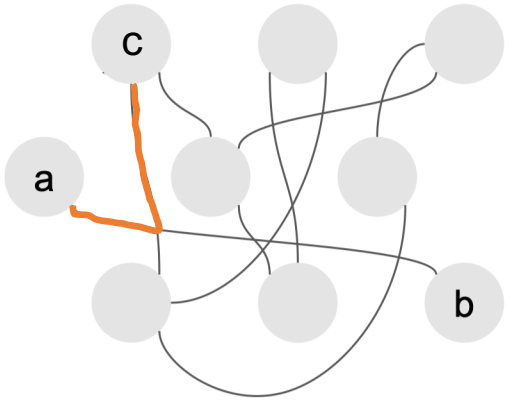

Facebook
Alphabet
Microsoft
Apple
stock price, indexed
500
400
300
200
100
0
2013
2014
2015
2016
2017
year



Connectedness: things that are conencted are grouped together.



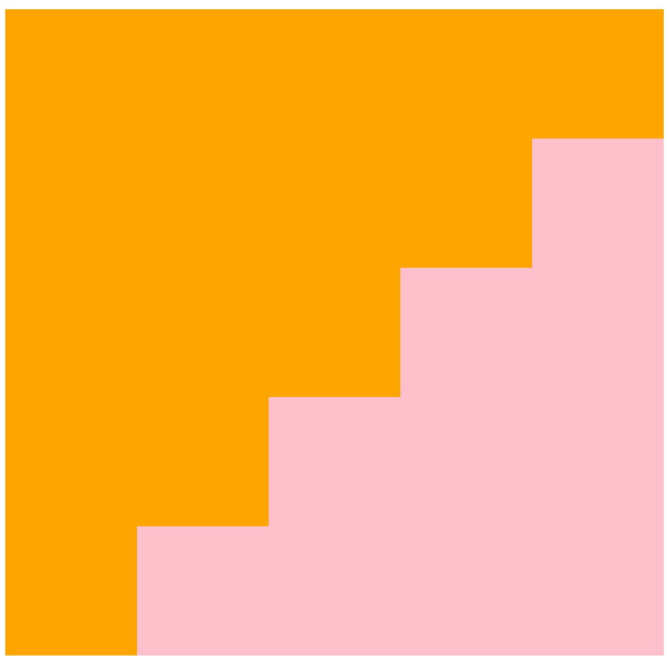


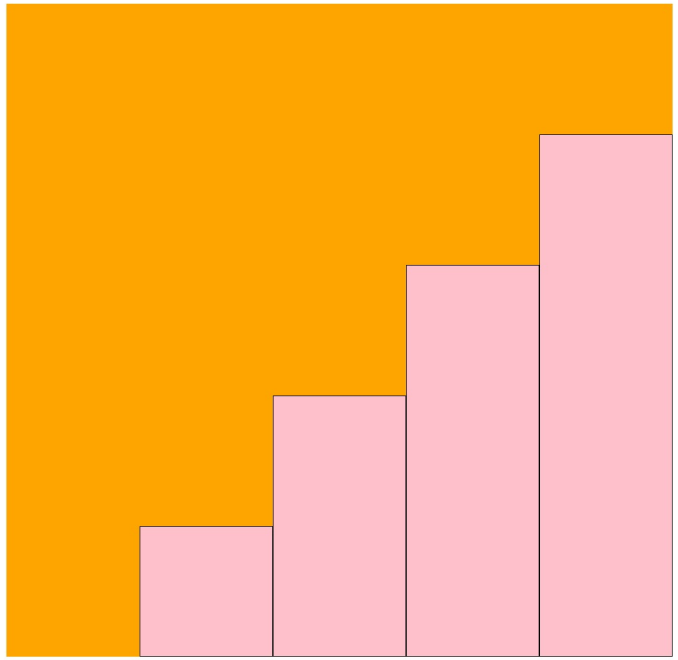


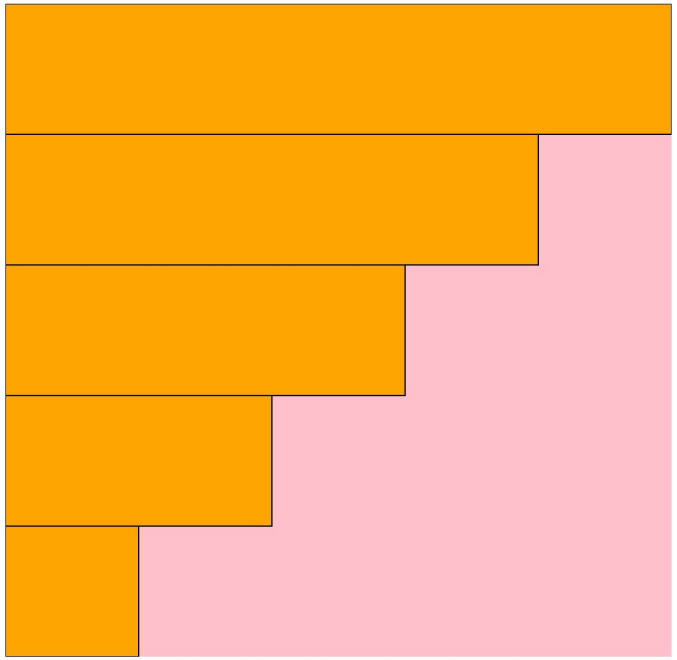
