Lecture 5

9/22/2020

Visual Encoding

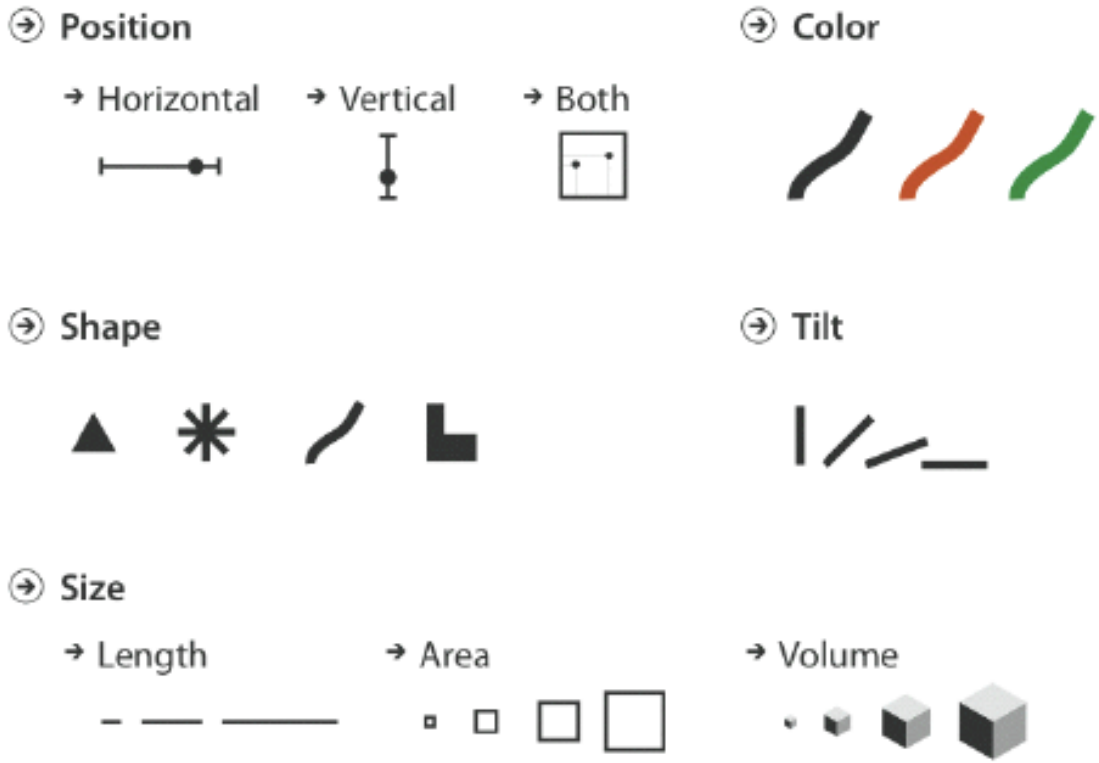
- How do we encode data visually?
  - Marks – basic graphical elements in a visualization
  - Channels – ways to control the appearance of the marks

Marks

- Classified by dimensionality
- Classified according to number of spatial dimensions required

Channels

- Parameters that control the appearance of marks



Channels

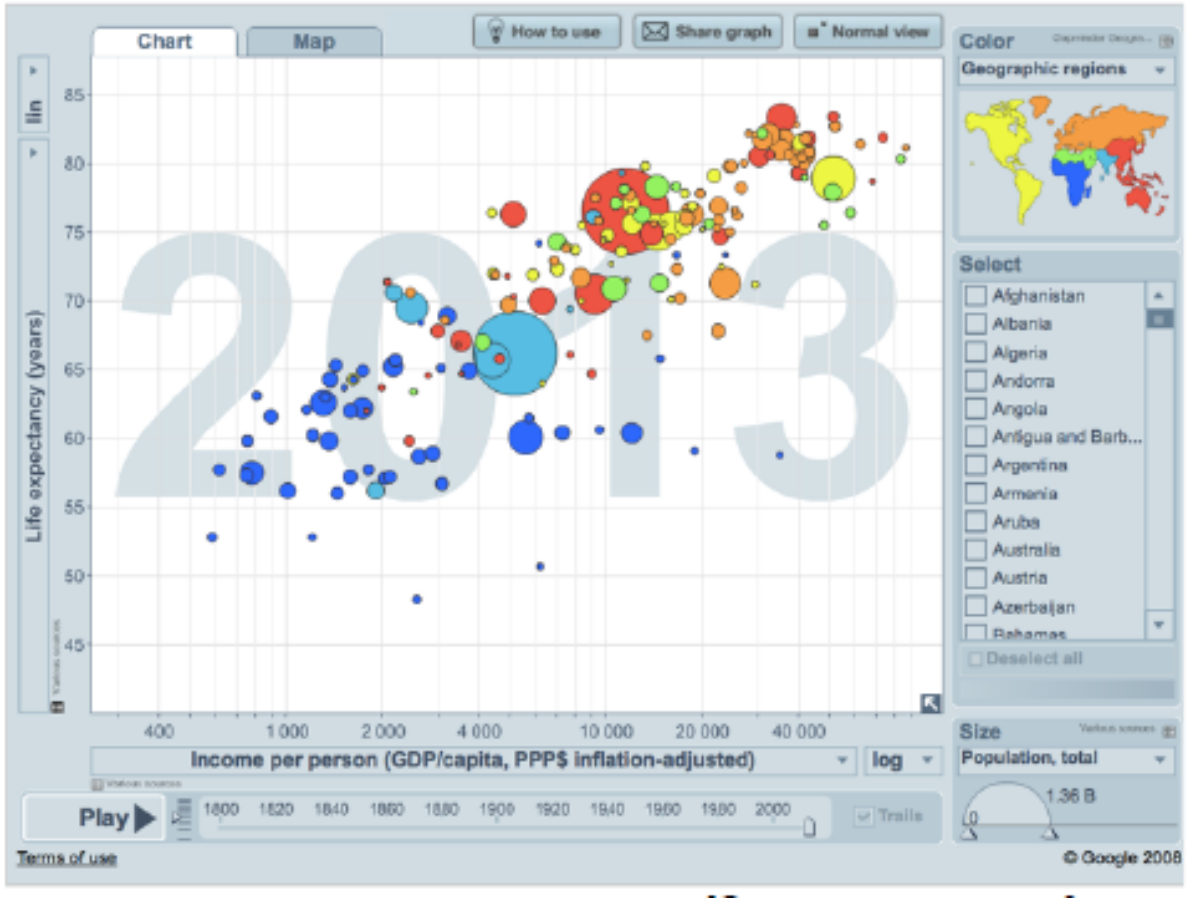
- Usually map an attribute to a single channel
  - Could use multiple channels, but…
  - Limited number of channels
- Restrictions on size and shape
  - Points are nothing but location so size and shape are ok
  - Lines have a length, cannot easily encode attribute as length
  - Maps with boundaries have area, changing size can be problematic

Channels: Visual Appearance

- How should we encode this data?