Continuity: elements that are arranged on a line or curve are perceived to be more related than elements not on the line or curve

Connectedness & Continuity

We try to identify a *figure* from the back*ground*.





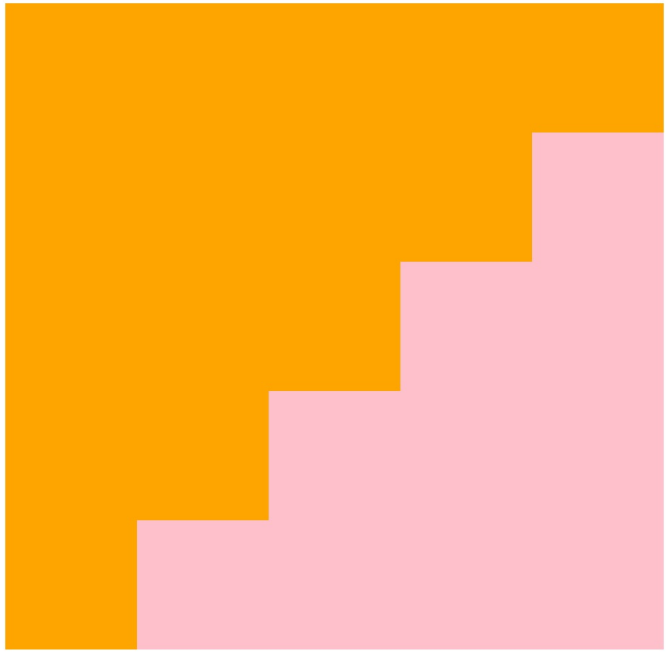


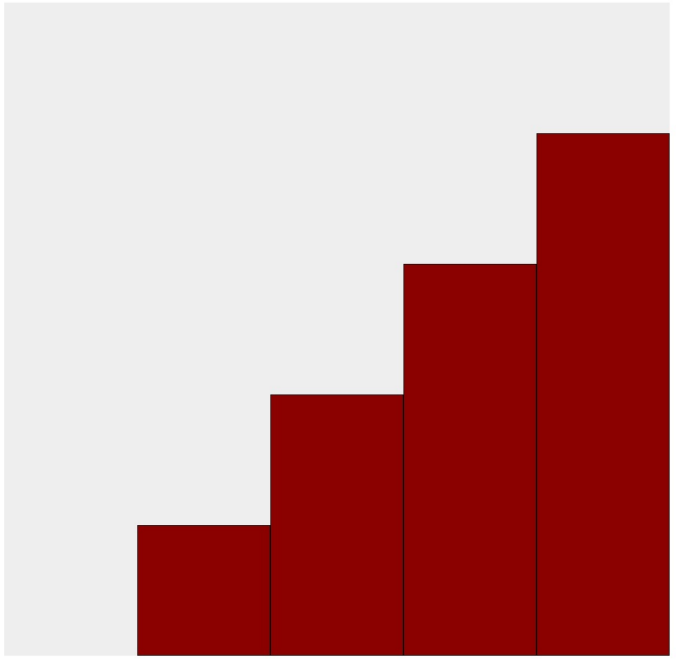
This can be difficult if the figure and ground compete

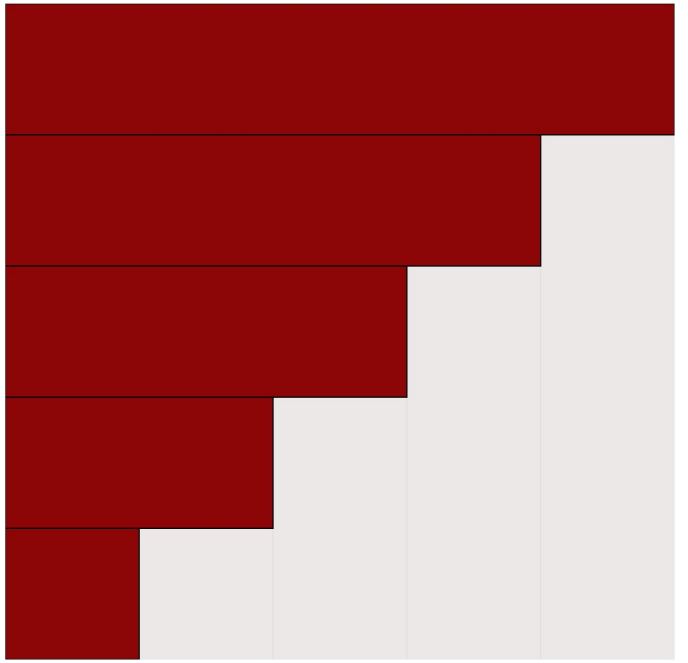
https://medium.com/@Elijah_Meeks/gestalt-principles-for-data-visualization-59f18f20bd40

Figure & Ground

We try to identify a *figure* from the back*ground*.