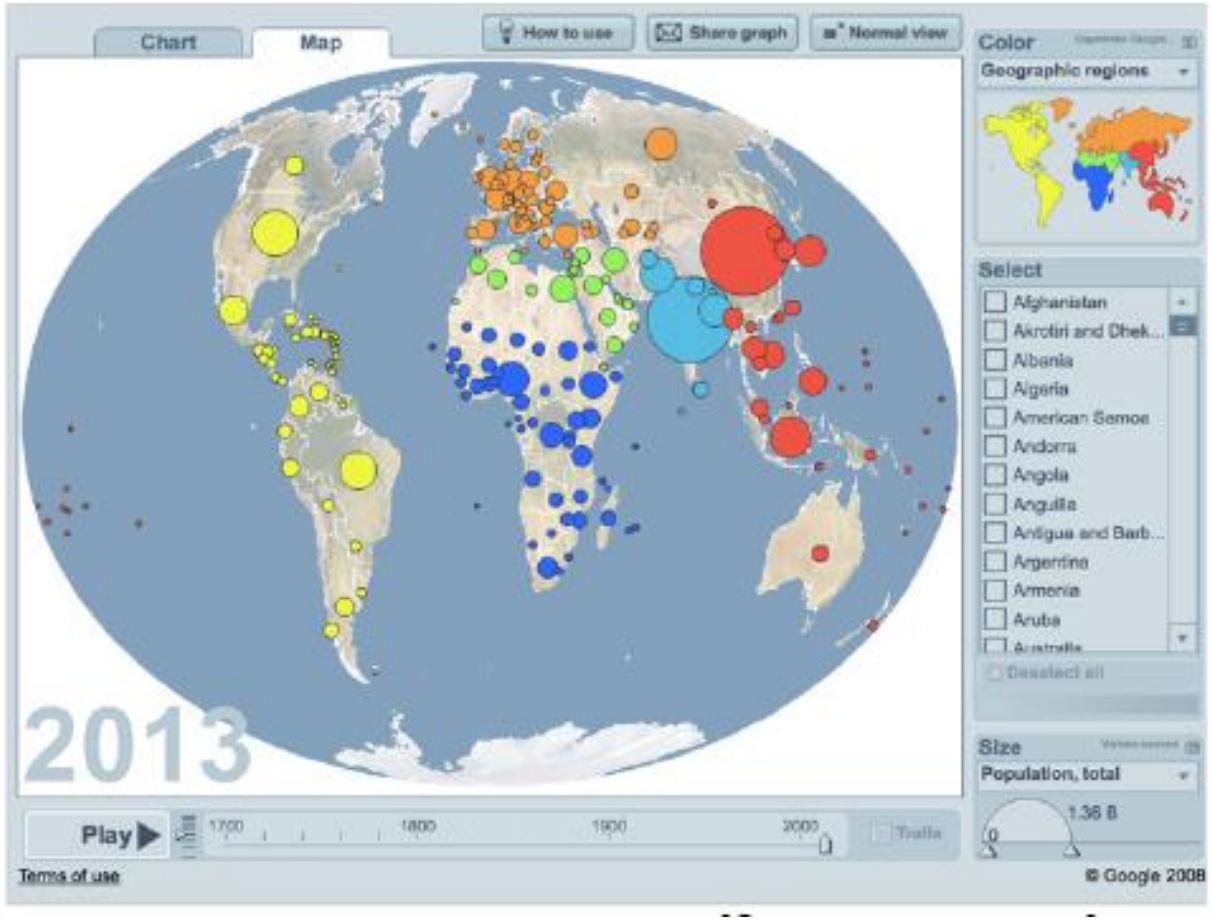
Name	Region	Population	Life Expectancy	Income
China	East Asia & Pacific	1335029250	73.28	7226.07
India	South Asia	1140340245	64.01	2731
United States	America	306509345	79.43	41256.08
Indonesia	East Asia & Pacific	228721000	71.17	3818.08
Brazil	America	193806549	72.68	9569.78
Pakistan	South Asia	176191165	66.84	2603
Bangladesh	South Asia	156645463	66.56	1492
Nigeria	Sub-Saharan Africa	141535316	48.17	2158.98
Japan	East Asia & Pacific	127383472	82.98	29680.68
Mexico	America	111209909	76.47	11250.37
Philippines	East Asia & Pacific	94285619	72.1	3203.97
Vietnam	East Asia & Pacific	86970762	74.7	2679.34
Germany	Europe & Central Asia	82338100	80.08	31191.15
Ethiopia	Sub-Saharan Africa	79996293	55.69	812.16
Turkey	Europe & Central Asia	72626967	72.06	8040.78

Potential Solution



[Gapminder, Wealth & Health of Nations]

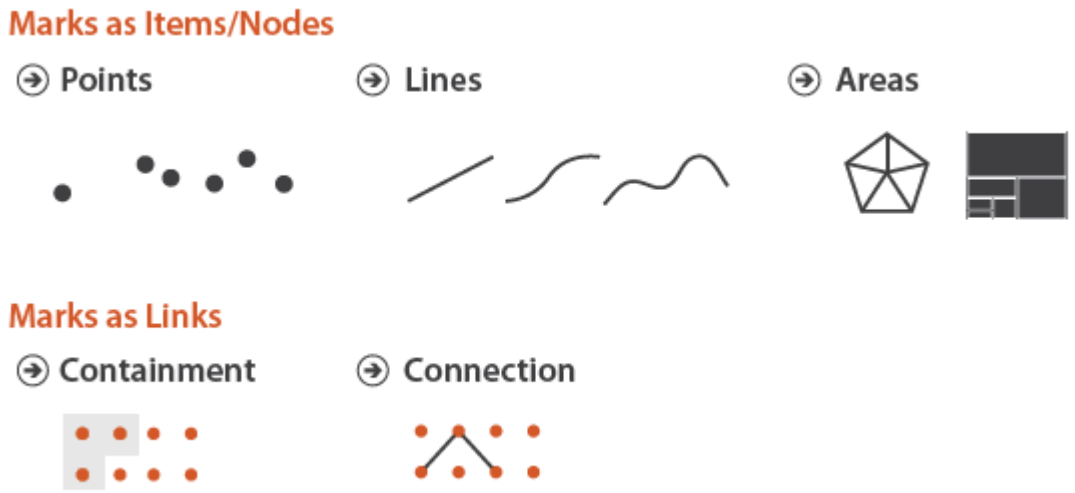
Another Solution



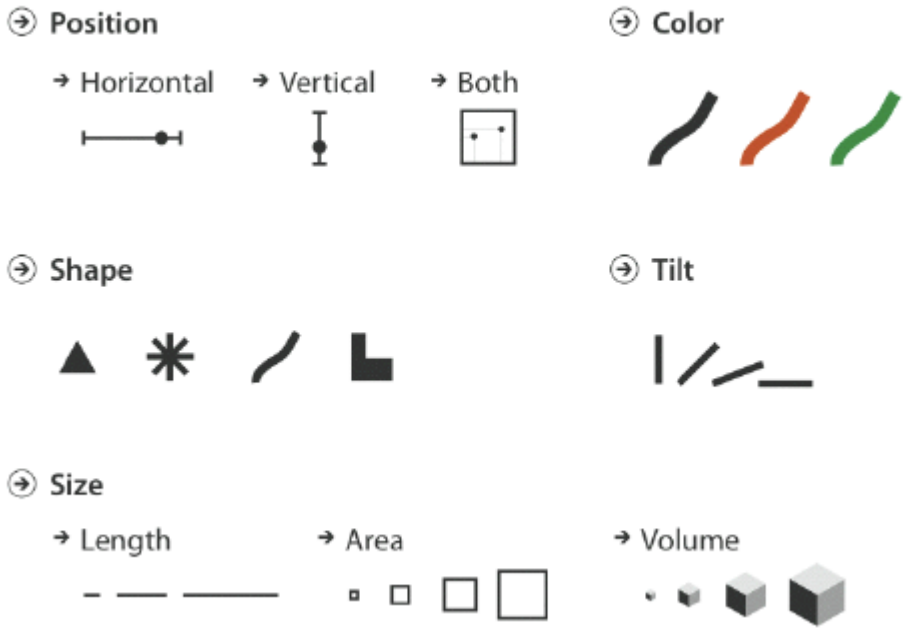
[Gapminder, Wealth & Health of Nations]

Mark Types

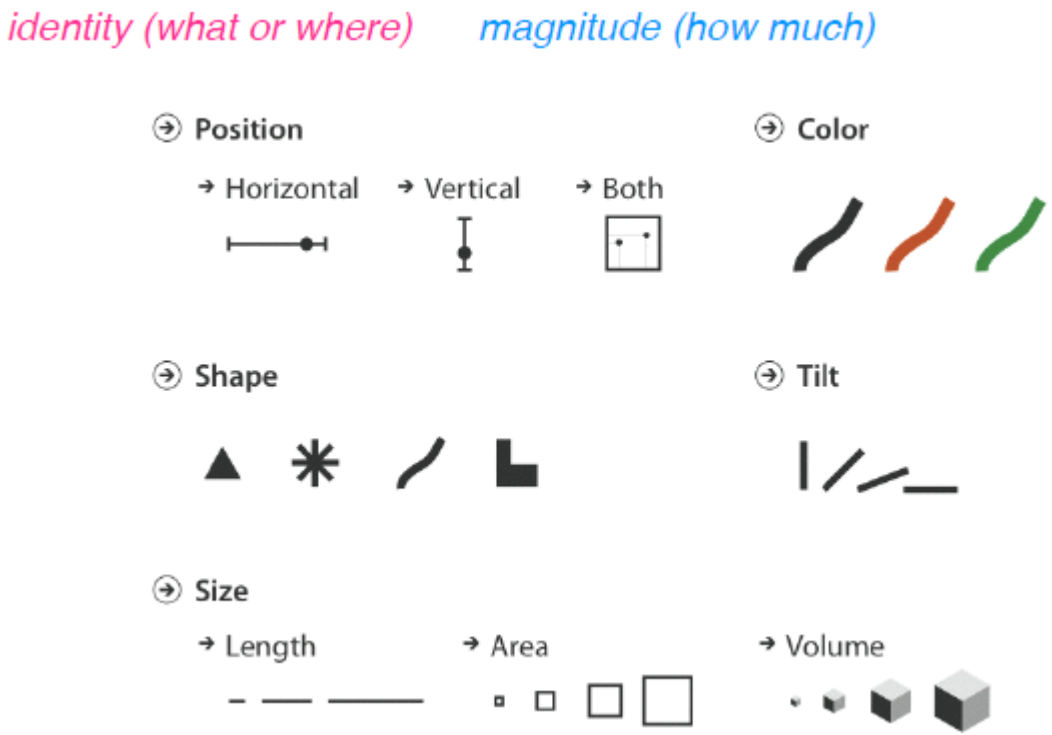
- Can have marks for items/nodes and links
- Link marks
  - Connection -> pairwise relationship
  - Containment -> hierarchical relationship using areas; connection marks can be nested within each other at multiple levels