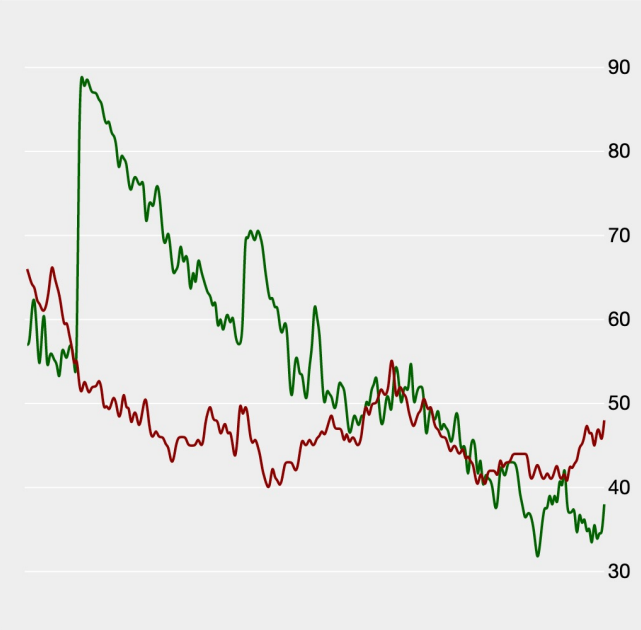


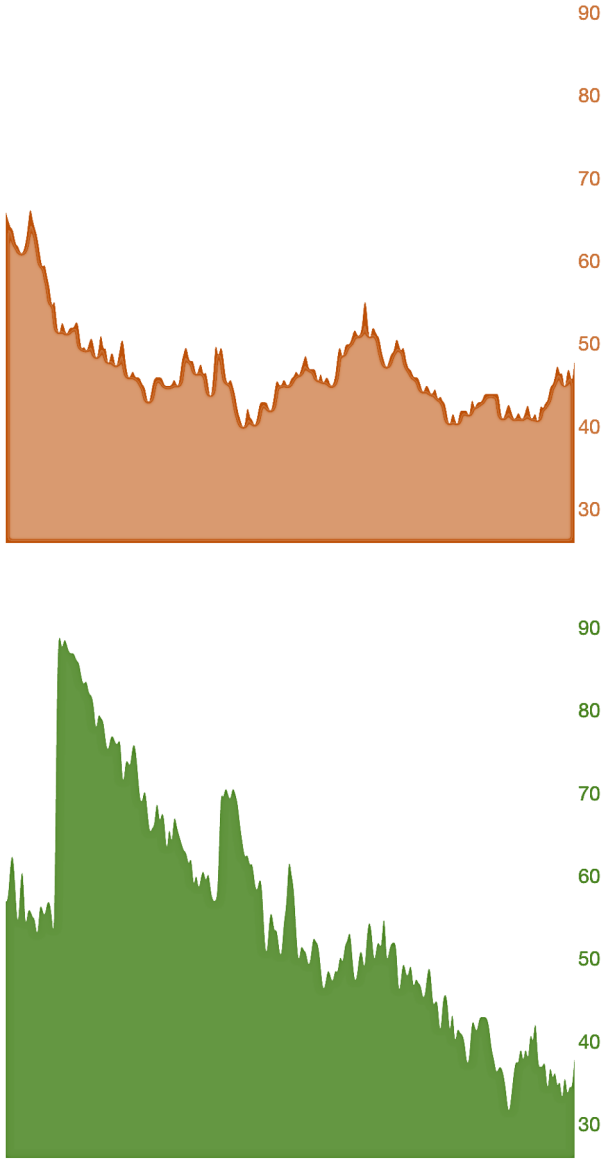
This can be difficult if the figure and ground compete

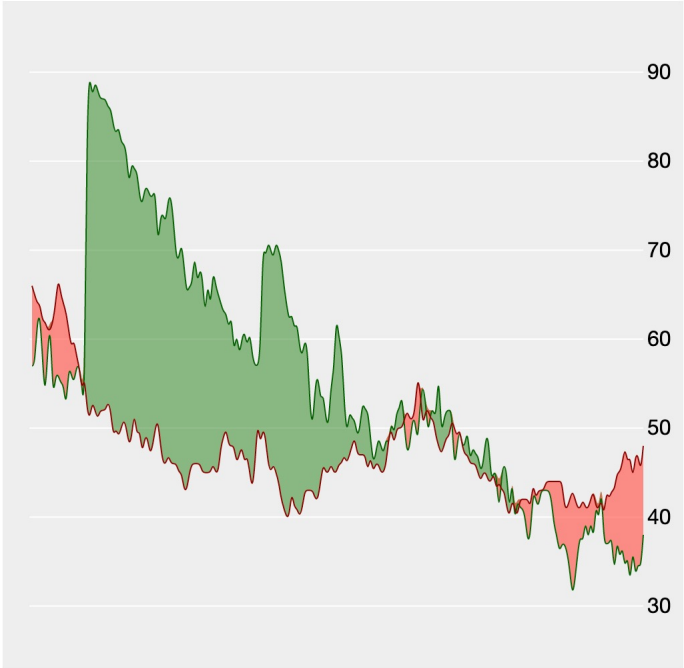
https://medium.com/@Elijah_Meeks/gestalt-principles-for-data-visualization-59f18f20bd40

Figure & Ground

Approval ratings of Obama (red) vs. Bush (green) during the same presidency periods