Channel Types

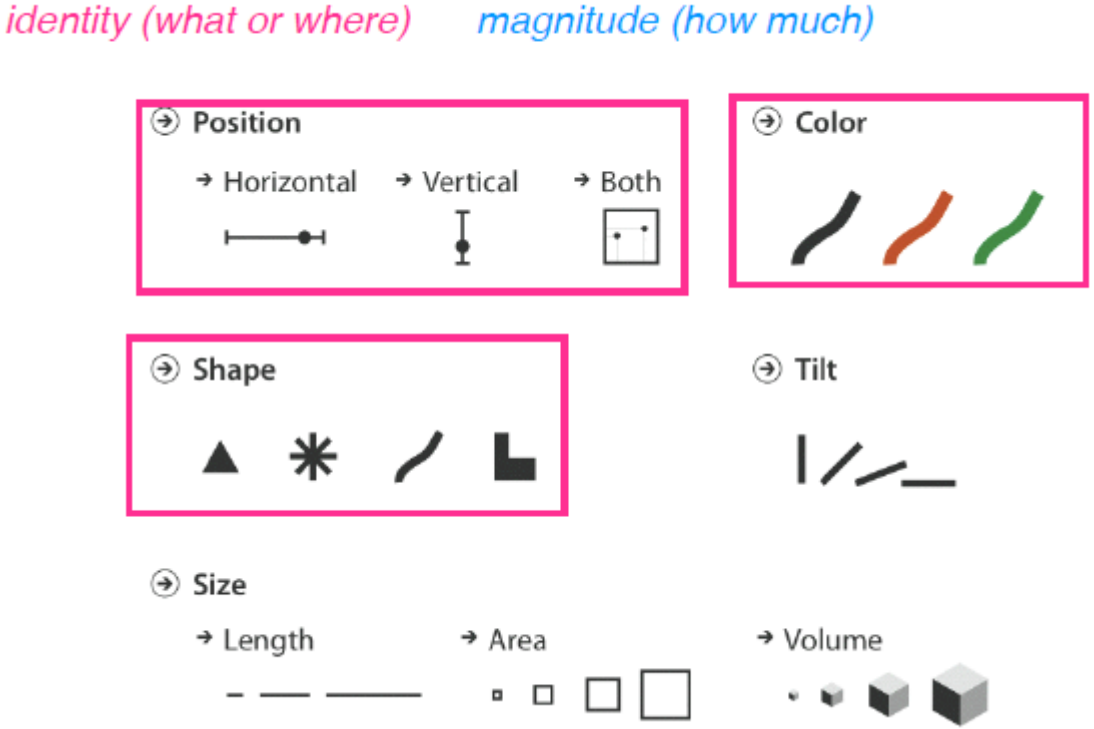


Channel Types

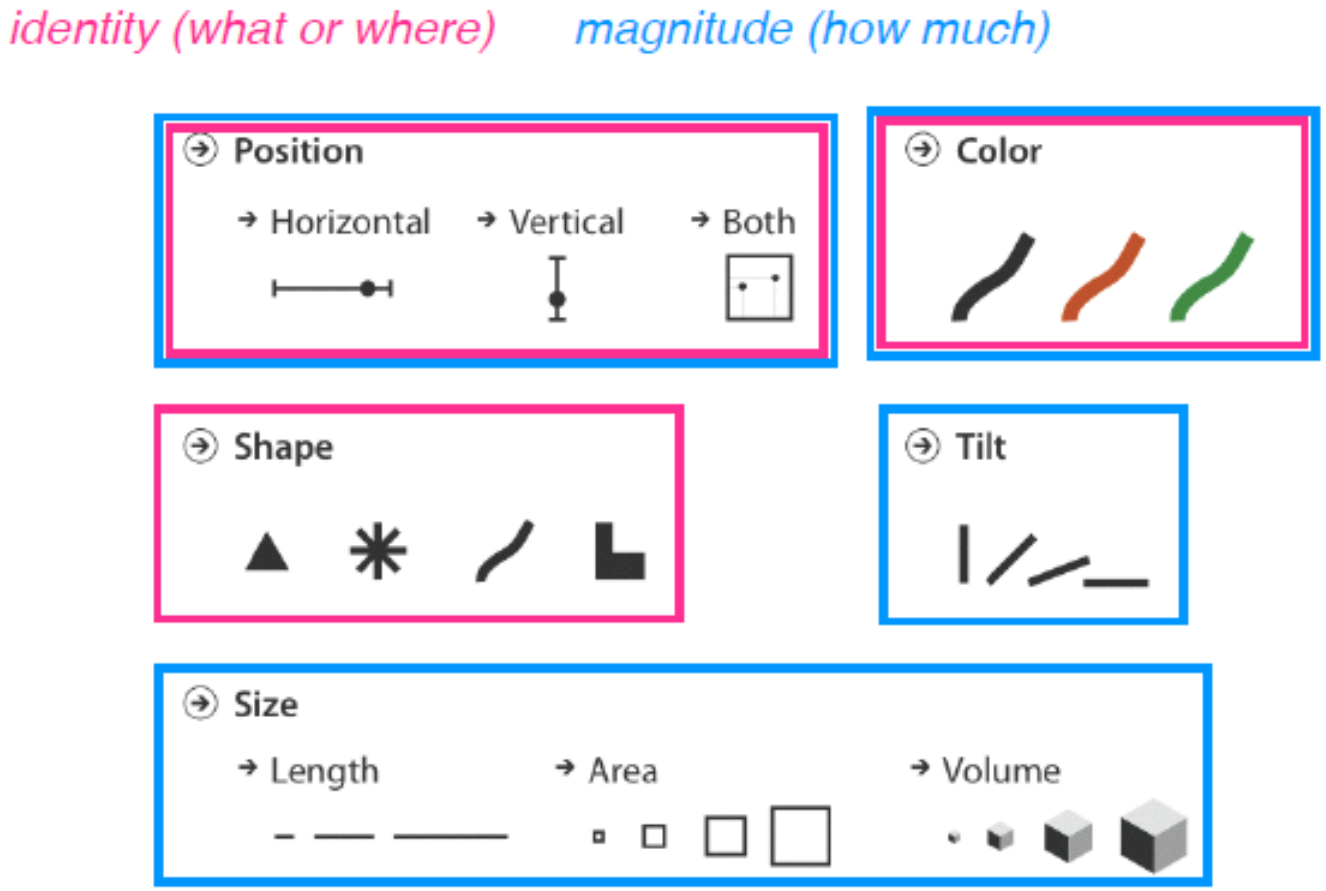


Channel Types

identity (what or where) *magnitude (how much)*



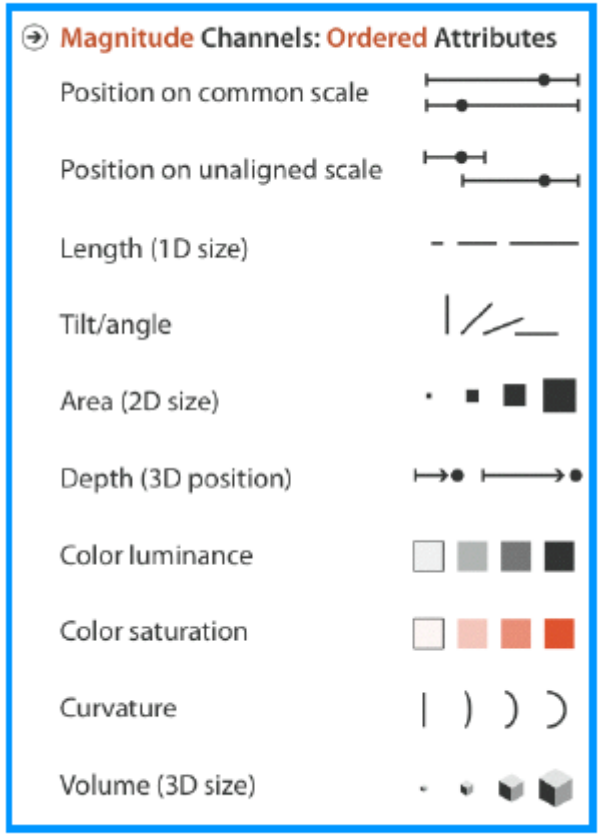
Channel Types



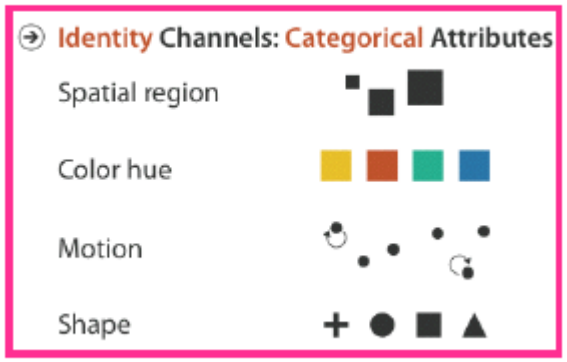
Expressiveness & Effectiveness

- Expressiveness Principle: all data from the dataset and nothing more should be shown
  - Do encode ordered data in an ordered fashion
  - Don’t encode categorical data in a way that implies an ordering
- Effectiveness Principle: the most important attributes should be the most salient
  - Saliency: how noticeable something is
  - How do the channels we have discussed measure up?
  - How was this determined?

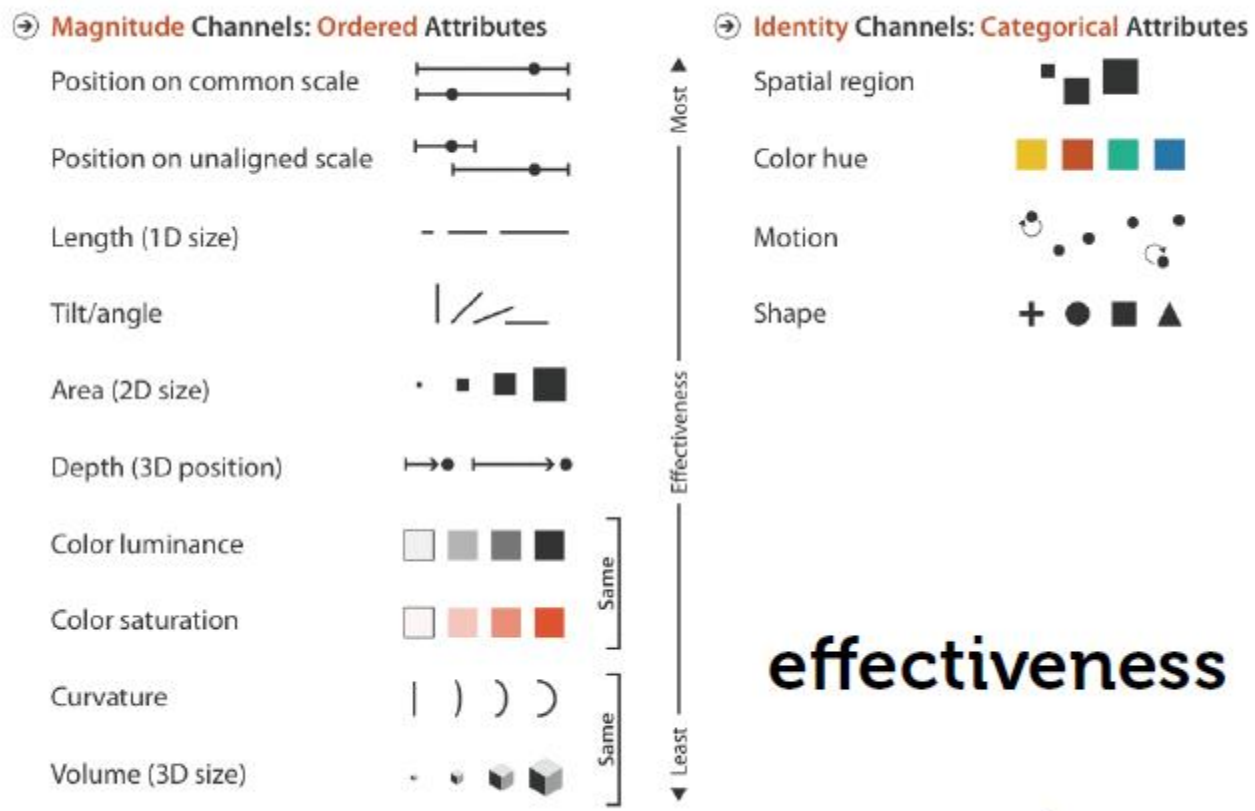
(how much)



(what or where)



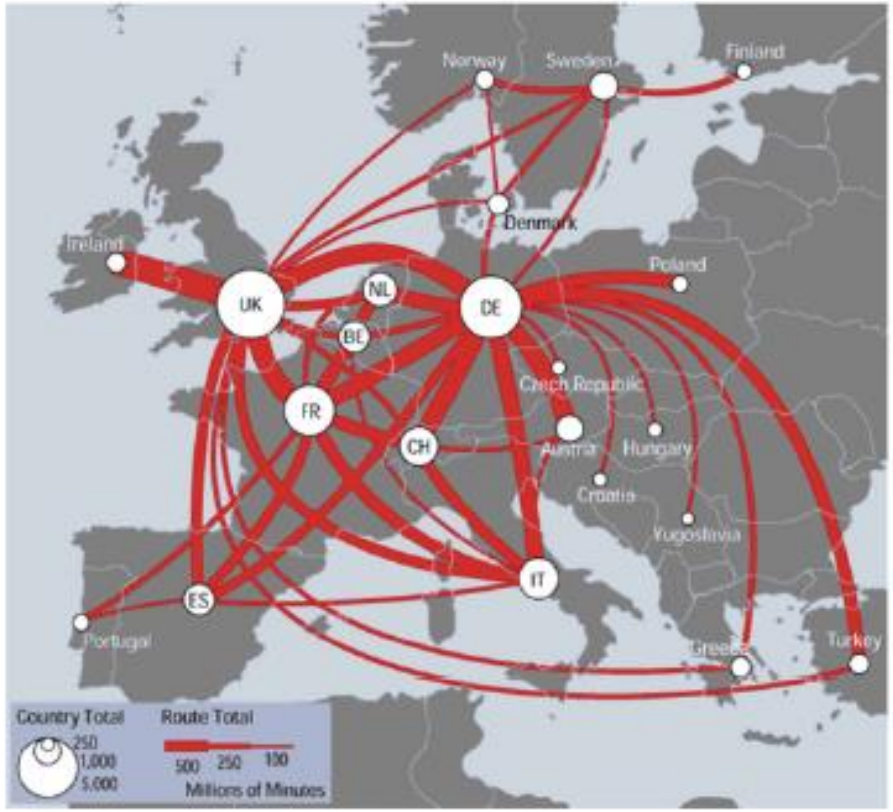
expressiveness



effectiveness

Discriminability

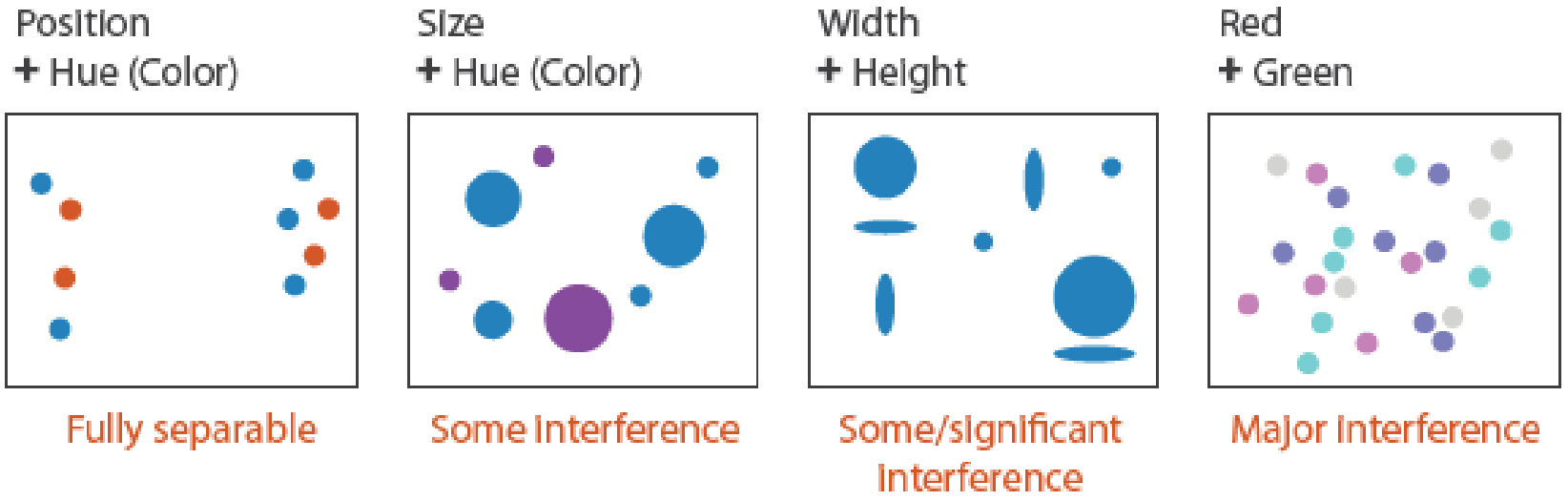
- Can you discern channel differences?



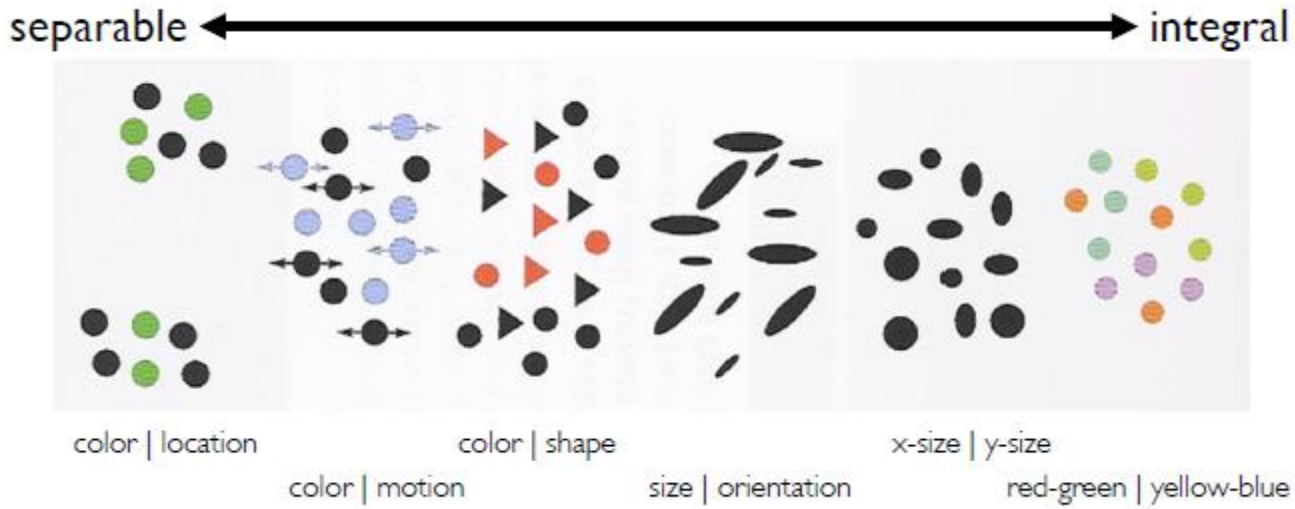
- Bins
  - # of different values that need to be shown for the attribute being encoded must not be greater than the number of bins available for the visual channel used to encode it.

Separability

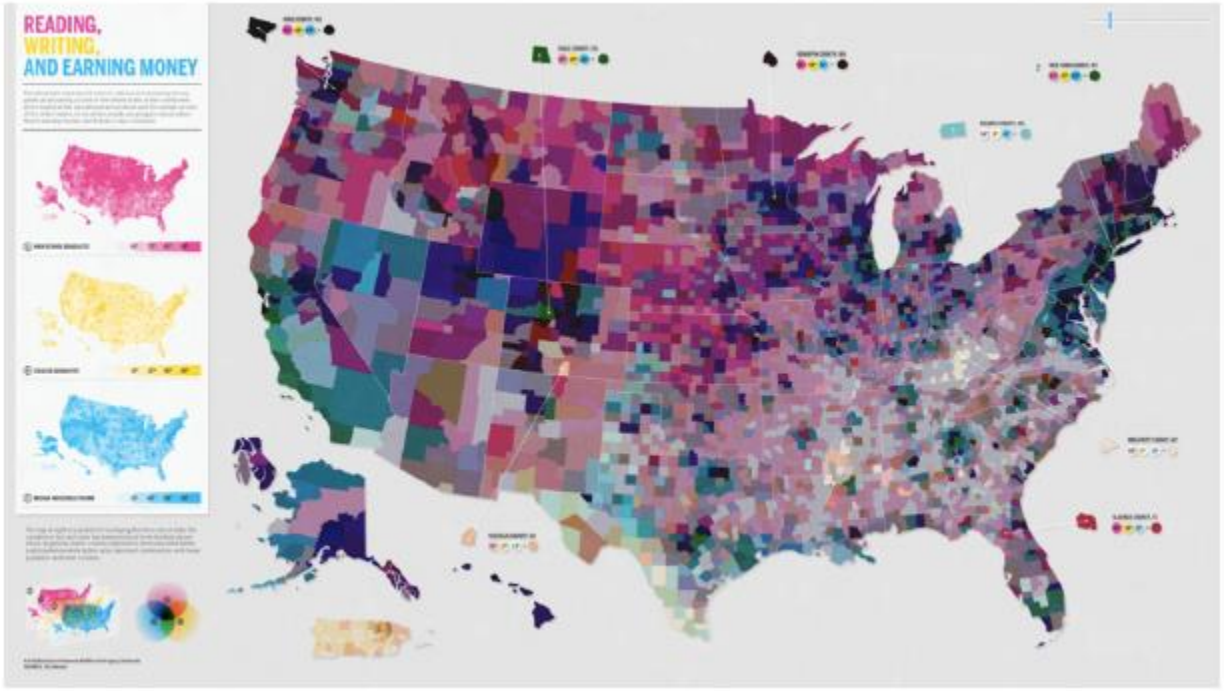
- Cannot treat all channels as independent!
- Separable: each individual channel can be distinguished
- Integral: the channels are perceived together
  - Attempts to encode different information in integral channels will fail