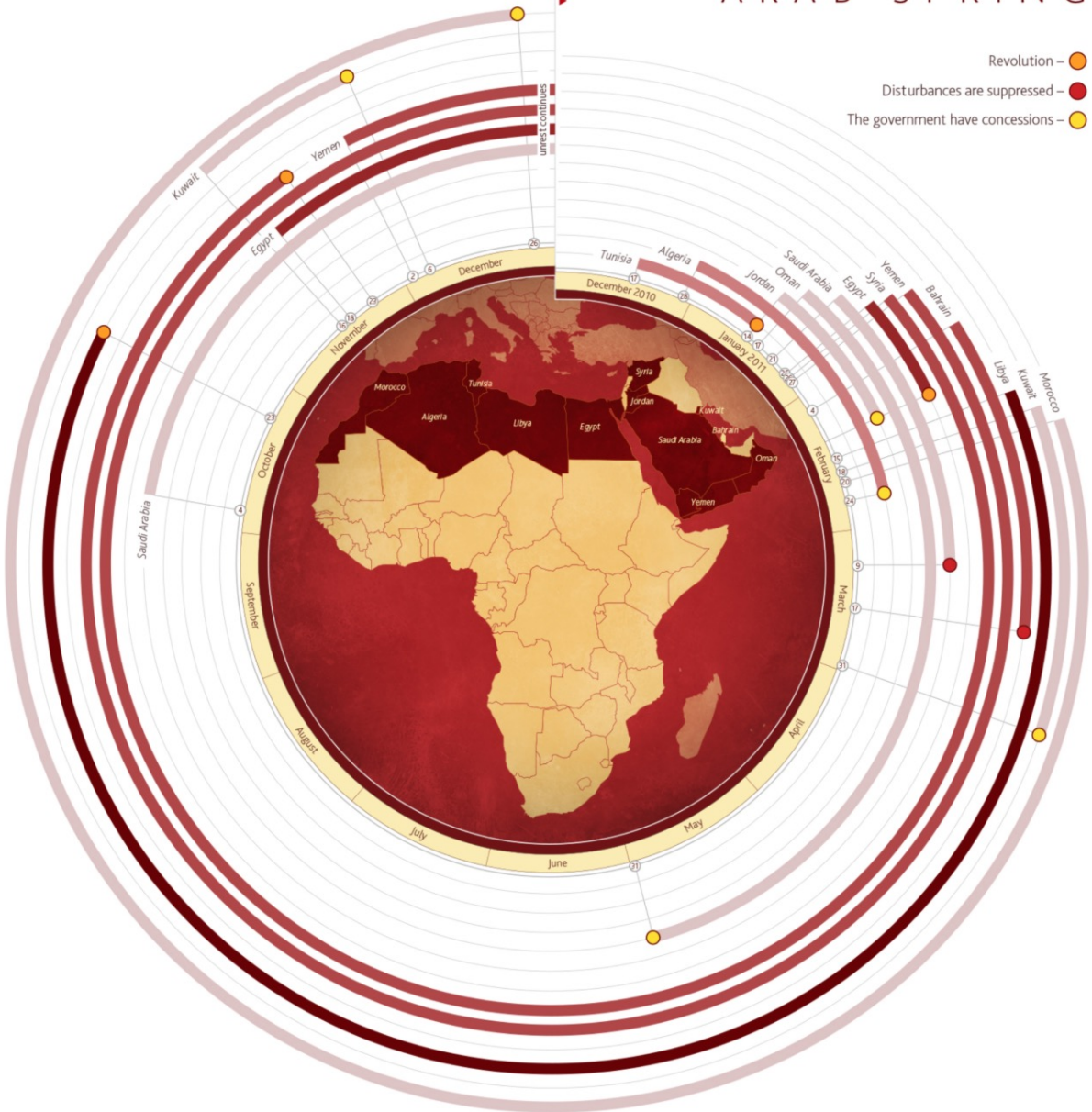
The difference chart plays with figure/ground principles to better illustrate differences.

Visualizations that play on this

https://medium.com/@Elijah_Meeks/gestalt-principles-for-data-visualization-59f18f20bd40

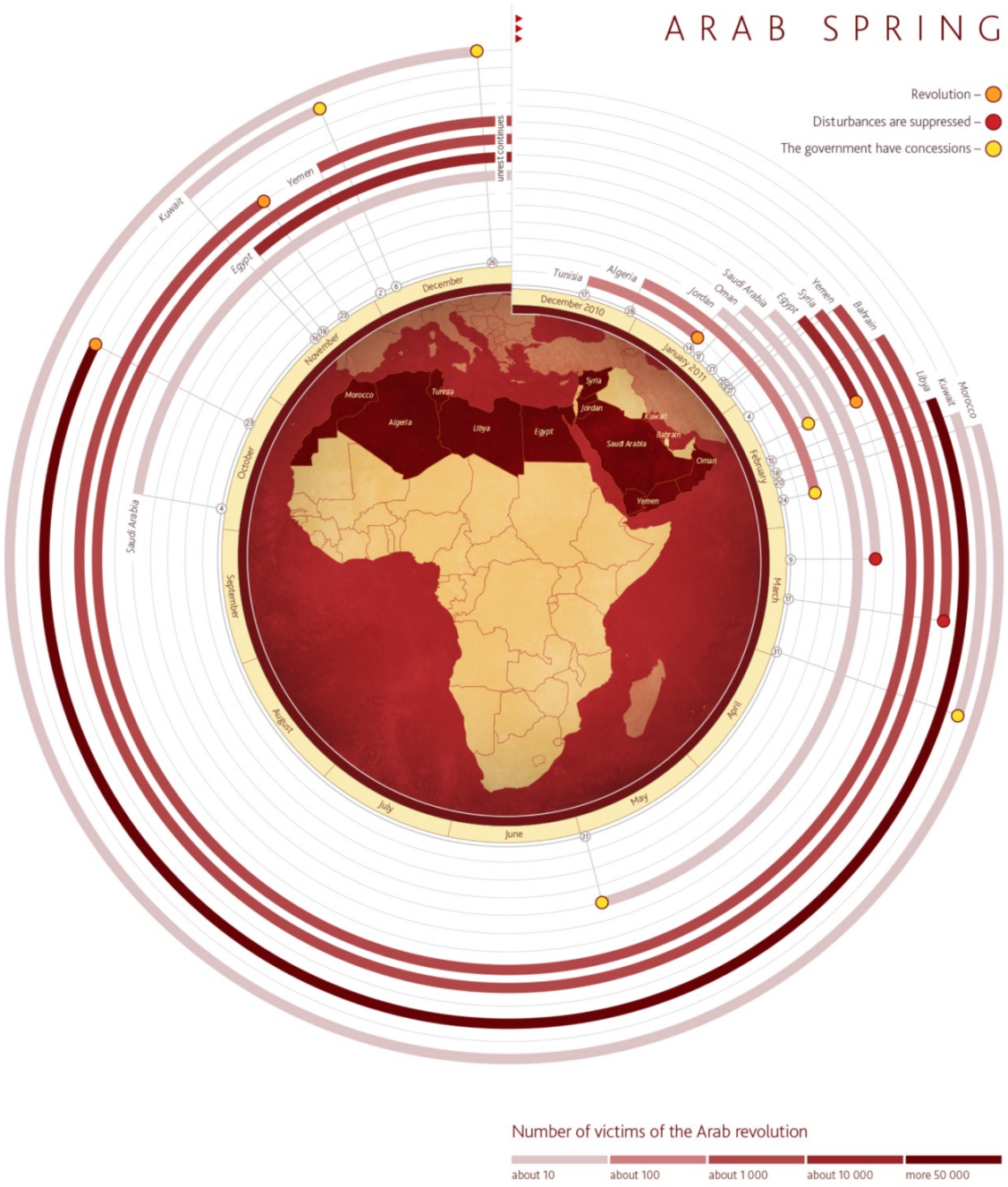
Design & Redesign

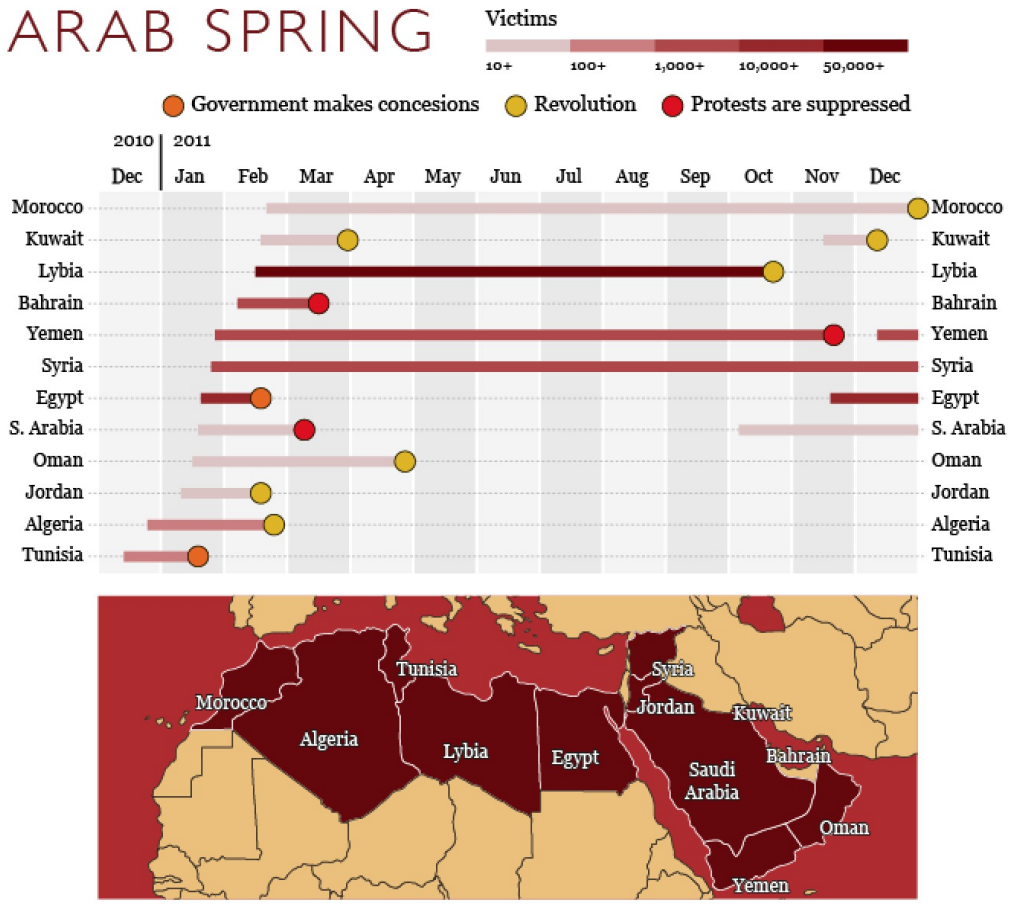
ARAB SPRING



Number of victims of the Arab revolution

about 10 | about 100 | about 1 000 | about 10 000 | more 50 000





https://medium.com/@hint_fm/design-and-redesign-4ab77206cf9

Teacher Salaries: Is It Really That Bad?

National and State averages for K-12 Public-School Teachers

UNITED STATES

AVG. SALARY: $47,674

Avg. vacation days: 63

HOURLY
Hours per week on-site: 36.5
Public-School Teacher: $34.06
Private-School Teacher: $21.08
Average Worker: $25.08
Police: $22.64
Fire: $17.91