Separable vs Integral



Integral Channels

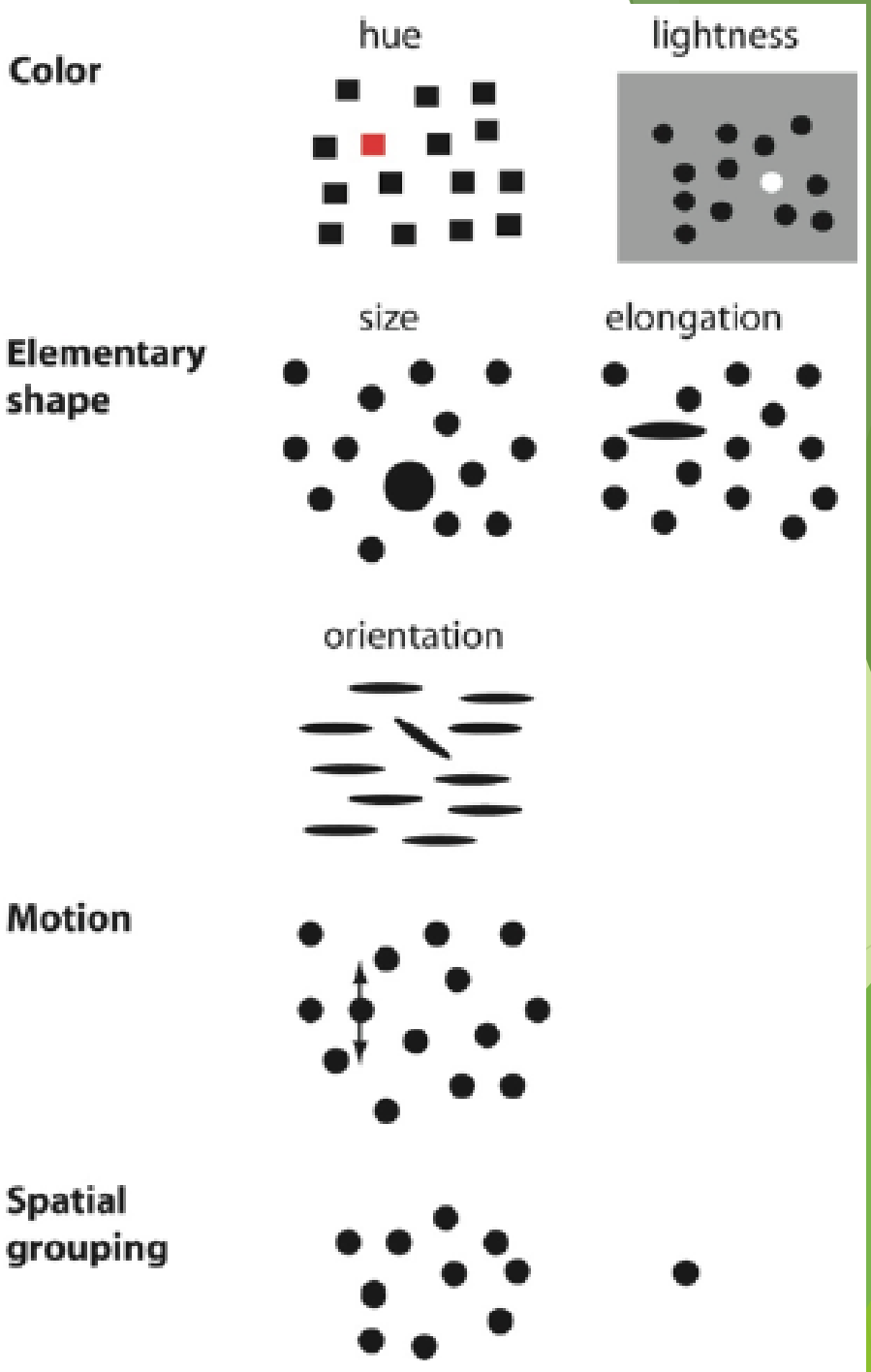


[http://magazine.good.is/infographics/america-s-richest-counties-and-best-educated-counties]

Perceptual Effects

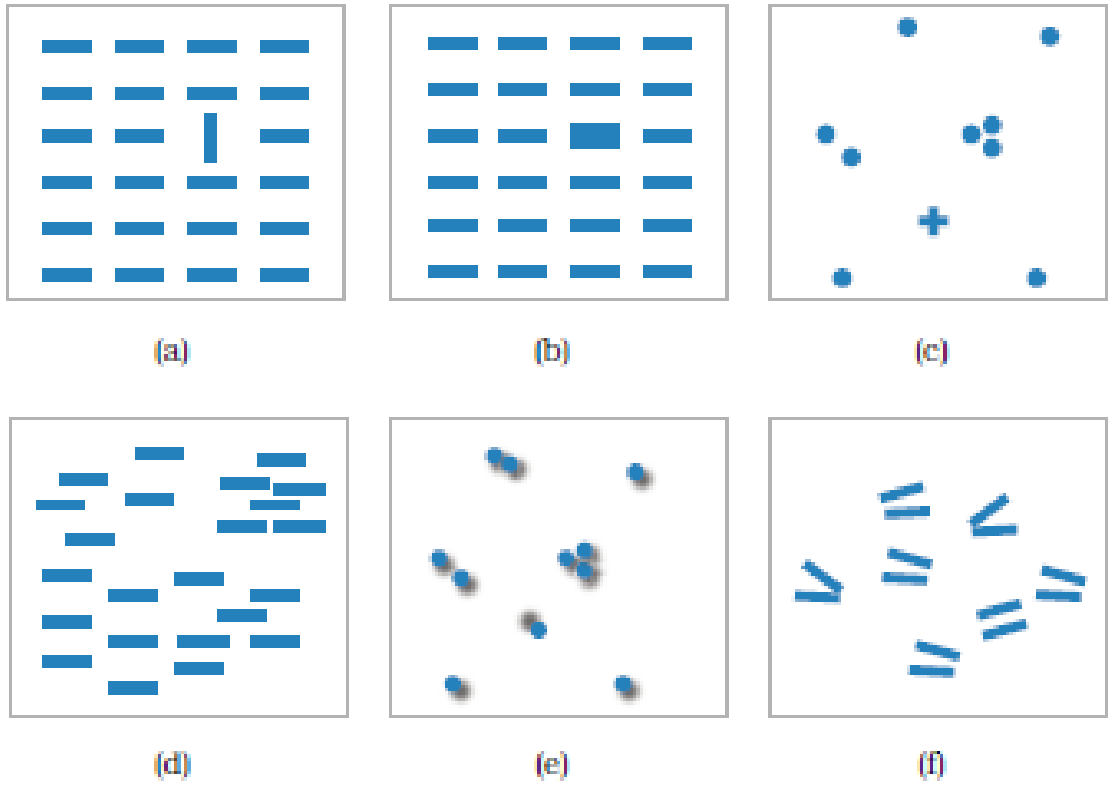
- Pop-out
- Steven's Power Law
- Weber's Law
- Gestalt principles