CANADA

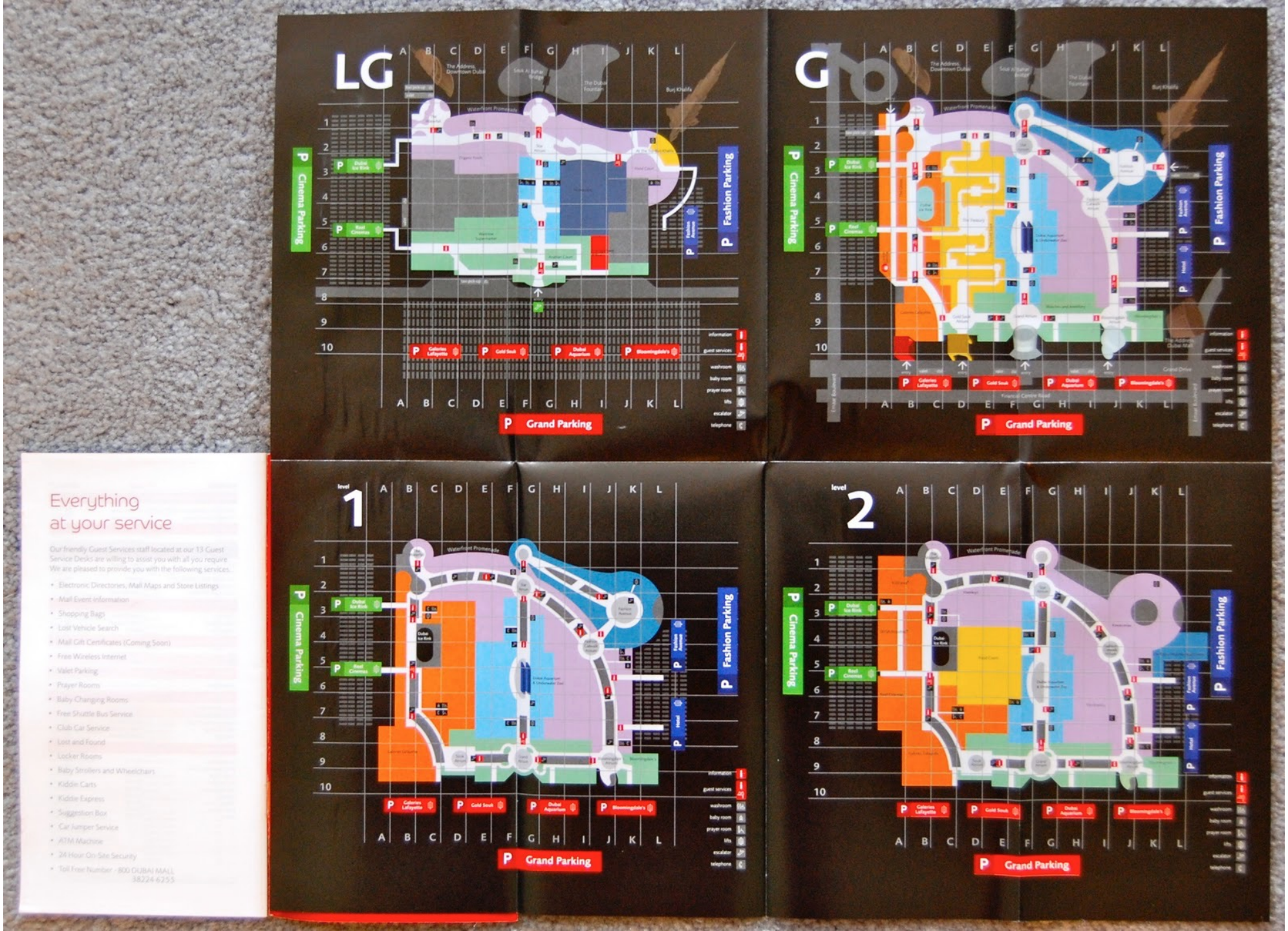
AVG. SALARY: $43,000

Avg. vacation days: 50

HOURLY: $30.18
Hours per week on-site: 55.6

SOURCES Manhattan Institute; National Center For Education Statistics; National Education Association; U.S. Bureau of Labor Statistics

AVERAGE Workers' salaries used for comparison are those of white-collar, nonsales employees.


LG
G
level 1
level 2
Cinema Parking
Fashion Parking
Grand Parking
Dubai Ice Rink
Reel Cinemas
Galeries Lafayette
Gold Souk
Dubai Aquarium
Bloomingdale's
Fashion Avenue
Hotel
information
guest services
washroom
baby room
prayer room
lifts
escalator
telephone
Everything at your service
Our friendly Guest Services staff located at our 13 Guest Service Desks are willing to assist you with all you require. We are pleased to provide you with the following services.
• Electronic Directories, Mall Maps and Store Listings
• Mall Event Information
• Shopping Bags
• Lost Vehicle Search
• Mall Gift Certificates (Coming Soon)
• Free Wireless Internet
• Valet Parking
• Prayer Rooms
• Baby Changing Rooms
• Free Shuttle Bus Service
• Club Car Service
• Lost and Found
• Locker Rooms
• Baby Strollers and Wheelchairs
• Kiddie Carts
• Kiddie Express
• Suggestion Box
• Car Jumper Service
• ATM Machine
• 24 Hour On-Site Security
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38224 6255