Basic Popout Channels

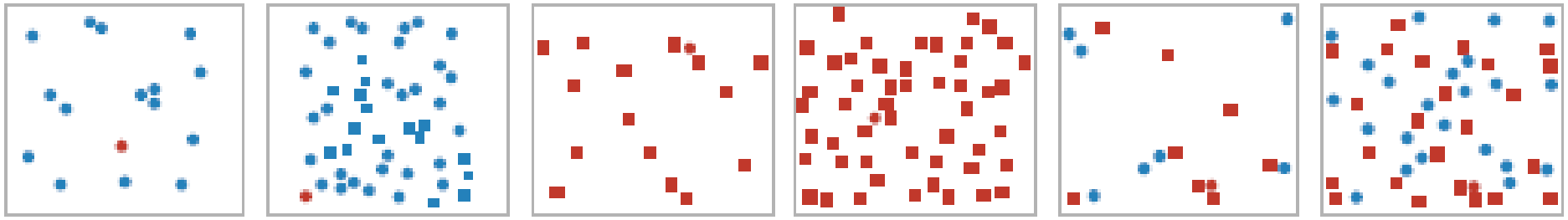


Ware 2008

Visual Popout



Visual Popout



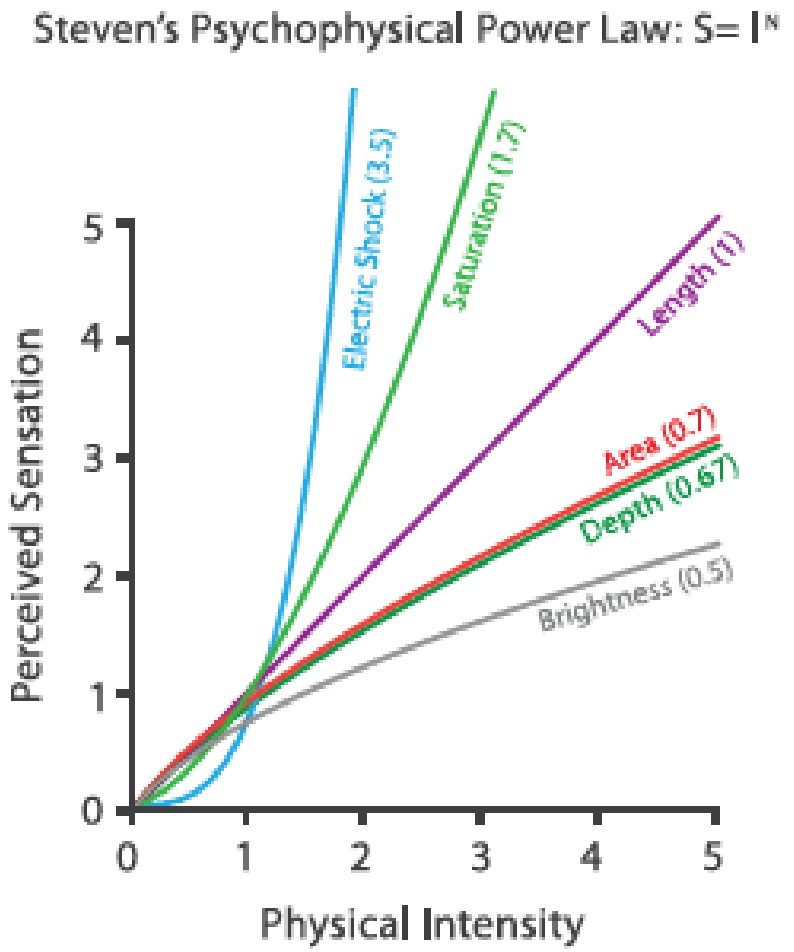
Takeaway

We can easily see object that are different in color and shape, or that are in motion.

Use color and shape sparingly to make the important information pop out.

Psychophysics

- Way to quantify effectiveness: accuracy
- How do we perceive changes in stimuli
- The Psychophysical Power Law [Stevens, 1975]: All sensory channels follow a power function based on stimulus intensity ($S = I^n$)
- Length is fairly accurate
- Magnified vs. compressed sensations

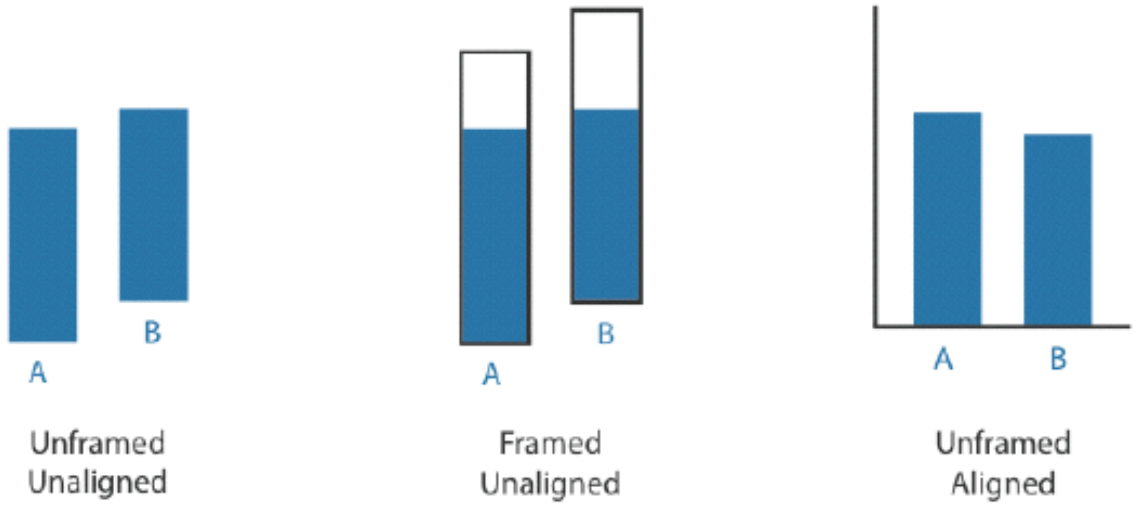


Our visual system sees differences, not absolute values, and is attracted to edges

Maximize the contrast with the background if the outlines of shapes are important.

Relative vs Absolute Judgement

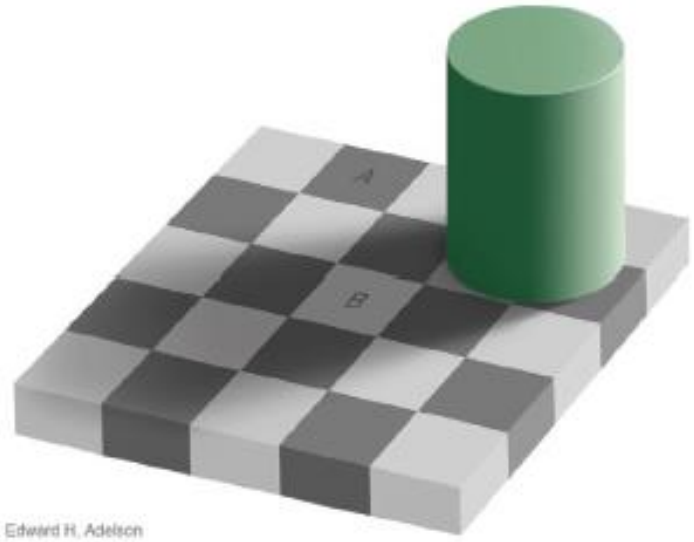
- Weber's Law
  - We judge based on relative, not absolute, differences
  - The amount of perceived difference depends is relative to the object's magnitude!



Gestalt Principles

- Similarity: things that look like each other (size, color, shape) are related
- Proximity: things that are visually close to each other are related
- Connection: things that are visually connected are related
- Continuity: We complete hidden object into simple, familiar shapes
- Closure: we see incomplete shapes as complete
- Figure/Ground: elements are perceived as either figures or background
- Common fate: elements with the same moving direction are perceived as a unit

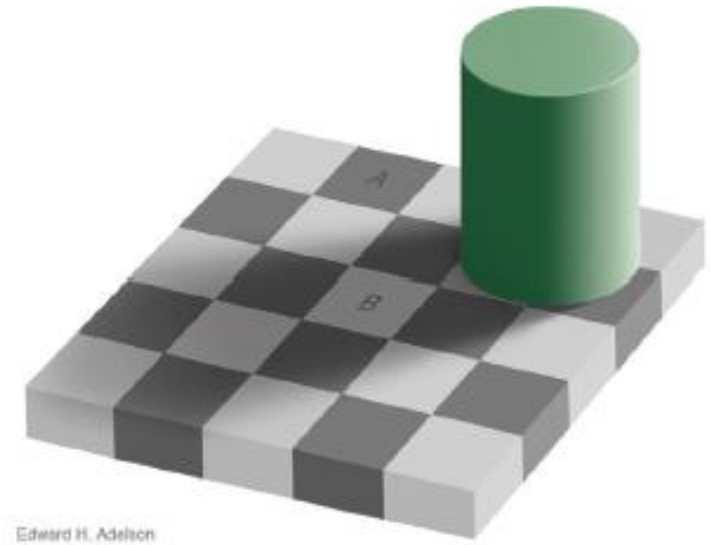
Luminance Perception



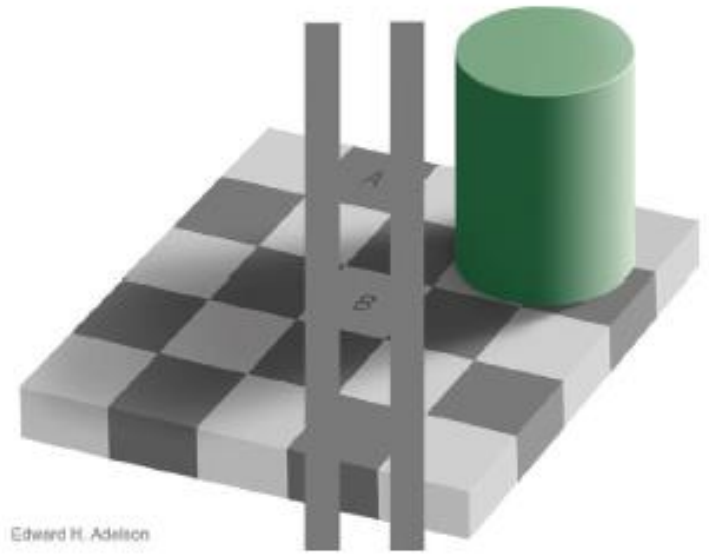
Edward H. Adelson

(a)

Luminance Perception

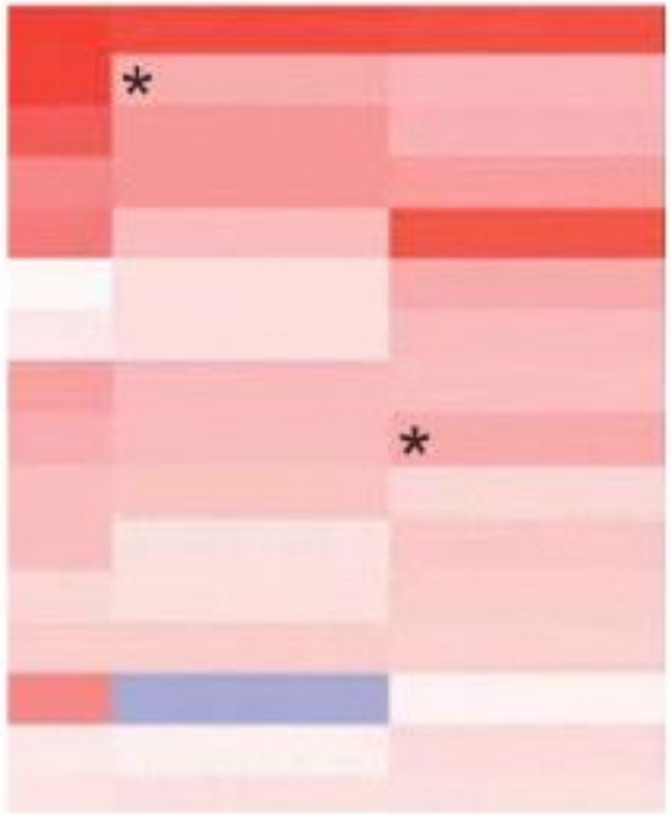


(a)



(b)

Interaction of Color



Wong 2010

Hue, Saturation, Luminance

Green Hue at 0 Value | Green Hue at -100 Value

An example of the hue slider's ability to replace and alter colour tones.

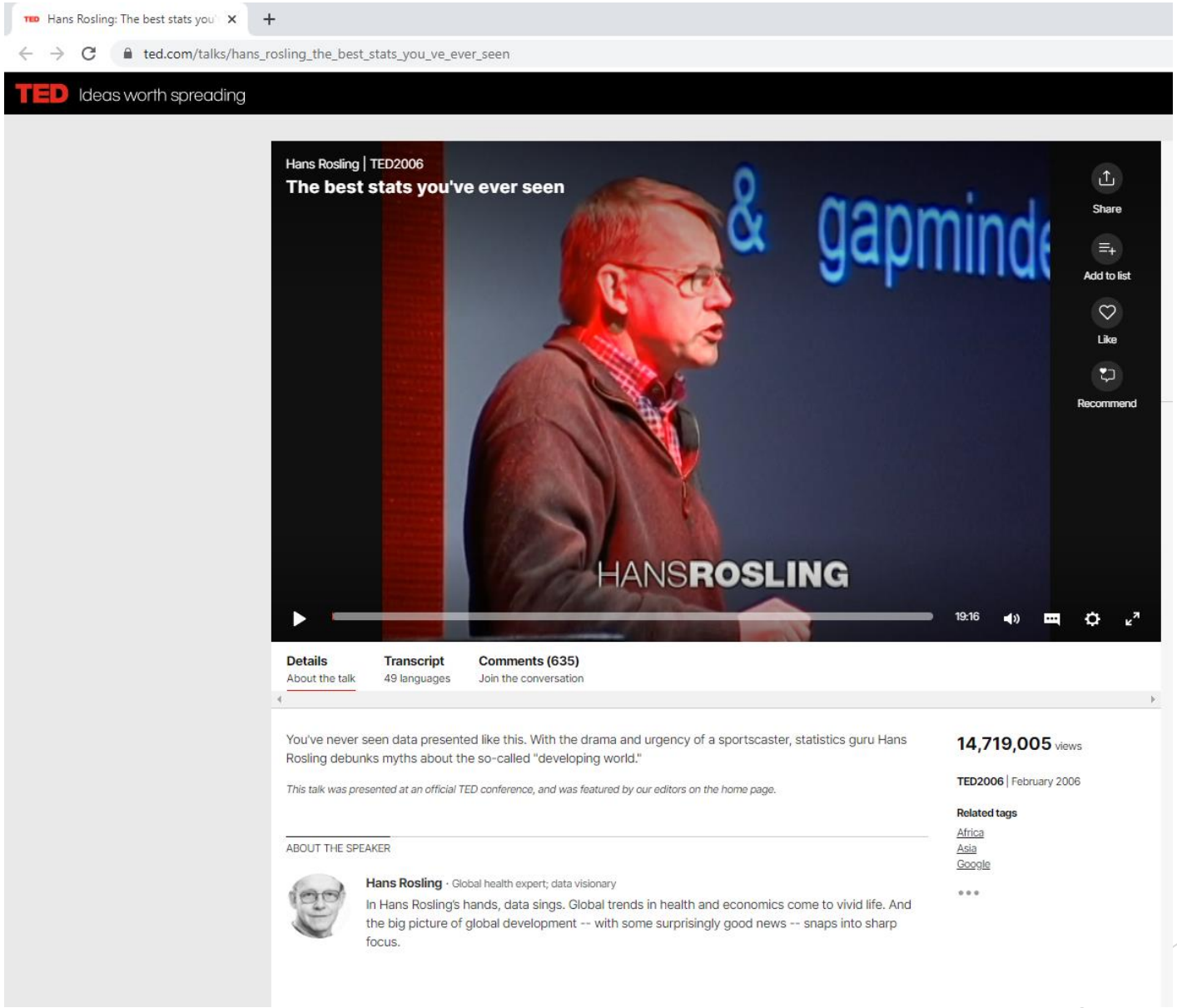
Red Saturation at 0 Value | Red Saturation at -82 Value

Decreasing the saturation of individual colours is good for removing 'offensive' colours.

Green Luminance at 0 Value | Green Luminance at +64 Value

Adjusting the luminance slider changes the brightness of a colour.

https://www.naturettl.com/lightroom-colour-correction-hue-saturation-luminance/



https://www.ted.com/talks/hans_rosling_the_best_stats_you_ve_ever_seen

Sources/Credits

- Tamara Munzner, Visualization Analysis & Design, A K Peters Visualization Series, CRC Press, 2014.
- Utah, Miriah Meyer, Visualization (2014).
- UMass Dartmouth, David Koop, Data Visualization (2015).